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Refocusing Structure in Architectural Education: Integrating Technical Logic and Creative Design

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Abstract

Architectural education increasingly suffers from a conceptual separation between design and structure. While design studios tend to privilege abstract formal exploration, structural education is often reduced to technical calculations detached from spatial imagination. This division leaves students uncertain about how to translate creative intentions into structurally coherent architectural proposals. This paper argues that structure should be understood not as a secondary technical requirement, but as a generative and formative component of architectural design. Drawing on a two-year pedagogical implementation in undergraduate architectural education, the study presents a three-phase experiential learning model integrating analytical observation, digital modeling, and physical model making. Students analyze selected buildings to understand structural behavior and load paths, reconstruct these systems through digital tools, and finally test them through hands-on workshop production. The findings demonstrate that this cyclical learning process strengthens structural intuition, improves proportional and spatial clarity, and fosters more integrated relationships between form, material, and construction. The paper concludes that reintegrating structural knowledge into the creative core of architectural education enhances both design quality and architectural thinking in architectural education.

Keywords: architectural education, structure, experiential learning, model making, structural logic, design pedagogy

1. Introduction: The Problem of Separation

In contemporary architectural education, a persistent separation between design and structure has become increasingly visible. Design studios frequently emphasize conceptual narratives, abstraction, and visual expression, while structural education is often delivered through formulas, calculations, and isolated technical exercises. As a result, students struggle to integrate these two domains into a coherent architectural language.

This fragmentation produces a critical pedagogical gap. While students may develop strong conceptual intentions, they often lack the ability to translate these ideas into structurally sound and spatially coherent proposals. Structure is often treated as a secondary technical layer rather than a formative design component. Previous studies in architectural pedagogy have identified this division as one of the core challenges of design education (Salama, 2015).

This paper addresses this gap by reframing structure as an integral component of the design process rather than an external technical layer.

1.1 Integrating Structure and Design in Architectural Education

Architectural education has long struggled with the challenge of integrating structural knowledge into the design process in a meaningful and generative manner. Within conventional curricula, courses on structures and construction are often positioned as technically oriented requirements that remain detached from architectural studio work. As a result, structural systems are frequently perceived by students as constraints to be accommodated after formal and spatial decisions have already been made, rather than as active drivers of architectural thinking. This pedagogical separation has contributed to a persistent gap between architectural imagination and structural logic, reinforcing a division between design creativity and technical knowledge (Salama, 2015; Lawson, 2006).

Scholars in studio-based education have critically addressed this issue, emphasising the need for more integrative teaching models that bridge design studios and technical courses. Schön's concept of the "reflective practitioner" highlights the importance of learning through action and reflection, suggesting that architectural knowledge is developed through iterative engagement with design problems rather than through the passive acquisition of theoretical information (Schön, 1983). Similarly, Salama argues that design education must move beyond compartmentalised instruction and adopt holistic learning environments in which design, technology, and theory operate in dialogue (Salama, 2015). Building upon this perspective, recent scholarship has emphasised the importance of embedding structural reasoning directly into studio pedagogy, positioning structural thinking as a core component of design development (Fisher, 2021). Within this framework, structural knowledge gains relevance when it is embedded in design processes and tested through spatial, material, and constructive experimentation. Recent empirical studies further reinforce this integrative perspective. Research on design-build pedagogy demonstrates that experiential, material-based engagement enhances students' structural awareness, collaborative learning, and constructional reasoning (Al-Ashmori et al., 2020). Such findings suggest that hands-on structural experimentation is not merely a supplementary activity but a central pedagogical strategy for bridging the divide between conceptual design and constructive logic.

The emergence of digital design tools has further reshaped the pedagogical landscape of architecture, offering new opportunities to rethink how structural systems are taught and explored. Parametric modelling, three-dimensional visualisation, and digital simulation enable students to analyse structural behaviour alongside spatial configurations, fostering a more dynamic understanding of the relationship between form and structure. However, as Oxman and Oxman have noted, digital tools alone do not guarantee meaningful integration; without critical pedagogical frameworks, digital modelling risks becoming a purely representational exercise rather than an analytical and conceptual tool (Oxman & Oxman, 2014). For this reason, digital methods must be combined with embodied learning practices that allow students to experience structural logic at a tangible scale.

