TOWARD A REFLECTIVE PEDAGOGY OF AI-AIDED DESIGN: INSIGHTS FROM AN EXPERIMENTAL DESIGN STUDIO

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ABSTRACT

This study explores a structured, semester-long integration of artificial intelligence (AI) into architectural design education through an experimental studio course at Abdullah Gül University. Rather than positioning AI as a mere tool for automation, the studio investigated its potential as a speculative design collaborator, embedded within a pedagogical framework centered on research-by-design. Students engaged in iterative processes of problem framing, concept development, and visual exploration, using AI systems both as generative aids and dialogic partners.

The course emphasized critical authorship and interpretive reasoning, prompting students to interrogate AI outputs and incorporate them into evolving manual design practices. Through hybrid prompt strategies, students developed the ability to translate abstract spatial ideas into grounded proposals, navigating ambiguity and reconciling machine-driven outputs with contextual constraints. Findings suggest that AI, when scaffolded within reflective pedagogies, can expand students' cognitive engagement, conceptual depth, and representational fluency without displacing human design agency.

This research contributes an alternative model of AI-aided pedagogy—one that destabilizes deterministic workflows and instead fosters epistemic diversity, design literacy, and critical synthesis.

KEYWORDS

Design education, Artificial Intelligence (AI), Design Creativity, Teaching Creativity

1. RESEARCH DESIGN

This research (Figure 1) adopts a qualitative action research approach situated within an experimental architectural design studio. It aims to explore the structured, term-long integration of AI into students' creative design processes. The study is grounded in constructivist and active learning paradigms, focusing on how students interact with AI in speculative, research-by-design environments, and how instructional frameworks can support and structure this engagement to foster knowledge-based design thinking. The study is positioned within the context of AGU_ARCA101 Experimental Design Studio at Abdullah Gül University, Turkey, offered to fourth-year architecture students. Previous iterations of this studio had revealed a surprising level of student-led AI engagement (Figure 2), extending beyond visualization and automation toward concept formation and creative decision-making. This pattern prompted a re-evaluation of the studio's pedagogical priorities, shifting attention from final design outcomes to the cognitive and epistemological processes through which design knowledge is generated using AI.

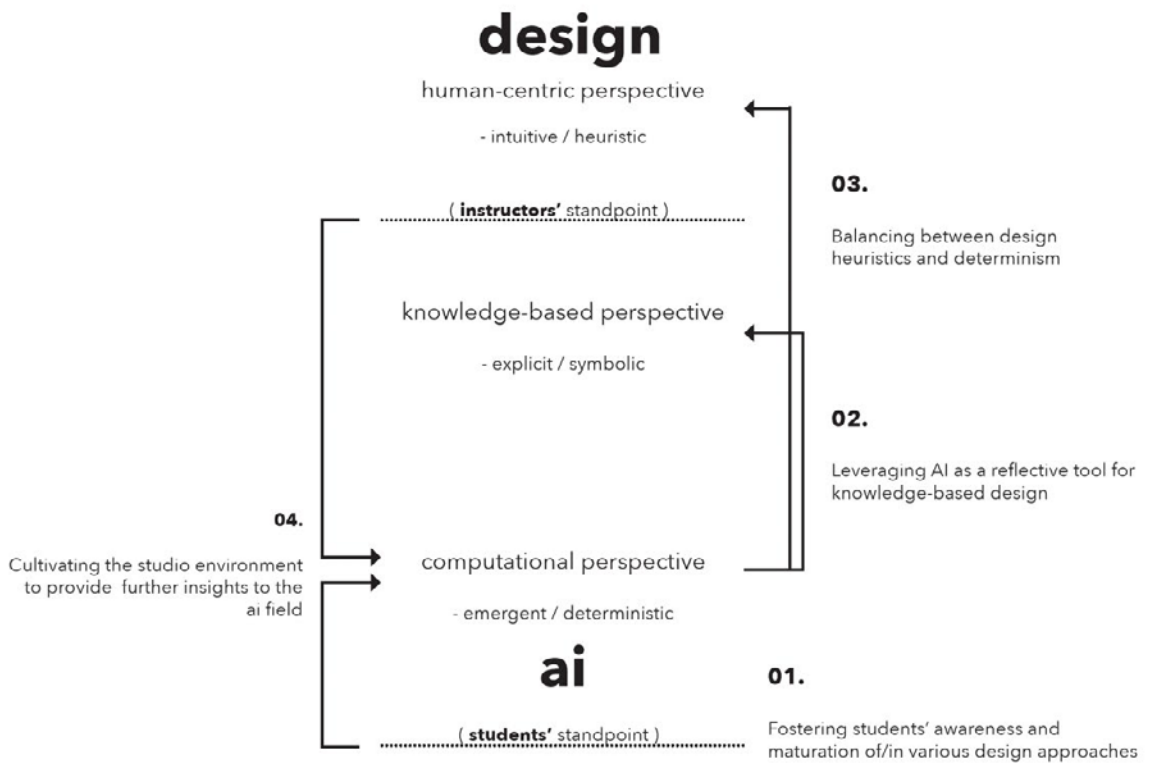

Figure 1: Research design (aims, objectives, questions etc.) diagram

While AI tools offer significant opportunities for research, learning, and design development in architectural education (Xiao et al. 2023; Komatina, Miletić, and Mosurović Ružičić 2024), their integration into design studios remains largely fragmented, short-term, and undervalued (Xiao et al. 2023; Özorhon et al. 2025). Students tend to use AI for isolated, efficiency-driven tasks rather than as part of integrated, reflective design processes. These tendencies are further constrained by institutional limitations, including curriculum rigidity, lack of access to AI tools, policy gaps, and the persistence of traditionalist attitudes in architectural education.

