JOURNAL of DESIGN THINKING

Cultivating an Internal Understanding of "Proportion" in Freshman Undergraduate Students Through the Teachings of "Design Thinking" (Case Study: Architecture Students)

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DOI: 10.22059/jdt.2026.417242.1211

Received: *25 June 2026,* ***Revised:*** *9 August 2026,* ***Accepted:*** *10 August 2026,* ***Available Online*** *from 10 August 2026.*

Abstract

Due to the complexity of the contemporary world, the design process has shifted from its former reliance on fixed principles toward the outlook of design thinking, a shift that has brought about extensive transformations in design education; design thinking is a form of pre-reflective awareness that serves as an internal compass along the path of design, which is referred to as design meta-awareness. This approach is capable of cultivating within the individual a key tool such as proportion, whose task is to objectify the designer's mental images. Nevertheless, instruction based on design thinking is not simple, and the design teacher must take multiple factors into account. Teaching proportioning on the basis of design thinking is an internal process rather than an external prescription. Accordingly, the aim of this study is the internalization of proportion in freshman undergraduate students on the basis of the teachings of design thinking. At the outset, this study examines the literature of design thinking through a descriptive-analytical method in order to extract strategies for cultivating the mechanism of proportioning. In the next step, these strategies were tested experimentally on freshman architecture students at Payame Noor University. The findings derived from the research literature indicate that, in the internalization of proportion, the following strategies should be taken into account: release after learning, architectural education within the building atmosphere, the apprenticeship approach, and intra-group interactions. Testing the aforementioned strategies among Payame Noor freshmen provides architecture teachers with a diverse toolbox of guidelines for the internalization of proportion.

Keywords

Design Process, Design Thinking, Proportioning, Freshman Students.

Introduction

Throughout history, "proportion" has been the principal pillar in the formation of a design's physical form. Until the modern period, designers learned design and the techniques of proportioning through apprenticeship (Lawson, 2005); however, at the beginning of the 1960s, design process theorists believed that this approach was not suited to the demands of the age and that uniform rules should be applied to freshman design students. The aforementioned scientific and structuralist approach was in conflict with the nature of the design process and the mechanism of proportioning; for this reason, it was met with limited acceptance among freshman students and led design teachers to turn toward "design thinking." Design thinking is a form of pre-reflective awareness that serves as an internal compass along the path of design and is referred to as metacognition or design meta-awareness. Approaches prior to design thinking believed in formulating design, whereas the nature of the design process and proportioning was grounded in internal cultivation. Accordingly, this study is based on teaching proportion through the non-formulated outlook and internal cultivation of "design thinking."

Design thinking is an appropriate tool for solving complex problems, yet multiple difficulties exist in teaching design on the basis of this approach. For example, because of the complex nature of the aforementioned paradigm and insufficient understanding of its dimensions, freshman students show little inclination toward learning (Bertão, Jung, Chung & Joo, 2023). Nevertheless, to address the complexities of contemporary problems, teaching techniques based on this approach is considered necessary. Therefore, this study examines the following question: "What is the teaching strategy for developing the mechanism of proportioning in freshman students based on the perspective of design thinking, such that, on the one hand, it creates a system within the freshman student's pre-reflective awareness[1] that gives rise to dynamic space, while, on the other hand, it does not restrict freedom of action?" To answer this question, the structure is set out in four steps. In the first step, based on the research background and theoretical foundations, instruction based on design thinking and strategies for proportioning in freshman students are explained. In the next step, the theoretical roots of design thinking in the domain of the creative education of freshman students are explored so that the nature of education in design thinking may be represented. In the third step, strategies for idea generation in the domain of design thinking are examined, and the cases relevant to this research are selected. In the final step, the findings related to testing the strategies for teaching proportioning in freshman students at Payame Noor University are described and explained.

Methodology

The research method of the present study is a combination of descriptive-analytical and experimental approaches. In the descriptive-analytical section, the place of education in design thinking, the effect of this perspective on design techniques and tools, and the views of design thinking theorists were examined, and materials relevant to the subject were extracted. Then, through analysis and the logical interrelation of the data, the theoretical framework and strategies for teaching proportioning were delineated (Figure 1). In the experimental section, the strategies derived from the foundations of design thinking were tested on freshman architecture students at Payame Noor University, Bushehr, over seven semesters (from 2017 to 2021). This experimental method is founded on the collective participation of an active group of freshman students for the purpose of identifying practical guidelines for teaching proportioning. In other words, the students were placed under controlled conditions so that the hypotheses could be tested.

