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Rethinking Building Construction Education: A Phased and Guided Pedagogical Framework

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ABSTRACT

Architectural education requires students to integrate design thinking with technical knowledge, yet building construction and building component design courses are often structured around instructor-centered knowledge transmission in which technical information precedes and remains partially detached from design exploration. Although integrated, experiential, and problem-based approaches have sought to bridge this divide, less attention has been given to when formal technical instruction enters the design learning process and how this timing may shape students' engagement with technical-design problems.

This study proposes a phased and guided pedagogical framework that treats the timing of formal technical instruction as a deliberate instructional design variable in building construction education. The framework is organized through three successive stages: initial problem exploration, structured technical guidance, and the revision of initial design decisions following technical instruction. The framework is conceptually articulated through a stair and vertical circulation module within an undergraduate Building Component Design course, where spatial, ergonomic, regulatory, structural, and representational considerations must be addressed simultaneously. Traditional lecture-based, discovery-based, and phased and guided configurations are used as contrasting pedagogical structures to clarify differences in the sequencing of technical knowledge rather than to establish comparative performance outcomes.

The proposed framework does not claim pedagogical superiority and has not yet been empirically validated. Instead, it provides a conceptual and methodological basis for future investigation of technical reasoning, design decision-making, reflective revision, and knowledge transfer. Its underlying sequence is intended to be adaptable across different building components and stages of architectural education, while also accommodating contemporary access to technical information through digital resources and generative AI.

Keywords: Building construction education; architectural education; phased and guided instruction; technical knowledge; design pedagogy

1. INTRODUCTION

Architectural education has historically been defined as a field of learning in which the acts of designing and building are addressed simultaneously and in an integrated manner. This field has been understood not only as a domain of formal production, but also as a multi-layered body of knowledge that centers on the reciprocal interaction of technical knowledge, construction logic, and spatial decision-making (Gropius, 1965; Schön, 1987; Salama, 2016). In this sense, architectural education is positioned as a dynamic learning environment in which the relationship between theoretical knowledge and practical production can be continuously re-examined. However, this holistic perspective is not reflected equally across all components of architectural education. In particular, in courses on building construction and building component design, the relationship between technical knowledge and the design process is often addressed within a fragmented and transmission-oriented pedagogical framework. National and international literature indicates that these courses are largely conducted through instructor-centered lectures, standards-based information transfer, and technical drawing practices (Webster, 2008; Aydınlı & Avcı, 2010; Aydınlı, 2015; Salama, 2016). Within this approach, the primary expected learning outcome is defined as the ability to accurately reproduce and represent

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technical rules, while technical knowledge is frequently reduced to a decontextualized set of regulations (Webster, 2004; Kahvecioğlu, 2007).

This transmission-oriented pedagogical structure separates construction knowledge from the design process and positions students as passive recipients of information, thereby limiting the development of critical thinking, problem-solving skills, and the ability to justify technical decisions (Freire, 1970/2007; Webster, 2008). Teaching building construction primarily through regulations, dimensions, and detail accuracy makes it difficult for students to perceive this knowledge as an active component of architectural decision-making. As a result, technical knowledge is often understood not as a cognitive tool that informs design thinking, but rather as an external requirement that must be applied.

In contrast, the literature demonstrates that learning environments in which building construction courses are integrated with design studios and experiential learning processes significantly strengthen students' conceptual understanding, technical reasoning, and ability to establish the design–construction relationship (Alakavuk, 2016; Shareef & Farivarsadri, 2020). These studies show that introducing technical knowledge at the appropriate moment and within a relevant context enables students not only to produce correct solutions, but also to evaluate these solutions through cause–effect relationships. However, in the context of Türkiye, there are relatively few studies that systematically address such integrated pedagogical frameworks in building construction education (Altun & Yazıcıoğlu, 2010; Yazıcıoğlu, 2013; Kızılyaprak & Altun, 2019; Metin, 2023).

Existing pedagogical practices have already demonstrated different ways of integrating technical knowledge with architectural design through integrated studios, coordinated technology courses, and comprehensive design frameworks (Saghafi & Crowther, 2021; Metin, 2023; Shahverdi et al., 2024; Uçar et al., 2025). These approaches indicate that the integration of technical and design knowledge is not, in itself, a new pedagogical proposition. Rather than claiming novelty through integration alone, the present study focuses on a more specific pedagogical variable: the timing, sequencing, and contextualization of technical knowledge within the design process. The proposed framework examines what changes when students first encounter a design problem through exploration and structured technical guidance is subsequently introduced in direct relation to the questions, difficulties, and decisions emerging from this initial experience.

