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Artificial Intelligence in Design Education: A Systematic Review and CIDA-Aligned Framework for Interior Architecture and Design

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Abstract

Background: Generative Artificial Intelligence (AI) is rapidly becoming integral to design practice, yet its integration into interior architecture and design education faces challenges, creating a potential gap between academic preparation and industry needs. There is an urgent need for evidence-based strategies to integrate AI effectively while upholding core pedagogical values.

Objective: This study systematically reviews recent literature on AI integration in interior architecture and design education to identify current patterns, pedagogical models, challenges, and opportunities, with specific implications for CIDA-accredited interior architecture and design programs.

Methods: Following PRISMA 2020 guidelines, the author searched five databases (2021–2025) and screened records based on pre-defined eligibility criteria. Data from 80 included peer-reviewed studies were extracted and synthesized using thematic analysis, guided by postdigital pedagogy and human-centricity lenses.

Results: Eight key themes emerged: (1) AI use is heavily concentrated in early design phases; (2) integration paradoxically reinforces the need for human-centric skills and judgment; (3) literacy demands are evolving from prompt fluency toward broader AI literacy; (4) pedagogical models are diversifying but often lack formal structure; (5) AI's role is expanding beyond generation to analysis and critique; (6) AI increasingly operates within larger technological ecosystems; (7) a quantifiable education-practice gap persists, particularly in later design phases; (8) Affective factors (motivation, anxiety) significantly influence adoption.

Conclusion: AI in interior architecture and design education is advancing fastest in early ideation but remains comparatively underdeveloped in later, standards-intensive phases, indicating that the central curricular challenge is not whether to adopt AI, but how to position, bound, and assess it so that it strengthens auditable human judgment. In response, this paper proposes a CIDA-aligned curricular framework and phased implementation roadmap that link early creative leverage to later-stage rigor through phase-aware AI roles, transparency artifacts, ecosystem thinking, and human-centered evaluation.

Keywords: Artificial Intelligence, Design Education, Interior Design, Curriculum, Systematic Review

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1. INTRODUCTION

1.1. Why AI now: What is changing in Design Education?

Generative artificial intelligence (AI) has rapidly shifted from a speculative toolset to an ordinary layer of design work (Çelik 2025; Karadağ and Ozar 2025; Montenegro 2024). In practice, AI systems augment precedent search, expand early ideation, accelerate visualization, and scaffold communication tasks (Jin et al. 2024; Liu et al. 2024; J. Wang et al. 2025). This diffusion alters the design process for interior design and related fields, enabling more parallel exploration, shorter iteration cycles, and new methods for assembling evidence (Gu and Amini Behbahani 2021; Şekerci et al. 2023). These gains also create new instructional responsibilities: clarifying authorship, making judgment criteria explicit, and re-centering human outcomes against polished but weakly reasoned results (Kołata and Zierke 2021; Leibowitz et al. 2025; Shen 2025; J. Wang et al. 2025). AI is no longer a marginal addition; it is a primary curricular problem and opportunity (He and Chen 2024; Ishizawa 2025; Komatina et al. 2024).

1.2. The Problem

A Widening Education–Practice Gap While the profession experiments with workflows enabled by AI, universities, particularly programs centered on studio work, face significant alignment challenges (Alnaser et al. 2024; Ghanbaripour et al. 2024; Komatina et al. 2024). Curricula revise slower than tools update, while policies and rubrics lag behind classroom use (Ghanbaripour et al. 2024; J. Wang et al. 2025; Y. Wang et al. 2025). Recent studies report uneven adoption, ad hoc experiments at the course level, and limited alignment between learning goals, activities, and assessment methods (Jin et al. 2024; Komatina et al. 2024; Montenegro 2024; Şekerci et al. 2023). These factors signal a structural gap between industry expectations and program delivery. This gap hinders graduate effectiveness and risks stifling innovation by producing designers ill equipped to use emergent technologies (Alnaser et al. 2024; Ghanbaripour et al. 2024). Educators also voice a deeper concern: without careful scaffolding, AI can mask weak problem framing, flatten material sensibility, and erode critical discrimination, the human strengths interior design must amplify (Leibowitz et al. 2025; Soulikias et al. 2021). The field urgently needs evidence on AI integration, its value, recurrent barriers, and curricular strategies that sustain human-centered rigor (Karadağ and Ozar 2025; Petrova and Kuhnen 2025; J. Wang et al. 2025).

1.3. Positioning and Contribution

This article responds with a systematic review, using PRISMA 2020 guidelines (Page et al. 2021), of AI integration in interior architecture and design education. This paper synthesizes dispersed experiments into eight thematic findings. These themes include: (1) the phase dependency of AI; (2) the reassertion of human-centered skills; (3) the evolution from prompt literacy to AI Literacy as an individual competency; (4) the diversification of pedagogical models; (5) AI's expanding role beyond generation to analysis and critique; (6) AI Ecosystems as a technical infrastructure (e.g., BIM, parametric tools, VR/AR); (7) the macro level gap between curricula and industry; and (8) the affective landscape of adoption. Building on these themes, this paper advances a curriculum framework aligned with CIDA that specifies how AI can deepen student learning across CIDA Professional Standards 2024 (Global Context, Human-Centered Design, Communication, Design Process & Creativity, Technical Knowledge & Codes). The contributions are fourfold. First, this paper provides a consolidated evidence map of AI integration strategies. Second, it translates this evidence into actionable curricular moves aligned with CIDA standards. Third, it proposes a program-level framework to cultivate 'Intelligent Design Strategists' who combine computational leverage with critical, ethical, and human-centered judgment. Fourth, it provides a phased implementation roadmap to guide departments through institutional transitions without overwhelming staff.

1.4. Research Questions

Guided by these goals, the review addresses three questions:

• RQ1. How have recent studies integrated AI (especially generative AI) into interior architecture and design education, and what patterns and trends are observable across courses and studios?

• RQ2. What educational opportunities and challenges emerge in these integrations—pedagogically, ethically, and operationally—and how are they addressed?

• RQ3. What implications do these patterns hold for aligning the interior design curriculum with CIDA Professional Standards 2024, and how might programs structure AI integration to strengthen those standards?

2. THEORETICAL FRAMEWORK: LENSES FOR ANALYZING AI IN DESIGN EDUCATION

This systematic review is guided by a theoretical framework integrating postdigital pedagogy with a steadfast commitment to human-centricity (Leibowitz et al. 2025; Patil and Salama 2024; Zahra et al. 2025). This framework serves as the core evaluative lens for AI integration in interior design education and directly informs the approach to answering the research questions (RQs).

First, adopting a postdigital stance, this paper treats AI not merely as a new tool to be mastered but as a fundamental condition reshaping the educational landscape (Ishizawa 2025; Komatina et al. 2024; Montenegro 2024). This perspective moves beyond simple tool proficiency to address more critical pedagogical concerns relevant to RQ1 and RQ2. It asks how the pervasive presence of AI alters the ways design knowledge is generated, shared, validated, and assessed. To analyze these shifts precisely, this review distinguishes between AI Literacy and AI Ecosystems. In this review, AI Literacy refers to the competencies that learners develop to understand, steer, document, and verify AI-mediated work. By contrast, AI Ecosystems refers to the interoperable socio-technical environments in which multiple tools, platforms, and governance structures are orchestrated across design phases (K. Wang et al. 2025). The former concerns what students must know and do; the latter concerns the environments and handoffs within which that knowledge becomes professionally usable (Gu and Amini Behbahani 2021). This conceptual distinction requires analyzing AI integration patterns not only for technical novelty, but also for their implications for deeper learning, judgment, and curricular design. It also foregrounds the need to evolve educational focus from basic "prompt literacy" towards a more comprehensive model and data literacy (Jin et al. 2024; Petrova and Kuhnen 2025; J. Wang et al. 2025), encompassing understanding of model limitations, data provenance, and verification strategies, which is a key challenge highlighted in RQ2.