The experimental section of the research is based on two steps. In the first step, the designs of the freshman students were observed and explored before they had learned the rules of proportioning. After recording and archiving the students' outputs in the previous step, the rules of proportioning under golden proportions were explained. Golden proportions are regarded as one of the oldest systems of proportioning (Balilan & Hasanpour Lomer, 2019), having emerged in design through inspiration from nature. The aforementioned ratio is derived from the Fibonacci rule (Abbas, 2017) and is based on two propositions. The first

[1] An aspect of human thinking that develops unconsciously within the individual (Hoseinyzadeh Mehrjerdi, 2025).

proposition is that the golden rectangle is a quadrilateral whose diagonal-to-length ratio is 1.6. The second proposition states that a rectangle whose diagonal is parallel or perpendicular to that of a golden rectangle is also considered a golden rectangle (Ching, 2007), as illustrated in Figure 2. After explaining the rules, the students were asked to undertake the design of elevations and plans by combining vertical and horizontal rectangles in relation to the initial golden rectangle (Figure 3). They were also advised to continue developing their designs simultaneously with learning the rules of proportioning.

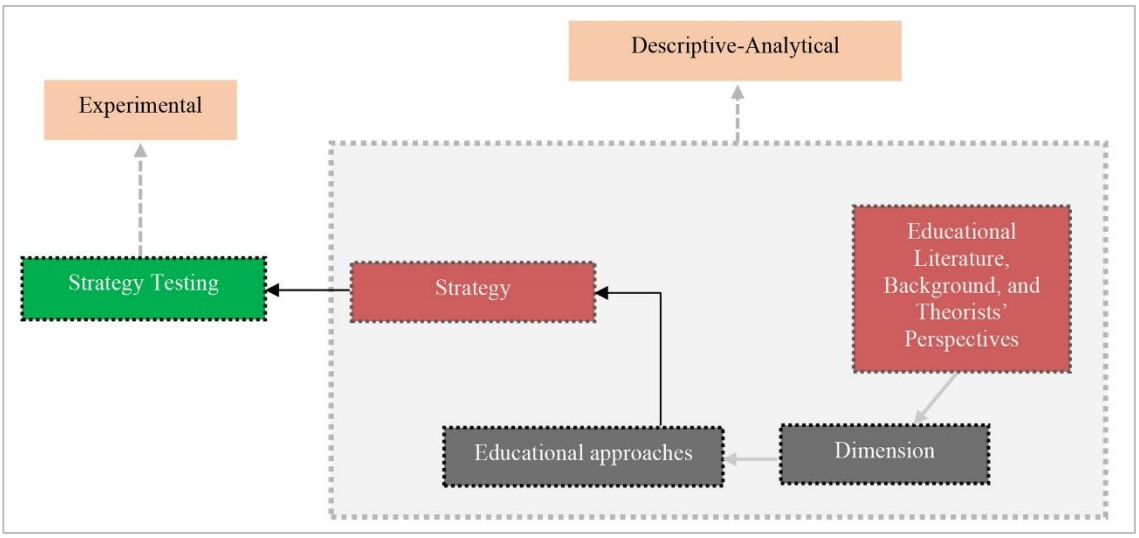


Figure 1: *Steps of the Research Method.*

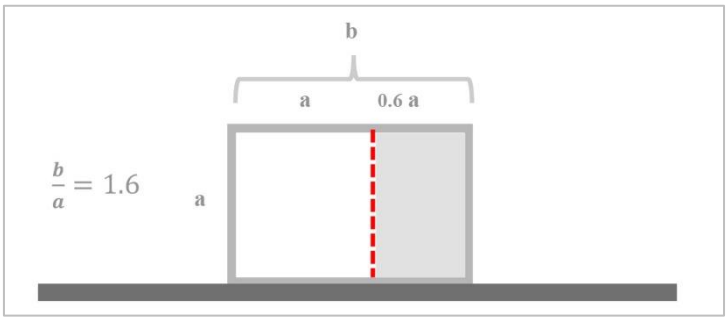


Figure 2: *Fundamental Basis of the Golden Proportions.*

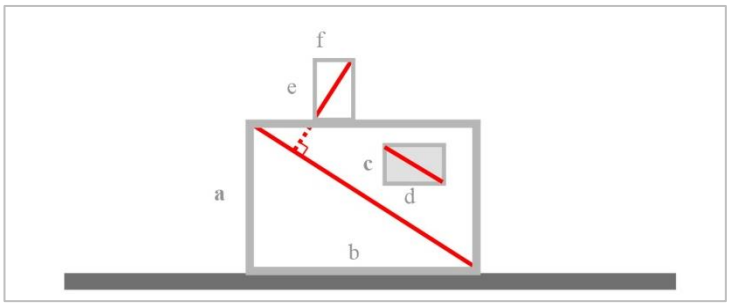


Figure 3: *Elevation Design Based on the Rules of Golden Proportions*

In the second step, the freshman students were placed in an experiential encounter with the atmosphere of professional work in order to examine the qualitative effect of that environment on their outlook. Accordingly, in each semester, three urban and architectural spaces were selected on the basis of the students' abilities and the design potential of the site. In parallel, the researchers examined the effect of plan diagramming of leading architectural works on increasing the tacit knowledge of freshman students. On the one hand, plan diagramming enhanced the students' level of visual awareness, and on the other hand, it helped them at the idea-generation stage (Alipour, 2019). Plan diagramming of leading architects' plans

is among the foundational principles of architectural education, yet because of students' lack of awareness, it has been met with limited acceptance or approached only superficially. This issue constitutes the principal concern of instructors (Alipour, 2019).

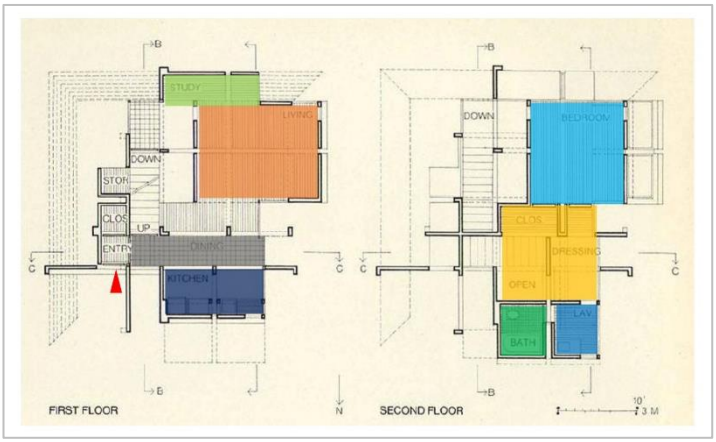


Figure 4: *Plan Diagramming of House VI by Peter Eisenman* (Perez, 2010)

Literature Review