In recent years, digitalization in architectural education has emerged as a potential area of response to these pedagogical challenges. Tools such as Building Information Modeling (BIM), augmented reality (AR), virtual reality (VR), and digital simulation offer significant opportunities for the representation and analysis of building construction knowledge. Nevertheless, it is emphasized that the integration of digital tools into courses does not, in itself, constitute a pedagogical transformation. When used without a coherent pedagogical framework, these tools tend to reproduce traditional transmission-based teaching approaches in a digital environment (Barison & Santos, 2010; Zuin & de Mello, 2021). Therefore, digitalization should be considered not as the cause of pedagogical transformation, but as a component that gains meaning only within a well-defined learning framework.

Contemporary student profiles further reinforce the need to reconsider how technical knowledge is introduced within architectural education. Recent studies suggest an increasing preference for experiential, interactive, and problem-based learning environments that encourage active engagement rather than passive information reception (Güzelçoban & Coşgun, 2020; Erişen & Bavlı, 2024). In this study, however, changing student profiles are treated as a contextual factor rather than as the primary justification for pedagogical transformation. The underlying need to connect technical knowledge with active, contextualized learning is understood as a broader pedagogical concern that extends beyond a particular student generation.

Against this background, the study develops a comparative conceptual structure consisting of three instructional approaches to building construction and building component design: traditional lecture-based instruction, discovery-based learning, and a phased and guided approach. These approaches are used as contrasting configurations rather than as experimental conditions. The specific contribution of the proposed framework lies in treating the point at which formal technical instruction enters the design process as a deliberate instructional design variable. It examines a sequence in which students first encounter and question a design problem, receive relevant technical instruction in response to the issues that emerge, and then revisit their initial decisions. The framework therefore shifts attention from whether technical knowledge should be integrated with design to how the timing of its introduction may influence students' engagement with technical-design problems.

The proposed sequence also relates to educational approaches that question the assumption that explicit instruction must always precede problem engagement. Research on guided discovery suggests that exploration can support learning when appropriate guidance is provided, rather than leaving students to rely on unguided discovery (Mayer, 2004). Similarly, problem-based learning places the problem itself at the beginning of the learning process and uses it to help students identify what they need to learn (Hmelo-Silver, 2004). Productive failure takes this sequence further by examining what may be learned when students first attempt a complex problem before receiving formal instruction (Kapur, 2008). From this perspective, delaying structured technical instruction is not intended to leave students without support, but to allow questions and knowledge gaps to emerge before formal explanation is introduced. At the same time, such an approach requires careful guidance. Minimally guided instruction can place considerable demands on novice learners, particularly when they lack sufficient prior knowledge (Kirschner et al., 2006). The timing and amount of guidance therefore need to reflect students' prior knowledge, the complexity of the task, and the technical consequences of incorrect assumptions.

2. AIM AND OBJECTIVES

The point of departure for this study is the need to reconsider how technical knowledge is introduced and integrated into the learning process in building construction education. While conventional teaching approaches may position technical knowledge as predefined information to be transferred before design activity begins, exclusively exploratory approaches may provide insufficient structure for technically demanding design problems. This suggests a need for a pedagogical framework that balances exploration with structured guidance and enables technical knowledge to emerge in direct relation to the problems encountered during the design process.

Within this context, the primary aim of the study is to propose a phased and guided instructional framework for building construction education that treats the timing of formal technical instruction as a deliberate instructional design variable. The framework begins with an exploratory encounter with a design problem, introduces structured technical guidance in response to the questions and difficulties that emerge, and then asks students to revisit their initial design decisions. In doing so, the study considers technical knowledge not merely as predefined content to be transmitted, but as knowledge whose relevance can be understood in relation to an encountered design problem.

In line with this aim, the study has three main objectives:

- To examine the timing of formal technical instruction as an instructional design variable in building construction education;
- To develop a phased and guided instructional framework that progresses from initial problem exploration to structured technical guidance and subsequent revision of design decisions;
- To establish a conceptual basis for the future evaluation and curricular adaptation of the proposed framework.