Second, aligned with the core mission of interior design, this paper employs human-centricity as the primary evaluative horizon for assessing the opportunities and challenges identified in RQ2 and for addressing CIDA alignment in RQ3. The goal of interior design education is not tool mastery, but rather the cultivation of professionals capable of enhancing human health, well-being, inclusion, and cultural meaning through the built environment. Therefore, AI's curricular value is judged by the extent to which it helps students operationalize these human-centered outcomes (Abouelela et al. 2025; He and Chen 2024; Öztürk and Durukan 2025; Salingaros 2025). This lens necessitates examining how AI tools are used, whether as analytical partners in evidence-based design, aids in exploring inclusive design solutions, or tools requiring critical checks against bias and oversimplification. Furthermore, this focus on human outcomes provides the essential link for mapping AI integration strategies onto the CIDA Professional Standards 2024 (RQ3), ensuring that technology serves disciplinary goals rather than dictating them.

Consequently, this review analyzes the collected studies through specific analytical questions derived from our theoretical framework, focusing on how AI integrations address:

• Human Outcomes: Do activities enhance reasoning about well-being, inclusion, or cultural context?

• Reasoning Transparency & Responsibility: Are AI-mediated processes made explicit, auditable, and ethically considered (addressing authorship, bias, sources)?

• Literacy vs. Ecosystem: Does the integration address individual skill development (Literacy) or the broader technical environment and workflow (Ecosystem)?

• Institutional Maturity: Does the study provide insights into the implementation roadmap, including how departments manage the transition from traditional to AI-hybrid studio models?

• CIDA Standards Alignment: Which professional competencies are demonstrably strengthened by the AI integration?

By applying these lenses, grounded in postdigital pedagogy and human-centricity, this paper aims to move beyond descriptive accounts of AI use (RQ1) to a critical evaluation of emergent pedagogical strategies (RQ2) and their potential for systematic, standard-aligned curricular integration (RQ3). This approach ensures that the findings and the resulting framework prioritize the development of adaptable, critical, and human-centered Intelligent Design Strategists (Komatina et al. 2024; Patil and Salama 2024; Zhang et al. 2025).

3. METHODS

This study employed a systematic review methodology, adhering to the PRISMA 2020 reporting guideline (Page et al. 2021). The protocol guided the review, specifying the research questions, information sources, eligibility criteria, screening workflow, data extraction variables, and the plan for synthesis. Supporting documents, including the detailed protocol, specific search strings adapted for each database, the PRISMA checklist, and the data extraction template with its codebook, are available in the Appendices.

3.1. Eligibility Criteria

To align with the research questions and theoretical framework, studies were required to meet the inclusion and exclusion criteria outlined in Table 1.

Criteria	Inclusion Criteria	Exclusion Criteria
Population/Setting	Formal architecture, interior design, or closely related design programs within higher education (undergraduate or graduate levels)	Studies focused solely on K-12 education or HCI without a direct curricular link
Intervention/Focus	Any structured pedagogical engagement with AI, particularly generative AI, within design courses, studios, workshops, etc.	Purely technical AI papers lacking educational implementation; opinion pieces without empirical data
Outcomes	Focus on pedagogical processes or learning outcomes (e.g., ideation, modeling, assessment, workflow integration)	
Study Types	Empirical studies (qualitative, quantitative, mixed methods), design-based research, pilot or controlled trials, case studies, or systematic reviews	Grey literature or theses
Publication Status & Language	Peer-reviewed journal articles, reviews, or full conference papers published in English	Non-peer-reviewed sources

Table 1. Eligibility Criteria

3.2. Information Sources and Search Strategy

The author conducted searches across five major publishers' full-text platforms: ScienceDirect (Elsevier), SAGE Journals, Wiley Online Library, MDPI, and Taylor & Francis Online. The searches covered the period from January 1, 2021, to October 13, 2025 (final search run date). Additionally, reference lists of included studies and relevant review articles were hand searched to capture potentially missed records.

A master Boolean search string, adapted for each platform's syntax, combined domain, education, and AI terms: ("Interior Design" OR "Interior Architecture" OR "Architectural Education") AND ("Generative AI" OR "Artificial Intelligence" OR "AI") AND ("Education" OR "Curriculum"). Searches were limited to peer reviewed research articles, reviews, or full conference papers published in English within the specified date range. Platform-specific filters were used only to enforce these general constraints, without further topical narrowing.

3.3. Data Extraction and Quality

Appraisal The author performed extraction and verified all fields, using investigator memos to capture reflections that informed the Discussion. Quality appraisal focused on: (i) design clarity; (ii) reporting transparency (AI use, parameters, provenance); (iii) outcome credibility (evidence quality, triangulation); (iv) threats to validity (selection or novelty effects); and (v) relevance to CIDA competencies. Studies were not excluded based on quality alone; the appraisal instead informed evidence weighing in the synthesis; studies with transparency limitations were treated as illustrative rather than decisive evidence in thematic synthesis.

3.4. Data Synthesis and Analysis

An inductive thematic synthesis was guided by the five analytic lenses from the theoretical framework (Section 2): human outcomes, reasoning transparency, model/data literacy, workflow integration, and CIDA standards alignment. Analysis progressed through (i) open coding, (ii) axial grouping, and (iii) consolidation into the eight themes reported in Section 4. Descriptive summaries (e.g., frequencies of AI roles) complemented the qualitative themes where appropriate. Robustness checks included: (a) a self-audit rescreening of excluded abstracts; (b) second-pass re-coding of ~20% of included studies; and (c) subgroup reads (e.g., by education level and AI role) to probe theme stability. Results remained stable.