In response, this research investigates how a structured instructional framework might position AI as a meaningful and sustained component of the design studio. The central research questions include: What might a structured, term-long AI integration in architectural design studios look like? How can such a design, management, and evaluation framework enhance students' creative and knowledge-based design processes? And how does legitimizing students' implicit engagement with AI within a formal structure affect their learning experience? These questions are explored through a case project involving the speculative design of user-centered street furniture for a semi-open space adjacent to the architecture studios. The design problem allowed students to work within real-world constraints while using AI to experiment with novel approaches.

The study employs an opportunistic case-study design informed by action-research methodology, embedded directly within the design studio environment, allowing the instructor to act both as facilitator and researcher (Herr 2017; Lewin 1946). This positioning enables close observation of students' creative processes and supports iterative adjustments to the instructional model throughout the semester. Rooted in participatory pedagogical values and design-based research principles—emphasizing contextual responsiveness and iterative learning cycles (Design-Based Research Collective

2003)—the studio draws on qualitative data collection tools including students' design journals, visual process documentation, semi-structured interviews, in-class critiques, and instructor field-notes. Analysis focused on interpreting how AI tools become integrated into student workflows and on how their perceptions and uses of AI evolve over time.

Figure 2: Students' AI experience observed in previous semesters.

The instructional framework was developed to support a multi-modal understanding of AI's role in design—situated across human-centric, knowledge-based, and computational perspectives (Kulkarni et al. 2023; Özorhon et al. 2025). Students were encouraged to traverse between intuitive-heuristic, reflective-symbolic, and emergent-deterministic epistemic stances, iterating through design stages. AI was introduced early via exploratory prompt-based tasks using both visual and textual inputs; students subsequently progressed to manual modeling, sketching, scenario building, and site-specific investigations. This aligns with scaffolded learning principles, which use structured support to promote effective creative development (Deng et al. 2016; Kulkarni et al. 2023). Instructors provided critical feedback in weekly seminars, helping students evaluate AI's generative possibilities and limitations—treating AI not as a replication tool, but as a collaborator whose agency could be tested, negotiated, and interpreted (Özorhon et al. 2025; Zhou et al. 2024).

The study is purposefully limited in scope to speculative design contexts and does not seek to measure learning outcomes through quantitative metrics or standardized evaluations. It does not address broader teaching efficiency or curriculum-wide reform. Rather, it focuses on understanding how students' creative and epistemological engagements shift when AI is integrated into a long-term, structured studio environment as a situated, process-based case (Stake 1995; Yin 2009). The outcomes are interpretive in nature and intended to inform both design pedagogy and future applications of AI in architectural education. Accordingly, the research does not claim generalizability but offers a situated, process-based perspective on learning and design inquiry (Flyvbjerg 2013; Stake 1995).

As a practitioner-led study within an academic setting, ethical attention was given to the voluntary and open-ended nature of student participation. No part of the design process was mandatory in terms of AI use, and students retained autonomy over their conceptual directions. Reflexivity was maintained through weekly debriefings by the instructional team, ensuring that pedagogical intentions and

research goals remained aligned. By positioning AI not as a replacement for human creativity but as a collaborator in the learning process, the research contributes to a deeper understanding of how emerging technologies can expand the boundaries of architectural education.

2. DESIGN PROBLEM

This design studio invites students to respond to a highly situated and spatially meaningful problem: the everyday challenges architecture students face in physically producing design work due to the lack of workshop-compatible infrastructure in and around studio buildings (Figure 3). At Abdullah Gül University, it is not uncommon for students to spill out onto sidewalks, stair landings, and adjacent streets in order to build models or collaborate on hands-on tasks. This informal and unprotected use of exterior space has long revealed a critical yet unmet need: a spatial interface that bridges the disciplinary world of the studio with the performative demands of making.

Recently, a notable change has occurred in this micro-context. The main vehicular road running in front of the architecture studios has been closed to traffic by university authorities, transforming the street into a semi-pedestrianized zone. This shift opens up possibilities for reconceptualizing the street not simply as leftover circulation space, but as a latent spatial resource—one that could support creative production, social interaction, and experimental learning.

The central design problem, then, is to intervene at what we refer to as the “transitional scale”—a threshold condition that exists between conventional street furniture and permanent architectural structures (Figure 4). Students are asked: what kind of spatial elements can be introduced that are more than benches or trash bins, but less than full buildings? How can this in-between scale support physical making, enable temporary shelter, or mediate flows between indoor and outdoor academic life?