The contemporary concept of the design process was first introduced in the early 1960s on the basis of scientific theory. In this period, theorists such as Archer, Matousek, and Christopher Alexander believed that the design process, according to a scientific structure, consisted of multiple stages and that a single model of it should be given to novice design students. For example, Matousek defined the stages of problem, preliminary design, material selection, construction, work form, and total cost (Matousek, 1963). This view believed in the linear progression of the design process and in carrying out each step only after the previous one had been completed. The systematic and rigid outlook of this method was at odds with the mysterious and complex nature of the design process; for this reason, it received little acceptance among architectural offices (Lawson, 2005). Years later, Christopher Jones, by adopting the theory of the black box and the glass box, presented a realistic view of the design process (Jones, 1970).

After examining the rule-based method of the design process, Jones explained the reasons for the inadequacy of that method. He regarded the prescriptive solution of twentieth-century rationalist researchers as inconsistent with the practical reality of architects and believed that this method entirely ignored architects' reflective minds and reduced design to the making of an artificial object. The central proposition of Jones's theory was that design creativity approaches maturity when a faculty beyond one's will (the unconscious) is stirred into activity (ibid.).

From the 1970s to the present, theorists such as Lawson (2004 & 2005), Peter Zumthor (2006_a & 2006_b), Hojjat (2014), Dorst (2011), and Cross (2011) have undertaken to develop the theory of Jones and Rowe (1991). A weakness common to these studies is their failure to examine the perspective of design thinking in the actuality of design and the cultivation of the designer. Examining the designer's actuality on the basis of design thinking helps the reader attain a desirable reconsideration of the essence of design thinking (Kimbell, 2011). For this reason, the present research examines the paradigm and ontology of design thinking in the practical dimension of design (here, education). Despite limited research in the practical dimension, attempts have been made to discover the design process of expert and novice architects. Some have tested the strategies of design thinking in architectural offices, and others among students in architecture studios or specialized workshops.

After examining fourteen architectural offices, Nadimi and Shariat Rad (2012) stated that among the project-related factors, the problem-oriented parameters, including context and subject matter, play a

greater role in idea production than the designer-related components. Accordingly, design teachers should pay greater attention to problem-related factors than to other factors. Törnroth, Nilsson, and Luciani organized a workshop for the local residents of Porsön, Luleå, Sweden, in order to examine the extent to which individuals' participatory perspectives affect the creation and development of aesthetic patterns. That workshop became the core of teaching aesthetic issues based on design thinking. The use of workshops in urban development processes—especially in the early stages of the process—makes it possible for the local community to gain an understanding of the importance of renewable energy in design projects (Törnroth et al., 2022). Törnroth et al. (2022) stated that the collective participation of stakeholder groups and an active relationship with the aesthetic foundations of the project ultimately increase individuals' familiarity with aesthetic concepts.