Physical model-making remains a powerful pedagogical instrument in this context. By translating digital structural models into physical artefacts, students confront issues of scale, material behaviour, assembly, and stability in a direct and experiential manner. Frampton's emphasis on tectonic expression underscores the importance of material and structural articulation as integral components of architectural meaning (Frampton, 1995). When students engage with structural systems through both digital and physical production, they are encouraged to move beyond abstract formalism and consider how architectural ideas are realised through constructional logic.

Within this broader pedagogical discourse, the integration of structural education into early design studios emerges as a critical objective. Second-year architectural education represents a formative phase in which students begin to develop foundational design methodologies while still remaining open to experimental approaches (Nicol & Pilling, 2000; Salama & Wilkinson, 2007). Introducing structural thinking at this stage allows students to internalise the idea that structure is not an external imposition on architecture, but rather an intrinsic component of spatial organisation and architectural expression. This approach aligns with contemporary educational models that advocate for learning through making, critical experimentation, and iterative design processes.

Against this theoretical and pedagogical background, the present study investigates an integrated teaching model that brings together theoretical instruction, digital modelling, and physical model-making within a structure-focused course for second-year architecture students *(Figure 1)*. Rather than treating structural systems as isolated technical content, the course framework positions structure as a generative design input that actively shapes architectural decisions from the early stages of the design process. By analysing the outcomes of a two-year implementation of this teaching approach, the study aims to contribute to ongoing debates on architectural pedagogy and offer insights into how structural education can support creativity, analytical thinking, and design coherence in architectural training.

Contemporary empirical research underscores the pedagogical importance of experiential and constructivist approaches in architectural education. Recent studies on design–build projects suggest that hands-on making activities and experimental structures significantly enhance students' understanding of structural systems and material logic by bridging theoretical knowledge and practical application (Avinç, 2024). Research on transformative pedagogy in design studios highlights how process-based, student-centered learning contributes to creativity, critical reflection, and autonomy in architectural thought (Xhambazi & Aliu, 2024). Investigations into pedagogical effectiveness in architectural studios further indicate that active strategies such as iterative making, collaborative engagement, and reflective practices can improve the coherence between conceptual intentions and technical competencies (Anteet, 2025; Kassem, 2023). Additionally, experimental learning approaches in basic design studios have been shown to positively affect students' observational skills and analytical reasoning by integrating real-world observations into design tasks (Wang, 2025). These empirical insights support the present study's three-phase experiential model and locate it within a broader trend towards integrated, embodied architectural pedagogy.

Figure 1: Students constructing timber structural models during the workshop phase, emphasizing collective learning and material-based experimentation
Source: Author's archive.

1.2 Structure as a Generative Design Element

The central pedagogical argument of this study is simple yet radical: structure is design**.** Structural systems do not merely support architectural form; they actively generate spatial order, proportion, rhythm, and material expression. Decisions regarding material choice, span, load transfer, and connections inherently shape architectural experience.

Instead of approaching structure as abstract knowledge, the proposed methodology treats it as embodied understanding an encounter with material behavior, gravity, and resistance. This approach aligns with constructivist learning theories, which emphasize learning through experience and physical engagement (Kolb, 1984).

By situating structural logic at the core of design thinking, students begin to recognize that every architectural decision carries structural consequences and opportunities.

2. Materials and Methods

The study adopts a qualitative interpretive research design grounded in studio-based educational inquiry. Rather than aiming for statistical generalization, the research seeks analytical generalization through recurring patterns identified across student outputs over a two-year implementation.

2.1 Course Context and Participants

The study was conducted over two consecutive academic years within a compulsory Structure and Construction course offered in the second year of the Bachelor of Architecture program at Samsun University. The course ran weekly throughout one academic semester.

The participant cohort consisted of 41 second-year undergraduate architecture students. At this stage, students had completed introductory design studios but had limited prior engagement with structural reasoning beyond theoretical exposure. The second-year level was intentionally selected as a formative phase where integrative thinking between design and structure can meaningfully emerge.

