Journal of Philology and Educational Sciences

EngiScience Publisher

Research Article

Reconsidering Teaching Construction in Architectural Education

Sardar S. Shareef [1,*], **Hozan Latif Rauf** [2], **Ejeng Bassey Ukabi** [3]

[1] Department of Interior Design Engineering, Tishk International University, Sulaimaniyah,46001, Iraq

[2] Decoration Engineering-Interior Design Department, Kurdistan Technical Institute, Sulaimaniyah, 46001, Iraq

[3] Department of Architecture, Girne American University, Kyrenia, 99300, Mersin 10, Turkey

*Corresponding Author: Sardar S. Shareef, E-mail: sardar.shareef3@gmail.com

Article Info

Article History

Received Feb 12, 2024

Revised Mar 24, 2024

Accepted May 06, 2024

Keywords

Architecture education

Construction and design

Technical issues

Design-build

Ontological methods

Life-long learning

Abstract

This paper critically examines the weakening connection between design and construction in architectural education, highlighting the underrepresentation of construction courses in comparison to their design counterparts. By analyzing contemporary pedagogical methods, it aims to uncover a more effective teaching approach that simultaneously nurtures students' enthusiasm for construction and design, emphasizing the synergy between technical proficiency and creative vision. Proposing a hands-on, problem-solving methodology integrated within design studios, this study suggests a paradigm shift towards an ontological observational approach. It argues for a transformative change in perception among educators and students alike, advocating for a unified educational framework that fosters technical and theoretical coherence, ultimately contributing to sustainable architectural practices.

1. Introduction

In the past, architects were master builders who both designed and supervised construction, indicating that design and construction were not separate disciplines. However, the changing demands of life after the Industrial Revolution introduced a shift towards multidisciplinary specialization driven by market forces. This shift meant that each discipline had to practice its profession with greater specificity and intensity (Cushman & Loulakis, 2001). This change has weakened the connection between construction and design in architecture. The introduction of various machines and instruments in the construction field means that builders, designers, and other professionals require specific yet comprehensive knowledge. This separation has negatively impacted architecture over the long term. Both historically and in contemporary practice, there is a challenge in trying to reestablish the genuine link between design and construction.

In 1920-21, Professor Edouard Arnaud from the École des Beaux-Arts introduced his first construction course, which architectural and engineering students attended in their second year. This course was designed to enhance technical practice. However, the class critiqued the course for its exclusive focus on technical issues while neglecting artistic aspects, particularly the art of composition. In response, Arnaud aimed to refine the course to serve as an effective component of the École des Beaux-Arts curriculum. He advocated for the inclusion of contemporary architecture and successfully integrated the course into the fine arts curriculum. The course was notable for introducing reinforced concrete as a building material and covered a wide range of topics, including masonry construction, roofs, foundations, staircases, decorations, and more. Arnaud's approach wisely combined teaching technical construction problems with architectural drawing (Guelle, 2022).

Reevaluating the relationship between design and construction within architectural education requires significant refinement to meet contemporary demands. While there are some efforts to bridge design and construction, they fall short of the desired standard. Most initiatives rely on traditional methods, which architecture students often find dull and overly time-consuming (Yunus, 2001). This paper seeks to identify an integrated approach to teaching construction courses that not only facilitates the absorption of knowledge by students but also inspires them to incorporate construction principles into their design concepts. Furthermore, this method aims to meet contemporary architectural, and construction needs by weaving construction into the fabric of design studio education. This necessitates a transformation in how construction courses are taught, moving from traditional, teacher-centered lectures to a model that embraces active learning environments. As construction education evolves to reflect the broader trend in higher education towards more engaging and participatory learning spaces (Obla & Ukabi, 2021), the physical environments in which faculty and students interact will become increasingly important (Farrow & Wetzel, 2021).

2. Literature Review

2.1. History of Construction

In response to the question, "When did architecture begin, Furtado (2014) cites Vittorio Gregotti, an Italian architect, who asserts that the act of burying a stone into the earth marked the inception of architecture by defining a place and claiming territory". For this reason, there is a significant demand to integrate the history of construction into the current architecture curricula. Evidence suggests that existing curricula offer limited information on construction to students of architecture and engineering. Understanding the entire history of the construction industry is crucial, as it helps to appreciate the human role in construction culture. This awareness is essential in recognizing the transition from the master builder tradition to the specialized labor that is indispensable in the modern era (Diekmann, 2007). The demand for construction history and its study is robust in countries with a rich heritage of historic architecture, more so than the push to include construction history as a mere complementary subject. This approach allows the new generation of architects to readily engage with and be inspired by past achievements. Observationally, students who study construction history as a distinct course gain a profound understanding of the interconnections between standards and techniques, materials and forms, and structures and materials. This knowledge fosters a sustainable paradigm shift within the realms of architecture and construction (Voyatzaki, 2002).