Figure 3: Workshop problematic of AGU Architecture Design Studios

This speculative problem requires students to design street furniture for a specific location, but with an eye toward programmatic ambiguity, spatial adaptability, and temporal responsiveness. The intervention should respond to both short-term student needs—such as space for model-building or reviews—and long-term spatial narratives of the campus. Issues of microclimate, material robustness, mobility, and social usability are expected to be addressed.

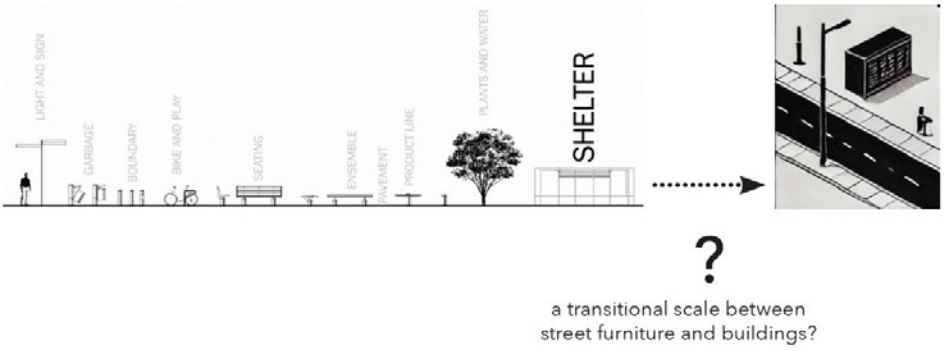

Figure 4: Conceptual diagram of scale in between furniture and building

AI is integrated into the project as a critical design partner. Students are expected to generate design ideas, typologies, or spatial scenarios through AI tools (e.g., image generation, form manipulation, or prompt-based exploration). However, rather than accepting AI-generated outputs as final, students are expected to evaluate, reinterpret, and rework them through manual sketching, modeling, and contextual analysis. They are encouraged to use AI not for speed or optimization, but as a way to challenge their own assumptions about spatial use, typology, and aesthetics.

Key questions students are invited to reflect on include: Where does furniture stop and architecture begin? What spatial qualities make a design element “transitional” rather than fixed or decorative? How can AI contribute to—but not dictate—the development of design strategies that operate at this intermediate threshold?

The goal is not to propose definitive solutions, but to cultivate architectural sensitivity to overlooked spatial potentials, and to critically integrate emerging technologies like AI into speculative, yet contextually anchored, design processes.

3. CONDUCT

The conduct of the experimental design studio was not structured as a linear sequence of assignments, but rather as a layered pedagogical ecology composed of three interrelated thematic domains: research, design, and realization (Figure 5). Each domain hosted specific intentions and learning dynamics (Figure 6), framing how students encountered, negotiated, and ultimately reframed the relationship between architectural design and AI. Rather than positioning AI as a neutral or technical addition to the studio, the course treated it as an epistemic actor—a speculative collaborator with the potential to reshape how problems are posed, how form is imagined, and how authorship is distributed.

3.1. Research

The studio opened not with a fixed brief, but with an invitation to problematize. Students were introduced to the design context—an underutilized, newly pedestrianized campus street often appropriated informally by architecture students due to the lack of proper workshop facilities. Through collective framing exercises, they were guided to identify embedded contradictions, site-specific frictions, and spatial silences. These reflections were expanded through critical site analysis, photographic documentation, behavioral mapping, and observational sketching.

The research process was also dialogical. Students conducted open-ended interviews with key user groups, which revealed how spatial needs, frustrations, and improvisations shaped everyday use of the site. In parallel, students held generative dialogues with AI systems, using large language models to simulate counter-arguments, alternate framings, and provocative what-if scenarios.

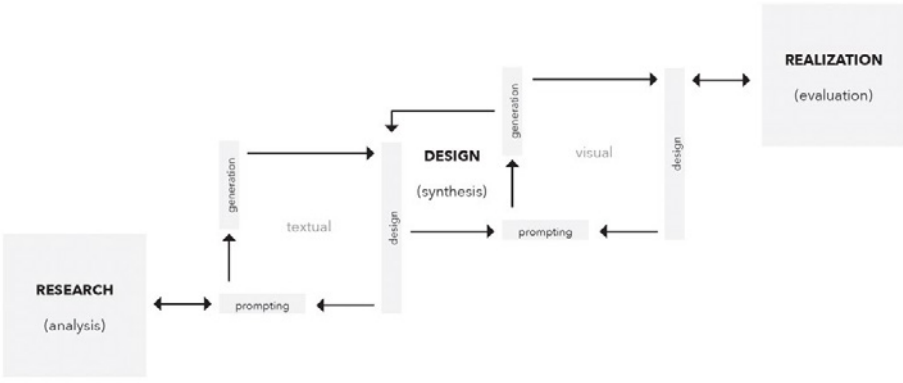

Figure 5: AI-aided design process conception

These multiple layers of inquiry were synthesized into comparative concept maps that visualized overlapping—and conflicting—interpretations of the same design problem.