2.2 Instructional Framework and Learning Instruments

The instructional framework was structured around a three-phase experiential learning model:

1. Analytical Observation (theoretical and structural reading),
2. Digital Modeling,
3. Physical Model-Making Workshops.

These phases functioned as sequential yet cyclical pedagogical instruments.

1. **Analytical Observation:**
   Core structural concepts -including load transfer, material behavior, and structural typologies -were introduced through lectures framed around spatial and architectural implications rather than calculation-based instruction.
2. **Digital Modeling Exercises:**
   Students developed structural systems in digital environments (e.g., SketchUp, Rhino, Revit). Models were evaluated based on structural clarity, dimensional consistency, and coherence between structural logic and spatial configuration.
3. **Physical Model-Making Workshops:**
   In workshop sessions, students translated digital systems into physical scale models using timber elements and basic connection components. This phase functioned as the primary experiential instrument, enabling direct confrontation with gravity, stability, material resistance, and joint performance.

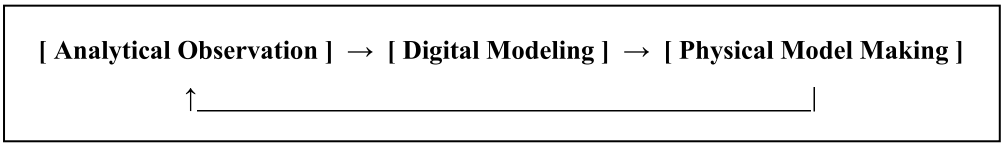

Figure 2: Conceptual diagram of the three-phase experiential structure–design integration model.

While the three phases function as methodological instruments within this study, their detailed pedagogical articulation and theoretical positioning are further elaborated in Section 3.

2.3 Data Collection and Analytic Procedures

Data were collected from multiple qualitative sources generated within the course:

- Student digital structural models
- Eight selected physical structural models
- Instructor observation notes
- Critique session discussions
- Structured assessment rubric evaluations

The eight physical models were selected as representative cases based on completeness of submission and visibility of structural reasoning processes.

Thematic coding was conducted in two stages. First-cycle coding identified recurring structural articulation patterns within student projects. Second-cycle axial coding clustered these observations into three principal pedagogical dimensions.

1. Structural clarity and load articulation
2. Coherence between structural system and spatial organization
3. Material awareness and constructability logic

Special attention was given to revision traces observed during the workshop phase for instance, cases where instability or oscillation led students to introduce diagonal bracing, reinforce connections, or complete omitted structural members. These iterative corrections were interpreted as evidence of developing structural understanding.

2.4 Ethical Considerations and Limitations

All student works were analyzed anonymously and used exclusively for educational research purposes. The study prioritizes qualitative depth over statistical measurement and aims to contribute to pedagogical discourse through process-based insights rather than standardized performance metrics.

3. Methodology: The Three-Phase Experiential Learning Model

Building upon the methodological framework outlined in Section 2, this section elaborates the pedagogical logic of the three-phase experiential model. Rather than presenting the phases merely as instructional steps, the model is understood as a structured process that gradually shifts students’ engagement with structure—from analytical observation to embodied material experimentation.

The following articulation is guided by the central research question:

How can structural education be repositioned as a generative component within the architectural design process through a phased experiential learning framework?

In this regard, the cyclical structure of the model aligns with recent studies examining experiential learning cycles in architectural education, which emphasise iterative reflection, material engagement, and phase-based pedagogical sequencing (Rittelmeyer & Sandström, 2022).

3.1 Phase One: Analytical Observation and Structural Reading

The first phase focuses on analytical observation through the study of selected architectural examples. Buildings are introduced as structural systems rather than formal compositions, and students are guided to examine how loads are transferred, how structural elements define spatial order, and how material choices influence architectural expression.

Rather than privileging stylistic or historical interpretations, this phase emphasizes structural legibility and clarity. Students trace load paths diagrammatically and compare different structural typologies -such as timber frames, reinforced concrete systems, and steel structures- to understand how each system generates a distinct spatial and architectural language. This analytical reading establishes a conceptual foundation that informs subsequent digital and physical explorations.

3.2 Phase Two: Digital Modeling as Analytical Representation

The second phase translates analytical observations into digital structural models, positioning digital modeling as an analytical rather than representational tool. Students reconstruct structural systems using accessible architectural software and explore the relationship between geometry, span, proportion, and structural logic.