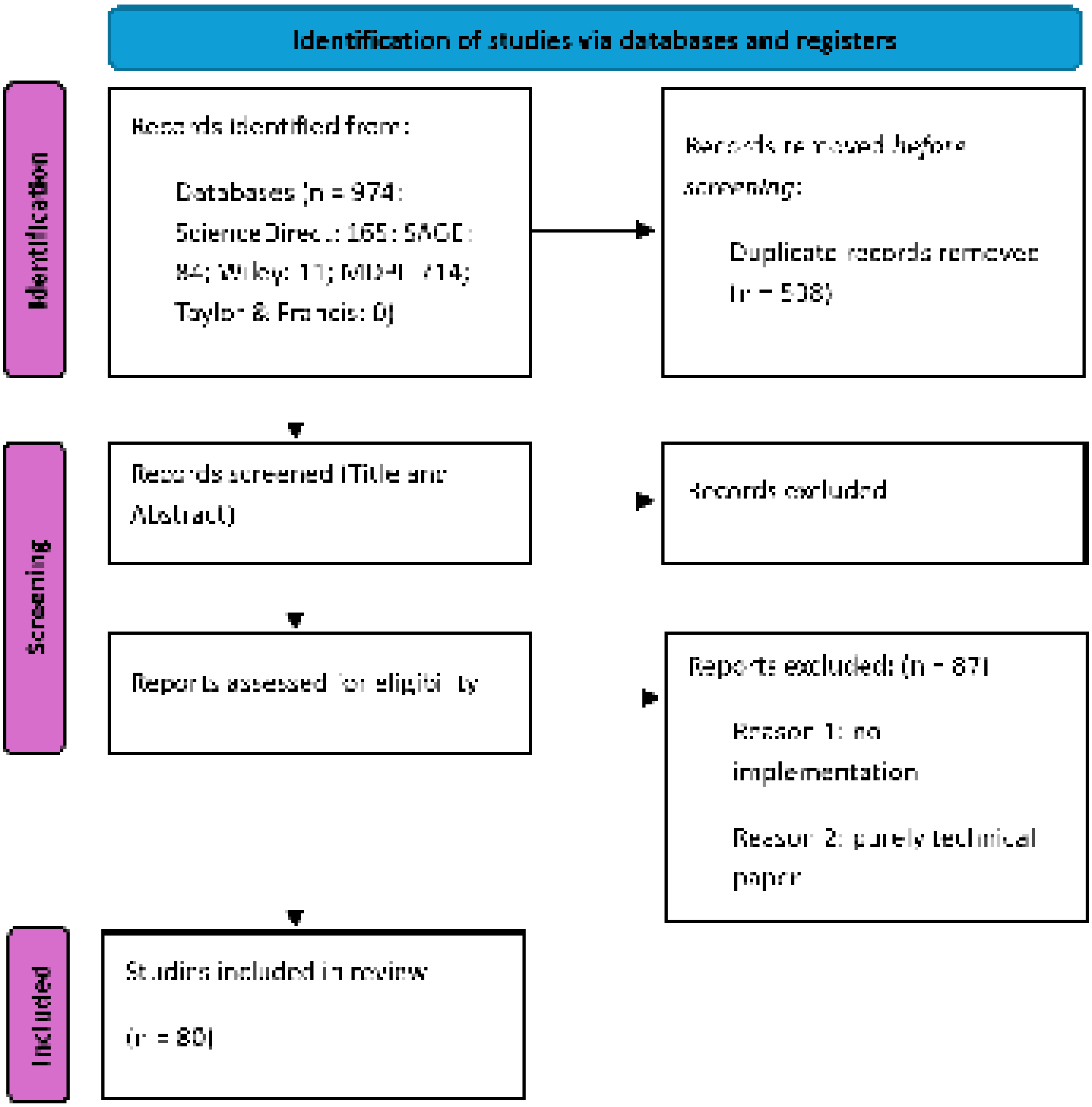

Figure 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

Section	Extracted Items
Bibliographic metadata	No.; Author(s) & Year; Title; Journal, DOI
Research design & methodology	Research Type; Methodology; Participants/Data; Geographic Context
Technological focus	Primary Technology; Specific Tool(s); AI's Role in Study
Pedagogical context & application	Educational Level; Course/Subject; Pedagogical Model; Application Phase
Key findings & outcomes	Key Findings—Positive; Key Findings—Challenges; Impact on Human-centric Values
Theoretical contribution & future research	Main Argument/Theoretical Contribution; Future Research; Investigator Memos (by the author)

Table 2. Data Extraction Categories

4. RESULTS: THEMATIC ANALYSIS OF AI INTEGRATION IN DESIGN EDUCATION

The final corpus comprises 80 peer-reviewed studies published between 2021 and 2025. The overall characteristics of this corpus, including the technologies used, the roles AI played, and the design phases studied, are summarized in Table 3. The combination of an ideation-heavy focus, limited coverage of later phases, and sparse model specification frames the challenge addressed in the Discussion: moving from tool-led pilots to standards-aligned, auditable learning architectures that translate early creative gains into human-centered, evidence-rich outcomes.

4.1. Theme 1: The Phase-Dependency of AI Adoption

AI usage is unmistakably front-loaded in the design workflow, clustering around pre-design and schematic exploration while thinning out as projects move toward development, documentation, and specification. Synthesizing these findings, the corpus depicts a step-function pattern. AI excels where the design space needs to widen, for instance, during rapid ideation, visual hypothesis generation, and surrogate environmental or performance checks. It recedes where the process must narrow into accountable, precise, and code-constrained decisions. This stage-specific utility aligns with broader observations, noting AI's expanded functional roles are visible at multiple junctures, but robust later-phase

Category	Item	Count (Percent)
Primary Technology	Generative AI	46 (57%)
	Other AI Techniques	4 (5%)
	AI with/without ML Analytics / BIM / XR / Others	30 (38%)
Specified AI Role	Generation	52 (65%)
	Analysis	15 (19%)
	Unstated	5 (6%)
	Critique / Feedback	8 (10%)
Design Process Phase	Concept & Schematic	39 (49%)
	Unstated	24 (30%)
	Full Cycle	6 (7%)
	Programming / Research	6 (7%)
	Design Development (DD)	5 (7%)
	Documentation (CD)	0 (0%)
Pedagogical Model	Not Named	58 (73%)
	Project-Based / Integrated	22 (27%)

Table 3. Overview of the Reviewed Corpus (n=80)

adoption is limited by gaps in standardized datasets, metrics, and model transparency. Pedagogically, these findings suggest instructors should intentionally map AI tools to phase-appropriate intents. They might leverage generative and surrogate models to broaden early exploration, while requiring verification logs, version trails, and source attributions to sustain rigor as projects develop. Coupling fast AI screening with higher-fidelity analyses, such as CFD or BIM-based checks, appears crucial as projects converge. In parallel, cultivating model and data literacy is indispensable for extending AI's usefulness beyond early phases without eroding human judgment or accountability. Supporting evidence for this theme is detailed in Table 4.

4.2. Theme 2: The Paradox of Technology: Reassertion of Human-Centric Skills

A pattern emerges: as programs pilot generative systems, instructors and students repeatedly recenter human judgment, embodied ways of knowing, and evidence-based discrimination. Rather than displacing core design capacities, AI's presence appears to sharpen attention to them. Multiple studies frame AI not as an autonomous author but as a tool whose value depends on the strength of human criteria supplied to it and the quality of human assessment applied afterward. Specific examples demonstrating this paradox, where AI is used to validate theories or where its use is intentionally constrained, are detailed in Table 5.

These findings complicate narratives equating AI integration with the automation of design intelligence. In practice, instructors and students are redistributing labor in ways that foreground interpretive and ethical capacities. This includes clarifying authorship (using prompt histories), articulating evaluative criteria (using pattern-based constraints or human outcome metrics), and grading the reasoning path that produced the final image. The strongest results appear when AI is bounded by human purpose. For example, it is asked to select, compare, or synthesize against criteria rooted in human perception, cultural context, and health, rather than being tasked to populate the studio with unfiltered novelty. This is not a retreat from technology; it is a reassertion of design as a humanistic discipline that leverages computation to amplify judgment instead of substituting for it. Finally, the paradox carries concrete pedagogical implications. Course designs that documented gains tended to (a) insulate early, sense-making phases for human exploration; (b) introduce AI where its comparative advantage is clear, such as accelerating rendering; and (c) require explicit artifacts of reasoning, like prompt logs, so critiques can target judgment rather than surface polish. In short, the more AI tools enter the studio, the more programs must teach, and assess, what only students can supply: framing, discrimination, and responsibility.

Source	Key Evidence	Implication
Jang et al. (2025)	A systematic review quantified that 68.94% of documented AI applications occur in the early design (SD) phase. Markedly fewer studies were found in Design Development (DD) or Construction Documents (CD)	Confirms a heavy "front-loading" of AI use. Even in later phases, AI's role tends to be evaluative or interpretive, not end-to-end decision-making
Huh et al. (2025)	A multi-institutional survey found students embrace AI most strongly during concept design (valuing speed and breadth). Acceptance drops in later phases due to concerns over authorship, originality, and technical correctness	Learner perceptions mirror this structural skew: students tend to value AI in early design phases, while transparency artifacts, such as "prompt histories," are needed to support accountability.
Gür and Karadağ (2024)	Compared an ML surrogate (Autodesk Forma) with CFD (OpenFOAM) for wind analysis. The ML tool provides millisecond-scale predictions for early screening	CFD remains essential for late-stage validation. The ML tool is complementary (fast screening) but not substitutive (lacks numerical detail for validation)
Jin et al. (2024)	A nine-week "AI-embedded" course showed students shift AI types by phase: LLMs for programming/research (problem framing, text synthesis) and image models for concept design (creative divergence)	The type of AI used is also phase dependent. Students reported motivation (efficiency) alongside apprehension (uncontrollable outputs)

