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Reassessing educational strategies: Direct instruction outperforms information search process for novice students in architectural design studios

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Abstract
This study investigates the effectiveness of Direct Instruction (DI) compared to the Information Search Process (ISP) in architectural studio education for novice learners. While design education often favours constructivist approaches like ISP—where students construct knowledge through self-directed exploration—such minimally guided methods may overwhelm beginners who lack foundational knowledge, leading to cognitive overload and limited learning gains. This research evaluates whether structured instruction that explicitly conveys core architectural concepts can better support novice students in solving design problems. A controlled experimental study was conducted with 72 third-semester architecture students, randomly assigned to either the DI group (n = 41) or the ISP group (n = 31). The DI group received a concise, targeted presentation on the concept of human scale in architecture, while the ISP group engaged with printed materials simulating an authentic information search process. Following the instructional sessions, all participants completed a design task. Their work was evaluated by a jury, and cognitive load was measured using a standardized self-report scale. Findings revealed that a significantly higher number of students in the DI group successfully applied the targeted concepts in their design proposals and experienced lower cognitive load during the task. However, no significant difference was observed between the groups in overall design quality scores. These results suggest that DI offers substantial advantages for novice learners by providing essential conceptual scaffolding and reducing mental effort during complex tasks. The study recommends aligning instructional strategies with students' expertise levels—prioritizing DI in early semesters and progressively incorporating constructivist methods as learners gain experience and cognitive readiness.

Keywords
Architecture education, Constructivism, Design studio, Direct instruction, Information search process.

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1. Introduction

Design education has traditionally relied on a master-apprentice model, where experienced educators guide students through ongoing design problems. Studios—educational environments that trace their origins to the École des Beaux-Arts system, where students presented their work in a structured yet critique-driven setting—remain the core environments in which students develop their design skills through presenting and defending proposals in front of instructors and peers (Oh et al., 2013). Rather than employing direct teaching methods such as lectures, studio education emphasizes learning by doing, through critique, iteration, and tacit knowledge transfer. Informal peer critique and tutor–student role constructions have been discussed in the literature as influential dimensions of studio learning (Belluigi, 2016; Gray, 2013), though these studies are primarily conceptual or interpretive in nature, rather than experimental.

This practice-based approach is particularly effective for conveying the experiential and procedural knowledge of design. However, it assumes that students already possess foundational knowledge—ostensibly delivered through supporting courses such as design theory, structures, and materials—and are capable of integrating diverse concepts such as form, scale, culture, and construction into design solutions. In studio settings, mentors often take these competencies for granted and expect students to apply them fluidly in complex design tasks. In reality, novice students in early semesters frequently lack the integrated cognitive schemas—mental structures that organize knowledge in long-term memory—required to interpret critiques, structure design logic, or navigate ambiguous project briefs effectively. This disconnect between the compartmentalised delivery of foundational content and the integrative demands of studio work creates a cognitive gap that many beginners are unprepared to bridge. For instance, students may excel in isolated coursework on structural systems but fail to integrate that knowledge into spatial layouts when designing a building.

The open-ended and loosely structured nature of design studios, while intended to simulate professional practice, can overwhelm beginners. Many first- and second-year architecture students struggle not because they lack creativity, but because they are exposed to complex problem-solving tasks without sufficient cognitive scaffolding. Instructors, assuming students have absorbed knowledge implicitly, often provide feedback that is too abstract or context-dependent for novices to apply. As Oh et al. (2013) argue, these practices—though central to studio culture—are rarely grounded in formal pedagogical frameworks, and are instead guided by intuition and inherited conventions. Our study addresses a complementary dimension by testing an instructional method that explicitly targets cognitive readiness for such critique-based learning.

We explore the potential of a contrasting approach: Direct Instruction (DI), which offers clearly structured guidance and worked examples to reduce cognitive load. Rather than equating instruction with learning, we adopt a cognitive perspective in which learning is defined as a durable change in long-term memory (LTM) (Mayer, 2009; Sweller, 1988). According to this view, information must be processed in working memory (WM)—a system with highly limited capacity—before it can be encoded into LTM. If cognitive load exceeds this capacity, no learning occurs. This risk is especially high for novice learners, who lack robust pre-existing schemas and are thus more susceptible to WM overload even with moderately complex material. Instructional effectiveness, therefore, depends not only on what is taught, but on how it is structured, paced, and cognitively managed to support meaningful schema construction. The DI condition in our study was designed with these constraints in mind.

1.1. Instructional challenges for novice students in studio-based education

Constructivist strategies are often cited as effective in contexts where learners have prior knowledge and are actively involved in constructing

understanding through complex challenges. While these strategies have been highlighted for fostering creativity, critical thinking, and the integration of complex concepts into problem-solving (Philips, 1995), their application to design education, particularly in early stages, requires careful consideration. In advanced design studios, students with foundational knowledge are expected to apply these strategies to engage with intricate design problems, integrating their prior learning into novel solutions. This perspective aligns with Jonassen's (1991) model of knowledge acquisition, which outlines three stages: introductory, advanced, and expert. He argues that constructivist environments are most effective during the advanced stage, when learners already possess sufficient domain knowledge. In this study, we interpret his framework within the design studio context and suggest that constructivist strategies are best suited for students at this advanced stage, where structured conceptual understanding is already in place.

However, in introductory studios, where students lack foundational knowledge and structured cognitive schemas, such methods can create significant learning barriers. Novice students often misinterpret implicit feedback, replicate solutions uncritically, and spread misconceptions among peers. These challenges stem from the constructivist model's reliance on tacit guidance and self-directed discovery. Instructors typically avoid explicit teaching, expecting students to conduct independent research using design precedents, site visits, supporting courses, or open-ended resources such as the internet and libraries. This aligns with Kuhlthau's (1991) Information Search Process (ISP), where learners move through stages of uncertainty, exploration, and formulation. Yet without the cognitive structures to process and apply complex information, novices often become overwhelmed.

Jonassen (1991) argues that guided instruction is more appropriate for learners in the introductory phase to help them establish a foundational knowledge base. Similarly, Ertmer and Newby (2013) suggest that behaviorist and cognitivist strategies—featuring clear explanations, structured tasks, and modeled thinking—are better suited for early-stage learners.

Despite the dominance of constructivist practice in studio culture, there is little clarity on how novices should acquire foundational knowledge. Without explicit guidance, students must not only identify relevant information but also figure out how to apply it meaningfully. A more balanced instructional approach—combining structured guidance with opportunities for creative exploration—can reduce cognitive overload and support more effective learning in early architectural education.

1.2. Dominant pedagogical paradigms in architectural studio education

Direct or explicit instruction—where knowledge is clearly transmitted by the instructor—is typically minimized in studio settings due to concerns that it may limit creativity or reduce students to passive recipients of information. Schön (1985) associates design learning with reflective practice and tacit knowledge, implicitly favouring open-ended and self-directed learning environments. Lord (1999) and Webster (2008) caution that teacher-centred approaches may suppress originality and discourage critical engagement. Dutton (1987) frames the studio as a site of cultural ritual, where hierarchical instruction may reinforce conformity. Morgado (2010) similarly argues that direct teaching methods are incompatible with the exploratory and iterative nature of design thinking. However, these concerns are primarily theoretical, philosophical, or cultural critiques. Despite their influence in architectural education discourse, they are not grounded in empirical evidence. To date, few studies have systematically tested whether direct instruction genuinely suppresses creativity, autonomy, or engagement in studio-based learning environments.

Instead, feedback in studio environments is largely implicit, prompting students to derive meaning and direction through critique sessions, self-re-

flection, and independent research. During this process, learners explore relevant concepts and apply them to design proposals using sources such as precedents, site visits, libraries, and internet-based materials—often with encouragement from instructors.

Schön (1987) conceptualizes the studio as a setting for situated learning through individual or collaborative projects. He introduces *reflection-in-action*—real-time problem-solving and adaptation during the design process—and *reflection-on-action*, which involves post-hoc analysis to inform future performance. Both are central to the constructivist model, contributing to ongoing professional development.

Despite its pedagogical appeal, constructivist theory often lacks specificity regarding how learners acquire, process, and store information (Ertmer & Newby, 2013). Kirschner et al. (2006) criticize minimally guided instruction—including discovery, problem-based, and inquiry learning—for misaligning with cognitive architecture. Drawing on Cognitive Load Theory (Sweller, 1988), they argue that such methods can overload working memory, especially in novice learners who lack prior knowledge. However, while studio education rightly values exploration and autonomy, the near-absence of explicit instruction raises concerns about the cognitive demands placed on beginners.