At this stage, digital models function as an intermediate thinking environment**,** enabling students to test alternative structural configurations, evaluate spatial consequences, and refine design intentions prior to physical production. Emphasis is placed on clarity of load-bearing logic and coherence between structural systems and spatial organization, reinforcing the integration of technical reasoning into early design decisions.

3.3 Phase Three: Physical Model-Making and Material Experimentation

The third phase constitutes the pedagogical turning point of the model and centers on hands-on physical model-making workshops**.** Students translate their digital structural models into physical artefacts using real materials, most commonly timber elements and simple connection components.

This phase enables direct engagement with material behavior, gravity, balance, and resistance. Structural failures -such as bending members, unstable joints, or collapsed spans- are treated as productive learning moments rather than design errors. Through tactile interaction and collective workshop critique, students gain embodied understanding of structural behavior that cannot be fully conveyed through drawings or digital simulations alone.

Physical model-making thus serves as the primary experiential instrument of the methodology, bridging abstract structural logic with material reality and reinforcing the idea of structure as an active generator of architectural form.

3.4 Cyclical Integration and Pedagogical Outcomes

Although presented sequentially, the three phases operate as a cyclical learning process**.** Insights gained through physical experimentation frequently lead students to revisit digital models and analytical assumptions, fostering iterative refinement and reflective learning.

This cyclical structure supports the development of structural intuition by encouraging students to continuously move between analysis, representation, and material engagement. As observed across the two-year implementation, this methodology facilitates a shift in students' perception of structure from a technical constraint applied after design decisions to a generative component embedded within the architectural design process itself.

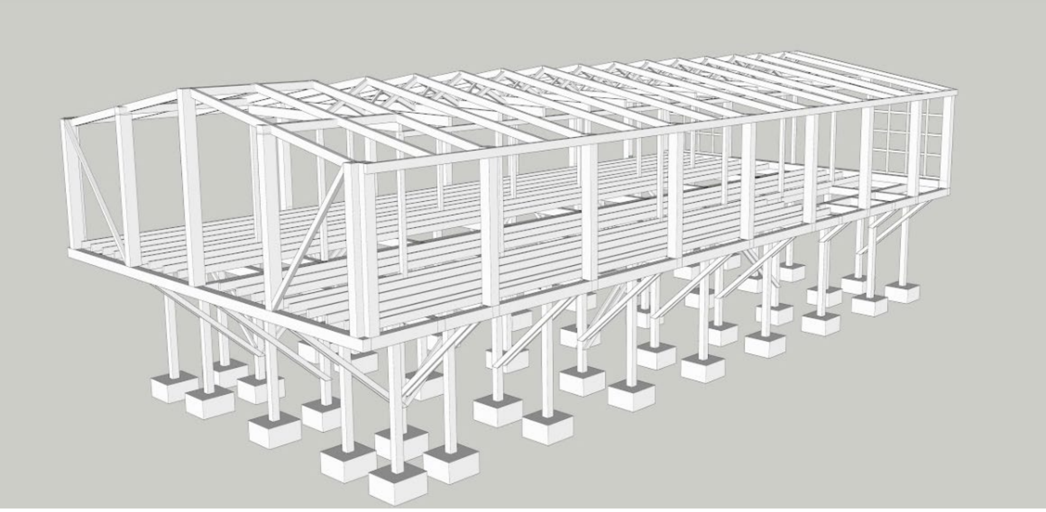

Figure 3: Individual material testing and dimensional calibration as part of developing structural intuition.
Source: Author's archive.

Figures 3 and 4 illustrate the material-testing process and the completed structural prototypes produced during the workshop phase.