Arefi and Tayyebi, through examining students active in the design studio, stated that linking academic education with the professional studio expands individuals' practical knowledge of design thinking. On the other hand, they stated that professional studios elevate students' value system, while academic courses facilitate framing and categorization for graduate students (Arefi & Tayyebi, 2024). The combination of professional architectural training and academic experiences develops the designer's internal richness and indirectly contributes to the advancement of the designer's knowledge.

Bromage et al. (2025), after examining companies that teach "design thinking," stated that these companies tend to commodify "design thinking" and have neglected its essential and ontological aspects. To substantiate this proposition, Bromage and colleagues examined participatory projects in Australian communities over a six-month period. That study demonstrated that design thinking appears to be an appropriate approach for attaining creative strategies and solving complex problems; however, it is not sufficient in itself. Creative solutions are the result of design thinking together with attention to indigenous data arising from the experiences of the local community. That study showed that the group participation of indigenous people in the early stages of design contributes to the advancement of innovative ideas. Most studies in the practical domain of design thinking have focused on partial and micro-level aspects and have paid less attention to the ontology of design thinking in the domain of practice. By adopting a broader view of the nature of design thinking in the domain of practice, Lawson (2004) concluded that designers first learn a proposition or acquire a technique, then abandon that technique and proceed to their own architectural practice. Lawson's approach has been emphasized by leading design thinkers up to the present and is also regarded as one of the pillars of this research. Other thinkers have likewise explored education based on design thinking and have proposed corresponding strategies, which are explained in Table 1.

Table 1: *Strategies for Teaching Techniques Based on design thinking.*

Researcher	Title of Contribution	Year	Testing Method	Target Population	Strategy for Teaching Skills Based on Creative-Thinking Guidelines	Approach
Kwangmuang, Kosum, Sarakan, & Nguyen	Innovative Learning Approaches to Develop Students' design thinking Skills through Digital Technology and Local Wisdom in Border Patrol Police Schools	2026	Correlational	Police schools in northeastern Thailand	In creative instruction based on design thinking, digital tools should be used alongside other educational resources. In addition, to make students' learning meaningful, attention should be given to local wisdom, which emerges from the participation and indigenous knowledge of local people.	Indigenous participation

Dell'Era, Magistretti, Candi, Bianchi, Calabretta, Stigliani, & Verganti	design thinking in Action: A Quantitative Study of design thinking Practices in Innovation Projects	2025	Logical reasoning	Examination of 221 projects in consulting firms	design thinking in the domain of indigenous participation leads to the creation of innovative ideas. The researchers argue that, in order to arrive at an innovative solution based on Design thinking, two methods should be adopted: challenging existing assumptions and exploring the problem–solution pair. These components are regarded as pillars of instruction based on creative thinking.	Indigenous participation
Shih, Wang, & To	Fostering Thinking Skills: Transitioning from Routine to Creative Design Spaces	2026	Inductive	Design students who won architecture awards between 2021 and 2024	In order to improve the creativity of freshman students, they should be placed in conditions of competition and challenge so that both aesthetic and functional dimensions can be developed. This causes students to pursue design problems with greater seriousness.	Collective participation
Wang, Long, Mei, & Liu	Fusing Six-Hat Thinking with AI: How the Green Hat and ChatGPT Co-Regulate Pre-Service Teachers' Instructional Design—Insights from Epistemic Network Analysis	2026	Mixed approach—coding	Pre-service teacher education	ChatGPT, as an innovative AI-based chatbot, has considerable potential to redefine human–computer interaction and improve teaching and learning. Nevertheless, it should be regarded as an auxiliary tool and should not become the principal pillar, because excessive reliance on it may reduce the creative faculty and agency of students and teachers in relation to design problems.	The unconscious mind
Li, Goei, van Joolingen, & Raijmakers	Shaping Maker Education through design thinking: A Lesson Study Perspective	2026	Logical reasoning	Students in technical disciplines	Creative-thinking strategies based on reflective inquiry lead to the development of thinking. Moreover, the development of such thinking, together with the student's release from constraints, leads to the enhancement of creativity.	Internalization—cultivation of pre-reflective awareness

Previous studies on design thinking may be categorized into three domains: internalization, the cultivation of pre-reflective awareness, and collective participation. The latent ideas of project stakeholders emerge through collective participation, while the cultivation of pre-reflective awareness and internalization strengthen the designer's individuality. Pre-reflective awareness is a precondition for the emergence of ideas within the individual, while internalization contributes to the cultivation of technique in the designer's unconscious. However, consensus on these domains does not in itself provide a clear account of the method of internalization or the formation of pre-reflective awareness—the very objective pursued by this research (Table 2). For this reason, the present study seeks to teach methods of internalization and the cultivation of pre-reflective awareness so that, from this perspective, proportion may be internalized in freshman students.