1.3. Theoretical framework

1.3.1. Constructivist learning theory

Constructivist learning theory posits that individuals actively construct knowledge based on their experiences and internal cognitive structures. Rather than passively receiving information, learners generate meaning by engaging with their environment and interpreting new information through their existing mental frameworks (Bednar et al., 2013; Jonassen, 1991). Learning, in this view, is not simply the acquisition of facts but the result of an active process of understanding.

Piaget (1952) introduced two core mechanisms underlying this process: assimilation, where new information is integrated into existing schemas, and accommodation, where schemas are modified or newly created to fit unfamiliar data. Through the dynamic interplay of these processes, learners achieve equilibration—a balance between internal cognitive structures and external experience—resulting in increasingly complex knowledge structures.

Vygotsky and Cole (1978) expanded this perspective by emphasizing the social and cultural dimensions of learning. They introduced the concept of the Zone of Proximal Development (ZPD), which defines the distance between what learners can achieve on their own and what they can accomplish with support. Learning is maximized within this zone when scaffolding is provided by more knowledgeable individuals, enabling learners to internalize complex skills and concepts.

Constructivist theory has influenced various pedagogical strategies including discovery learning, problem-based learning, inquiry learning, experiential learning, and project-based learning (Kirschner et al., 2006; Kokotsaki et al., 2016). These methods encourage learners to engage actively, explore ideas independently, and derive personal meaning from learning experiences.

However, critics argue that constructivism often downplays the importance of structured guidance. Some scholars contend that the theoretical foundations of constructivism are primarily ideological rather than empirically validated (Phillips, 1995), and caution that minimising the teacher's role can be detrimental—especially when learners are faced with novel or cognitively demanding content (Kirschner et al., 2006). While constructivism supports autonomy and engagement, its effectiveness for novice learners—who lack prior schemas—remains contested.

1.3.2. Information search process

In studio-based learning, students are frequently expected to identify, locate, and evaluate relevant information to support their design decisions. This process, often referred to as the information search process, requires learners to engage with a range

of resources such as architectural precedents, site analyses, literature, and internet-based sources. While this approach fosters autonomy and inquiry, it can be cognitively and emotionally demanding—particularly for novice learners.

To better understand the nature of these demands, Kuhlthau (1991; Kuhlthau et al., 2008) developed the Information Search Process (ISP) model, which outlines six stages that individuals typically experience when seeking information. These stages are:

(i) *Initiation* – recognizing the need for information, often accompanied by uncertainty;

(ii) *Selection* – choosing a general topic and experiencing optimism;

(iii) *Exploration* – encountering confusion and doubt as initial information proves inconsistent;

(iv) *Formulation* – gradually identifying a clear focus, increasing confidence;

(v) *Collection* – gathering targeted information with greater direction and clarity;

(vi) *Presentation* – organizing and using the information, often with a sense of relief or satisfaction.

A key contribution of Kuhlthau's model is its emphasis on the affective dimension of information seeking. Learners do not simply process information rationally; they also navigate emotional responses such as uncertainty, frustration, or confidence as they progress through each stage. This interplay of cognition and emotion has significant implications for studio-based education, where the research process is rarely linear or fully supported.

For novice learners, these stages may amplify cognitive load, particularly if they lack guidance in filtering, organizing, or applying the information they gather. Without structured support, the information search process can become a source of confusion rather than a pathway to insight.

1.3.3. Information processing theory

While constructivist learning theory offers valuable insights into how learners engage with experience and construct meaning, it does not clearly articulate the cognitive mechanisms by which information is processed, stored, or retrieved. In contrast, information processing theory provides a structured framework for understanding learning as the transformation of information into long-term memory (Atkinson & Shiffrin, 1968; Kirschner et al., 2006; Ofsted, 2023, paragraph 251). Central to this theory is the dynamic interaction between working memory and long-term memory, and the cognitive processes that facilitate the transfer between them.

Working memory, as conceptualized by Baddeley and Hitch (1974), is a limited-capacity system responsible for holding and manipulating information over short periods. Research has shown that this capacity is highly constrained—typically allowing only a few discrete units of information, or *chunks*, to be processed simultaneously (Cowan, 2001; Miller, 1994). When instructional content exceeds this capacity, learning is likely to be impeded.

Cognitive Load Theory (Sweller, 1988; Sweller et al., 1998) builds on this model by identifying three types of load imposed on working memory:

Intrinsic Load, which stems from the complexity of the material itself;

Extraneous Load, which results from poor instructional design and hinders learning;

Germane Load, which refers to the mental effort dedicated to processing and integrating information into existing schemas.

Effective instruction aims to reduce extraneous load while promoting germane load, thereby enabling working memory to operate efficiently. Instructional strategies that optimize this balance are more likely to facilitate meaningful learning and support the transfer of knowledge to new contexts. This framework is particularly important for novice learners, who lack robust schemas and are therefore more vulnerable to overload. In design education, which involves complex and interrelated information, managing cognitive load is essential for enabling learners to internalize and apply knowledge effectively.

1.3.4. Limitations of constructivist strategies for novice learners

While constructivist approaches emphasize learner autonomy and open-ended exploration, research in cognitive science suggests that such methods may not be equally effective for all learners. One critical factor is the learner's level of prior knowledge, which influences how they process feedback, engage with information, and construct new understanding. This point has been emphasized by Kirschner, Sweller, and Clark (2006), who argue that minimal guidance during instruction places unnecessary cognitive demands on novice learners, often hindering rather than facilitating learning. Similarly, Tobias and Duffy (2009) present a balanced yet critical examination of constructivist instruction, concluding that its success is highly dependent on learner expertise and the nature of the task.

Shute (2008), in a comprehensive review of feedback in education, emphasizes that the effectiveness of feedback is highly dependent on its type, specificity, and degree of explicitness. For novice learners, who often lack structured schemas and problem-solving strategies, explicit and detailed feedback is generally more beneficial (Knoblauch & Brannon, 1981; Moreno, 2004). It helps identify knowledge gaps, clarify misunderstandings, and direct learners toward relevant concepts. In contrast, advanced learners may benefit more from implicit feedback, such as prompts or reflective questions, which challenge them to apply and extend their existing knowledge (Vygotsky, 1987).

This divergence creates a practical dilemma in educational settings, particularly in design studios where students with varying experience levels often coexist. Relying solely on one instructional approach—whether purely constructivist or instructivist—can result in ineffective learning experiences for some students. Rather than adhering rigidly to a single method, educators must be able to adapt their strategies based on the learner's current level of expertise and the nature of the task.

Such adaptability aligns with the principle of systematic eclecticism (Snelbecker, 1974), which advocates for drawing upon multiple instructional theories and methods as needed. This perspective acknowledges that no single instructional approach is universally effective. Instead, effective teaching requires a flexible and evidence-informed combination of strategies to address learners' varying cognitive needs. In the context of architectural design education, this means integrating explicit instruction where foundational knowledge is lacking, while preserving constructivist elements that promote higher-order thinking and creativity as learners advance.

Furthermore, design tasks in architectural studios are often classified as "wicked problems"—ill-defined, open-ended, and without clear solutions. Coyne (2004) contends that such complexity is the norm rather than the exception in design practice, while Casakin (2008) provides empirical evidence linking students' creative performance to their ability to cognitively restructure these problem spaces—an ability that itself depends on prior schema development (Sweller et al., 1998).

1.3.5. Direct istruction: principles and cognitive foundations

Direct instruction (DI), also referred to as explicit instruction, is an instructional approach grounded in cognitivist and information processing theories. Unlike constructivist methods that emphasize learner-driven discovery, direct instruction involves the structured transmission of clearly defined knowledge, skills, and procedures from teacher to student—conceptually grounded in cognitivist theory (Jonassen, 1991), aligned with the information-processing model of memory (Atkinson & Shiffrin, 1968), and informed by the working memory framework (Baddeley & Hitch, 1974). This approach assumes that objective knowledge exists independently of the learner and can be taught effectively through well-organized, incremental instruction aligned with the learner's cognitive capacity.

Kirschner et al. (2006) define direct instruction as the provision of information that fully explains concepts

and procedures, supported by learning strategies consistent with human cognitive architecture. Effective implementation of DI reduces extraneous cognitive load while enhancing germane load, allowing learners to process and internalize information more efficiently—especially critical for novices lacking prior schemas.

Despite its strong empirical support, the term "direct instruction" (DI) is frequently misunderstood and inconsistently used in the literature. In some cases, it is reductively equated with passive, lecture-based teaching or rote memorization—leading to negative connotations that overshadow its research-based effectiveness. Rosenshine (2008) critically examines this confusion and identifies five distinct uses of the term "direct instruction" in educational discourse:

(1) teaching delivered by a teacher, regardless of method quality;

(2) instructional behaviors observed in effective teachers;

(3) strategies for teaching cognitive skills;

(4) the structured and scripted DISTAR program developed by Engelmann; and

(5) a negatively framed stereotype of teacher-centred lecturing with passive students.