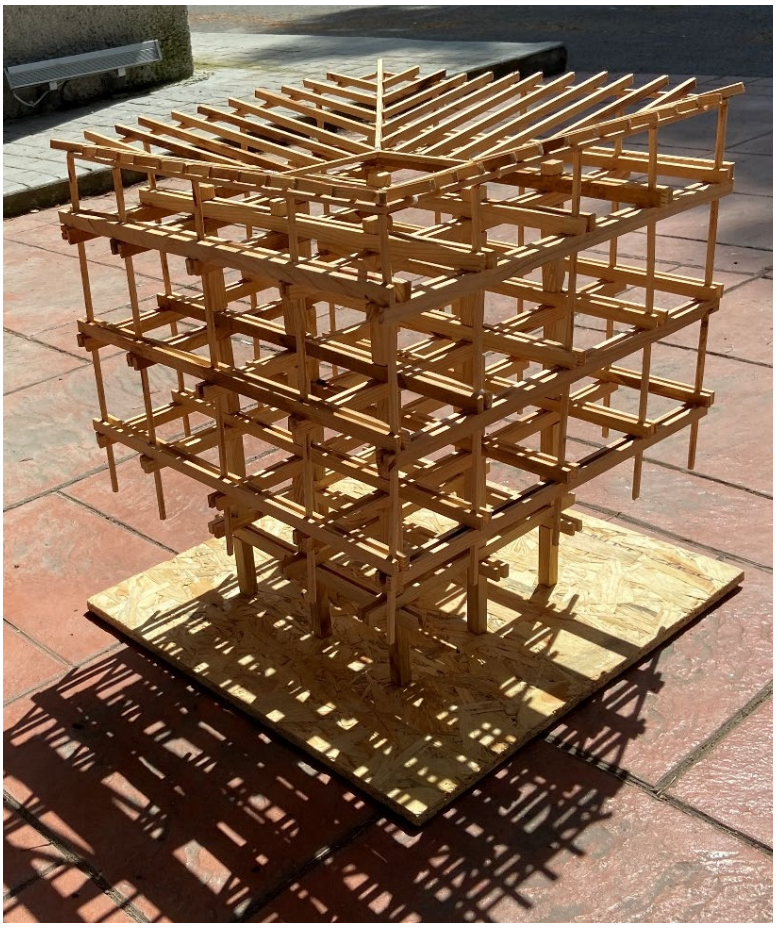

Figure 4: Completed physical structural models illustrating the integration of structural logic and spatial clarity.
Source: Author's archive.

4. Material Awareness and Structural Intuition

During the workshop process, students gradually develop material awareness. Timber reveals its affinity for rhythm and repetition, steel resists bending and favors tension, while concrete demands precision and formwork discipline. These encounters cultivate structural intuition -an ability to anticipate how systems behave under load.

This phase transforms students' design instincts. Structural decisions are no longer postponed but inform early design moves. The workshop thus bridges abstract design intentions with physical reality. Recent studies on material-based studio experimentation further emphasise the cognitive and spatial impact of embodied learning processes within architectural education (Bologna & Pinto, 2021).

5. Observed Outcomes

The model was implemented over two consecutive academic years, allowing for systematic observation of learning outcomes. Several consistent patterns emerged:

- Students demonstrated increased confidence in selecting and comparing structural systems.
- Design decisions became more clearly grounded in structural logic.
- Architectural projects showed observable improvement in proportion, clarity, and feasibility.

Most significantly, students' perception of structure shifted. Structure was no longer perceived as a constraint, but as a supportive component of architectural expression.

6. Discussion: Reintegrating Structure into Creative Practice

In an era of rapid technological advancement and disciplinary specialization, architectural education risks becoming fragmented. Design, technology, and construction are often taught as separate domains, weakening their conceptual integration.

The three-phase experiential model discussed in this paper offers a structured means of reintegrating structure into architectural education. By aligning analytical reasoning with tactile experience, the method supports a holistic understanding of architecture as both imaginative and constructive.

In addition to these outcomes, the discussion highlights the broader pedagogical implications of integrating structure and design through experiential learning. By positioning structural systems not as constraints to be resolved but as instruments of inquiry, the proposed model supports a noticeable pedagogical shift in students' structural awareness when approaching architectural design problems. This shift enables learners to negotiate architectural complexity through iterative testing, comparison, and reflection, reinforcing critical thinking alongside creative exploration.

Furthermore, the integration of analytical observation, digital modeling, and physical model making encourages students to move fluidly between abstraction and material reality. This iterative movement strengthens their ability to evaluate architectural decisions across multiple representational modes. The transferable nature of the three-phase experiential model suggests that it may be adapted to different institutional contexts, curricular structures, and material emphases. While the present study focuses on a specific educational setting, the framework offers a pedagogical reference for future curriculum development and comparative research on the long-term impact of integrated structure–design education in architectural training.