Table 2: *Researchers' Approaches to Teaching Based on design thinking*

Cultivation of the Designer's Pre-Reflective Awareness (the Unconscious)	Internalization	Collective Participation
Törnroth et al., 2022 Hoseinyzadeh Mehrjerdi, 2025 Wang et al., 2026 Arefi & Tayyebi, 2024	Li, Goei et al., 2026 Lawson, 2005 Dell'Era et al., 2025	Shih et al., 2025 Bromage et al., 2025 Kwangmuang et al., 2026

Theoretical Literature of the Research

1. *Design Thinking*

Design thinking is a structuralist and human-centered approach grounded in the production and reproduction of creative solutions across diverse disciplines (Micheli et al., 2019). Placing the designer's mind at the center of the design process (Lawson & Dorst, 2013), together with examining the behavioral paradigms embedded in the nature of the design process, is regarded as a key component of this approach. Design thinking emerged to redefine design as a process in which neither the operating logic is clearly rule-bound nor the primary materials and tools are readily identifiable (Shariat rad & Nadimi, 2016), and also in response to design-office managers' dissatisfaction with the lack of creativity (Nakata & Hwang, 2020). According to most scholars, the concept or school of design thinking, because of its adaptability to varying conditions, can be extended, developed, and applied across other disciplines (Kwangmuang et al., 2026). Nevertheless, design instructors face multiple complexities in implementing this school of thought. For this reason, strategies for resolving these complexities have received increasing attention from researchers over the past decade, and the present study likewise seeks to propose appropriate strategies.

Design thinking is regarded as one of the principal pillars of advanced design education (Li et al., 2024) and as the most appropriate method for addressing wicked problems (Brown, 2009), helping architects operate beyond the limits of their traditional rules (Kimbell, 2011). Design thinking is a novel and emerging topic in the field of architecture, and Christopher Jones played an important role in developing and explicating its foundations. Over the past two decades, it has been widely employed by professionals and empirically oriented practitioners in architecture, education, business, and medicine as an effective means of solving wicked and sensitive problems and attaining creative strategies (Dorst, 2011; Bender-Salazar, 2023). Because of the complex nature of design thinking and its capacity to respond effectively to wicked problems, theorists in various disciplines have been inclined to draw on the guidelines of this approach. Even so, according to the design thinking Research Society (DTSR), progress in this field has been slow (Dorst, 2018). One reason for this is the underdevelopment of Design thinking in the domain of design practice. Accordingly, the present research examines the principles and guidelines of design thinking in the teaching of proportioning systems.

In the domain of practice, design thinking consists of five fundamental stages—empathy, problem definition, ideation, prototyping, and testing—and is capable of generating cost-effective, value-creating innovations (Kusumawardhany et al., 2025). Such innovation derives from the multifaceted nature of design thinking, which enables it to address complex problems (Stevens, 2021). The nature of this approach comprises three dimensions—socio-cultural, critical, and adaptive—each of which encompasses distinct teachings (Figure 5). In the following section, instruction based on design thinking is explained in relation to each of these dimensions.

2. *Instruction Based on design thinking*

Design thinking, or creative thinking, is a common approach for generating novel ideas in response to diverse design problems and, as a means of strengthening the creative capacity (the critical dimension) of freshman students, should serve as a model for architecture instructors. Within this paradigm, drawing plays a fundamental role and helps the designer in the emergence of design ideas (Suwa & Tversky, 1997), the improvement of problem-solving ability, the clarification of design performance (Atilola et al., 2016), the