Numerous examples analyzed from various historical backgrounds highlight structures and landmarks of significant importance, leading to the integration of architectural approaches with structural design, with Gothic architecture serving as a pivotal example (Mokhaberi, 2010). Moreover, studying construction reveals the potential to teach methodologies that have shaped both historical and contemporary trends in the built environment. This approach helps us understand the dynamic relationship among society, machinery, and building materials (Voyatzaki, 2002). Through this approach, we can grasp the connections between culture and construction, thereby understanding the values of specific historical periods in terms of architectonics, construction innovations, and the relationships between form and construction, among others.

2.2 Construction and Architectural Design

Long ago, master builders oversaw all aspects of designing and constructing buildings, including technical, aesthetic, and structural considerations. However, this dynamic shifted after the Industrial Revolution, leading to the emergence of multidisciplinary layers. Consequently, architecture and other disciplines, such as structural design and construction, evolved into distinct professions (Mokhaberi, 2010). Subsequently, the nuanced understanding of integrating these disciplines gradually lost its essence. However, the issue sparked debates at various levels, culminating in a focused reconsideration during the European Policies for Higher Education Bologna Declaration in 1999 (Voyatzaki, 2002). Furthermore, the environmental challenges of today underscore the importance of making construction a central focus in architectural education curricula.

Leon Battista Alberti also stated that the relationship between construction and design has broader implications. He introduced the concept of “lineaments” into the discourse, asserting that “design and construction represent two distinct yet interconnected matters: construction encompasses all the technical procedures required to carry out the work, while design—or lineaments—precedes construction, embodying the accurate and detailed outline of the design, composed of lines and angles” (Hartoonian, 1994).

Construction, whether on-site or off-site, and its associated education are multifaceted and require diligent study to master, as indicated by students in building industry professions. It is a challenging field, deeply rooted in knowledge of materials, construction methods, building components, and more (Allen & Iano, 2019). Theoretical concepts supporting the relationship between design and construction emphasize the importance of including construction in the architectural education curriculum. Moreover, design teaching methods can play a significant role in enhancing construction knowledge and awareness among students of architecture and related disciplines.

2.3 Tectonics of Construction

Hurol (2015) defines tectonics—or architectonics—as “a holistic and qualitative approach to the artistic use of technology in architecture.” This concept introduces an artistic or qualitative dimension to architecture and construction through the exploration of architectonics.

Kenneth Frampton explores the origins of architecture as construction. He illuminates the concept of tectonics, derived from the Greek word meaning the art of joining, fitting, and connecting parts of a constructed building. Frampton argues that structural elements alone cannot define a building; instead, it is the integration of these elements with aesthetic values that truly shapes a structure. This perspective gained traction among postmodern architects, who emphasized cultural, aesthetic, and formal values in their work. Furthermore, Frampton advocated for a revival of modern movement principles, aiming for their reorganization in a rational and contextually sensitive manner (Furtado, 2014).

Furtado (2014) describes tectonic architecture as a concept that articulates “the structural foundation of construction and forms a partnership with the construction process, expressing the physical structure through which the aesthetic principles of the work are revealed”. Tectonics is thus seen as the grammar of construction systems, defining the art of connection (Frampton, 2001). Furthermore, it can be stated that tectonics is not merely the art of construction; rather, it acts as a catalyst that bridges material aspects with aesthetic and cultural values (Pantoja,et al., 2012). Similarly, art and technology occupy two distinct realms. Technology emerges from reason and calculation, serving as a means to achieve practical objectives. Art, in contrast, is representational and dwells within the sphere of values (Hartoonian, 1986).

Sir et al. (2015) connect the concept of tectonics in architecture to Vitruvius's principles, positing that Vitruvius’s notions of function, strength (structure), and aesthetics align with the idea that strength embodies construction (tectonic) as an integral system within architecture. Researchers like Edward Sekler, in his essay “Structure, Construction, and Tectonic,” equate structure with the overarching principle of a building that bears loads and view construction as the nexus between systems and materials. Thus, they suggest that construction essentially represents tectonics. This perspective underscores that technical aspects and aesthetics complement each other, positing architects as practitioners of metaphysics who rely on the physical expertise of engineers, designers, and technicians. This relationship is likened to Janus with his two faces, symbolizing the dual nature of architecture that combines practicality with artistry.