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3. CONCEPTUAL FRAMEWORK DEVELOPMENT AND METHOD

This study develops a conceptual pedagogical framework rather than testing an instructional model empirically. It examines how the timing and sequence of technical knowledge can be reconsidered in undergraduate building construction education. The framework draws on literature from architectural education concerning the relationship between technical knowledge and design, together with educational studies on experiential learning (Kolb, 2015), active learning (Bonwell & Eison, 1991), problem-based learning, guided exploration, and instructional guidance. These perspectives were brought together to examine a specific question: what changes in the learning process when students encounter a design problem before receiving structured technical instruction? The study therefore focuses on the structure and logic of the proposed teaching sequence rather than on comparisons of student performance or measured learning outcomes.

The framework was developed in three steps. First, the literature on building construction education was examined to identify recurring problems in the relationship between technical instruction and design activity, particularly the tendency to present technical information before students encounter the problems in which that knowledge becomes relevant. Second, this issue was considered alongside educational approaches that allow students to explore a problem while providing guidance at different points in the learning process. Based on this reading, a three-phase teaching sequence was developed: initial problem exploration, structured technical guidance, and the revision of design decisions using the newly introduced technical knowledge. These phases are proposed as a way of organizing the learning process and have not been derived from measured student outcomes.

The proposed framework shares several principles with existing learner-centered approaches, but it is not intended as a replacement for them or as a new general theory of learning. Its focus is narrower: the sequence through which technical knowledge enters a design-based learning process. Table 1 compares the proposed framework with related approaches and identifies the specific role of exploration, guidance, and instructional timing in each.

Table 1. Conceptual comparison of related pedagogical approaches and the proposed framework

Approach	Starting point	Role of guidance	Timing of formal instruction	Main emphasis
Experiential learning	Experience	Reflection supports learning from experience	Not defined as a fixed sequence	Learning through experience and reflection
Problem-based learning	A problem or problem situation	Facilitator supports inquiry and learning	Knowledge is developed in relation to the problem	Problem solving and self-directed learning
Guided discovery	Exploration or discovery task	Guidance is provided during discovery	Explicit guidance accompanies or supports exploration	Discovery with instructional support
Productive failure	Initial attempt at a complex problem	Consolidation and instruction follow initial problem solving	Formal instruction follows the initial attempt	Learning from prior problem-solving attempts
Phased and Guided Framework	Initial encounter with a technical-design problem	Limited guidance during exploration, followed by structured technical instruction	Structured technical knowledge is deliberately introduced after initial exploration and before design revision	Timing of technical knowledge and its reintegration into design decisions

The comparison shows that the proposed framework overlaps with existing approaches rather than operating independently from them. Problem-based and guided-discovery approaches share its use of problem engagement and learner exploration, while productive failure provides a particularly relevant parallel through the sequence of problem solving before formal instruction. The distinction proposed here lies in applying these principles to building construction education and explicitly organizing the entry of structured technical knowledge between an initial design attempt and its subsequent revision. In this sense,

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instructional timing is treated as a design variable within the teaching process rather than as an incidental feature of the instructional method.

The framework is structured around stair and vertical circulation design, as this building component inherently involves the integration of both spatial and technical decision-making processes. As an architectural element, the stair incorporates multiple dimensions, including structural performance, ergonomics, building regulations, detail resolution, and spatial configuration, making it a suitable exemplar module for building construction education.

The stair module is conceived primarily as a teaching unit within an undergraduate Building Component Design or Building Construction course rather than as a substitute for the architectural design studio. However, the framework may also be implemented in coordination with a concurrent design studio, allowing technical learning to respond to related design problems within the broader curriculum. Its pedagogical structure is therefore intended to be adaptable to both stand-alone technical courses and coordinated technical–design learning environments.

For comparative purposes, the framework presents three instructional configurations based on the same design problem: a traditional lecture-based configuration, a discovery-based configuration, and the proposed phased and guided configuration. These configurations are not presented as experimental groups. Rather, they are used as conceptual reference points for comparing when and how structured technical knowledge enters the design process.