proper understanding of the design context, and the facilitation of collaboration (Goldschmidt, 1991). Through drawing-based thinking, the designer creates something more than a mere combination of several elements (Eppler & Kernbach, 2016). Mastery of the fundamentals of sketching and freehand drawing is a key means of understanding the visual relationships among components and of appropriately representing the empty space between them. This technique has faded in the contemporary era because of the expansion of virtual tools. Architects often engage in drawing unconsciously at the beginning of the design process and tend to sketch their ideas. The designer's sketches continually change through the dialectics inherent in the process until coherence is achieved (Goldschmidt, 1991). These points demonstrate the importance of drawing in the course of design thinking. In Nigel Cross's view, this component constitutes the architect's toolbox for Design thinking and for thinking like a designer. For this reason, the present research treats drawing-based thinking as a key pillar in testing its hypotheses (Cross, 2011). Creative thinking is inherently capable of generating and regenerating creative and novel solutions. For such a solution to emerge, the individual must engage in a critical and adaptive exploration of the existing situation—hence the importance of the adaptive dimension—so that a configuration of the idea may arise in the unconscious. According to the theory of creative thinking, critical thinking should be taught to students in light of the cultural dimension. Most instructors of critical thinking teach freshman students derivative versions of the views of Western theorists, whereas the international and universal principles of design thinking should be translated for local communities in accordance with their cultural conditions (Giacomazzi, Fontana, & Trujillo, 2022). In this regard, instructors in the design process, in cultivating critical thinking, must take into account the individual's knowledge, character, and skills (Zeng & Ravindran, 2025) (Figure 6).

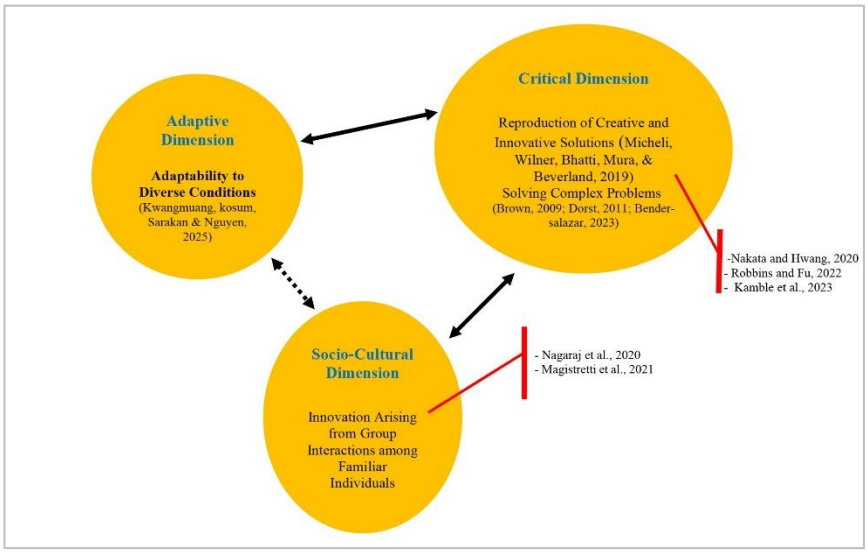


Figure 5: *The Existential Dimensions of design thinking in the Design Process* (Authors)

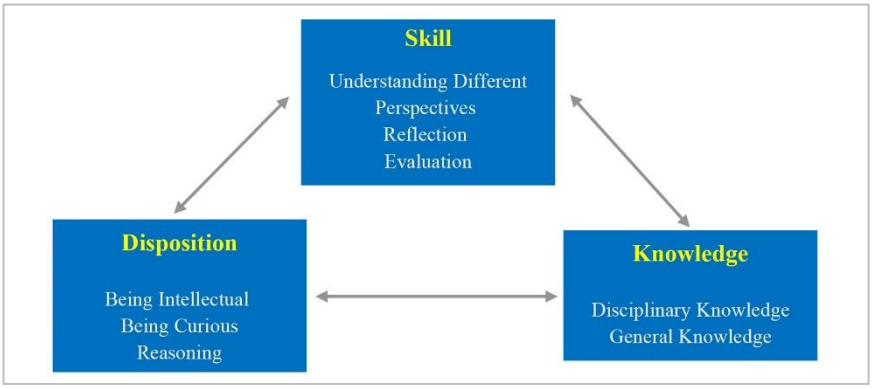


Figure 6: *Key Components for the Internalization of Critical Thinking* (Zeng and Ravindran, 2025).

Critical thinking is a principal pillar in the development of creativity in freshman students and designers, while drawing-based thinking elevates the adaptive and cultural dimensions of design (Figure 7). Drawing-based thinking develops the practical dimension of the designer, and critical thinking is a key tool for the internalization of design techniques and concepts. At the same time, instruction based on design thinking must also address strategies for the generation—or emergence—of ideas, because every successful design necessarily arises from a compelling idea.