Many architectural discussions emphasize that the significance of construction is still framed by the metaphysical concept of techne, which guides the process of creation by aesthetic values and technical standards (Hartoonian, 1994). We can relate this to the profound truth advocated by John Ruskin, who emphasized the importance of morality and aesthetic expression (Söffker & Deplazes, 2005). However, this emphasis on honesty and justice in the use of materials leads to a diminishing sense of nostalgia. From Viollet-le-Duc's perspective, construction possesses a significant expressive potential; he argued that a building should visibly communicate its construction methods (Hartoonian, 1994). This insight into the relationship between technology and values suggests a need for renewed examination in the research on architectonics. Hurol (2015) asserts: "Evaluating tectonic value necessitates a method capable of bridging the gap between the quantitative and the qualitative: a method that can assess both the artistic value (the qualitative) and the engineering value (the quantitative) simultaneously".

2.4 Construction in Architecture Education

The Charter for Architectural Education by UNESCO/UIA (2004) emphasizes the need for acquiring a comprehensive understanding of technical knowledge, construction, and materials. It also stresses the importance of maintaining an integrated approach to structure, construction technology, and service systems to form an efficiently functioning whole (Alakavuk, 2016). The architectural education curriculum is comprised of four main categories as follows:

- Theory courses focused on the fundamentals of construction.
- Technology-based courses on construction, materials, and structures.
- Expression-based courses in technical drawing.
- Design studio courses. (Alakavuk, 2016; Uluoğlu, 1990)

The architecture education curriculum should ideally encompass both architectural design and construction courses. However, there is a notable separation, with construction courses often placed outside of design studio activities. This disconnection between architectural design and construction courses fosters a prevailing notion that the design product (form and function) is of utmost importance in architectural education, leading to a gap in the comprehensive understanding of architectonics.

In a similar vein, the European Association for Architectural Education (EAAE), recognized as an authoritative body in the field, emphasizes the exchange of ideas within architectural education. It has established principles aimed at enhancing architectural design education. Among these, certain principles specifically address the importance of construction and the methods for integrating it with design:

- The capability to produce architectural designs that meet both aesthetic and technical demands.
- Provision of comprehensive knowledge of the history and theories of architecture, related arts, technologies, and human sciences.
- A deep understanding of structural design, construction, and engineering challenges related to building design.

- Sufficient knowledge of the industries, organizations, regulations, and procedures for transforming design concepts into buildings and integrating these plans into broader planning. (Europe, 2014).

Europe (2014) underscores the significance of integrating design and construction to attain architectonic satisfaction in architectural education. The intricate, multi-layered connections among architectonic elements necessitate meticulous assembly (Hartoonian, 1994). By dividing the subject matter into segments and exploring the relationships between these segments, we can view it as an integrated whole. This leads to an important question: How can architecture students be taught construction in a manner that prepares them to address construction challenges in architectonics effectively? Moreover, how can these students fully grasp and internalize this knowledge? “Engineering is a creative activity that requires imagination, intuition, and deliberate choice. This is precisely what architecture students should understand” (Ilkovič et al., 2014).

2.4.1. The technicality in construction education

To tackle technical challenges, technology-based solutions are likely essential in defining architectonic dimensions (Rahman, et al., 2020). However, certain perspectives have historically minimized the role of technology in architecture, especially in the early 20th Century. Le Corbusier described buildings as simply “a composition of building elements, where everything is available; yet it is the architect who selects and thereby is responsible for the architecture. The architect picks the elements and decides on their arrangement to create an architectural entity” (Staib, et al., 2008).

Today, schools of architecture often offer limited technical insight into construction (Rauf, et al., 2019; Shareef & Farivarsadri, 2020). This shortfall contributes to challenges in understanding and assimilating knowledge. Masri (2017) notes that the difficulty in integrating construction courses with design studio work leads students to devote significant effort to grasping statistics and analytical measurements for their structural solutions. This issue is compounded by time constraints in understanding structural and construction principles, which extend beyond mere beams and columns.

Alakavuk (2016) highlights the construction-related topics present in architectural education curricula, such as building materials, material statics courses, project management, and building construction, underscoring that these technical courses are crucial for professional practice. Furthermore, Alakavuk (2016) argues that this knowledge equips architects with the insight to understand the principles of how buildings are structurally supported, much like they comprehend structural concepts for their designs. While load calculations are primarily the domain of civil engineers, the responsibility for determining the placement of structural elements falls to architects.

Practitioners in the construction industry often express concerns over architects’ lack of sufficient knowledge in construction composition, attributing this shortfall to the limited emphasis placed on practical learning and teaching processes in architecture schools. This issue appears to stem partly from the instructors' focus on research (theoretical methods) in teaching construction, which results in students acquiring less practical knowledge in essential building technology and construction subjects (Clayton, et al., 2002; Rauf, et al., 2021). Research indicates that construction in architecture necessitates a technical understanding, serving not only as a tool for materializing thought and function but primarily as a means of shaping the integral parts of an architectonic piece (Ilkovič et al., 2014).