This conceptual ambiguity has led to frequent mischaracterization of DI, particularly in fields like design education where student autonomy and open-ended exploration are valued. However, as Rosenshine emphasizes, properly implemented direct instruction—especially as defined in the second and third senses above—does not inhibit critical thinking or creativity. On the contrary, it provides explicit guidance, scaffolded practice, and cognitive structure, enabling learners to engage more meaningfully with complex material. Rather than replacing student agency, effective DI builds the foundational knowledge and mental frameworks that support higher-order learning and independent application.

Rosenshine (2008) outlines nine key features of effective direct instruction, including: review of prior knowledge, clear articulation of objectives, segmented delivery of new content, frequent student practice, concise explanations, continuous questioning, active monitoring, timely feedback, and structured guidance during independent work.

In design education, these principles can be applied to scaffold studio processes for novice learners. Breaking complex tasks into cognitively manageable steps and providing clear feedback and modeling during mentorship sessions can help students build a more stable foundation of design knowledge—enabling them to engage in higher-level creative processes with greater competence and confidence.

1.3.6. Applying direct instruction to studio education: Cognitive and pedagogical implications

Direct instruction holds significant potential for supporting novice students in architectural design studios, particularly by addressing common cognitive challenges such as overload, fragmented knowledge, and weak schema development. Unlike minimally guided approaches, which assume that learners can independently construct complex design knowledge, direct instruction offers structured support to build the foundational knowledge base necessary for design problem-solving.

First, DI helps reduce extraneous cognitive load, especially in domains like architecture where element interactivity is high. Design tasks require the integration of multiple variables—such as structure, function, materiality, spatial perception, and human scale—which can easily overwhelm working memory if not sequenced and contextualized effectively (Kirschner et al., 2006; Sweller et al., 2019). By providing clear explanations and worked examples, DI allows students to focus on understanding core concepts rather than navigating ambiguity.

Second, DI facilitates the construction of cognitive schemas. These schemas help students recognize patterns, connect related concepts, and transfer learning across different contexts. For instance, a lesson on "public-private spatial transitions" can explicitly link concepts like thresholds, circulation, social interaction, and form, enabling

students to see how these ideas interrelate.

Third, DI ensures that novice learners receive the essential building blocks—factual knowledge, procedural strategies, and domain-specific rules—that underpin problem-solving and creative ideation. According to cognitive research, these elements form the basis of expertise and can be taught directly, while skill development emerges through guided practice.

Finally, by aligning instructional design with cognitive load theory, DI can accelerate the development of expertise. Techniques such as worked examples, process worksheets, and completion tasks provide scaffolding that supports efficient schema construction and gradual cognitive automation.

While hands-on experience and creative exploration remain vital, the structured guidance provided by direct instruction plays a critical role in equipping novice students with the knowledge, confidence, and cognitive readiness required for deeper engagement in design practice. For example, students who first learn the structured principles of spatial hierarchy through DI are later better equipped to manipulate these principles creatively in open-ended projects.

1.4. Empirical gaps in the literature on instructional strategies in design education

Despite the widespread adoption of constructivist pedagogy in architectural education, empirical evidence comparing alternative instructional strategies remains limited. The existing literature is heavily dominated by case studies that apply constructivist methods in various studio contexts. While such studies are valuable for exploring teaching practices in complex settings, they offer limited generalisability and methodological rigour. This reveals a significant empirical gap in our understanding of which instructional strategies most effectively support student learning—particularly for novices working in cognitively demanding environments.

A systematic review conducted by Sawyer (2017) examined 45 English-language empirical studies on architecture and art education published between 1984 and 2017. The review found that most studies characterised studio education as constructivist, open-ended, and student-centred. However, only two of the reviewed studies (Andjomshoaa et al., 2011; Vanada, 2016) directly compared constructivist and direct instruction approaches. Among them, only one (Andjomshoaa et al., 2011) used a controlled pretest–posttest design—highlighting how rarely experimental methods are applied in this field, despite their stronger evidential weight compared to case studies.

In that study, 32 second-year architecture students were divided into two groups. The constructivist group engaged in experiential activities, including site visits and sensory exercises, while the control group received direct instruction. A follow-up design task showed better performance in the constructivist group. However, the instructional content, duration, and engagement were disproportionately richer in the constructivist group, raising concerns about the comparability of the two conditions. This design imbalance implies that the apparent superiority of the constructivist group may not stem from the instructional model per se, but from the richer, multisensory, and social learning environment provided. For instance, the direct instruction group was merely told that a bedroom's location was incorrect due to noise, while the constructivist group conducted environmental recordings, shared findings with peers, and reflected on the design implications. As Rosenshine (2008) emphasizes, effective direct instruction requires structured, explicit, and detailed guidance—conditions that were not met in this study. The imbalance weakens the validity of any claim regarding the superiority of the constructivist approach and instead demonstrates the limitations of superficial feedback in both methods.

Additional support for structured instruction comes from Al-Sayed et al. (2010), who found that architects with explicit spatial-configuration knowledge outperformed those with implicit understanding in solving design problems. This distinction reinforces the

argument that certain types of knowledge—especially procedural and relational—should be explicitly taught, particularly to novice learners. According to Sweller (1988), effective problem-solving relies on four key components: domain-specific knowledge, procedural strategies, problem-solving methods, and skill. The first three can be directly taught, while skill develops through practice under guided supervision.

Constructivist theorists, such as Schön (1987), argue that learning should mirror real-world complexity and promote reflection through project-based engagement. According to Kirschner et al. (2006), such models are typically based on two assumptions: that students learn best by constructing their own solutions, and that instruction should emulate professional practice. However, these assumptions have been criticised for lacking empirical support and for misaligning with cognitive architecture. In contrast to Schön's theoretical model, Kirschner et al. (2006) and Chi et al. (1981) present experimental findings showing that novices approach problems fundamentally differently from experts—relying on surface features, trial-and-error, and unguided exploration, often with poor learning transfer.

This body of evidence underscores the need for controlled comparative studies that assess the impact of instructional strategies under equivalent conditions. The current literature lacks such studies, which limits educators' ability to make informed decisions about how to support learners at different stages of expertise. The resulting gap has contributed to an uncritical dichotomy between constructivist and direct instruction models, often ignoring contextual variables such as learners' prior knowledge, cognitive capacity, and instructional design.

Recent research outside the design domain (e.g., de Jong et al., 2023) suggests that combining direct instruction with inquiry-based learning produces the most effective outcomes. These findings imply that architectural studios—particularly in the early years—could benefit from the structured delivery of foundational knowledge, followed by opportunities for open-ended exploration. Integrating direct instruction in studio-based learning has the potential to reduce cognitive overload, strengthen conceptual understanding, and enhance problem-solving capacity.

By addressing this gap through a controlled experimental design, the present study aims to provide much-needed empirical insight into the instructional needs of novice architecture students and to contribute to a more evidence-based discourse in design education.

1.5. Research questions and hypotheses

Focusing on the research phase of the studio process for novice architecture students, this study compares two approaches to delivering foundational design knowledge: DI, which involves structured, explicit teaching aligned with Rosenshine's (2008) principles, and the ISP model (Kuhlthau, 1991), in which students independently seek out knowledge as part of their learning journey—a common practice in design education. The investigation centres on the acquisition and application of a core design concept: human scale. Building upon the empirical gap identified in the literature, the study employs a mixed-methods design to evaluate both the instructional effectiveness and the cognitive impact of each approach. Accordingly, the following research questions and hypotheses were formulated:

RQ1: What is the impact of using Direct Instruction (DI; Rosenshine, 2008) versus the Information Search Process (ISP; Kuhlthau, 1991) for teaching foundational design concepts, on the number of novice architecture students who successfully apply targeted spatial behaviors (variables 3DR1–3) in their design proposals? (Mixed-methods approach.)

H1: There is a statistically significant difference between instructional methods (DI vs. ISP) in the proportion of novice students who demonstrate application of targeted 3D design behaviors (3DR1–3) in their design proposals (two-tailed).

RQ2: How do DI and ISP approaches impact students' cognitive load during

instructional and design processes? (Quantitative approach.)

H2: There is a statistically significant difference in perceived cognitive load between students instructed via DI and those taught through the ISP (two-tailed).

RQ3: How do students perceive and evaluate the two instructional approaches—DI and ISP—specifically in the context of learning about human scale in architecture? How do these methods influence their engagement during design sessions? (Qualitative approach.)

2. Method

This study employed a post-test-only control group design to manage instructional variables and reduce external confounds within the studio environment. The controlled design enabled consistent treatment conditions and minimized distractions across sessions. While data collection was designed to be efficient, the full implementation spanned two consecutive days to accommodate participant availability and logistical constraints.