Table 4. Key Evidence for Theme 1: Phase-Dependency of AI Adoption

Source	Key Evidence	Implication
Kalleya et al. (2024)	Designers deliberately withheld AI from early interpretive moves (problem framing, mood boarding, spatial modeling). AI (Vizcom) was reserved for late-stage visualization to accelerate rendering	AI improved image polish and speed, but the creative and strategic decisions that made the image meaningful remained irreducibly human
Huh et al. (2025)	Students embraced AI for rapid, low-stakes ideation but grew cautious in later phases (development, final communication) where originality and contextual fit became salient	Students noted AI does not yet understand "design rules and the human condition in space". Recommends "prompt histories" to reinforce human responsibility
Salingaros (2025)	AI was tasked to select façades, not invent them. It consistently favored "living geometry" (aligned with C. Alexander's 15 properties) over minimalist or disordered options	AI can function as an analytical partner for human-centered design logics (like biophilia) and paradoxically help reconfirm the salience of human responses
Postle and Salingaros (2025)	Coupled an LLM to Alexander's Pattern Language, treating it as a curated, human-centered knowledge base to navigate relationships between validated patterns	The objective shifted from "outsourcing authorship" to "augmenting access" to embodied wisdom. The human designer remains the final arbiter
Kim and Park (2025)	Developed an AI tool to estimate how proposed architectural features might mitigate adolescent depression, supporting evidence-based decisions	AI's role is diagnostic and justificatory. It helps designers reason about human health impacts but does not absolve them of ethical responsibility.

Table 5. Key Evidence for Theme 2: Reassertion of Human-Centric Skills

4.3. Theme 3: The Evolution of New Literacies From Prompting to Model and Data Literacy

Literacy demands clearly shift from surface-level "prompt craft" toward deeper model and data literacy, procedural transparency, and systems thinking about AI toolchains. Early course pilots rightly foregrounded prompt technique, where students learned to compose and iterate textual inputs to steer image or text generation. However, several studies argue that prompt skill alone is insufficient for reliable alignment, reproducibility, or meaningful curricular assessment. Studies show that this literacy is evolving, beginning with treating prompt design as a core, teachable competency but quickly pressing beyond prompts to the architecture of models and data. This includes developing "control literacy" for imaging and "system literacy" for text generation, positioning students as curators and configurators of AI systems who can reason about provenance, scope, and verification. Specific evidence for this evolution is detailed in Table 6. Here, the emphasis is on learner competence, that is, what students must understand, document, and verify when working with AI.

These strands suggest a three-layer literacy progression for interior design education: (1) Prompt Literacy, involving progressive, relational prompting with documented histories and rationales; (2) Control & Adaptation Literacy, knowing when and how to deploy LoRA, ControlNet, and related controllers to reconcile imagination with constraints; and (3) System Literacy, assembling and auditing end-to-end pipelines such as RAG, naming components, and tracing sources. This progression is reinforced empirically: students value transparency when process artifacts (e.g., prompt histories) are visible, and learning outcomes improve when instruction moves beyond ad hoc prompting to structured, auditable workflows. For curriculum design, these findings justify concrete assessment shifts. First, studios can require prompt histories and verification logs alongside visuals, enabling instructors to grade how work was reasoned and controlled, not just what was produced. Second, courses can scaffold model awareness, perhaps having students compare outcomes across different model checkpoints or with and without ControlNet, to surface tradeoffs. Third, methods courses could introduce lightweight RAG builds tied to local syllabi, making provenance and privacy design decisions part of the learning objectives. In short, the review converges on a post-prompt horizon where model choice, data curation, and pipeline disclosure become first-class learning goals. Students who master these literacies are better positioned to explain, replicate, and defend AI-mediated decisions in ways that align with professional standards and human-centered values.

Source	Key Evidence	Implication
Huh et al. (2025)	Students regard "prompt design" as a core literacy and accept AI use when acknowledged transparently; Recommends requiring "prompt histories" to evaluate intent, iteration, and verification; A studio workshop reported that "progressive prompting" (using relational phrases, not just keywords) yields better alignment	Turns opaque AI mediation into an assessable artifact of process; Empirically frames prompt strategy as a teachable, improvable competency
Wu and Tseng (2025)	Critiqued the limits of simply "asking an LLM"; Implemented a Retrieval Augmented Generation (RAG) pipeline constrained to course PDFs via a vector database	Positions students as curators/configurators of AI systems, able to reason about provenance, scope, and verification
Kim and Park (2025)	Developed "control literacy" by fine-tuning Stable Diffusion with LoRA (for biophilic preferences) and adding ControlNet (for architectural constraints)	Represents a move from prompting to understanding explainable pipelines (documenting base models, adaptations, and controllers)
Meng et al. (2025)	Paired AIGC with ControlNet to embed cultural heritage logics into interior proposals, using designer line drawings as enforceable spatial priors	An example of model selection and conditioning to ensure outputs honor layout and cultural intent, moving beyond simple text prompts

Table 6. Key Evidence for Theme 3: The Evolution of New Literacies

4.4. Theme 4: The Diversification of Pedagogical Models

AI integration is not confined to a single "add a tool to studio" recipe. Instead, educators are actively experimenting with multiple instructional logics. These include workshop-based Add-Ons, staged or phased integration inside core studios, bottom-up human-AI co-analysis exercises, and fully balanced models that couple technical leverage with structured ethical reflection. Three representative lines of experimentation, detailed in Table 7, illustrate this diversification.

These experiments sketch a spectrum of AI-integrated pedagogies: workshop-in-studio for momentum and access; bottom-up co-analysis for making tacit criteria explicit and cultivating critique; and dual-path-combined-with-reflection for balancing capability with responsibility. They also suggest designable parameters that programs can tune to context: when in the term AI enters, what role it performs (generator, analyst, or reflective foil), and how evidence and ethics are operationalized. Crucially, these models do more than bolt a tool onto a course; they restructure learning interactions so that human capacities like framing, discrimination, and argumentation are exercised in relation to computational outputs. That reframing is precisely what allows the same technology to support distinct curricular aims: rapid divergent exploration in the Karadağ and Ozar workshop (2025); metacognitive calibration in the Zeng et al. comparison studio; and professional responsibility in the Wang et al. dual assignment framework. As such, diversification here is not fragmentation; it represents a portfolio of intentional pedagogical designs aligning AI's role to specific learning outcomes and program values.

4.5. Theme 5: The Expansion of AI's Role: Beyond Generation

AI's function extends decisively beyond image or text generation into roles involving analysis, evaluation, critique or feedback, prediction, optimization, and orchestration. Several studies frame AI as an assessor or analytic partner that helps make tacit judgments explicit and links design intent to evidence. Specific examples of these expanding roles, from aesthetic appraisal and performance simulation to optimization and critique, are detailed in Table 8.