The three configurations provide a common basis for considering how different sequences of instruction might shape the relationship between technical knowledge and design activity. Their purpose at this stage is conceptual rather than experimental; no comparative claims are made regarding their effectiveness. Figure 1 illustrates the main differences in the timing and sequence of technical knowledge across the three configurations.

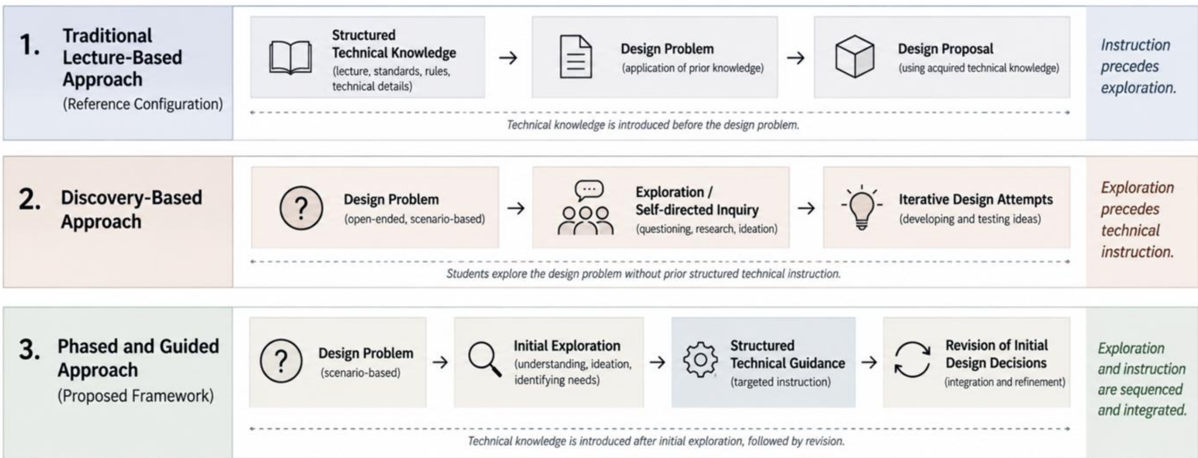

Figure 1. Comparative sequencing of technical knowledge across traditional, discovery-based, and phased and guided instructional configurations

- Configuration 1 – Traditional Lecture-Based Approach (Reference Configuration):

An instructional approach in which structured technical knowledge is introduced before the design problem is addressed. Students then apply this previously introduced knowledge while developing their design proposals.

- Configuration 2 – Discovery-Based Approach:

An instructional approach in which students encounter an open-ended design problem without prior instructor-led technical instruction. Students explore the problem through questioning, self-directed inquiry, and iterative design attempts.

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- Configuration 3 – Phased and Guided Approach:

An instructional approach that begins with exploration and introduces structured technical guidance after students have encountered the design problem. Students then revisit their initial decisions in relation to the technical knowledge introduced during this second stage. Together, these configurations provide three reference structures for examining differences in when and how technical knowledge is introduced during the design process. They are used here for conceptual comparison and do not represent experimental groups or measured differences in learning outcomes.

The empirical evaluation of these configurations would require measures that address both the learning process and changes in students' technical and design reasoning. A proposed evaluation strategy is presented in Section 5.3.

4. PROPOSED PEDAGOGICAL FRAMEWORK: THE STAIR MODULE FOR BUILDING COMPONENT DESIGN COURSES

4.1. Three-Phase Learning Framework

The proposed pedagogical framework consists of three successive learning phases. These phases differ in terms of the sequencing of knowledge delivery and instructional approach, yet they complement one another within a coherent and holistic learning process (Figure 2).