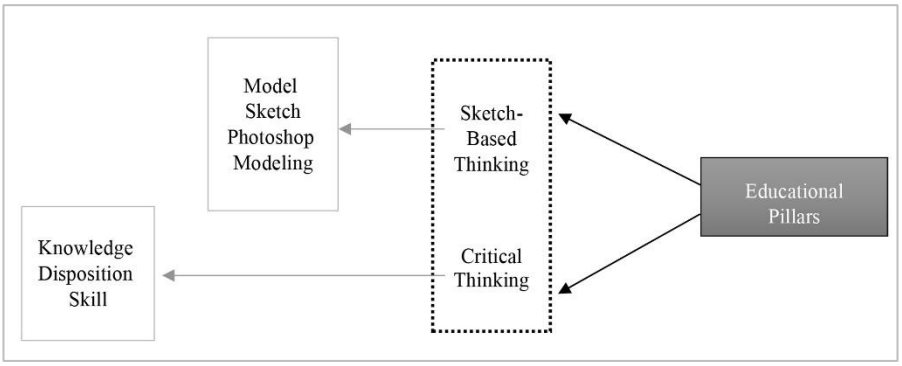


Figure 7: *Pillars of Instruction Based on design thinking.*

3. *Strategy for Idea Generation Based on design thinking*

Processes based on design thinking encompass a broader range of idea-generation strategies than the systemic process. Some researchers believe that there is no fixed precedence between problem and idea and that, fundamentally, discovering the exact link between these two essential pillars is impossible. This group holds that the design idea appears to the designer unconsciously and on the basis of intuitive holism (Lawson, 2005). Drawing on Kahneman (2011)'s view, they argue that the designer must first consciously examine and internalize technique, then set aside that tool or technique and proceed to the act of design itself (Lawson, 2005). Others maintain, more generally, that there are two principal strategies for idea generation based on design thinking, under which other strategies may be defined: a problem-focused strategy and a solution-focused strategy for the discovery and emergence of the idea (Shariat rad & Nadimi, 2016). Still others believe that the designer should first arrive at an initial scheme and that, through acting on that preliminary design and adjusting the conditions, a more mature design will emerge (Sharif, 2012).

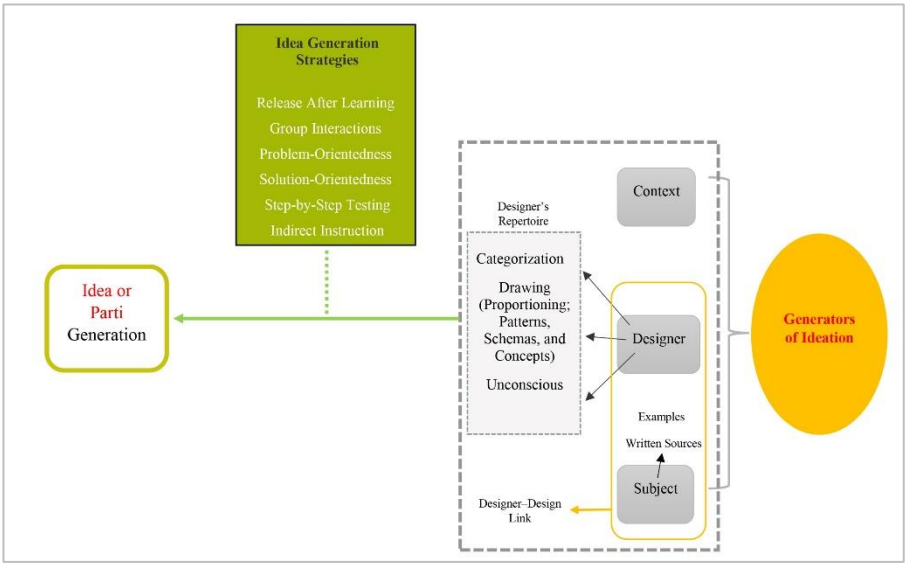


Figure 8: *Strategies and Techniques of Idea Generation based on design thinking*

Dam and Siang argue that an initial design should be presented to the user of the space and that the resulting feedback should then serve as the basis for the subsequent design (Dam & Siang, 2020). Others maintain that the indirect teaching of architectural concepts and techniques contributes to the enrichment of freshman students' ideas. According to Mirjany and Nadimi, the active experience of freshman students in encountering architectural examples enriches their mental schema (Mirjany & Nadimi, 2022), a schema regarded as one of the pillars of idea generation in expert designers. Haghighi et al. (2022) state that teaching innovative structures at the beginning of freshman students' design process, because of the phenomenon of simultaneity and co-presence, enhances creativity in the process of idea generation and design development. Others believe that creative solutions emerge from intra-group interactions (Shih et al., 2026; Bromage et al., 2025; Kwangmuang et al., 2026). These formal and informal interactions constitute the foundation for the emergence of novel ideas under complex conditions (Figure 8). The theoretical framework section explains how these strategies are employed in testing with freshman students.