These expanding roles beyond simple generation carry distinct implications for pedagogy. First, when AI acts as an evaluator, instructors can require transparent criteria and audit trails, for instance by mapping outputs to theory or rubric descriptors. This trains students to interrogate why a design scores as it does, rather than deferring to algorithmic authority. Second, when AI acts as a predictor or analyst, curricula should stress model and data literacy, including understanding uncertainty, using validation metrics (like SSIM/MSE/

Source	Pedagogical Model	Key Evidence	Implication
Karadağ and Ozar (2025)	Workshop-Based Phased Insertion	A Midjourney workshop was inserted at week four of a 14-week studio to position AI as a "collaborative partner"	12 of 16 students reported AI played a substantial role. This format lowers entry barriers and accelerates ideation but also surfaces student worries about ethics and creative restriction
Zeng et al. (2025)	Human-AI Comparison & Critique	A "student mode" model (trained on 1,250 student plans) annotated 52 master designs. Students then compared the AI's annotations to the masters' annotations to find where the model "gets it wrong"	Uses "guided misalignment". By interrogating the AI's mistakes, students surface their own cognitive gaps. AI is positioned as an analysis and critique instrument, not just a generator.
Wang et al. (2025)	Dual Assignment with Ethical Reflection	A 16-week studio (N=70) used a "dual assignment" structure, having students complete tasks via conventional and AI-assisted pathways in parallel	An "ethical reflection module" (covering provenance, bias, environmental cost) functions as a "checks and balances" design. This improved ethical awareness while still delivering efficiency benefits

Table 7. Key Evidence for Theme 4: Diversification of Pedagogical Models

Source	AI Role	Key Evidence
Jiang (2025)	Aesthetic Evaluator	A "Beautimeter" (using GPT-4o) was harnessed not to produce images, but to evaluate them against C. Alexander's theory of "living structure." Its rankings broadly matched human canonical answers
Gür and Karadağ (2024)	Performance Analyst / Predictor	Compared a fast, ML-based tool (Autodesk Forma) against compute-intensive CFD (OpenFOAM) for wind analysis. ML was effective for rapid, early-stage estimation, while CFD was essential for deeper verification
Kim and Park (2025)	Decision Support Engine	An AI-assisted tool estimates the "depression alleviation potential" (DAP) of biophilic design strategies, integrating expert weights (AHP) and fuzzy logic to score scenarios
Albadrani (2025)	Policy Optimizer	A hybrid pipeline coupled T2I models (DALL·E) with a decision engine that recommends drought-resistant native species based on soil/climate data, optimizing greening scenarios for urban heat mitigation
Zahra et al. (2025)	Critique & Feedback	Deployed ChatGPT 4.0 as an "objective assessor" to reduce students' anxiety around critique and strengthen emotional intelligence. This reframes the LLM as an affect-sensitive feedback partner
Li et al. (2025)	Multi-stage Analyst	A framework for estimating demolition waste fused GPT-4o (for expert classification of interior types) with deep learning (for plan segmentation) to produce quantitative waste predictions
Tang et al. (2025)	Data Orchestrator	In digital twins and metaverse environments, ML (Gaussian Splatting) supplies 3D inputs, LLM agents parse complex IoT streams, and intelligent NPCs mediate interactive behaviors

Table 8. Key Evidence for Theme 5: AI Roles Beyond Generation

PSNR), and distinguishing between rapid screening and high-fidelity verification. Third, hybrid generation plus decision workflows, like Albadrani's (2025) greening engine, invite assignments where students must justify design choices with environmental or health evidence, reinforcing links to human-centered outcomes. Fourth, affect-aware critique assistants, similar to those described by Zahra et al. (2025), can be embedded to lower fear of evaluation while preserving human juries for synthesis and values-based judgment.

Theme 5 shows that AI in interior and architectural education is becoming an infrastructural partner for reasoning. It audits aesthetics against theory, screens environmental performance, forecasts impacts on well-being, optimizes urban scenarios with local data, and moderates critique. These roles situate AI as an engine for analysis, evaluation, prediction, and interactionbthat, when coupled with explicit validation practices and human oversight, can deepen students' capacity to argue with evidence and design toward human outcomes.

4.6. Theme 6: The Emerging Technological Ecosystem: Complementarity with Adjacent Tools

AI rarely operates as a stand-alone "magic box". Instead, it plugs into larger constellations of tools, including XR (VR/AR/MR), BIM and parametric platforms, GIS or remote sensing pipelines, IoT feeds, simulation engines, and even blockchain. These combinations form complementary ecosystems in which each component offsets another's weaknesses while amplifying its strengths. This ecosystemic view clarifies why many promising results occur not when a single model is taught, but when instructors choreograph handoffs among tools, teach students to reason about fit by phase, and demand explicit validation between components. The corpus provides diverse examples of these ecosystems in practice, ranging from data capture and simulation to governance and control, as detailed in Table 9. Here, by contrast, the emphasis shifts from learner competence to the wider socio-technical environments within which multiple tools and validations are coordinated.

Finally, several papers formalize interoperability as a learning objective. Studies beginning in Midjourney or Stable Diffusion typically move back into CAD or BIM (and sometimes energy analysis) to test feasibility. Others route through XR for stakeholder dialogue, or into simulation for performance screening before circling to documentation. When these loops are explicitly designed, incorporating checkpoints, audit trails (like prompt or version histories), and verification metrics, students see why no single tool can meet CIDA's performance, health, and code competencies alone. Instead, they learn to assemble fit-for-purpose stacks, such as moving from fast approximation to immersive

Source(s)	Ecosystem Type	Key Evidence
Tang et al. (2025)	Capture & Simulation (XR/IoT/BIM)	Details the stack reshaping design information. ML (Gaussian Splatting) supplies 3D input; LLM agents query IoT streams in Digital Twins; and XR provides the immersive interface for simulation and multi-user critique
Gür and Karadağ (2024)	Screening & Verification (Simulation)	Contrasts a millisecond-fast, ML-driven tool (Autodesk Forma) for "early-stage screening" with high-fidelity CFD (OpenFOAM) reserved for "verification and calibration." This implies students must learn tool roles and handoffs
He and Chen (2024)	Analysis & Visualization (GIS)	Synthesizes work showing AI integrating with GIS and remote sensing data. AI provides the analytic value (classification, prediction, pattern mining) while GIS provides spatial structure and visualization. While this paper focuses on urban-scale GIS integration, the same spatial pattern recognition and layer analysis logic transfers readily to interior zoning and material flow mapping, enabling students to reason about programmatic adjacencies and wayfinding at the building scale.
Kim and Park (2025); Meng et al. (2025)	Generation & Control (LoRA/ControlNet)	Demonstrates "pipeline design". AIGC is fused with ControlNet (to honor interior line drawings or building massing) and LoRA (to encode specific biophilic preferences)
Abdallah (2025)	Immersive Therapeutics (XR/AR)	AI's generative capacity (storyboarding) is coupled with VR/AR overlays and physical materials to create hybrid therapeutic interventions
Fitriawijaya and Jeng (2024)	Governance & Provenance (Blockchain)	AIGC for divergent exploration is integrated with blockchain/NFT infrastructure to notarize prompts, authorship, and versioning, providing an architectural solution to legal and provenance risks

Table 9. Key Evidence for Theme 6: The Emerging Technological Ecosystem

review and then rigorous verification, or from cultural synthesis through controlled generation to technical compliance. This ecosystem perspective suggests several instructional strategies. First, teach roles and handoffs: which component explores, which constrains, which verifies, and how evidence flows between them. Second, grade the pipeline, not just the final picture, requiring artifacts that make the ecosystem auditable (like prompt logs, controller settings, model IDs, data provenance, and accuracy metrics). Third, link ecosystems explicitly to human outcomes: using XR/DT stacks for accessibility drills; applying AI+GIS for environmental justice mapping; or employing LoRA/ControlNet for age-friendly façades. In short, the strongest results in the corpus arise when AI is taught not as a solitary instrument but as an orchestrated ensemble, essentially a technological ecology aligned to phase-specific tasks and human-centered goals.

4.7. Theme 7: The Macro-Level Reality: A Quantifiable Gap

The corpus depicts a structural misalignment between how AI is often taught in design programs and what professional practice increasingly requires. Evidence for this gap appears in multiple layers. First, numerous classroom trials and surveys show asymmetric, phase-specific adoption. Students and instructors welcome AI for fast reconnaissance and early ideation but tend to retreat from it when stakes rise concerning technical coordination, code compliance, and accountability. This pattern is visible in reports registering strong acceptance of AI for divergence, coupled with hesitation when feasibility and rigor become paramount. This gap manifests across several dimensions, from tool capabilities and literacies to policy and ecosystem integration, as detailed in Table 10.