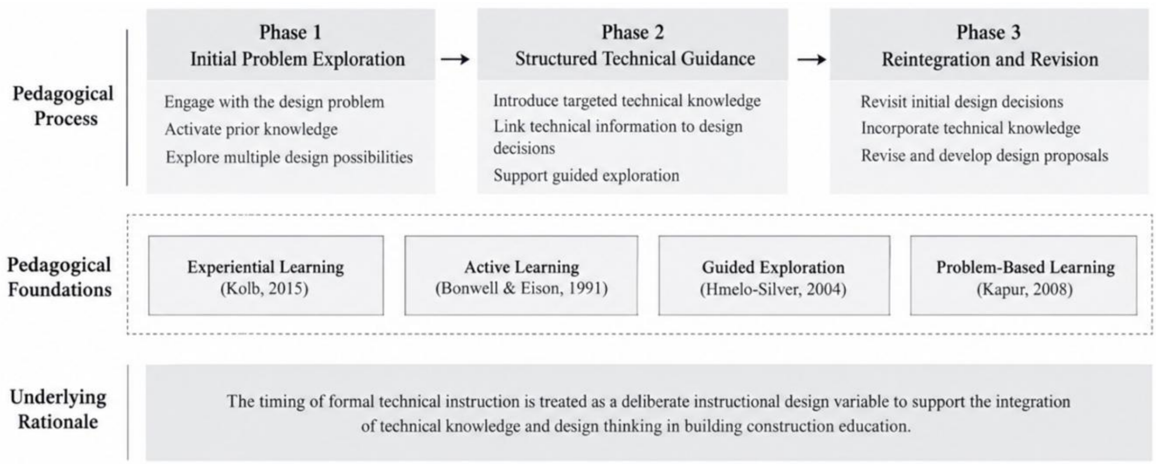

Figure 2. Proposed phased and guided pedagogical framework.

4.1.1. Phase 1 – Exploratory Learning: Encountering the Problem

In the first phase, students are introduced to an open-ended problem related to stair and vertical circulation design. Stairs are particularly suitable for this initial exploration because they are familiar building components that students regularly encounter and experience in everyday life. Rather than beginning with formal technical instruction, the phase draws on this existing experience through visual examples, user scenarios, and guiding questions. Students are encouraged to question movement, user needs, spatial relationships, and possible constraints before stair-specific technical requirements are formally introduced. The purpose is not to expect a technically resolved stair solution at this stage, but to make students' initial observations, assumptions, questions, and knowledge gaps visible.

The aim of this phase is to enable students to:

- define the problem,
- question spatial and functional relationships,
- develop initial design responses,
- recognize the necessity of technical knowledge on their own.

This phase positions students as active agents in the learning process and encourages them to recognize technical knowledge not merely as predefined information to be received, but as knowledge that becomes relevant through the questions and constraints encountered

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during design exploration. Exploration at this stage does not imply an absence of instructor guidance. Where students' emerging assumptions involve critical safety, accessibility, or regulatory issues, the instructor may draw attention to the issue through questions or prompts without providing the complete technical solution. This limited guidance is intended to prevent critical misconceptions from being reinforced while preserving the exploratory character of the phase.

4.1.2. Phase 2 – Structured Technical Knowledge: Explanation and Clarification

In the second phase, structured technical knowledge is introduced through the proposals developed by students during the first phase. At this stage, the instructor presents technical information related to stair design—such as:

- ergonomic criteria,
- regulatory requirements,
- relationships with structural systems,
- principles of detail resolution,

through drawings, examples, and direct reference to students' own work.

The pedagogical function of this phase is to structure the uncertainties experienced in the first phase and to establish clear links between technical competence and design decisions. Technical knowledge is therefore introduced not as an abstract set of rules detached from the design process, but as a structured explanatory framework that responds directly to the questions, difficulties, and decisions emerging from students' prior explorations.

4.1.3. Phase 3 – Reintegration and Revision

In the third phase, students revisit and further develop their designs by applying the structured technical knowledge acquired in the previous stage. This phase focuses on:

- integrating technical knowledge into design decisions,
- justifying these decisions, and
- materializing them at the levels of representation and detailing.

Through this process, students experience technical knowledge not as a constraint on design, but as a tool that supports and informs design decisions. Accordingly, the learning process aims not only at reaching a solution, but at understanding how the process leading to that solution is constructed.

The three phases describe the instructional structure of the framework, while the learning processes associated with each phase are proposed rather than observed effects. Initial exploration is expected to help students recognize the technical questions and knowledge gaps raised by the design problem. Structured guidance is intended to connect these questions with relevant technical principles and support the reconsideration of initial