2.1. Participants

Participants were third-semester architecture students from Yıldız Technical University, İstanbul, Türkiye. Only students taking the course for the first time were eligible. This criterion ensured that all participants had comparable levels of prior exposure to studio instruction. Participation was voluntary, and those who completed the study received bonus credit toward their studio course. A total of 72 students participated and were randomly assigned to either the Direct Instruction (DI) group (n = 41) or the Information Search Process (ISP) group (n = 31).

To accommodate classroom capacity, both groups were divided into two subgroups, each undergoing the same instructional procedure on different days. Statistical tests revealed no significant differences between these subgroups in terms of key outcome measures, confirming consistency across sessions.

2.2. Variables

The independent variable was the instructional method, with participants assigned to either the Information Search Process (ISP, control) or Direct Instruction (DI, experimental) group. The dependent variables included cognitive load and post-instruction design behaviour, grouped under five categories comprising 12 items in total (Table 1): three-dimensional relations (3DR1–6); creativity (CR1–2); flexibility (FLX); circulation (CIR1–2); and overall evaluation. These categories were derived from recurring evaluation criteria used in architectural studio critiques and refined through consultation with expert jurors to align with pedagogical priorities.

These variables were defined prior to the study by the authors in consultation with the jury. Among them, 3DR1–3 were directly targeted by the instructional content, while 3DR4–5 were designed to assess knowledge transfer to untaught but related design behaviours. The final item, 3DR6, reflected the jury's holistic judgment based on their usual evaluation practices.

The 3DR variables were assessed on two levels: a categorical score (present/absent), indicating whether the relevant design feature was attempted (serving as a proxy for long-term retention), and a continuous quality score (1–10), reflecting the contextual and effective use of that knowledge. The same quality scoring was also applied to six additional variables. The presence score was treated as a proxy for long-term retention, based on the assumption that design features not reinforced through memory would likely be omitted.

2.3. Content of the instructional material

The instructional content addressed the effect of spatial height on the perception of human scale in architecture. Materials were intentionally generic and excluded best-practice examples to prevent design bias. Concepts were presented through simple 2D drawings and 3D visualizations accompanied by concise definitions.

Table 1. *Abbreviations and data types of dependent variables.*

Dependent Variable	Abbreviation	Data Type	
		Categorical	Continuous
Three-Dimensional Relations (3DR)		Present/Absent	
Presence of a gallery/atrium in the design (target variable)	3DR1	P/A	1-10
Variation in ceiling height within the space (target variable)	3DR2	P/A	1-10
Variation in ceiling height across consecutive spaces (target variable)	3DR3	P/A	1-10
Changes in floor levels within the same space	3DR4	P/A	1-10
Changes in floor levels across consecutive spaces	3DR5	P/A	1-10
Overall evaluation of three-dimensional relationships	3DR6		1-10
Creativity			
Creativity in the approach to the space	CR1		1-10
Creativity in the approach to the exhibition	CR2		1-10
Flexibility			
Adaptability to various exhibition configurations	FLX		1-10
Circulation			
Planning exhibition spaces in a way that can tell a coherent story	CIR1		1-10
Efficient visitor circulation throughout the exhibition spaces	CIR2		1-10
Overall			
The jury's overall evaluation	Overall		1-10

The ISP group received five printed booklets (10 pages each); only one, "Human Scale in Architecture," was relevant and identical in content to the DI group's presentation. The remaining four, adapted from Ching (2023), were included to simulate the expansive and ambiguous search space that students typically encounter in real-world design research contexts.

The DI group watched a 14-minute narrated slide presentation aligned with Rosenshine's (2008) explicit instruction principles and followed by a recall test to reinforce learning (Roediger & Butler, 2011). To manage cognitive load (Cowan, 2001; Miller, 1994), content focused only on 3DR1–3 variables.

Of the 33 visuals, 2 targeted 3DR1 and 15 addressed 3DR2–3. Nineteen included the phrase "human scale." No material was provided for 3DR4–5 to assess whether knowledge transfer would occur. The visuals in the relevant ISP handout—the one titled *Human Scale in Architecture*—were identical to those used in the DI group's slides, while the remaining four booklets featured unrelated content. This ensured that any observed differences could be attributed to the instructional method, not the content itself.

2.4. Design problem

Participants were tasked with producing conceptual sketches for an exhibition space designed to showcase student work from a fictional fine arts university. The design was constrained to fit within a 20×20×20 meter volume. A design programme was provided, requiring participants to accommodate artworks of varying scales—from very large pieces (up to 6 meters) to small objects (as small as 0.5 meters)—thus encouraging the creation of spaces with diverse ceiling heights and spatial configurations.

2.5. Procedure

All sessions were conducted at 1 p.m., in separate workshop spaces to prevent interference between groups. Upon arrival, participants received information sheets, and the design brief was distributed on A4 paper and read aloud by the facilitator. All students were instructed not to use mobile phones or communicate during the session. Materials provided included grid paper (1:100 scale), and students were asked to produce freehand sketches including plans, sections, and perspectives as needed.

ISP Group (n = 31) received a 50-page A4 handout containing five topics (10 pages each), only one of which was relevant to the design task (*Human Scale in Architecture*). The remaining four were randomly selected and unrelated, simulating an authentic information search process. Participants studied individually for 40 minutes without interaction. The Cognitive Load Scale (Paas & Van Merrienboer, 1994; Turkish version by Kılıç & Karadeniz, 2004) was administered twice: once after the

search task and again following the 90-minute design session. This single-item instrument has been validated for capturing subjective mental effort across varied instructional contexts and is widely used due to its simplicity and sensitivity (Paas et al., 2003). The scale was used to assess perceived mental effort during both the instructional phase and the subsequent design task. Afterwards, participants wrote a half-page reflection report and completed post-task surveys. A supervisor ensured adherence to the instructions, and all materials were collected at the end (Figure 1).

DI Group (n = 41) received a 14-minute slide-based presentation titled *Human Scale in Architecture*, projected on a 240 × 200 cm screen. The slides were purely visual and narrated by an instructor—who was also a professional voice actor—reading aloud from the same text provided in the relevant section of the handouts used in the ISP group. This choice ensured clear pacing and professional clarity in delivery, reducing extraneous auditory load (Sweller et al., 1998). Each slide advanced after a five-second pause to control pacing. Following the presentation, students completed a 10-minute ungraded recall test and then rewatched the presentation to verify their answers. The instructional session lasted 40 minutes. The Cognitive Load Scale was again administered twice—after the presentation and after the design task—mirroring the ISP group. The session concluded with the same reflection report and post-task surveys. A supervisor monitored compliance, and all materials were collected at the end (Figure 1).

2.6. Data analysis

Design sketches were evaluated online by a jury of three full-time architecture professors from different universities. The five variables in the 3DR1–5 group were coded categorically (1 = present, 0 = absent). In cases of disagreement, the majority decision (two out of three jurors) was taken. To ensure scoring consistency, the authors provided a schematic evaluation form outlining how each spatial relationship should be assessed (Prior to the main evaluation, two independent experts reviewed the form for clarity and relevance). When present, jurors also rated the quality on a 1–10 scale. Jurors were not guided on how to interpret quality scores. This approach preserved the natural judgment of each juror, in line with authentic studio assessment practices. To reduce the impact of individual subjectivity, we calculated the mean of the three scores for each item rather than relying on a single rating. The remaining seven variables were evaluated on quality only.