In sum, Theme 7 consolidates a quantifiable macro gap characterized by: (i) phase-dependent use dropping off where verification intensifies; (ii) a tool competency mismatch where fast generators outpace training in analysis and codes; (iii) process opacity without graded transparency artifacts; (iv) ecosystem underexposure to complex tool handoffs; and (v) human outcomes under-alignment where AI is not systematically tied to well-being, inclusion, or performance. The corpus also hints at measurable correctives, like requiring auditable workflows (e.g., prompt logs), teaching paired tool ecologies (screening followed by verification), and structuring assignments around end-to-end pipelines (like using RAG or controlled generation), which will later underpin our CIDA-mapped recommendations in the Discussion.

Dimension of the Gap	Evidence from Corpus	Implication for Education
1. Tool vs. Competency Mismatch	Studies (Gür and Karadag 2024) show ML shortcuts (like Autodesk Forma) are effective for millisecond screening but cannot replace physics-grade verification (like CFD).	A curricular shortfall exists where students learn fast approximation tools without mas-tering rigorous verification methods.
2. Literacy Mismatch	Prompt skill without model and data literacy yields brittle outcomes. Course pilots using advanced pipeline approaches, such as RAG (Wu and Tseng 2025) or SD+LoRA/ControlNet workflows (Kim and Park 2025; Meng et al. 2025) remain rare.	Programs stopping at basic prompting fail to equip students with practice-ready skills like provenance, model constraint, or validation.
3. Policy and Trust Mismatch	Students are willing to use AI when process transparency is graded (e.g., submitting "prompt histories" per Huh et al., 2025).	Few programs institutionalize these require-ments, hindering faculty's ability to evaluate rigor and potentially misaligning student habits with professional norms
4. Ecosystem Mismatch	Practice increasingly orchestrates AI with XR, IoT, BIM, and GIS in digital twin contexts (Tang et al. 2025).	Students, by contrast, often encounter these tools in isolation, missing a necessary skills bundle related to handoffs, interoperability, and validation
5. Human Outcomes Mismatch	Studies have begun to retool AI as an evalua-tor of theory (Jiang 2025) and as a decision-support engine for health-related design questions (Kim and Park 2025), demonstrat-ing plausible CIDA-aligned pathways.	The need to "invent" these pipelines at the course level suggests that program-wide scaf-folds for evidence-based, human-centered AI use are emergent, not normative.

Table 10. Key Evidence for Theme 7: The Education–Practice Gap

4.8. Theme 8: The Affective Dimension: Psychological Barriers and Motivations

Affect emerges as both a brake and an accelerant for AI adoption. Studies consistently report a layered emotional terrain where excitement about speed, variety, and expressive range coexists with anxiety over bias, authorship, cultural authenticity, and even the ecological costs of computation. The evidence, detailed in Table 11, shows how this affective tension is being managed: by balancing technical work with ethical reflection, by channeling cultural skepticism into data literacy, and by using AI to reduce affective friction in critiques.

These findings suggest three implications. First, motivation to adopt AI is strongest when students connect tool affordances to meaningful, human-centered outcomes and when instructors offer structured comparisons. Wang et al.'s (2025) dual assignment design evidences how carefully engineered choice can transmute ambivalence into informed agency. Second, fear and distrust often track legitimate critiques. Perceived cultural erasures, stereotyping, or outputs that are "polished but wrong" are signals that curricula must cultivate model and data literacy and critical sourcing habits. The Sukkar et al. (2024) analysis is instructive, showing how culturally situated suspicion can be pedagogically productive when harnessed to inquiry about datasets and provenance. Third, affective support can be intentionally designed. The Zahra et al. (2025) protocol demonstrates that reframing AI as a low-stakes interlocutor can lower the social heat around critique, enabling deeper iteration and better metacognitive awareness.

For interior architecture and design programs, the affective lesson is clear: adoption is not merely a function of tool availability but of how courses choreograph confidence, curiosity, and care. Embedding explicit conversations about bias, authorship, and environmental impact; inviting culturally informed skepticism where warranted; and building "emotionally intelligent" feedback circuits that include AI as a provisional critic can convert apprehension into durable literacies. In practical terms, this means structuring studios where students can (1) test AI in parallel with baseline methods, (2) audit outputs for cultural and ethical fit, and (3) practice receiving feedback from human and machine partners. When these conditions are met, the emotional weather of AI shifts from a source of noise into a driver of judgment, reinforcing the human-centered ends that anchor the discipline.

5. DISCUSSION

5.1. What the eight themes mean

Read together, the eight themes show that AI in interior architecture and design education is strongest in early, generative phases and weakest in later, standards-intensive phases where documentation, codes, and accountability dominate. The central curricular task is therefore not simply to normalize AI use, but to position it by phase and connect rapid exploration to slower modes of verification and justification. In this sense, AI integration succeeds when it strengthens human judgment rather than substituting for it. This requires literacies that extend beyond prompting to include model literacy, data literacy, and process transparency. The most promising pedagogies therefore grade the pipeline, not just the picture, by assessing

Source	Affective Tension	Key Evidence
Wang et al. (2025)	Enthusiasm vs. Anxiety ("Checks & Balances")	A 16-week studio operationalized this balance by pairing AI-assisted workflows with "dual assignments" and a "structured ethical reflection" module covering bias, authorship, and environmental cost
Sukkar et al. (2024)	Cultural Skepticism (as legitimate critique)	Probed image generators for Islamic Architecture (IA). Documented fears that AI flattens cultural nuance or creates "culturally unrooted" images. This skepticism is not technophobia but a "defense of cultural meaning" linked to opaque datasets.
Zahra et al. (2025)	Critique Anxiety (Reduction)	Demonstrated AI reducing affective friction. Positioning ChatGPT 4.0 as an "objective assessor" mitigated students' fear of criticism, eased anxiety, and improved revision tolerance.

Table 11. Key Evidence for Theme 8: The Affective Dimension

process artifacts such as prompt logs, retrieval scopes, controllers, and verification steps. When those artifacts become visible deliverables, AI-assisted work shifts from opaque spectacle into auditable reasoning.

The pedagogical landscape is diversifying accordingly, using varied models like workshops, comparison-based studios, and dual-path assignments with ethical reflection. These models share an intentionality about roles and handoffs, refusing to let technical fluency drift away from professional and human-centered goals. Concurrently, AI's remit is expanding from generation to analysis, critique, and prediction. This pivot from "making more images" to "arguing with evidence" aligns AI with the discipline's evaluative core. Crucially, the strongest results occur when AI operates inside a technological ecosystem, integrating with BIM, simulation, XR, and provenance infrastructures. Ecosystem teaching invites students to reason about fit-by-phase and interoperability, which is a primary driver of the macro-gap between curricula and practice. Finally, adoption is as affective as technical. Motivation rises with visible usefulness, while anxiety increases with opacity. Programs that treat affect as designable can convert apprehension into agency. In aggregate, the eight themes argue for a reframing: AI should be taught as a phase-aware, ecosystemic collaborator that amplifies human judgment through auditable pipelines. As established in the theoretical framework (Section 2), this synthesis operates across two distinct levels: AI Literacy, which concerns what students must competently do, and AI Ecosystems, which concerns the interoperable environments in which that competence becomes practice-ready; and curricular reform must address both. The next section translates this synthesis into CIDA-aligned actions.