Instructional stage (Framework component)	Proposed learning mechanism (How learning is supported)	Potential measurable outcome (For future empirical study)
Phase 1 **Initial Problem Exploration** (Encountering and interpreting the design problem)	**Recognition of questions, constraints, and knowledge gaps** • Identifying what is unknown • Questioning and defining information needs • Exploring possible directions	**Identification of technical issues and constraints** • Range and type of issues identified • Awareness of relevant parameters (e.g. spatial, ergonomic, regulatory, structural) • Quality of problem interpretation
Phase 2 **Structured Technical Guidance** (Introduction and discussion of technical knowledge)	**Contextualization and clarification of technical knowledge** • Linking technical information to student proposals • Clarifying misconceptions • Providing targeted, component-specific guidance	**Recognition and revision of unsupported or incorrect decisions** • Identification of technical gaps or inaccuracies • Evidence of changes in response to feedback • Improved alignment with technical principles
Phase 3 **Reintegration and Revision** (Applying and refining design decisions)	**Application, justification, and reflective revision** • Revisiting initial decisions in light of technical input • Integrating technical and design considerations • Justifying design decisions	**Technical–spatial integration, decision justification, and quality of revision** • Degree of integration between technical and spatial criteria • Quality of justification for design decisions • Depth and coherence of revisions

assumptions. The final phase provides an opportunity to apply this knowledge through revision and to explain the reasoning behind subsequent design decisions. These relationships are proposed for future investigation and should not be interpreted as findings of the present study. Figure 3 distinguishes the instructional stages from the proposed learning mechanisms and the outcomes that could later be examined empirically.

Figure 3. Instructional stages, proposed learning mechanisms, and potential measurable outcomes of the framework.

4.2. Illustrative Three-Week Stair Module

The framework is illustrated through a three-week stair and vertical circulation module within a 14-week Building Component Design course. The duration reflects the curricular structure of the course, in which stair design is addressed alongside other building components and therefore occupies only part of the semester. The three-week module allows the proposed sequence to be organized across three successive stages: initial exploration, structured technical guidance, and subsequent revision and integration. However, the three-week duration is not a fixed requirement of the framework, nor is it assumed to be sufficient for demonstrating longer-term learning effects. The duration of each phase may be adjusted according to the course structure, the complexity of the component, students' prior knowledge, and the expected level of technical resolution. Longer implementations may be required to examine longer-term development or knowledge transfer.

4.2.1. Week 1 – Problem Definition and Exploratory Process

In the first week, students would encounter an open-ended problem requiring the development of a stair and vertical circulation solution within a defined architectural context. The initial problem definition would provide basic spatial information about the building context, user profiles and scenarios, and the spaces to be connected.

Structured instruction concerning ergonomic dimensions, regulatory requirements, and detail-resolution principles would not be front-loaded at this stage. The intention is not to restrict students' access to technical information, but to delay its formal instructional introduction until students have encountered questions and knowledge needs through their initial design exploration.

Students would be expected to:

- redefine the problem in their own terms,
- explore circulation and spatial relationships through initial design responses,
- produce initial sketches, diagrams, and preliminary solutions.

This phase is intended to enable students to recognize the relevance of technical knowledge through the problems encountered during their own design exploration. Rather than immediately resolving technical questions, the instructor would primarily support the process through discussion-provoking questions that encourage students to articulate uncertainties, identify constraints, and reconsider initial assumptions.

In contemporary learning environments, however, students may independently access regulatory and technical information through online databases, digital reference materials, and generative AI tools. The proposed framework therefore does not depend on restricting access to information. Instead, it distinguishes between access to information and the structured interpretation, validation, and contextual application of technical knowledge. In this context, the instructor's role extends beyond that of an information provider to include guiding students in evaluating the reliability, relevance, and design implications of the information they encounter.

4.2.2. Week 2 – Structuring and Clarifying Technical Knowledge

In the second week, structured technical knowledge would be introduced in direct relation to the preliminary solutions developed during the exploratory stage. This phase represents the central guided component of the proposed pedagogical sequence.

The instructor would introduce fundamental ergonomic criteria for stair design, relevant regulations and standards, relationships between structural systems and stair design, and principles related to treads, risers, landings, and detailing through drawings, examples, and direct reference to students' initial proposals. In this way, technical guidance would respond to problems already encountered by students, transforming technical instruction from decontextualized information transfer into contextualized clarification.

Students would be expected to:

- critically examine their first-week solutions in light of technical knowledge,
- identify incorrect or insufficient decisions,
- revise and rework their designs from a technical perspective.