Within this phase, students began developing an acute sensitivity to the act of framing itself. They learned to recognize how problems are shaped by context, narrative, and perspective. They cultivated the ability to integrate analog, social, and computational sources of knowledge into a shared conceptual space. The aim was not just to define what the problem was, but to understand how it could be continuously redefined.

3.2. Design

The design domain unfolded not as a linear progression from research to solution, but as an iterative space of negotiation between human-centered reasoning and machine-supported speculation (Zhou et al. 2024; Dall'Asta 2025). Inspired by speculative frameworks, the studio emphasized iterative prompt refinement in the creative cycle (Ayres 2023). In this context, students were introduced to AI-aided design as a dynamic co-creative process involving both textual and visual prompting—leaning on cycles of ideation, evaluation, and refinement (Kulkarni et al. 2023; Ayres 2023).

In the textual prompting phase, students crafted 300-word design narratives that synthesized their research insights into structured design intents. These narratives served dual roles—as critical reflections and as operational instructions to be interpreted by AI. Prompt-writing became a design act in itself, demanding clarity, intentional ambiguity, and narrative precision. The students' growing awareness of how language shapes form—and how AI responds to tone, structure, and specificity—became central to the studio's pedagogical focus. When students submitted their prompts to AI systems, they received speculative visual outputs that varied widely in quality, alignment,

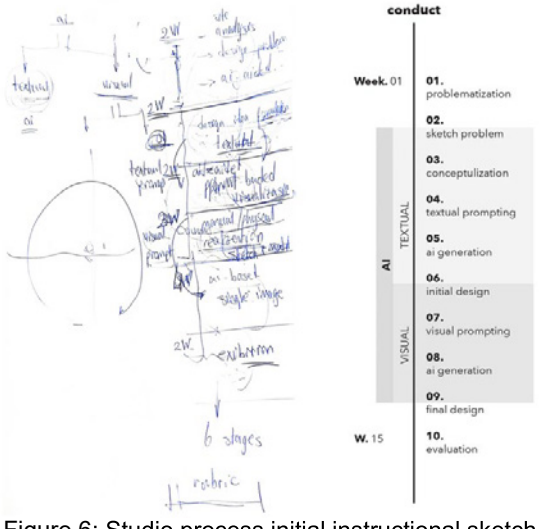

Figure 6: Studio process initial instructional sketch and its realization

and usefulness. These images were treated not as proposals, but as provocations: aesthetic suggestions that required interrogation. Students learned to evaluate what AI had "understood" or misread, to identify where the outputs aligned with their intentions and where they departed into

unexpected terrain. Through this engagement, they developed the capacity to see design not as a one-way projection of vision, but as a reflective process conditioned by interpretation and feedback.

In the visual prompting phase, the dynamic reversed. Students submitted their own sketches, diagrams, and models as visual prompts to AI systems, initiating a second layer of iteration. This time, AI was asked to read the student's work, process its compositional logic, and generate speculative continuations or alternatives. Students were challenged to interpret how the machine responded to form, proportion, line weight, and atmosphere. This process deepened their representational awareness and expanded their ability to modulate design intent through both form and input strategy.

Across both phases, students were developing critical literacies that extended beyond software skill. They were learning to direct AI with purpose, to recognize when it reinforced or distorted their concepts, and to balance computational outputs with human judgment. They refined their ability to use AI as a means of deepening design thought, not shortcutting it.

3.3. Realization

The realization domain marked a return to manual authorship—not as a rejection of AI, but as a synthesis of all preceding iterations. Students re-approached their designs through sketching, model-building, and heuristic testing, engaging with AI-generated materials as unresolved artifacts to be critically edited, layered, and reconfigured. The aim was not to finalize a form, but to evaluate which elements carried spatial or programmatic integrity, and which were decorative, speculative, or insufficiently grounded.

This final manual phase served as a filter. Students exercised judgment, tested assumptions, and restored complexity where AI had generalized or oversimplified. In doing so, they began to see the value of ambiguity, contradiction, and partial resolution as components of design intelligence. The physical process of reinterpretation also made room for material logic, tectonic consideration, and real-world constraint—elements often abstracted away in AI workflows.

The studio concluded with an interactive exhibition, in which students presented their work to the same user groups interviewed at the beginning of the semester. These public sessions allowed students to reflect on how their ideas had changed, how AI had influenced their process, and how user feedback was re-integrated into the final outcome. This loop from human to machine and back again—reflected in both the work and the conversation around it—solidified the studio's goal of forming a critical, reflective, and participatory design culture.

Through this structure, students developed the ability to synthesize human and nonhuman inputs, to trace design logic across multiple representational forms, and to communicate how intentions evolve across iterations. They learned that authorship is not a fixed identity, but a situated role negotiated across time, tools, and conversations.

3.4. Section Summary

The conduct of the studio demonstrated that AI's integration into architectural education must be approached as a pedagogical rethinking, not a technical substitution. Rather than providing efficiency, AI was positioned to destabilize assumptions, provoke re-framings, and surface new connections across scales, systems, and styles. The studio structure made space for students to test, reject, co-opt, and rework AI outputs—not to rely on them, but to think through them.