Table 1. Learning Outcomes of the Three-Phase Experiential Model

Phase	Intended Learning Outcome	Assessment Indicator
Analytical Observation	Ability to trace load paths and identify structural logic	Clarity of diagrammatic analysis
Digital Modeling	Integration of geometry and structural reasoning	Coherence of structural system in digital model
Physical Model Making	Material awareness and structural intuition	Stability, joint resolution, structural articulation

6.1 Limitations and Transferability of the Model

While the findings of this study demonstrate the pedagogical value of integrating structure and design through experiential learning, certain limitations should be acknowledged. The research is based on a specific educational context, institutional structure, and cohort size, which may influence the transferability of the results. Additionally, the qualitative nature of the study relies on observational data and student outputs rather than quantitative performance metrics.

Despite these limitations, the proposed three-phase experiential model offers a flexible pedagogical framework that can be adapted to different architectural curricula. The emphasis on analytical observation, digital modeling, and physical experimentation does not depend on a particular software environment or material system, allowing educators to tailor the approach to local resources, teaching traditions, and cultural contexts.

The model may also be scaled or modified to address different stages of architectural education. While this study focuses on second-year undergraduate students, similar principles could be applied in advanced studios, interdisciplinary courses, or integrated design–build programs. Future research could examine the long-term impact of experiential structure–design integration on students' professional development and explore comparative implementations across institutions.

6.2 Illustrative Case Evidence

A representative case among the eight analyzed physical models further illustrates the pedagogical impact of the three-phase framework. Students who demonstrated greater precision in the analytical and digital phases -particularly in maintaining dimensional consistency and structural alignment- produced more stable and coherent physical prototypes. In contrast, several projects initially omitted essential structural elements such as columns, beams, or diagonal bracing members. During the workshop phase, these omissions resulted in visible instability and structural oscillation. This prompted students to reintroduce missing columns, reinforce beam connections, and incorporate diagonal bracing to ensure lateral stability. The subsequent structural correction not only improved physical integrity but also reshaped spatial articulation. This iterative refinement process evidences a shift from formal abstraction toward material-informed structural reasoning, demonstrating how embodied experimentation reinforces structural awareness and design coherence.

6.3 Practical Implementation Guidelines for Structure–Design Integration

To enhance the transferability of the proposed three-phase experiential model, this section outlines practical guidelines for its implementation within undergraduate architectural curricula. These guidelines are derived directly from the two-year teaching experience discussed in this study and are intended as a flexible framework rather than a prescriptive method. Structured assessment approaches have been shown to strengthen learning outcomes in integrated design-build education contexts (Clevenger et al., 2020). To ensure evaluative transparency and pedagogical consistency, student works were assessed according to the qualitative criteria outlined in Table 2.

Table 2. Assessment Rubric for Structural Integration in the Three-Phase Model

Criterion	Emerging Level	Developing Level	Proficient Level
Structural Clarity	Load transfer unclear or incomplete	Partial load articulation, minor inconsistencies	Clear and consistent load transfer logic
Spatial–Structural Coherence	Structure detached from spatial logic	Partial integration of structural and spatial systems	Structural system fully generates spatial organization
Material Awareness	Inadequate joint resolution, instability	Improved stability with limited refinement	Stable construction with articulated structural detailing
Constructability Logic	Missing elements (columns, bracing, beams)	Corrections applied during assembly	Complete structural system with logical reinforcement

6.3.1 Required Resources and Learning Environment

The model can be implemented using readily available educational resources and does not depend on specialized laboratory infrastructure. Digital modeling activities require standard architectural software commonly used in undergraduate education (e.g., SketchUp, Rhino, or equivalent platforms). Physical model-making workshops rely on basic materials such as timber sticks, simple connectors, and hand tools, allowing the model to be adapted to institutions with limited technical facilities.

Equally important is the learning environment itself. Studio-based settings that support collective discussion, peer observation, and iterative critique are particularly well suited to the experiential nature of the model.