2.4.2. Construction education and design values

Design values play a crucial role in architects' and designers' decision-making processes (Rane, 2023). However, these values and intentions do not uniformly influence all architects and designers. The impact of design values varies across architectural movements, schools of architecture, and among individual architects and designers (Tozer, 2011). Table 1 illustrates the design values that contribute to the unique identity of any design. These values have the potential to complement the technical aspects of design with artistic and aesthetic dimensions.

Table 1. Design values and intentions (Ukabi, 2015)

Design Values	**Intentions**
Aesthetic value	Artistic aspects and self-expression; zeitgeist (spirit of the time); structural, functional, and material honesty; simplicity and minimalism, the natural and organic; classical, traditional, and vernacular styles; and regionalism.
Social value	Social change, consultation and participation, crime prevention, and considerations for the third world.
Environmental value	Green and sustainability initiatives, reuse and modification practices, and health considerations.
Traditional value	Tradition, restoration and preservation, and vernacular architecture.
Gender-based value	Gender differences as they relate to architectural practice and history, equity in training and job opportunities in architecture, and theories on gender in the built environment.
Economic value	Voluntarism which facilitates a break from client control over design activities, enabling deliberate design decisions from within the architectural office.
Novel value	Big ideas, themes, zero starts.
Mathematical/ Scientific value	Synthesis of form and space.

Architects are expected to address various aspects of their designs, including aesthetic values, function, and form, as well as structural and construction elements (Mokhaberi, 2010). In this concept, an ontological approach recognizes the inclusion of construction. The entire design process, integrating values and technology, culminates in a distinctive architectural design or architectonic, inseparable by nature. Similarly, the contemporary architect Renzo Piano discusses the blurred lines between science and art, suggesting the distinction is not so clear-cut. Furthermore, he thinks that technology, function, shape, and technical equipment are indistinguishable, all converging and communicating in the same language with equal vigor (Mokhaberi, 2010).

2.4.3 Design-build method

The origin of the Design-build approach in architectural education can be traced back to the Bauhaus in the 1920s. The Bauhaus was likely the first school in the 20th Century to incorporate Design-build into its curriculum. Before this, the Ecole des Beaux-Arts saw an effort by Arnaud, who was among the first to teach construction topics supplemented with architectural drawings (Guelle, 2022). This was a step toward re-establishing the connection between designers and the process of shaping construction materials, as well as design constraints (Lonman, 2010). Design-build is referred to in various terms such as hands-on learning, learning-by-making, learning-by-building, and 1:1 basis. It is recognized as a form of experiential learning, a concept promoted early on by John Dewey and further developed by David Kolb (Canizaro, 2012). Importantly, while it involves a tactile experience, it extends beyond mere physical contact of students with materials. It encompasses decision-making, designing, and building processes (Fowles, 1984).

The learning-by-doing method proves to be more effective than merely listening and recalling, as it fosters the development of solutions for proposed problems. It is argued that this approach offers numerous advantages in construction education compared to traditional methods (Lee, et al., 2015). Another advantage of the design-build approach is that it enhances students' understanding of architectural details, connections, and joints within structural systems and materials, especially when they participate in real-life projects.

The design-build method in education serves as a pedagogical alternative to the media-driven, desk-based, and technically oriented design processes prevalent in architecture schools (Canizaro, 2012). The design-build approach has been implemented in numerous architecture schools since its reintroduction into the architectural education curricula, particularly in Canada and the United States. In his research on "how to make in architecture" at Laurentian University Canada, Gaber (2014) underscores the importance of incorporating the design-build method into the school's curriculum. He advocated for the creation of real-size construction models based on design concepts, taking into account factors such as commercialization, budget, time, and historical and cultural contexts. Initially, students created 1:10 scale models for the first evaluation phase, which were then exhibited to the public for potential sale. Subsequently, the original models were constructed at a 1:1 scale for the final stage (Gaber, 2014).

2.5. Ontological Methods of Teaching Construction in Architecture Education

Voyatzaki (2002) critiques the linear techniques commonly used to teach construction in current architecture schools. He argues that only an integrated approach, encompassing both technical issues and design values, can address the problem of students' insufficient construction awareness. This innovative approach should merge tectonics, the poetics of construction, and their contribution to formal expression (Frampton, 2001). Integrating design and construction from the conceptual stage is an essential part of the educational process. This approach not only upholds the tectonics of design and construction but also fosters a relationship between the two disciplines. This, in turn, empowers students with the cognitive ability to generate diverse design ideas by applying knowledge of construction technology (Amato, et al., 2004). The goal of architectural education, as Ham and Arch (2004) note, is to equip architecture graduates for real-world practices, with the ultimate objective being the attainment of tectonic mastery. This includes skills related to design and construction, viewed as two integrated and inseparable components.