By embedding learning objectives and developmental outcomes across the research, design, and realization domains, the studio supported a coherent but flexible pedagogical trajectory. Students moved from reframing the problem, to generating and interpreting speculative content, to asserting grounded design decisions through layered synthesis. Along the way, they built a design literacy

attuned to ambiguity, agency, and collaboration—both human and artificial.

Ultimately, the studio enacted a model of AI-aided design not as an end in itself, but as a means of expanding critical and creative capacity—equipping students with the ability to work reflectively within complex, evolving, and increasingly hybrid design environments.

4. FINDINGS

The initial phases of the studio revealed a strong motivation among students to engage with the design problem, particularly in light of the course's emphasis on AI as a creative research partner rather than a mere tool. Through early discussions and sketch problems, students demonstrated curiosity and enthusiasm, particularly encouraged by the course's open research-driven structure and transparent incorporation of AI. However, their conceptual development and representational capacities proved limited at this stage. Many students struggled with abstracting spatial problems, particularly in understanding the scale differential between furniture and architectural design. Their sketches often lacked depth, coherence, and graphical clarity, revealing unfamiliarity with visual taxonomy and critical vocabulary. Despite active participation, the gap between their motivation and expressive capabilities underscored a broader issue in early-stage design cognition—particularly in articulating spatial problematics both visually and verbally (Figure 7).

Simultaneously, site observations and critical documentation exercises carried out in parallel revealed further limitations. While students actively engaged in photographing and analyzing the designated street, their ability to translate spatial constraints into architectural insight remained underdeveloped. What emerged, however, was a growing sensitivity to site-based contradictions—shading, circulation, usability—that would later serve as anchoring points in more developed iterations (Figure 8).

A significant shift was observed during the third and fourth phases, where AI was formally introduced into the process. Students engaged

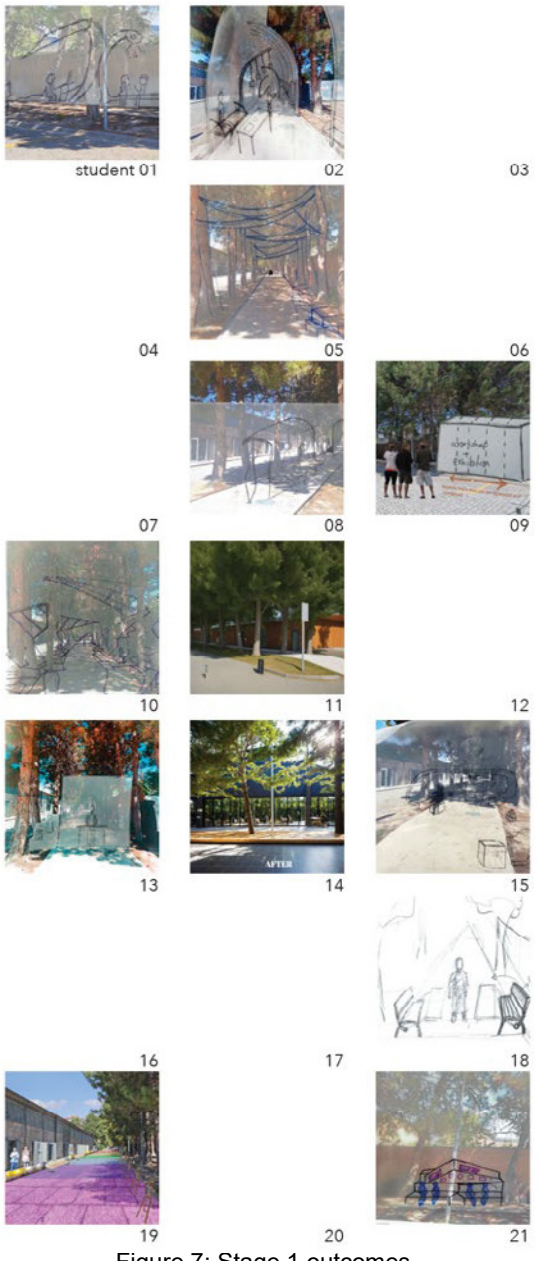

Figure 7: Stage 1 outcomes

in open-ended interviews with campus users and followed up with AI-based brainstorming sessions. This dual engagement—with both human and machine interlocutors—enabled students to refine and expand their conceptual maps. Their vocabulary became richer, their thematic concerns more layered. Notably, AI's capacity to offer terminological variety and associative breadth triggered what several

students described as “aha” moments, opening pathways for alternative framings of the design brief (Figure 9).