4.2.3. Week 3 – Reintegration, Revision, and Representation

The third week would focus on revisiting students' initial design decisions in light of the technical knowledge introduced in the previous phase and developing these revisions into concrete design outputs. During this phase, students would:

- further develop their stair and vertical circulation solutions technically,
- address spatial configuration and construction logic together,
- produce representations at the level of drawings, diagrams, and details.

Expected outputs would include:

- plan, section, and elevation drawings,
- circulation diagrams,
- basic detail solutions.

At this stage, the instructor would provide feedback that encourages students to justify their decisions and emphasizes the relationship between technical expression and design quality.

4.3. Evaluation Approach in the Studio Process

The proposed evaluation approach would focus not only on the technical quality of the final design product, but also on students' learning processes, reasoning, and decision-making strategies. In future empirical applications of the framework, student work could be evaluated using a common rubric addressing the following dimensions:

- problem definition and solution approach,
- technical reasoning and construction logic,
- integration of technical and spatial decisions,
- representational competence,
- ability to justify design decisions,
- reflective revision of initial design decisions.

Within this framework, success would not be defined solely by the technical correctness of the final design outcome. It would also involve students' ability to connect technical requirements with spatial decisions, justify design choices through technical reasoning, and critically revise initial assumptions after encountering structured technical knowledge. A further indicator would be the extent to which students can transfer acquired technical knowledge to a subsequent design problem, such as a different stair condition or another building component with comparable technical demands. These dimensions provide potential learning indicators through which the pedagogical effects of the proposed framework could be examined in future empirical studies.

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5. DISCUSSION

The contribution of the proposed framework lies primarily in treating the timing of technical instruction as a deliberate variable in the organization of building construction education. Rather than proposing technical–design integration as a new educational principle, the framework examines what may occur when students encounter a technical-design problem before formal component-specific instruction, receive relevant technical guidance in response to that encounter, and subsequently return to their initial decisions. Four conceptual propositions follow from this sequence and provide a basis for future empirical investigation.

First, encountering a problem before formal technical instruction may help students become more aware of what they do not yet know. In the proposed stair module, the initial encounter is not intended to produce a technically complete solution. Visual examples, user scenarios, and guiding questions provide a basis for students to identify relevant constraints, question familiar spatial situations, and recognize gaps in their technical understanding. The proposed mechanism is therefore the recognition of a need for knowledge rather than the independent discovery of technically correct answers.

Second, introducing technical instruction after this initial encounter may make the content more meaningful because it can be related to questions and difficulties that students have already identified. Ergonomic criteria, regulatory requirements, structural relationships, and detailing principles can then be discussed in relation to specific design decisions rather than as isolated technical information. This does not imply that delayed instruction is inherently more effective. Its value may depend on the nature of the task, students' prior knowledge, and the level of guidance provided during the exploratory phase.

Third, returning to an initial proposal after technical instruction creates an opportunity for reflective revision. The purpose is not simply to correct an incorrect dimension or detail, but to reconsider why an earlier decision should be retained, modified, or rejected in light of newly introduced knowledge. The nature and reasoning of these revisions could therefore provide a basis for examining changes in students' technical and spatial reasoning in future empirical applications.

Fourth, the broader educational value of the sequence would depend on whether students can apply what they have learned beyond the problem in which the knowledge was first introduced. Revision of the same stair proposal should not, by itself, be considered evidence of knowledge transfer. Transfer would need to be examined through a subsequent task, such as a different stair condition or another building component involving comparable technical and spatial constraints. The ability to identify relevant constraints, apply appropriate technical principles, and justify their use in this new context could then provide indicators of transfer in future empirical studies.

5.1. Curricular Adaptability

Although the framework is illustrated through stair and vertical circulation design, its use is not limited to a single building component or course level. The complexity of the design problem, depth of technical content, and degree of student autonomy can be adjusted according to the stage of architectural education.

At introductory levels, the framework may be applied to relatively bounded problems involving materials, basic building components, ergonomics, and fundamental construction principles. At intermediate levels, it may be extended to more complex component and system relationships, including building envelopes, roof systems, structural interfaces, and construction detailing. At advanced levels, the same sequence may support integrated or comprehensive studio environments in which multiple technical systems must be coordinated with broader architectural design decisions.

The stair module therefore serves as one example of how the framework can be adapted within the curriculum; its applicability to other building components and educational contexts remains to be examined through future implementations.