Over the past decade, the reevaluation of the relationship between design and construction has been gaining attention. Voyatzaki (2002) notes that, meanwhile, students often view design and construction as two separate and parallel subjects. Only towards the end of their education do these disciplines converge in the students' understanding, yet they are fundamentally two components of the same entity.

3. Methodology

3.1. Design

A qualitative ontological method was employed in this study. Two presentations were prepared by the researcher for the Construction and Materials II course in an architecture department. These presentations were designed to address different aspects of construction knowledge:

- Technical Knowledge Presentation: Focused on technical aspects of wall structures such as classifications, types, load considerations, and material bonding.
- Design Values Presentation: Emphasized aesthetic, social, and environmental values in construction, illustrated through case studies like the Fallingwater House, designed by Frank Lloyd Wright.

The class was divided into two groups of six students each. Group 1 received the Technical Knowledge Presentation, while Group 2 was exposed to the Design Values Presentation. Additional participants included eight instructors of *Architectural Construction* courses, each bringing their unique pedagogical perspective and experience to the research through interviews. The instruments used are as follow:

- Presentations: Two distinct presentations served as the primary instruments for data collection, crafted to elucidate students' engagement and retention of construction-related knowledge.
- Interviews: Conducted with instructors to gain insights into diverse teaching methods and their perceptions of construction education's role in architectural training.
- Student Feedback: Students were instructed to recall and email or write key points from the presentations, which helped in assessing their retention and engagement.
- Visual Aids: Employed in presentations to enhance understanding and retention of the discussed concepts.

The responses from students regarding what they recalled from both presentations were graded and analyzed to assess the retention rate. This assessment was visualized in Figure 1, depicting the memory retention rates for both groups. A notable outcome was the marked enthusiasm and deeper engagement with the presentation focusing on design values. Additionally, interviews with instructors enriched the understanding of varying teaching philosophies and effectiveness, contributing to a broader evaluation of the problem-based learning approach utilized in the course.

3.2. Presentations

To tackle this issue and gauge the students' enthusiasm for the knowledge required in construction courses, the researcher of this study prepared two presentations for the Construction and Materials II course in an architecture department. The class was split into two groups of six students each. Each group was given the presentation separately and had time allocated for rehearsal as follows:

Group 1: Technical Knowledge Presentation

The presentation for the first group focused on the technical aspects of wall structures, covering classifications and types of walls, distinctions between load-bearing and non-load-bearing walls, the impact of loads on walls, and the bonding of materials for load resistance, among other topics. These subjects had previously been taught by the course instructor, making this presentation a review with slight variations by another presenter. Visual aids from various media sources were used to illustrate the concepts. The students were instructed to email the researcher a chronological list of the key points they recalled from the presentation within a week.

Group 2: Design Values (construction-related) Presentation

In this presentation, the emphasis was on design values as illustrated by the Fallingwater House, designed by Frank Lloyd Wright in Pennsylvania, particularly in relation to the choice of building materials and the underlying philosophy. Aesthetic, social, and environmental values were discussed, with support from photographs of the building. For example, the use of stone in the construction highlighted several design values: organic and natural, material honesty, minimalism and simplicity, regionalism, social change, and sustainability—the discussion of other materials adhered to a similar structure. At the conclusion of the class, students were asked to write and submit their recollections of the presentation after one week.

For both presentations, the students' responses were graded, as this activity was incorporated into the semester's coursework, with the course instructor allocating 10% of the total grade to this task. This exercise served as a valuable method for assessing students' retention rate for the study, as illustrated in Figure 1. After the class assignment, the outcomes for the two groups diverged. The information presented was not new to the students, except for the introduction of design values as previously described. A notable difference was the students' evident enthusiasm for the presentation on design values. Several students expressed that this approach allowed them to reconsider their design processes, particularly in terms of material selection. This enthusiasm and appreciation were markedly more pronounced than the response to the technical presentation.