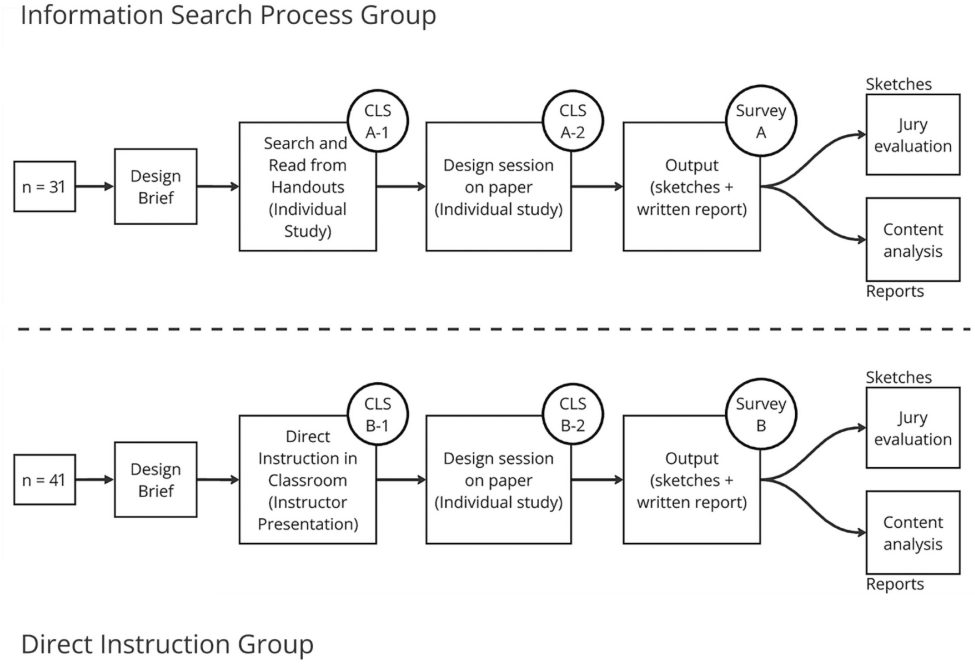

Figure 1. *Experiment design.*

Qualitative content analysis was conducted on both design reports and open-ended survey responses by a second jury composed of three trained research assistants. For the design reports, each assistant independently coded references to the 3DR variable set, then met to reconcile discrepancies and reach consensus. Themes were grouped, counted, and categorized per report. The presence of at least one relevant theme indicated retention of targeted knowledge; blank responses were coded as no long-term retention.

For the surveys, participants answered open-ended questions about how the instructional content and medium affected their learning and design process. The survey was administered in paper format immediately after the final design task, and was designed to elicit post-task reflections aligned with the pedagogical dimensions outlined in Tables 8 and 9. It consisted of two parts: one focusing on the instructional experience and one on the design process. Questions were formulated to explore how the materials supported or hindered understanding, and how they influenced participants' design performance and experience (see Appendix A for full question set).

Responses were analysed using a directed content analysis approach (Hsieh & Shannon, 2005). Each answer was categorized under predefined thematic headings corresponding to the study's instructional framework. The research assistants coded the responses independently and reached consensus through discussion. Two metrics were calculated to summarize results: (i) the percentage of participants mentioning each theme and (ii) the average number of distinct theme mentions per participant, indicating depth of engagement.

3. Findings

This section reports the outcomes of the experimental comparison between Direct Instruction (DI) and the Information Search Process (ISP) regarding novice students' application of foundational design behaviors. The primary focus was on the categorical presence of three explicitly taught variables (3DR1–3), as identified in student design proposals. Two additional spatial variables (3DR4–5), although not included in the instructional material, were also examined to explore the potential transfer of knowledge. Other design dimensions—such as circulation, flexibility, creativity, and overall design quality—were not central to the research questions but were analyzed descriptively to provide broader context and identify possible secondary effects of instructional strategy.

Each of the 3DR1–5 variables was assessed categorically as either present or absent in student work. If a behavior was observed, a quality score between 1 and 10 was also assigned. Table 2 presents interrater reliability values for the categorical evaluations, calculated using Fleiss' Kappa (κ). The results demonstrate high agreement among jury members ($\kappa = 0.865–1.0$, all $p < .000$), indicating strong consistency in the evaluation process. For interpretation of κ values, see Landis and Koch (1977).

3.1. Evaluation of sesign proposals

Participants' design proposals were assessed for the presence of 3DR1–5 variables. One incomplete submission from each group was excluded, resulting in a final sample of 70 students. No statistically significant difference was found between groups in the use of 3DR1.

Table 2. *Interrater agreement for present/absent ratings of targeted design behaviors (3DR1–5) using fleiss' kappa.*

	3DR1	3DR2	3DR3	3DR4	3DR5
Fleiss' Kappa (k)	.982	1.0	.963	.886	.858
p	<.000	<.000	<.000	<.000	<.000
***Interpretation**	* Almost Perfect Agreement	* Perfect Agreement	* Almost Perfect Agreement	* Almost Perfect Agreement	* Almost Perfect Agreement

* Agreement interpreted using Landis and Koch (1977).

Since 3DR2 and 3DR3 both assess manipulation of spatial height—either through floor depth or ceiling elevation—they were combined for analysis. These variables were observed more frequently in the DI group compared to the ISP group (Table 3). A chi-square test confirmed a significant association between instructional method and the application of the combined 3DR2–3 variables, $\chi^2(1, n = 70) = 5.31$, $p = .021$, with a moderate effect size, $\varphi = .275$ (Kim, 2017). This suggests that the teaching method had a meaningful influence on participants' ability to apply height-related spatial strategies in their designs.

3.2. Cognitive load scale results

Independent samples t-tests compared Cognitive Load Scale scores between the DI and ISP groups after both the instruction and design sessions. Levene's tests confirmed equal variances. No significant difference was found following the instruction phase (small effect size, d=0.14). However, after the design session, the ISP group reported significantly higher cognitive load than the DI group, with a moderate effect size (d=0.55). This suggests that DI may reduce cognitive load during the design process (Table 4).

3.3. Qualitative analysis of design reports

Forty participants from the DI group and 30 from the ISP group submitted design reports. A jury of three trained research assistants conducted a qualitative content analysis to identify references to the 3DR1–5 variables, counting each variable at most once per report. The coders first analyzed the reports independently, then convened to resolve discrepancies and reach full consensus (See Appendix B for qualitative content analysis of student design reports). An independent samples t-test showed that the DI group mentioned significantly more distinct learning outcomes than the ISP group, with a moderate effect size (Table 5). Here, "distinct" refers to the number of different learning outcomes mentioned per report, regardless of how many times each was repeated.

3.4. Quality assessment of design proposals

Although not directly tied to the study's main research questions, quality scores were examined for exploratory purposes. No statistically significant differences were found between the DI and ISP groups for the quality of 3DR1 and 3DR3, as shown in Table 6. Quality scores for 3DR2, 3DR4, and 3DR5 were not analyzed due to insufficient data.

Additional comparisons were made for creativity, flexibility, circulation, and overall design quality. Again, no significant differences emerged between the instructional groups. Levene's tests confirmed equal variances across all variables (Table 7), suggesting that both groups performed similarly across these secondary measures.

3.5. Perceived facilitation of learning

In the DI group, 74% of participants reported that the instructional content facilitated their learning, with an average of 0.9 theme mentions per participant (mpp). A similar rate was observed in the ISP group (77.7%, 1.0 mpp), which is consistent with the fact that the DI content was replicated in one of the ISP group's handouts, and the others followed a comparable instructional format (Table 8).

Among DI participants, 54% described the content as highly informative, 13% highlighted the clarity of explicit instruction (via narrated text), 10% noted improved comprehension through repeated viewing, and 5% found the recall test between presentations helpful. ISP participants reported similar experiences: 59.3% found the visuals informative, 14.8% said the handouts helped them recall forgotten knowledge, 7.4% appreciated the introduction of new information, and another 7.4% praised the clarity of the examples.

3.6. Perceived challenges in learning

Despite generally positive perceptions, 23.1% of DI participants reported learning-related challenges (0.26 mpp). These included difficulty understanding the topic (7.7%), struggling with nuanced or unfamiliar concepts (7.7%), and the need for additional examples to aid comprehension (5.1%).

Table 3. *2x2 contingency table for 3DR_2-3 combined.*

		3DR2_3 Variables Combined			
		Never Used		Used At Least Once	
		n	%	n	%
Groups	**DI (*n*=40)**	23	47.9%	17	77.3%
	ISP (*n*=30)	25	52.1%	5	22.7%
Total *(n=70)*		48	100%	22	100%

Chi-square test: $\chi^2(1, N = 70) = 5.31$, $p = .021$, $\phi = .275$, (small to moderate effect)

Table 4. *Comparison of cognitive load scale means, independent samples t-tests, and Levene's test results for DI and ISP groups.*

Test	Information Search Process Group Mean (SD)	Direct Instruction Group Mean (SD)	t(df)	p-value	Levene's F (df1,df2)	Levene's p-value	Interpretation
After Instruction Session	4.87 (1.36)	4.68 (1.40)	0.570 (70)	.570	0.545 (1, 70)	.463	No significant difference; Cohen's d = 0.14
After Design Session	6.87 (1.71)	5.93 (1.75)	2.289 (70)	.025*	0.010 (1, 70)	.922	Significant difference; Cohen's d = 0.55

**Note. The p-values for t-tests were considered significant at p < .05. Levene's test p-values (p>.05) indicate the assumption of equal variances has been met.*

Table 5. *Independent samples T-Test for the number of unique learning outcomes mentioned in report.*

Parameter	Direct Instruction Group Mean (SD) n=40	Information Search Process Group Mean (SD) n=30	t(df)	p-value	Levene's F (df1,df2)	Levene's p-value
The Number of Unique Learning Outcomes Mentioned in Reports	1.73 (1.18)	1.33(1.01)	2.21 (68)	.030*	0.43 (1, 68)	.516
Effect Size Cohen's d = 0.53, 95% CI [0.05, 1.00] (Moderate Effect)						

**Note. The p-values for t-tests were considered significant at p < .05. Levene's test p-values indicate whether the assumption of equal variances was met.*

Table 6. *Independent-samples mann–whitney U tests of quality scores.*

Variable	n	U	z	*p* (Exact, 2-tailed)	Decision
3DR1	DI 15 ISP 11	74.50	-0.417	.683	Retain the null hypothesis.
3DR2	DI 4 ISP 0				Insufficient data for analysis
3DR3	DI 16 ISP 5	140.50	0.561	.575	Retain the null hypothesis.
3DR4	DI 5 ISP 4				Insufficient data for analysis
3DR5	DI 2 ISP 2				Insufficient data for analysis

*The significance level used was .050.