5.2. Mapping the themes to CIDA Professional Standards 2024

This section translates the eight thematic findings into accreditation-aligned actions for interior architecture and design programs. For each theme, Table 12 indicates the most relevant CIDA 2024 Professional Standards and proposes actionable strategies that align with the Standards' intent while leveraging AI's potential. Furthermore, CIDA Standards emphasize weaving sustainability, DEIA, and human well-being throughout the curriculum. AI integrations must be assessed within this holistic program lens, not as isolated tool training. Framed this way, the eight themes become a scaffold to operationalize the Standards. Pedagogically, human-centered outcomes should be assessed not only by the visual quality of AI-assisted outputs, but also by the student's ability to justify claims about well-being, inclusion, cultural context, and ethical fit. In practice, this means evaluating three layers of evidence: the outcome artifact itself, the process artifact documenting how AI was used, and the judgment artifact explaining why specific AI suggestions were accepted, modified, or rejected. Rubrics may therefore include criteria such as evidence quality, inclusivity reasoning, bias awareness, provenance transparency, and the strength of the student's final human judgment. These principles are operationalized in Table 12 through theme-specific curricular actions and evidence structures.

5.3. Program-level framework and implementation roadmap

This section translates the themes and CIDA mappings into a program-wide plan. The aim is not to add a single AI class, but to thread phase-aware, ecosystemic, and auditable AI use through existing courses and checkpoints, as detailed in Table 13. This framework implements a three-layer assessment spine across all studios: (1) Artifacts of outcome, (2) Artifacts of process (prompt logs, model cards), and (3) Artifacts of judgment (rationales). This spine makes student learning visible (awareness → understanding → application) for CIDA evaluation. Program checkpoints (Portfolio Review, Study Abroad, Internship) are adapted to validate these process-oriented skills. By anchoring AI to roles (explore, constrain, verify) and grading auditable pipelines, the program aligns daily studio practice with CIDA standards while preserving the discipline's humanistic core. Equally important, this framework is intended to be adopted progressively, giving departments a realistic implementation pathway rather than requiring an immediate, program-wide overhaul.

Operationally, this framework is best understood as a phased roadmap rather than as a single institutional overhaul. In Phase 1, programs can begin with limited pilots and faculty calibration, introducing transparency artifacts such as prompt logs, model cards, data provenance sheets, and AI-use declarations in a small number of foundation or studio courses. In Phase 2, programs can extend these practices across key checkpoints, aligning portfolio review, study abroad, and internship expectations with visible evidence of process, handoff logic, and verification. In Phase 3, programs can institutionalize AI-hybrid studio practice through shared rubrics, policy guardrails, faculty development, and capstone-level requirements for audit-ready portfolios. In this sense, Table 13 functions as both a curriculum framework and an implementation roadmap, guiding departments from isolated experimentation to coordinated, program-level adoption.

5.4. Cross-domain insights: what interior design can borrow (and avoid)

Recent work outside interior design offers concrete design patterns for responsibly orchestrating AI. These

Theme	Key Finding	Relevant CIDA Standards	Curricular Strategy (Actionable Evidence)
1. Phase Dependency	Early-phase focus; late-phase gap.	Std. 8 (Process), 15 (Docs), 16 (Codes)	Design "handoff" assignments: AI-generated concepts must be iterated toward compliance (e.g., BIM constraints, code checks)
2. Human-Centric Skills	Reassertion of human judgment.	Std. 7 (Human-Centered), 4 (Global Context)	Counter "polished but weak reasoning". Require 'Human Outcomes Critique Sheets' that align AI-generated claims to well-being or inclusion evidence.
3. New Literacies	From prompting to model/ data literacy.	Std. 9 (Communication), 8 (Process)	Assess reproducible AI pipelines. Require "model cards" or "data provenance sheets" documenting model IDs, RAG scopes, or ControlNet settings.
4. Pedagogical Models	Diversification (workshops, dual-path).	Std. 5 (Collaboration), 9 (Communication)	Use team-based AI pipelines with distinct "explore, constrain, verify" roles. Use structured debates (AI vs. human) to cultivate critical listening.
5. AI Role Expansion	Beyond generation to analysis/critique.	Std. 9 (Communication), 8 (Process)	Target Std. 9's call to "build a compelling case". Require data-informed arguments (e.g., from theory-aware evaluators), not just visual appeal. (Evidence: Critique transcripts).
6. Ecosystem Thinking	Complementarity (BIM, XR, simulation).	Std. 15 (Docs), 14 (Environ. Systems), 9 (Comm.)	Teach tool handoffs. Route AIGC outputs through BIM constraints (Std. 15) and performance screening (Std. 14).
7. Macro-Level Gap	Education vs. Practice misalignment.	Std. 8, 15, 16 (Late-phase standards)	Address the gap by aligning deliverables with Std. 8 (evidence), 15 (documentation), and 16 (code). Grading transparency artifacts (prompt logs) provides tangible evidence for CIDA site visitors.
8. Affective Dimension	Anxiety vs. Motivation.	Std. 5 (Collaboration), 9 (Comm.), 4 (Global Context)	Design "emotionally intelligent" critiques, perhaps using AI as a low-stakes interlocutor. Use cultural anxiety (Std. 4) as a prompt to interrogate datasets.

Table 12. Mapping Themes to CIDA 2024 Professional Standards

Year	Phase	Key Courses & Check-points	AI Role & Key Activities	CIDA Stan-dards
1	Foundations (Prompt & Model Literacy)	IARD 10305 (Year 1 studio Fall) / 10405 (Year 1 studio Spring)	Idea Expander / Evidence Collector: work with both hand-based and AI-assisted methods and submit transparency artifacts (prompt logs, model cards, or data provenance sheets).	8, 9
2	Gateway & Alignment	IARD 28004 (Year 2 studio Fall) / 27203 (Digital Media); Portfolio Review	Constraint Triptych: (1) Explore (AIGC) → (2) Constrain (BIM) → (3) Verify (code prompts). Pipeline must be visible in portfolio.	8, 16
		IARD 28104 (Year 2 studio Spring)/ 38403 (Lighting System)	Theory-Aware Analyst: AI as evaluator (composition checklists); lighting proxies for screening (pre-Std. 14).	14
		Study Abroad (Summer)	Global Context: Build RAG mini corpus (site codes, local materials, cultural precedents) to constrain AI ideation.	4
3	Professional Spine (Ecosystems & Performance)	IARD 38005 (Year 3 studio Fall) / 38303 (Building System)	Ecosystem Stack: AIGC → BIM conformance → Screening analysis → XR walk-through. Formal "Screening-to-Verification" logic.	9, 14, 15
		IARD 38105 (Year 3 studio) / 48103 (Human Factors)	Decision-Support Partner: Anchor Std. 7. AI assists well-being/inclusion analysis (scenario scoring, bias checks).	7, 8, 14, 16
		IARD 48203 (Professional Practice); Internship (Summer)	Professional Practice: Provenance/IP exercises. Process Integrity Checklist (prompt logs, verification) for internship mentors.	6
4	Capstone (Consolidation)	IARD 48005 (Year 4 studio Fall) / 48405 (Year 4 studio Spring)	Full-Cycle Proficiency (DD-CD): Public, audit-ready portfolio. Requires (1) Handoff Map, (2) Verification Appendix, (3) Human-Outcomes Critique Sheet.	7, 8, 14, 15, 16
Note: The course codes listed here correspond to the curriculum of the Department of Interior Architecture and Design at the University of Arkansas.				