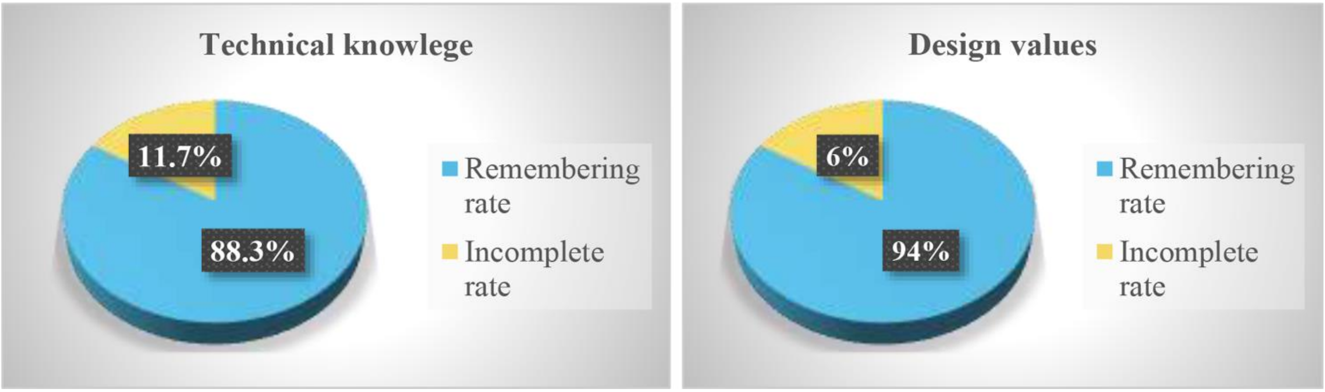

Figure 1. Graph illustrating the rate of memory retention among students for both presentations, as analyzed by the authors.

3.3 Interviews

Interviews were conducted with eight instructors of *Architectural Construction* courses, referred to in this study as P1, P2, and so forth. Each instructor employs a distinct teaching method, largely influenced by their individual perspectives. For example, one instructor (P1) focuses on analyzing internationally renowned buildings from a construction standpoint using a problem-based approach. P1 emphasized, "Students learn by drawing but showing them a particular detail on the board means that might be the only detail they remember; our approach avoids a memorization style." This instructor and her team aim to teach students to generate details and tackle construction challenges by working on real projects making models and drawings in class. Conversely, another instructor (P2) bases her construction course presentations on established textbooks, believing that "Construction may not be the main concern for students post-graduation; they should prioritize design." P2 advocates for a theoretical approach to teaching construction. Another instructor (P3) views construction knowledge as essential for expanding design thinking but does not believe it should dominate students' time. P3 prefers classroom presentations and, time permitting, site visits to demonstrate real-world applications of classroom topics. The remaining instructors shared similar views, suggesting that construction education should be delivered through classroom presentations and by redrawing construction details.

P1 also described the teaching mechanism for construction classes, stating:

> "We present the students with a problem, urging them to find solutions (referenced in Figure 2). Our examinations follow a similar pattern; they are open-book, allowing students to consult any resource. The key distinction in our teaching method lies in the absence of a single correct answer, setting us apart from others who focus solely on technical aspects. We first lay out the principles, enabling students to devise any detail creatively. For example, we might

challenge them with managing water egress from a building. This prompts students to consider various methods and intricacies of potential solutions. A common hurdle, however, is students' grasp of the behavior of materials and their interconnections. To overcome this, we start with examples and redraw selected cases to expand their thinking to other possible scenarios. Our focus on construction thinking also prioritizes maintaining the quality of space; any proposed detail must enhance user comfort and align with design values. Through practical engagement, we instill in them the understanding that construction is a dynamic process, not confined to a single detail or solution" P1.

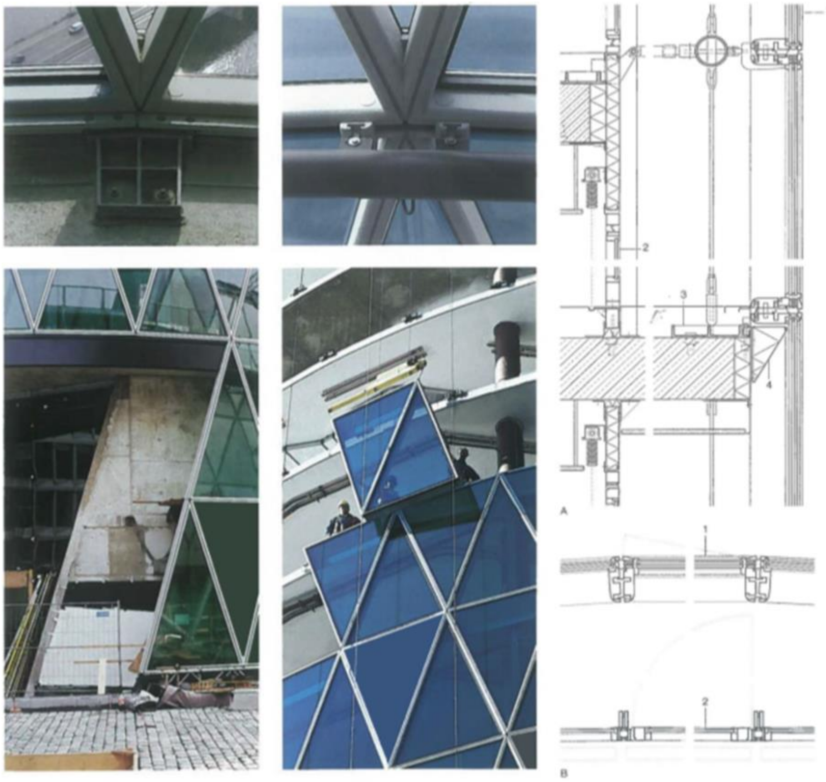

Figure 2. The Westhafen Tower in Frankfurt/Main, designed by Schneider + Schumacher Architecture GmbH, is featured by ARCH347 on the ARCH347 Facebook group page.