6.3.2 Duration and Course Structure

The three-phase model is designed to unfold across a single academic semester within a weekly course format. Each phase can be introduced sequentially, with analytical observation typically occupying the initial weeks of the semester, followed by digital modeling exercises and culminating in physical model-making workshops.

While the phases are presented in a linear sequence for pedagogical clarity, instructors are encouraged to allow iterative movement between phases as students refine their structural decisions. The model can also be scaled or condensed depending on institutional constraints, making it suitable for both standalone structure courses and integrated design–technology modules.

6.3.3 Assessment Criteria and Pedagogical Evaluation

Assessment within this framework prioritizes process-based learning outcomes rather than final formal resolution alone. Student work can be evaluated using qualitative criteria such as:

- the clarity of structural logic and load transfer,
- the coherence between structural systems and spatial organization,
- the integration of material considerations into early design decisions,
- the ability to reflect on structural failures and revisions.

Critiques, reflective discussions, and comparative reviews of digital and physical models function as key evaluative moments. Rather than employing rigid grading rubrics, this approach supports formative assessment that aligns with the experiential and exploratory nature of the learning process.

6.3.4 Transferability and Pedagogical Scope

Although implemented within a second-year architectural education context, the proposed model is transferable to different levels and formats of architectural teaching. With appropriate calibration, it may be applied in advanced studios, interdisciplinary design–build courses, or introductory construction modules.

By articulating structure as a generative design element and embedding it within an experiential learning cycle, the model provides a practical pedagogical tool for educators seeking to bridge the persistent gap between structural knowledge and architectural design practice.

7. Conclusion

When students engage with structure analytically, digitally, and physically, architecture emerges as a dialogue between imagination and material reality. Rather than positioning structural knowledge as a constraint applied after design decisions, the pedagogical approach discussed in this paper places structure at the beginning of the creative process.

The findings indicate that experiential, material-based learning supports deeper structural understanding and more coherent architectural outcomes. By allowing students to encounter load, resistance, and material behavior directly, the model cultivates structural intuition as an integral design capacity.

The study suggests that reintegrating structure into the creative fabric of architectural education offers a transferable pedagogical framework. Structural knowledge, when taught through experience and making, becomes a source of architectural inventiveness rather than a limitation imposed on design.

Beyond its immediate pedagogical application, this study contributes to ongoing discussions on structure–design integration in architectural education. By operationalizing structure as a cyclical experiential framework, the model offers a transferable methodological template for design–technology integration in architectural curricula.

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References

Al-Ashmori, Y. Y., Othman, I., Rahmawati, Y., Mugahed Amran, Y. H., & Samad, A. A. A. (2020). Design-build as a pedagogical model in architectural education: An experiential learning approach. *Sustainability, 12*(19), 8207. https://doi.org/10.3390/su12198207

Bologna, L., & Pinto, M. R. (2021). Material-based learning in architectural education: Studio experimentation and embodied cognition. *International Journal of Art & Design Education, 40*(3), 553–567. https://doi.org/10.1111/jade.12378

Clevenger, C. M., Ozbek, M. E., & Glick, S. (2020). Assessment strategies in integrated design-build education. *Journal of Professional Issues in Engineering Education and Practice, 146*(4). https://doi.org/10.1061/(ASCE)EI.1943-5541.0000475

Fisher, T. (2021). Integrating structural thinking into architectural studio pedagogy. *Journal of Architectural Education, 75*(1), 32–44. https://doi.org/10.1080/10464883.2020.1859003

Frampton, K. (1995). *Studies in tectonic culture: The poetics of construction in nineteenth and twentieth century architecture*. MIT Press.

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

Lawson, B. (2006). *How designers think: The design process demystified* (4th ed.). Architectural Press.

Oxman, R., & Oxman, R. (Eds.). (2014). *Theories of the digital in architecture*. Routledge.

Rittelmeyer, C., & Sandström, L. (2022). Experiential learning cycles in architecture education: A comparative pedagogical study. *Archnet-IJAR, 16*(2), 349–365. https://doi.org/10.1108/ARCH-09-2021-0194

Salama, A. M. (2015). *Spatial design education: New directions for pedagogy in architecture and beyond*. Ashgate.

Salama, A. M., & Wilkinson, N. (2007). *Design studio pedagogy: Horizons for the future*. The Urban International Press.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.