In contrast, 55.6% of ISP participants reported challenges (0.59 mpp). Common issues included insufficient time to read lengthy texts (22.2%), low-quality visuals (11.1%)—with some participants specifically interpreting Francis Ching's hand-drawn illustrations as unclear—and underdeveloped examples that hindered comprehension of complex concepts (7.4%) (see Table 8).

Table 7. *Comparison of means, independent samples t-tests, and Levene's test results for DI and ISP groups across various parameters.*

Parameter	Direct Instruction Group Mean (SD)	Search Process Group Mean (SD)	t(df)	p-value	Levene's F (df1,df2)	Levene's p-value
3DR6General	3.83 (1.39)	3.38 (1.55)	1.26 (68)	.212	1.79 (1, 68)	.185
Creativity 1	2.69 (1.22)	2.66 (1.16)	0.09 (68)	.930	0.00 (1, 68)	.991
Creativity 2	2.72 (1.25)	2.45 (1.24)	0.87 (68)	.389	0.05 (1, 68)	.821
Flexibility	2.74 (0.96)	2.57 (0.89)	0.72 (68)	.474	0.33 (1, 68)	.567
Circulation 1	2.84 (1.12)	2.76 (1.25)	0.29 (68)	.772	0.04 (1, 68)	.852
Circulation 2	1.41 (1.07)	3.04 (1.40)	-0.12 (68)	.901	1.77 (1, 68)	.188
Overall	3.87 (1.20)	3.64 (1.41)	0.77 (68)	.466	1.89 (1, 68)	.173

Note. The p-values for t-tests were considered significant at p < .05. Levene's test p-values (p>.05) indicate the assumption of equal variances has been met.

Table 8. *Participants' perceptions of how instructional content in slide presentations and handouts facilitates / challenges learning.*

Concepts and Themes (Respondents: n)	Participants mentioned (% of Participants Mentioning)	Total Mentions (Mentions per Participant)
How instructional content in slide presentation facilitates learning (n=39)	29 (74%)	35 (0.9)
Highly informative (no further details provided)	21 (54%)	21 (0.54)
Information was explicitly conveyed (clear explanations and definitons)	5 (13%)	5 (0.13)
Watching twice made understanding easier	4 (10%)	4 (0.1)
The recall-test between presentations	2 (5%)	2 (0.05)
How instructional content in handouts facilitates learning (n=27)	21 (77.7%)	27 (1.0)
Very informative illustrations	16 (59.26 %)	16 (0.59)
Handouts helped recalling fotgotton knowledge	4 (14.81 %)	4 (0.15)
I got information about the subject thanks to the handouts	2 (7.41 %)	2 (0.074)
Some examples were explained clearly	2 (7.41 %)	2 (0.074)
Short and effective explanations	1 (3.7 %)	1 (0.037)
Instruction helped me to understand size and shapes of spaces	1 (3.7 %)	1 (0.037)
Simple visuals and texts	1 (3.7 %)	1 (0.037)
How instructional content in slide presentation challenges learning (n=39)	9 (23.07 %)	10 (0.26)
Hard to understand the subject	3 (7.69 %)	3 (0.077)
New and nuanced concepts	3 (7.69 %)	3 (0.077)
More examples needed	2 (5.13 %)	2 (0.05)
Short instruction	1 (2.56 %)	1 (0.026)
Gray tone visuals	1 (2.56 %)	1 (0.026)
How instructional content in handouts challenges learning (n=27)	15 (55.55 %)	16 (0.59)
Hard to read long texts	6 (22.22 %)	6 (0.22)
Low quality visuals	3 (11.11 %)	3 (0.11)
Some examples were not explained in detail	2 (7.41 %)	2 (0.07)
Too theoretical explanations	1 (3.7 %)	1 (0.037)
More examples needed	1 (3.7 %)	1 (0.037)
Different fonts across different subjects	1 (3.7 %)	1 (0.037)
Monotonious text and visuals	1 (3.7 %)	1 (0.037)
Hard to understand the subject	1 (3.7 %)	1 (0.037)

3.7. Perceived facilitation of design

A majority of students in both groups found the instructional material helpful for the design task: 79% in the DI group and 82.1% in the ISP group (0.97 and 1.04 mpp, respectively), consistent with the shared content delivered through slides or handouts (Table 9).

Table 9. *Participants' perceptions of how instructional content in slide presentations and handouts facilitates/ challenges design.*

Concepts and Themes (Respondents: n)	Participants mentioned (% of Participants Mentioning)	Total Mentions (Mentions per Participant)
How / Which instructional content in slides facilitates design (n=39)	31 (79%)	38 (0.97)
Knowledge on human scale / space scale / scale / height / width / size	22 (56%)	22 (0.56)
Highly informative (no further details provided)	11 (28 %)	11 (0.28)
Learned about the psychological effects of building scale on humans	3 (7.5%)	3 (0.075)
How / Which Instructional content in handouts facilitates design (n=28)	23 (82.14 %)	29 (1.035)
Positive / Knowledgable (no details given)	14 (50.0 %)	14 (0.5)
Instructional material supports inspiration	5 (17.86 %)	5 (0.18)
I learned how should I approach design	3 (10.71 %)	3 (0.107)
Knowledge on human scale / space scale / scale / height / width / size	2 (7.14 %)	2 (0.072)
Helped designing staircases	1 (3.57 %)	1 (0.036)
Helped shaping spaces	1 (3.57 %)	1 (0.036)
Helped me to design circulation	1 (3.57 %)	1 (0.036)
Designing just after reading	1 (3.57 %)	1 (0.036)
Knowledge of human/space scale helped design decisions	1 (3.57 %)	1 (0.036)

In the DI group, 56% noted that concepts such as human scale, space dimensions, and proportions directly informed their design decisions. Another 28% found the content broadly informative, while 7.5% valued insights into psychological effects of scale, citing benefits for user experience. Although mentioned by a minority, such insights indicate that some students began to link spatial strategies with user-centred thinking—an indicator of higher-level conceptual engagement.

Among ISP participants, 50% offered general positive comments. In addition, 17.9% reported being inspired by the material, and 10.7% said they learned new design strategies. A smaller portion (7.1%) mentioned that knowledge of human scale and spatial dimensions contributed to their design thinking—echoing themes from the DI group.

4. Discussion

4.1. Summary of key findings

This study examined whether Direct Instruction (DI), designed according to principles of cognitive load theory and structured delivery (Rosenshine, 2008), outperforms the widely adopted Information Search Process (ISP) approach (Kuhlthau, 1991) in helping novice architecture students learn and apply fundamental spatial design knowledge—specifically regarding human scale. The results provide empirical support for DI in this context, showing both a higher rate of knowledge application in design tasks and reduced cognitive load during the problem-solving phase.

The strongest behavioral outcome was observed in the application of spatial concepts related to ceiling height (3DR2–3), with 17 out of 40 DI participants incorporating these strategies versus only 5 out of 30 in the ISP group. This difference was statistically significant ($\phi = .275$), representing a moderate effect size (Kim, 2017) and indicating a meaningful practical impact, particularly given the short duration and narrow instructional focus of the intervention. In contrast, no significant difference emerged for 3DR1, which was likely a result of prior exposure in earlier courses. This distinction suggests that the impact of instructional method is more visible when students are introduced to new, unfamiliar content—supporting Sweller's (1988) claim that guidance is most beneficial when prior knowledge is low.

Cognitive load measured after the design session was significantly lower for DI participants (Cohen's $d = 0.545$), despite no meaningful difference immediately after instruction. This supports the interpretation that DI helped

students store information in long-term memory in a well-structured format, enabling easier retrieval during problem-solving tasks.