Employing P1's methodology, the course addresses students' inquiries about contemporary construction techniques and their applications. Moreover, it motivates students to contemplate how design values and construction methodologies can be integrated into their semester design projects, drawing inspiration from the analyzed building examples. P1's approach exemplifies problem-based learning (PBL), where students are tasked with a problem and embark on a quest for the most effective solution. The solutions students arrive at may diverge from the original solutions devised for the buildings, encouraging reliance on their intuitive ideas for constructing details that uphold both technical and design principles. By the course's conclusion, students have acquired a comprehensive understanding of various structural types, construction methodologies, and detailing.

4. Results and Discussions

Based on the literature reviewed and evaluations of student-teacher interactions including interviews with instructors, it emerges that there is a montage approach (Hartoonian, 1994) to addressing construction issues in architectural education. The essence of addressing construction issues in architectural education is seen as a composite problem, where technical-based, design-value-based, and problem-based learning methods are integral components. This study identifies a gap between these approaches and aims to bridge it through an integrated method that combines technical issues and design values, aligning them with design in studio courses. This research particularly advocates for a problem-based learning approach, albeit with modifications and additional considerations. Instructors of these courses should also be present in design classes to oversee the integration of construction and design assignments. Additionally, construction courses, which are to be integrated with design studios, should require models for international projects covering each system. This approach enhances practicality and promotes learning by doing. Moreover, the implementation of these construction courses in students' final design projects should involve a comprehensive scale model that exhibits every construction system, detail, and material used.

5. Conclusion

Construction knowledge was once considered as vital as the architectural design itself. Historically, construction and design were unified disciplines, with architects overseeing both aspects during the building design process. However, following the Industrial Revolution, the emergence of multidisciplinary separations cleaved architecture into two distinct fields. This divide resulted in architects becoming less acquainted with construction methods, materials, and structural principles. In the 20th Century, the concept of merging design and construction was revisited by institutions such as the École des Beaux-Arts and the Bauhaus. These schools advocated for a *learning by doing* approach, reaffirming the importance of construction knowledge in architectural education.

The disconnection between design and construction in architectural schools has often led to criticism of architects for their insufficient understanding of construction and structural systems. A prevailing bias within architecture schools, emphasizing theoretical teaching over practical demonstration of construction techniques, has resulted in graduates who lack enthusiasm for construction and are inept at integrating design values with construction materials and structures.

Architectural design values play a critical role in the decision-making processes of architects and designers, yet their influence varies. These values are selected based on the individual perspectives of schools of architecture, architects, and designers. This study explores various teaching methods for construction courses, aiming to identify an effective approach (an integrated method) that motivates students by blending technical knowledge, design values, and practical activities. Furthermore, the study strongly advocates for the integration of construction courses with adequate credit hours into design studios. This integration is intended to inspire design through construction insights and vice versa in student projects, ultimately contributing to the development of the built environment with a well-rounded knowledge base.

Declaration of Competing Interest The authors declares that they have no known competing interests.

References

Alakavuk, E. (2016). Integration of building construction courses in the architecture education programme. In *SHS Web of Conferences* (Vol. 26, p. 01036). EDP Sciences.

Allen, E., & Iano, J. (2019). *Fundamentals of building construction: materials and methods*. John Wiley & Sons.

Amato, A., Thilakaratne, R., Henri, J., & Trinidad, S. (2004). Technology enhanced construction technology teaching. Paper presented at the *IEEE International Conference on Advanced Learning Technologies*, 2004. Proceedings.

Canizaro, V. B. (2012). Design-build in architectural education: Motivations, practices, challenges, successes and failures. *ArchNet-IJAR: International Journal of Architectural Research, 6*(3), 20.

Clayton, M. J., Warden, R. B., & Parker, T. W. (2002). Virtual construction of architecture using 3D CAD and simulation. *Automation in Construction, 11*(2), 227-235.

Cushman, R. F., & Loulakis, M. C. (2001). *Design-build contracting handbook*. Wolters Kluwer.

Diekmann, J. E. (2007). Past perfect: Historical antecedents of modern construction practices. *Journal of Construction Engineering and Management, 133*(9), 652-660.

Europe, E. I. (2014). *Chapter three flexibility in architectural education in Europe Herman Neuckermans.* Paper presented at the MIMED Forum IV: Flexibility in Architectural Education.