5.2. Digital Tools, Generative AI, and Technical Knowledge

The proposed framework also provides a basis for reconsidering the role of digital tools and information resources within building construction education. Technologies such as BIM, augmented reality, and virtual reality are positioned not as pedagogical solutions in themselves, but as supportive tools that are introduced at specific stages of the learning process to reinforce technical understanding. In doing so, digitalization is decoupled from the notion of pedagogical transformation as an end in itself and is instead emphasized as a complementary component that serves clearly defined learning objectives.

This perspective also extends to generative AI and other readily accessible information resources. Their pedagogical value lies not simply in providing immediate access to technical information, but in how that information is critically evaluated and incorporated into design reasoning. Information accessed independently by students, including AI-generated content, should therefore be distinguished from the structured and validated technical knowledge introduced in Phase 2. AI-generated information may support questioning and initial exploration, but it should not be treated as an authoritative source for regulatory, dimensional, structural, or safety-related decisions.

During Phases 2 and 3, students should be encouraged to verify independently accessed information against relevant regulations, technical standards, course materials, and instructor guidance. In this way, evaluating source reliability, verifying technical information, and taking responsibility for its use become part of technical learning itself. The instructor retains an important role in this process by helping students assess the relevance and reliability of information and its implications for specific design decisions.

5.3. Limitations and Future Research

A principal limitation of the present study is that the proposed framework has not yet been empirically evaluated through measured learning outcomes or comparative student performance. Accordingly, the framework should not be interpreted as evidence of the pedagogical superiority of the phased and guided configuration. Its contribution at this stage is conceptual and methodological: it defines a structured pedagogical sequence and identifies dimensions through which its effects on technical reasoning, design decision-making, reflective revision, and knowledge transfer may subsequently be investigated.

As an initial empirical step, a pilot implementation could examine the framework using the instructional configurations described in this study under comparable teaching conditions. Evaluation should address both the design process and the resulting student work. Initial and revised proposals could be assessed using a common rubric covering recognition of technical constraints, technical reasoning, integration of technical and spatial decisions, decision justification, and the quality of revision. Comparing work produced before and after structured technical guidance would make it possible to examine how students reconsider their initial decisions without assuming in advance that the phased and guided configuration will produce better results.

Process observations, student reflections, and interviews could complement the assessment of design outputs by showing how students identify knowledge gaps, respond to technical guidance, and explain changes in their decisions. Knowledge transfer would require a separate task rather than evaluation of the revised stair proposal alone. Students could therefore be asked to apply relevant principles to a new stair problem or another building component with comparable technical demands. Indicators could include the identification of relevant constraints, appropriate use of technical principles, and the ability to justify their application in the new context. Together, these measures would allow the proposed relationships shown in Figure 3 to be examined empirically.

6. CONCLUSION

This study proposes a phased and guided pedagogical framework for building construction and building component design education in which the point at which formal technical instruction enters the design process is treated as a deliberate instructional design variable. The framework organizes learning around an initial encounter with a technical-design problem, followed by relevant technical instruction and the reconsideration of students' initial decisions. Its contribution therefore lies not in proposing technical–design integration as a new principle, but in providing a structured way to examine how the timing of formal instruction may shape students' engagement with technical knowledge during design.

The stair and vertical circulation module illustrates how this sequence can be applied to a building component that combines spatial, ergonomic, regulatory, structural, and technical considerations. Although developed through this example, the framework may be adapted to other building components and course levels by adjusting the complexity of the problem, the depth of technical content, and the degree of student autonomy. In learning environments where technical information is increasingly accessible through digital resources and generative AI, the framework also highlights the need for students to critically evaluate, verify, and take responsibility for the technical information they use in design decisions.

As the framework has not yet been empirically evaluated, no claim is made regarding its effectiveness or superiority over the other instructional configurations discussed in this study. A next step would be to examine the framework through pilot implementations across different building components, course levels, and institutional contexts. Such studies could investigate how students identify technical knowledge gaps, revise and justify design decisions after instruction, and apply relevant principles to new problems. Empirical investigation of these processes would help determine the educational value, limitations, and broader applicability of the proposed framework.

7. DECLARATIONS

7.1. Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

7.2. Competing interests

The authors declare that they have no competing interests.

7.3. Funding

The authors received no funding for this work.

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