4.2. Theoretical implications

These findings are consistent with information processing theory (Atkinson & Shiffrin, 1968; Baddeley & Hitch, 1974), which emphasizes the role of well-organized long-term memory in supporting cognitive efficiency. The DI group's ability to retrieve and apply information more effectively suggests that the structure and clarity of instruction played a key role in reducing cognitive load during the task. In contrast, ISP participants had to simultaneously search, select, and integrate relevant information—placing higher demands on their limited working memory capacity.

Our results also align with Jonassen's (1991) staged model of learning, which proposes that direct instruction is most effective in early learning phases, while constructivist strategies become more appropriate as expertise grows. In this case, the benefits of DI stemmed not from its structure alone, but from its ability to reduce working memory demands and allow students to focus their cognitive resources on problem-solving.

While the superior performance of the DI group may appear theoretically predictable under Cognitive Load Theory, it is important to note that this expectation had not been empirically tested within the context of early-stage architectural design education. Our study addresses this gap by showing that DI—when focused narrowly on a single concept and supported with worked examples and a recall test—can promote schema acquisition without relying on rote memorization. The findings suggest that DI serves not merely as a delivery method, but as a cognitively optimized learning process, enabling novices to apply knowledge under complex representational demands.

4.3. Positioning within the literature

To our knowledge, no prior studies have employed a similar post-test controlled experimental design to directly compare DI and ISP in architectural design education. For instance, Andjomshoaa et al. (2011) compared direct instruction and constructivist approaches in terms of retention, but their study lacked details on instructional content or implementation, making it unclear whether differences were attributable to teaching methods or other variables. Al-Sayed et al. (2010) reported that explicit knowledge of spatial configurations enhanced problem-solving more effectively than implicit knowledge, though their participants were experienced architects. Since experts and novices differ significantly in how they approach problems (Chi et al., 1981), direct comparisons are limited.

Nevertheless, our findings reinforce that clearly structured, explicit knowledge supports better outcomes in architectural design tasks, especially for beginners. Casakin (2008) also investigated the link between design problem-solving strategies and creativity in architecture students. However, the study did not employ a controlled instructional intervention. Instead, it used exploratory factor analysis—a method designed to identify latent variables rather than test causal effects of instruction—and applied regression analysis within a single-group setting. These methodological choices make it difficult to draw robust conclusions about the impact of any specific instructional strategy. These results add to critiques of minimally guided instruction in cognitive science (Kirschner et al., 2006), which argue that novice learners often lack the schemas necessary for organizing and integrating complex new information. Our findings show that constructivist exploration, while philosophically appealing, may not provide sufficient cognitive scaffolding in early-stage design education.

4.4. Knowledge application vs. skill integration

While DI participants mentioned significantly more target concepts in their reports (Cohen's $d = 0.53$), indicating long-term retention, no group differences emerged in overall quality scores of design proposals. This

discrepancy highlights an important point: conceptual knowledge is necessary but insufficient for high-quality design performance. Although students retained key concepts, they may not have developed sufficient procedural strategies to translate them into integrated design decisions.

This finding echoes Sweller's (1988) view that four types of knowledge—factual, procedural, strategic, and skill—must interact for successful problem-solving. Future instruction might benefit from techniques like worked examples and completion problems (Sweller et al., 1998), which promote the transfer of conceptual knowledge into skill through guided, contextualized practice.

4.5. Student perceptions and cognitive experience

Qualitative feedback from participants further substantiates the findings. DI participants articulated more specific takeaways from the instruction, such as the relationship between space height and human experience, whereas ISP participants offered more general or vague comments. Additionally, the ISP group more frequently reported cognitive fatigue and difficulty parsing lengthy texts, confirming the hypothesis that unstructured research tasks may overburden novice learners.

Both groups acknowledged that the instructional content was useful, but the DI group's ability to name specific concepts suggests a stronger internalization of learning objectives—likely aided by the focused scope and structured delivery of the material.

4.6. Limitations and future research

It is important to note that this study was limited to a single design session and a narrowly defined instructional topic. Broader generalizations should be avoided without further studies exploring a range of content areas, durations, and student levels. While categorical design behaviors were assessed with high interrater reliability, the quality scores—though analyzed—were explored for secondary insights but were not central to the study's hypotheses or statistical power considerations. Their fair-to-moderate consistency reflects the subjective nature of jury-based assessments and limits the strength of any conclusions regarding creativity or execution quality.

Future work should explore whether integrating direct instruction with worked examples, studio critiques, or media-rich simulations can further enhance transfer of knowledge and skill development. Longitudinal studies could examine the durability of learning and its application across design problems and semesters.

4.7. Toward systematic eclecticism in studio pedagogy

The findings of this study point to the limitations of relying solely on either constructivist or instructivist approaches in early design education. Snelbecker's (1974) systematic eclecticism offers a pragmatic solution by advocating for the deliberate integration of strategies from multiple learning theories based on learners' needs and objectives. Rather than rigidly adhering to a single paradigm, instructors can flexibly combine direct instruction, scaffolding, and exploratory methods to support novices while gradually fostering independence.

Empirical observations from studio settings support this hybrid approach. For example, Sawyer (2022) found that even in ostensibly constructivist studio environments, instructors frequently reverted to direct explanations of their own design reasoning—revealing a tacit form of eclecticism already at play. While this can support struggling students, it is often subjective and inconsistent. Complementing this, de Jong et al. (2023) demonstrated in broader instructional contexts that combining guided instruction with exploratory learning yields more effective outcomes than relying on either method alone.

To reduce dependence on idiosyncratic instructional delivery and better support student learning, foundational design knowledge—such as scale, material, structure, and form—should be conveyed through structured methods aligned with cognitive load theory (Sweller et al., 2019). This

ensures that students acquire the cognitive frameworks necessary for informed creative exploration. As a result, a better balance can be achieved between instructional guidance and learner autonomy.

5. Conclusion

This study investigated the effectiveness of Direct Instruction (DI) versus an Information Search Process (ISP) approach—commonly used in constructivist architectural education—for teaching the concept of "human scale" to novice architecture students. Addressing three research questions through a mixed-methods post-test control group design, the study produced three key findings:

- First (RQ1), significantly more students in the DI group applied the targeted spatial design strategies (3DR2–3) in their proposals compared to those in the ISP group. This indicates that DI was more effective in promoting the application of foundational concepts among novice learners. These findings support the conclusion that explicitly taught and well-sequenced knowledge enhances the accessibility and usability of foundational concepts in applied design contexts.
- Second (RQ2), cognitive load scores collected after the design session revealed a significant difference between groups: DI students experienced lower cognitive load, suggesting they were cognitively more efficient during the design process. This aligns with cognitive load theory (Sweller et al., 1998), which argues that clear instruction frees up working memory resources for active problem-solving.
- Third (RQ3), while both groups perceived the instructional content as helpful for learning and design, DI students more frequently and specifically articulated how the material supported their design decisions—explicitly naming *human scale* and related spatial concepts. In contrast, ISP participants offered more general or vague statements. This suggests that DI not only improved information retention but also supported metacognitive awareness, as reflected in students' ability to identify and articulate specific design principles guiding their decisions.

However, no significant difference emerged between groups in terms of design quality scores. This may be attributed to the basic nature of the instructional content and the limited design experience of the participants, which likely constrained their ability to translate retained knowledge into high-quality spatial compositions. This reinforces the need to distinguish between knowing what to apply and knowing how and when to apply it.

To bridge this gap, future studies should explore worked examples and expert modelling, which may help students internalize not just principles but also their application. As students build fluency, more complex and open-ended problems can be introduced, gradually transitioning toward constructivist approaches.

This study advocates for systematic instructional alignment with student expertise levels. For novice learners, DI aligned with cognitive architecture offers clear benefits in efficiency and retention. As learners progress, constructivist methods can play a greater role. We argue for systematic eclecticism—the deliberate combination of methods based on learning goals and cognitive readiness—as a productive strategy in architectural studio education.

Finally, this study underscores the urgent need for more controlled experimental research in architectural education. The field remains dominated by case studies, which, while valuable for exploratory insights, rank low in the hierarchy of evidence. Case studies alone cannot generate reliable or generalisable knowledge about instructional effectiveness. To advance architectural pedagogy as a scientific discipline, controlled designs—capable of testing causal relationships and minimizing bias—are essential. Only through such methods can we move beyond anecdotal accounts and establish evidence-based, transferable instructional strategies.

Appendix.

Appendix A

Open-Ended Survey Questions

The following open-ended questions were administered immediately after the final design session. They were structured to capture participants' reflections on the instructional and design phases of the study. Each question corresponds to specific thematic clusters reported in the qualitative analysis tables.