Farrow, C. B., & Wetzel, E. (2021). An active learning classroom in construction management education: Student perceptions of engagement and learning. *International Journal of Construction Education and Research, 17*(4), 299-317.

Fowles, B. (1984). Design-build projects in architectural education. *Design Studies, 5*(1), 7-14.

Frampton, K. (2001). *Studies in tectonic culture: The poetics of construction in nineteenth and twentieth century architecture*: Mit Press.

Furtado, C. S. B. (2014). The Construction of Architecture: Notes for an Entrance Exam for a Professor at FAUUSP. *Journal of Engineering, 2*(2), 257-262.

Gaber, T. (2014). The agency of making and architecture education: Design-build curriculum in a new school of architecture. *ArchNet-IJAR: International Journal of Architectural Research, 8*(3), 21.

Guelle, G. B. (2022). Textbook. A Guide to the Teaching of Construction. Dimensions. *Journal of Architectural Knowledge*, 2(3), 335-354.

Ham, J. J., & Arch, B. (2004). *On representation and construction in a tectonic design studio*: Deakin University, Victoria.

Hartoonian, G. (1986). Poetics of technology and the new objectivity. *Journal of Architectural Education, 40*(1), 14-19.

Hartoonian, G. (1994). *Ontology of construction: On nihilism of technology in theories of modern architecture*. Cambridge University Press

Hurol, Y. (2015). *The tectonics of structural systems: An architectural approach*: Routledge.

Ilkovič, J., Ilkovičová, L., & Špaček, R. (2014). To think in architecture, to feel in structure: Teaching structural design in the faculty of architecture. *Global Journal of Engineering Education, 16*(2), 59-65.

Lee, S., Nikolic, D., & Messner, J. I. (2015). Framework of the virtual construction simulator 3 for construction planning and management education. *Journal of Computing in Civil Engineering, 29*(2), 05014008.

Lonman, B. (2010). Constructing design in the studio: Projects that include making. *Kinnard, J. and Goodwin*.

Masri, S. S. (2017). Improving architectural pedagogy toward better archistructural design values. *Athens Journal of Architecture, 3*(2), 2-12.

Mokhaberi, G. (2010). *Structural and technological principles within architecture education*. Eastern Mediterranean University (EMU),

Obla, M., & Ukabi, E. (2021). Education in the virtual space: A sustainable strategy for achieving tension-free and inclusive learning in COVID-19 dispensation. *Journal of Studies in Science and Engineering, 1*(2), 17-35.

Pantoja, M. F. F., Moreira, P., & Lomardo, L. (2012). Towards the performative architecture through the tectonic vision. *Int Sci J Archit Eng*.

Rahman, I., Chapman, T., Kazmi, M. A., & Ghasemzadeh, F. (2020). Enabling the potential of 5g: Solutions to the technical challenges of the diverse 5g bands. *IEEE Wireless Communications, 27*(2), 6-11.

Rane, N. (2023). Potential role and challenges of ChatGPT and similar generative artificial intelligence in architectural engineering. *Available at SSRN 4607767*.

Rauf, H. L., Shareef, S. S., & Othman, N. N. (2021). Innovation in architecture education: Collaborative learning method through virtual reality. *Journal of Higher Education Theory and Practice, 21*(16), 33-40.

Rauf, H. L., Shareef, S. S., & Ukabi, E. (2019). Understanding the relationship between construction courses and design in architectural education. *International Journal of Recent Technology and Engineering, 8*(3), 3201-3207.

Shareef, S. S., & Farivarsadri, G. (2020). An innovative framework for teaching/learning technical courses in architectural education. *Sustainability, 12*(22), 9514.

Sir, M. M., Wunas, S., Parung, H., & Patanduk, J. (2015). Tectonic model of architecture tongkonan toraja.

Söffker, G. H., & Deplazes, A. (2005). *Constructing architecture: Materials, processes, structures*: Springer Science & Business Media.

Staib, G., Dörrhöfer, A., & Rosenthal, M. (2008). *Components and systems: Modular construction-design, structure, new technologies*: De Gruyter.

Tozer, W. R. E. (2011). *A theory of making: Architecture and art in the practice of Adolf Loos.* UCL (University College London),

Ukabi, E. (2015). Conserving the architects' jewel in the 21st century. *Architecture Research, 5*(1), 10-15.

Uluoğlu, B. (1990). Mimari tasarım eğitimi tasarım bilgisi bağlamında stüdyo eleştirileri.

Voyatzaki, M. (2002). Construction history in the architectural curricula of Europe. *Europe, 2003*, 2004-2005.

Yunus, R. H. M. (2001). *A study on learning and teaching construction technology related to design: A case for architectural schools in Malaysia.* University of Sheffield.