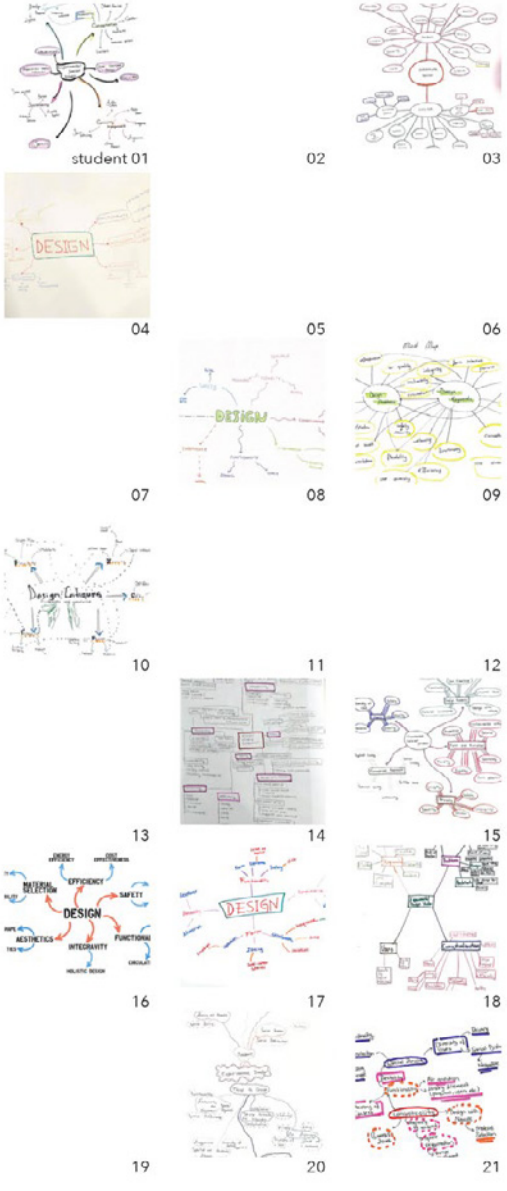

Figure 8: Stage 2 Outcomes

Visual outcomes in this phase reflected increased confidence in diagrammatic thinking. Students developed graphic syntaxes combining stakeholder feedback with AI-generated concepts, often reorganizing and critiquing their own frameworks through iterative mapping.

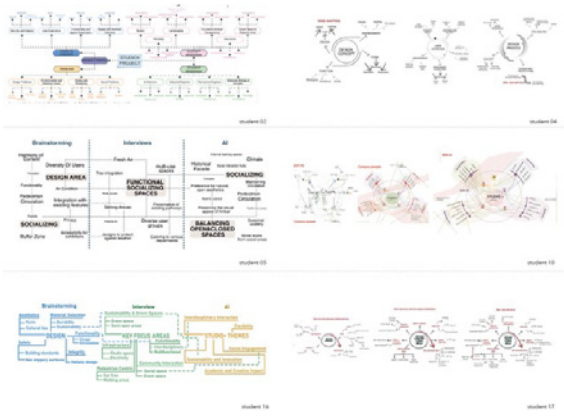

Figure 9: Stage 3 Outcomes

While challenges in categorical organization remained—particularly in synthesizing overlapping themes—the decision to leave classification methods open-ended proved pedagogically effective, as it encouraged interpretive agency. Overall, these stages facilitated a critical shift: students moved from viewing design as solution-oriented to seeing it as conceptually scaffolded inquiry.

In Phases 5 through 8, students moved into iterative design development, alternating between AI-generated visualizations and manual explorations. Initial attempts at translating the 300-word prompts (Figure 10) into visuals via text-to-image AI exposed a key limitation: AI struggled to grasp the specificity of the site’s physical context, often generating speculative but generic outputs. Nonetheless, students learned to engage with this shortcoming critically, using AI not as a form-giver but as a catalyst for design thinking. They began integrating AI visualizations into their manual work—via sketches, models, and hybrid diagrams—not as final outputs, but as provocations.

The interplay between AI and human-centered design practice was particularly evident in the sixth phase, where students appropriated AI outputs as heuristic starting points. The freedom to choose their own representation tools (analog sketching, physical models, or digital assemblages) allowed a diversity of creative expressions to emerge. Compared to earlier stages, students exhibited a more refined understanding of scale, proportion, and spatial

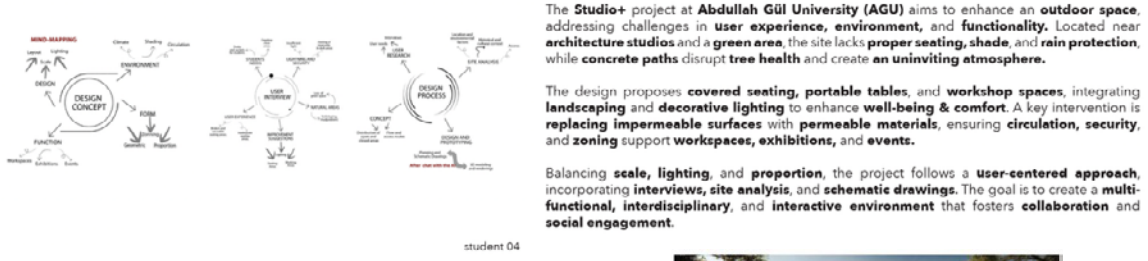

Figure 10: Stage 4 Outcomes

hierarchy. More importantly, they began to assert authorship—despite AI involvement—reflecting a growing confidence in their conceptual and ethical stance (Figure 11).