Part 1 – Reflections on the Instructional Phase

(Targets: "How/Which instructional content in slides/handouts facilitates learning/design" and "...challenges learning/design")

- *Can you describe your overall experience during the instructional phase of the study?*
  (General input – provides context for perceived instructional impact)
- *What aspects of the instructional content helped you better understand the subject matter?*
  (Feeds into: "How instructional content in [slides/handouts] facilitates learning")
- *What aspects of the instructional content made it difficult for you to understand the subject matter?*
  (Feeds into: "How instructional content in [slides/handouts] challenges learning")

Part 2 – Reflections on the Design Phase

(Targets: "How/Which instructional content in slides/handouts facilitates design" and "...challenges design")

- *Can you describe your overall experience during the design phase of the study?*
  (General input – used to assess student engagement and perceived fluency)
- *What aspects of the design process did you find challenging?*
  (Feeds into: "...challenges design" themes, both instructional and contextual)
- *What aspects of the design process did you find supportive or helpful?*
  (Feeds into: "...facilitates design" themes)
- *In your opinion, how did the instructional material (i.e. the worksheet / slide presentation) positively or negatively affect your design process and final output?*
  (Feeds into: overall perceived instructional impact on design — cross-validates themes from Q2 and Q6)

Appendix B

Thematic Coding Results from Design Reports

The list below presents the themes identified during the qualitative content analysis of student design reports, along with their frequencies in each group.

- Statements discussing the spatial relationship between the height of exhibited artworks and the height of the space:
  9 (ISP), 23 (DI)
- Statements referencing the presence of vertical voids:
  10 (ISP), 15 (DI)
- Statements about ceiling height and floor level differences:
  5 (ISP), 11 (DI)
- Statements expressing emotional responses to vertical spaciousness or compression:
  6 (ISP), 10 (DI)
- Statements explicitly referring to human scale:
  3 (ISP), 10 (DI)
- Statements referencing vertically moving structural elements:
  1 (ISP), 0 (DI)

Total frequency count: 34 (ISP n:30), 69 (DI n:40)

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References

Al-Sayed, K., Dalton, R. C., & Hölscher, C. (2010). Discursive design thinking: The role of explicit knowledge in creative architectural design reasoning. *AI EDAM*, *24*(2), 211-230.

Andjomshoaa, A., Islami, S. G., & Mokhtabad-Amrei, S. M. (2011). Application of constructivist educational theory in providing tacit knowledge and pedagogical efficacy in architectural design education: A case study of an architecture school in Iran. *Life Science Journal*, *8*(1), 213-233.

Atkinson, R. C., & Shiffrin, R. M. (1968). *Human memory: A proposed system and its control processes*. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 2, pp. 89–195). Academic Press. https://doi.org/10.1016/S0079-7421(08)60422-3

Baddeley, A. D., & Hitch, G. J. (1974). *Working memory*. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 8, pp. 47–89). Academic Press.

Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (2013). Theory into practice: How do we link? In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 17–34). Routledge.

Belluigi, D. Z. (2016). Constructions of roles in studio teaching and learning. *International Journal of Art & Design Education, 35*(1), 21-35.

Casakin, H. (2008). Factors of design problem-solving and their contribution to creativity.*Open house international, 33*(1), 46-60.

Chi, M. T., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive science*, *5*(2), 121-152.

Ching, F. D. (2023). *Architecture: Form, space, and order*. John Wiley & Sons.

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and brain sciences*, *24*(1), 87-114.

Coyne, R. (2005). Wicked problems revisited. *Design Studies, 26*(1), 5–17. https://doi.org/10.1016/j.destud.2004.06.005

Dutton, T. A. (1987). Design and Studio Pedagogy. *Journal of Architectural Education*, 41(1), 16-25.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance improvement quarterly*, *26*(2), 43-71.

Gray, C. M. (2013). Informal peer critique and the negotiation of habitus in a design studio. *Art, Design & Communication in Higher Education*, 12(2), 195-209.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277–1288. DOI: 10.1177/1049732305276687

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational technology research and development*, *39*(3), 5-14.

de Jong, T., Lazonder, A. W., Chinn, C. A., Fischer, F., Gobert, J., Hmelo-Silver, C. E., et al. (2023). Let's talk evidence: The case for combining inquiry-based and direct instruction. *Educational Research Review, 39*, 100536. https://doi.org/10.1016/j.edurev.2023.100536

Kuhlthau, C. C. (1991). Inside the search process: Information seeking from the user's perspective. *Journal of the American society for information science*, *42*(5), 361-371.

Kuhlthau, C. C., Heinström, J., & Todd, R. J. (2008). The 'information search process' revisited: Is the model still useful. *Information research*, *13*(4), 13-4.

Kılıç, A. G. E., & Karadeniz, Ö. G. Ş. (2004). Hiper ortamlarda öğrencilerin bilişsel yüklenme ve kaybolma düzeylerinin belirlenmesi. *Kuram ve Uygulamada Eğitim Yönetimi, 40*(40), 562-579.

Kim, H. Y. (2017). Statistical notes for clinical researchers: Chi-squared test and Fisher's exact test. *Restorative*

dentistry & endodontics, *42*(2), 152.

Kirschner, P. A., Sweller, J., & Clark, R. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86.

Knoblauch, C. H., & Brannon, L. (1981). Teacher commentary on student writing: The state of the art. *Freshman English News, 10*(2), 1–4.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving schools*, *19*(3), 267-277.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159–174. https://doi.org/10.2307/2529310

Lord, T. R. (1999). A Comparison Between Traditional and Constructivist Teaching in Environmental Science. *The Journal of Environmental Education*, *30*(3), 22–27. https://doi.org/10.1080/00958969909601874

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511811678

Miller, G. A. (1994). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 101*(2), 343–352. https://doi.org/10.1037/0033-295X.101.2.343

Moreno, R. (2004). Decreasing cognitive load for novice students: Effects of explanatory versus corrective feedback in discovery-based multimedia. *Instructional science, 32*(1), 99-113

Morgado, P. (2010). From passive to active learners: Implementing the pedagogy of "learning by doing" in a large-sized design foundation class. *Transformative Dialogues: Teaching and Learning Journal, 4*(2), 1–13

Ofsted. (2023). *School inspection handbook*. Office for Standards in Education, Children's Services and Skills. https://www.gov.uk/government/publications/school-inspection-handbook-eif/school-inspection-handbook-for-september-2023

Oh, Y., Ishizaki, S., Gross, M. D., & Do, E. Y. L. (2013). A theoretical framework of design critiquing in architecture studios. *Design Studies*, *34*(3), 302-325.

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. M. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educational Psychologist, 38*(1), 63–71. https://doi.org/10.1207/S15326985EP3801_8

Paas, F. G., & Van Merriënboer, J. J. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. *Educational Psychology Review, 6*(4), 351-371.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational researcher*, *24*(7), 5-12.

Piaget, J. (1952). *The origins of intelligence in children*. (M. Cook, Trans.). W. W. Norton & Company. https://doi.org/10.1037/11494-000

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in cognitive sciences*, *15*(1), 20-27.

Rosenshine, B. (2008). *Five meanings of direct instruction* (pp. 1–10). Center on Innovation and Improvement. http://centerii.org/techassist/solutionfinding/resources/FiveMeaningsOfDI.pdf

Sawyer, R. K. (2017). Teaching creativity in art and design studio classes: A systematic literature review. *Educational research review*, *22*, 99-113.

Sawyer, R. K. (2022). Teaching creative thinking: how design professors externalize their creative thinking in studio classroom talk. *Mind, Culture, and Activity*, *29*(1), 21-42.

Schön, D. A. (1985). *The Design Studio: An Exploration of its Traditions and Potentials*. London: RIBA Publications Limited.

Schön, D. A. (1987). *Educating the reflective practitioner.* Jossey-Bass Publishers.

Shute, V. J. (2008). Focus on formative feedback. *Review of educational research*, *78*(1), 153-189.

Snelbecker, G. E. (1974). *Learning theory, instructional theory, and psychoeducational design*. McGraw-Hill.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257-285.

Sweller, J., Van Merrienboer, J. J., & Paas, F. G. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251-296.

Sweller, J., van Merriënboer, J. J., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. *Educational Psychology Review, 31*(2), 261-292.

Tobias, S., & Duffy, T. M. (2009). The success or failure of constructivist instruction: An introduction. In S. Tobias & T. M. Duffy (Eds.), *Constructivist instruction: Success or failure?* (pp. 15-22). Routledge.

Vanada, D. I. (2016). An equitable balance: Designing quality thinking systems in art education. *International Journal of Education & the Arts, 17*(11), 1-20.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard university press.

Vygotsky, L. S. (1987). *The collected works of L.S. Vygotsky*. New York: Plenum.

Webster, H. (2008). Architectural education after Schön: Cracks, blurs, boundaries and beyond. *Journal for Education in the Built Environment, 3*(2), 63-74.