Table 13. Proposed CIDA-Aligned AI Curriculum Framework and Implementation Roadmap

Domain	Transferable Pattern (To Borrow)	Cautionary Lesson (To Avoid)
Hospitality & Tourism (Dogru et al. 2025)	Use the REFLECT framework (Resource, Ethical, Financial, Legal, Educational, Cultural, Tech) as a pragmatic checklist for planning AI deployments (e.g., in client-facing projects).	Value Co-Destruction: Recognize that "hyper-personalization" can manipulate, and automation can "erode trust" if provenance is opaque. These asymmetries must be surfaced in studio critiques.
Agrifood AI (Shaikh et al. 2025)	Adopt a "system of systems" habit. AI (LLMs, GANs) is embedded with IoT, CV, and robotics. Interior studios can borrow this by architecting pipelines (e.g., LLM synthesis + BIM checks + AR testing).	Skills Pitfall: Sophisticated models demand "literacies in architecture selection, training constraints, and verification," not merely clever prompting. This reminds educators to sequence model/data literacy.
Construction (Li et al. 2025)	Use AI "beyond generation." An LLM (as domain expert classifier) was integrated with segmentation and OCR to predict demolition waste. This is a template for chaining models for analysis and estimation.	Multi-stage pipelines can project false precision if upstream classification or segmentation errors go unchecked. Treat AI estimates as screening tools rather than autonomous ground truth, and require validation, uncertainty reporting, and human review.

Table 14. Cross-Domain Insights for AI Integration

Risk Category	Nature of Risk (from Cross-Domain Insights)	Proposed Educational Guardrail (Policy & Pedagogy)
Bias, Fairness & Ethics	Training data bias can reproduce stereotypes; synthetic content can pollute trust systems.	Mandate dataset/model declarations. Restrict use of sensitive prompts (client/culture) without consent. Mandate bias/threat modeling (e.g., REFLECT rubric) at project kickoff.
IP, Provenance & Liability	Copyright obligations can be breached; liability is murky when automated systems fail.	Require an "AI Use Declaration" and "Provenance Appendix" (for imagery, text, code) on every deliverable. Teach IP/licensing in practice courses.
Misinformation & Opacity	Criminally purposed "dark LLMs" amplify fraud. Opaque models erode trust.	Institute a basic security posture (vetted tool lists, sandboxing). Teach verification habits (cross-model checking, reference tracing).
Governance & Process	Governance gaps lead to unmanaged risks.	Demand role clarity in group work to prevent uncredited automation. Prefer secure, institution-licensed platforms with logging enabled.

Table 15. Summary of AI Risks and Proposed Educational Guardrails

insights, summarized in Table 14, provide transferable patterns for pedagogy, process, and risk assessment. Adjacent fields also highlight what to avoid. Hospitality surfaces failure modes when provenance and liability are unclear (e.g., fake reviews, copyright breaches). Agriculture underscores the security risks of "dark LLMs" and adversarial use. Syllabi must include basic operational security (OPSEC) and verification habits.

5.5. Risks, ethics, and guardrails (operationalizing responsibility)

Across domains, the AI risk profile clusters around bias, intellectual property (IP), provenance, misinformation, opacity, and security. For interior design education, these risks map to concrete guardrails, as summarized in Table 15. These guardrails align with cross-domain evidence suggesting that responsible value creation depends as much on culture, education, and clear accountability as it does on technical controls.

5.6. Limitations

This review has several limitations. First, the search was restricted to five major publisher platforms, peer-reviewed journal articles, and English-language publications between 2021 and October 2025, which may omit relevant work in other venues or languages. Second, grey literature, theses, and practitioner reports were excluded, potentially biasing the corpus toward more formalized experiments. Third, the synthesis centers CIDA's 2024 Professional Standards, which supports transferability to similarly structured accreditation regimes but may limit generalization to programs aligned with other frameworks (e.g., NAAB, LAAB, PAB). Finally, although robustness checks were conducted, coding and theme development were led by a single reviewer, which may introduce interpretive bias despite self-audit procedures. Because AI tools, platform policies, and model capabilities evolve rapidly, some tool-specific observations in this review should be read as time-bound snapshots rather than durable curricular prescriptions; the more stable contribution of this paper lies in the higher-order pedagogical patterns, assessment principles, and phase-based distinctions synthesized across the corpus.

5.7. Future research agenda

This review clarifies where AI integration shows promise and where significant gaps exist. A coherent research agenda must prioritize generating valid evidence, investigating later-phase integration, understanding ecosystem orchestration, developing model literacy pedagogy, and addressing responsibility at scale. The following outlines priority lines of inquiry:

- Longitudinal Studies: Move beyond single-course effects to multi-semester cohort studies tracking trajectories in ideation breadth, evidence quality, and code navigation, pairing within-subject designs with blinded expert ratings and process audit.
- Later-Phase (DD–CD) Benchmarks: Address the major gap by building open, privacy-safe benchmark suites testing AI-assisted performance in code-aware plan adjustments, detail coordination, and specification queries.
- Technological Ecosystems & Handoffs: Move beyond isolated tools to study "stack experiments" (e.g., AIGC → BIM → XR) and treat interoperability, metadata preservation, and version drift as first-class outcomes.
- Model/Data Literacy Pedagogy: Define and validate instruments for measuring "transparency competence" (documenting models/data), "verification competence" (designing check pathways), and "limits awareness" (naming errors/biases).
- Affect, Inclusion, and Culture: Extend findings on anxiety and motivation. Use design-based interventions (e.g., AI "pre-jury" interlocutors, dataset audits) and measure outcomes with validated scales (e.g., creative self-efficacy, epistemic trust).
- Equity, Access, and Cost: Quantify how to compute budgets, licensing, and device disparities shape learning (TCO analysis).
- Integrity, IP, and Provenance: Evaluate integrated policy/platform packages (e.g., mandatory AI use declarations, automated provenance capture, AIGC-adapted plagiarism checks) and their effect on instructor confidence and student accountability.
- Faculty Capacity & Organizational Change: Treat instructor development as a research object (e.g., comparing co-teaching vs. solo models) and measure the diffusion of practices (e.g., adopting transparency artifacts).

To make this agenda cumulative, researchers must foster open artifacts (anonymized student work, validated rubrics, shared benchmark tasks). Aligning research endpoints with CIDA Standards and practice-linked outcomes (e.g., pass rates on code-aware checkpoints, internship supervisor ratings on process integrity) is key. Future research should study pipelines, phases, and people, not just pictures.

6. CONCLUSION

This systematic review shows that AI in interior architecture and design education is advancing unevenly across the design process: it is well established in early ideation, visualization, and exploratory tasks, but remains comparatively underdeveloped in later, standards-intensive phases where documentation, codes, coordination, and accountability become central. Across the eight themes synthesized here, the literature suggests that the educational question is no longer whether AI should be present in the curriculum, but how it should be positioned, bounded, and assessed so that it strengthens rather than displaces human judgment. The strongest patterns in the evidence indicate that meaningful integration depends on phase-aware deployment, explicit verification pathways, and the use of interoperable ecosystems in which generative tools are connected to downstream environments such as BIM, simulation, and XR. At the same time, effective adoption requires a broader conception of literacy. Students must learn not only to prompt AI systems, but also to understand model limitations, evaluate data provenance, document workflows, and justify why particular AI outputs were accepted, revised, or rejected. For this reason, the most durable curricular shift is not the addition of isolated AI exercises, but the redesign of studio pedagogy around auditable pipelines, transparency artifacts, handoff logic, and human-centered evaluation criteria.

Taken together, these findings support a CIDA-aligned approach in which AI is taught as a phase-aware, ecosystem-based collaborator embedded within existing courses, checkpoints, and assessment structures rather than as a stand-alone technical novelty. The framework and implementation roadmap proposed in this paper translate that synthesis into a practical program-level strategy, linking early creative leverage to later-stage rigor through role-specific AI use, dual-path pedagogies, and assessments that reward evidence, process integrity, and judgment. More broadly, this review argues that the future of AI in interior architecture and design education will be determined less by the speed of tool adoption than by the quality of curricular design, faculty scaffolding, and institutional accountability. Future research should therefore continue building later-phase benchmarks, studying tool handoffs across ecosystems, validating literacy and judgment measures, and developing open artifacts that allow findings to accumulate across programs. Ultimately, the central task is not simply to teach students to generate more with AI, but to prepare them to reason more carefully, verify more rigorously, and design more responsibly with it.

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