In the subsequent phases (7 and 8), students returned to AI with their own models and visuals as visual prompts (Figure 12). This shift—from textual prompting to visual feedback—marked a deepening of the design dialogue. Students tested how AI "understood" their evolving design ideas, analyzing its interpretive capacities. However, new challenges emerged: most AI platforms lacked continuity across iterations, limiting their usefulness for progressive development. Some programs (e.g., Leonardo AI, Render AI) allowed partial progession, but others generated entirely new outputs with each prompt. Still, students demonstrated resilience by experimenting with hybrid prompt strategies and leveraging visual feedback cycles to refine their design language. For example, AI outputs were dissected spatially—across x, y, and z axes—to extract latent logics and feed them back into the students' own design grammars (Figure 13).

The final design phase (Phase 9) showcased projects that were both diverse and cohesive. Students integrated AI-derived and manually developed ideas into design proposals that reflected personal authorship. The studio structure had explicitly legitimized AI as a visible and discursive design component, which appeared to liberate students from ethical ambiguity or self-censorship. All students confidently claimed authorship over their work, arguing that AI served as a dialogic partner rather than an originator of ideas. This sentiment was shared by the instructor team and external

Figure 11: Stages 5 & 6 Outcomes

stakeholders, who agreed that the studio's open methodology offered a model for ethically sound, AI-integrated pedagogy (Figure 14, 15).

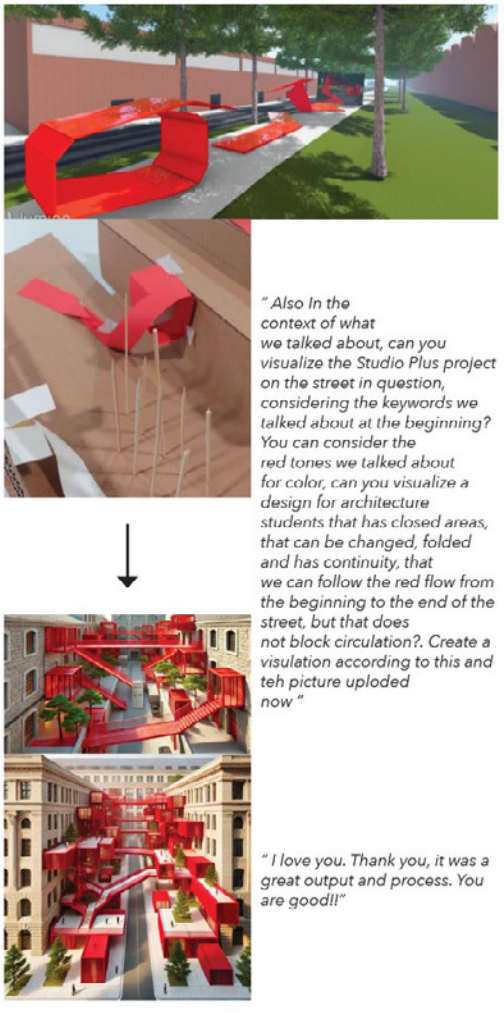

Figure 12: Stages 6 & 7 Outcomes

Figure 13: Example creative approach for AI-generated visual interpreation and utilization from stages 5 to 8

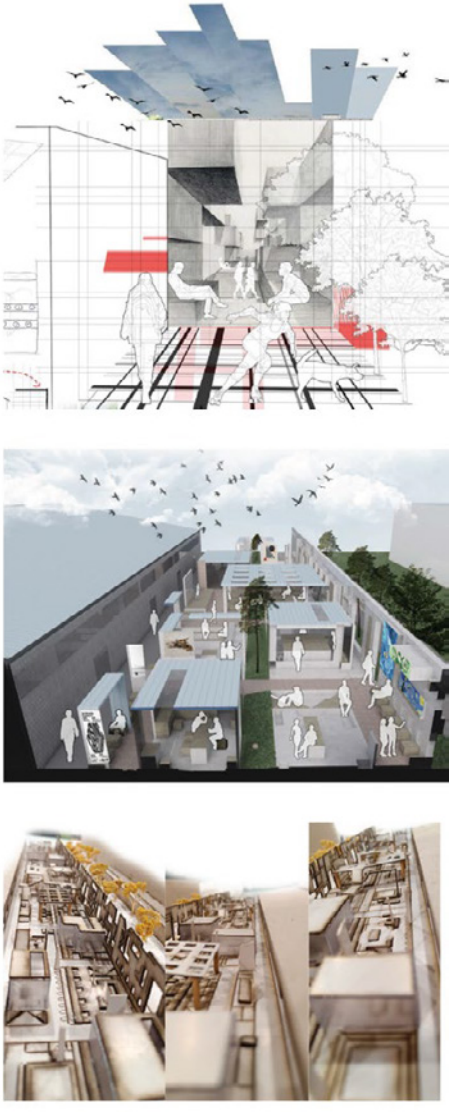

Figure 14: Examples of Final Design Outcomes

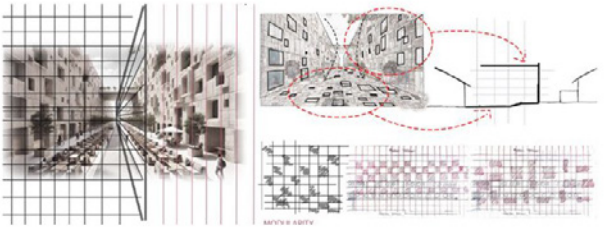

Figure 15: Final Design Outcomes

Yet, spatial critiques persisted. During the final exhibition (Phase 10), jury members questioned the spatial coherence of certain proposals, noting lapses in human-scale consideration, material thinking, and tectonic logic. Several designs were described as overly top-down, lacking in bottom-up spatial calibration. Nonetheless, reviewers were impressed by the conceptual maturity and narrative clarity of the projects. Many recognized that the richness of the design intentions stemmed from the iterative feedback cycles with AI, which allowed students to externalize and challenge their assumptions.

Student reflections revealed a shared recognition of AI's dual role: it was both a creative trigger and a mirror for self-awareness. Several students noted that the process helped them better understand traditional design workflows by contrast—emphasizing the importance of site-specific constraints, iterative detailing, and critical synthesis. Additionally, they acknowledged that while AI struggled with contextual fidelity, it excelled at pushing conceptual boundaries and facilitating representational innovation (Figure 16).

5. CONCLUSION

This study has explored the structured integration of AI within an experimental design studio, offering a pedagogical model that repositions AI not merely as a tool for production, but as a co-agent in architectural thinking and inquiry. By embedding AI at multiple stages of the design process—problem framing, concept development, iterative prototyping, and representation—students engaged in a hybrid design literacy that blended human intuition with machine-driven speculation. The findings reveal that when scaffolded appropriately, AI can catalyze critical reflection, epistemic awareness, and design authorship, rather than displace them.

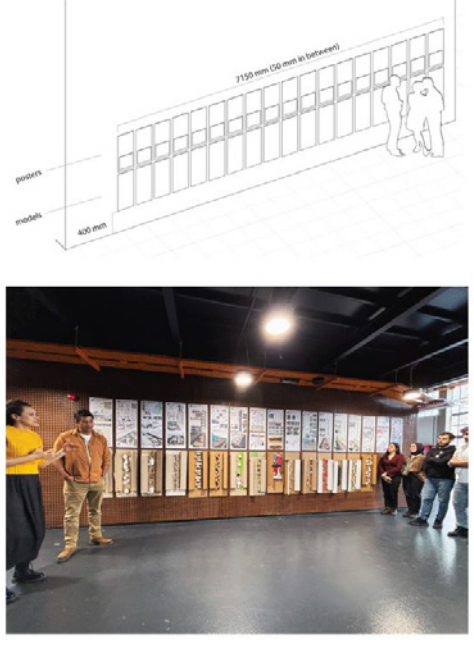

Figure 16: Final exibition jury format and day

One of the most significant outcomes of the studio was the shift in students' perception of design agency. Initially inclined to use AI for

efficiency—often to generate ready-made outputs or aestheticized imagery—students gradually began to engage AI systems as interpretive partners. This shift was not automatic, but emerged through carefully curated prompts, iterative feedback loops, and guided opportunities to misread, reinterpret, and reframe. Rather than replacing students' agency, AI exposed its limits, offering moments of contradiction, ambiguity, and surprise that students had to negotiate creatively. As such, the studio not only taught students how to use AI, but how to think with AI.

At the same time, the study surfaced persistent limitations and challenges. The inability of most AI platforms to understand site-specific physical context, particularly in early visual generations, reminded both instructors and students of the irreplaceable role of architectural judgment. Moreover, AI's lack of continuity across iterations often disrupted the progressive logic of design development. These shortcomings, however, became pedagogical opportunities in themselves: students had to confront questions of spatial coherence, scale, proportion, and tectonics—elements frequently abstracted away in generic AI outputs. Rather than undermining the studio's aims, these constraints enriched the learning environment by fostering comparative judgment and material reasoning.

The studio also challenged conventional assumptions about originality and authorship in design. By openly legitimizing AI as a visible part of the workflow, the studio allowed students to confidently claim ownership over their designs. They did not hide their use of AI; instead, they articulated how AI contributed to their thinking, and how they translated and transformed AI suggestions into situated, context-responsive proposals. This ethical transparency, supported by the course structure, prevented self-censorship and allowed students to explore design speculation without fear of plagiarism or misrepresentation.

Ultimately, this research suggests that AI can be pedagogically productive not because it automates design tasks, but because it disturbs them—provoking questions about how design ideas are formed, communicated, and refined. The goal of AI-aided pedagogy, therefore, is not to produce more efficient designers, but more critical ones—students who are capable of navigating hybrid workflows, translating ambiguity into design insight, and positioning emerging technologies within reflective, context-aware practices. As architectural education continues to grapple with the integration of AI, this study contributes an alternative vision: one that treats AI not as a shortcut to solutions, but as a collaborator in asking better questions.

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All participants were informed about the research process and gave consent for the use of their anonymized outputs for academic purposes. No personal data were collected, and the study adhered to institutional ethical standards.

The authors declare no conflict of interest.

7. FOOTNOTES

1- “A framework for ‘knowledge-based’ design, management, and evaluation of architectural design studios”

2- Architecture Students’ Creative Engagement with Artificial Intelligence in Their Creative Design Processes: Augmenting an Experimental Architectural Design Course as a Creative Instructional Practice

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