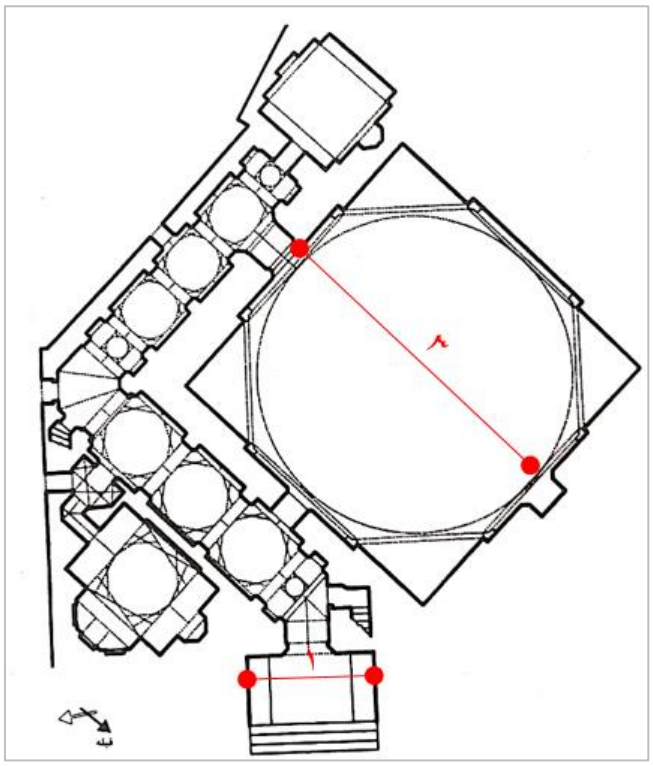


Figure 9: *Spatial Proportion in the Sheikh Lotfollah Mosque* (Pirnia, 1983).

4. *Proportioning System*

The word geometry is derived from the Greek word's "*geo*", meaning earth, and "*metry*", meaning measurement; thus, it denotes "measurable earth" or "earth measurement." Plato regarded geometry as the science of stereometry, or spatial measurement (Dabbour, 2012), which organizes the physical body of the design. From the perspective of many early designers, such as Palladio, geometry was the factor that shaped the beautiful work (Lee & Ostwald, 2024). In this context, adherence to the rules of proportioning is what gives form to the geometric building. Proportioning, or the establishment of proportion, is a rule-governed act undertaken by the designer on the basis of articulated principles and plays a principal role in shaping the body of the building. Proportioning is a mechanism that subtly takes shape within the individual and is regarded as one of the formative pillars of the components of the design. Historically, two systems of proportioning have been proposed in design: golden proportions and root rectangles based on √2, √3, and √5 (Dabbour, 2012). In the present research, golden proportions have been adopted as the criterion for evaluation. On the other hand, proportion is sometimes discussed in terms of the size of each space relative to another space (Figure 9), and at other times in terms of the proportions of a space's length, width, and height. In this study, both categories of criteria were taken into account, and they are discussed in detail in the findings section.

Theoretical Framework of the Research Literature

A review of the research background and literature showed that the effect of design thinking on the cultivation and learning of design techniques (the practical dimension) had received less attention. For this reason, the practical dimension of design thinking was regarded as the principal axis of the research. The practical domain of design thinking is classified into three dimensions: socio-cultural, adaptive, and critical.

Within the socio-cultural dimension, a collective-thinking approach is effective in cultivating proportion in freshman students. This means that individuals familiar with the subject and problem of the project engage in an exchange of ideas and share their mental aspirations concerning the future of the design. Adaptation to different conditions and the internalization of techniques are realized through the strategy of "release after learning," enabling the design instructor to educate freshman students who, when confronted with the complexity of design problems, can generate innovative ideas (Lawson, 2005). On the other hand, the cultivation of pre-reflective awareness is considered a prerequisite for the growth of freshman students' imagination (Hoseinyzadeh Mehrjerdi, 2025).

Therefore, the following strategies should be taken into consideration: teaching design concepts and their indirect effect on the creation of innovative ideas, solution orientation, step-by-step testing of the design, and problem orientation (Figure 10). In order to adapt these strategies to the particular conditions of this research, they were examined under the headings of apprenticeship and architectural education in the atmosphere of the building and the built space. In the following section, the findings resulting from testing the aforementioned strategies on freshman undergraduate architecture students are presented.

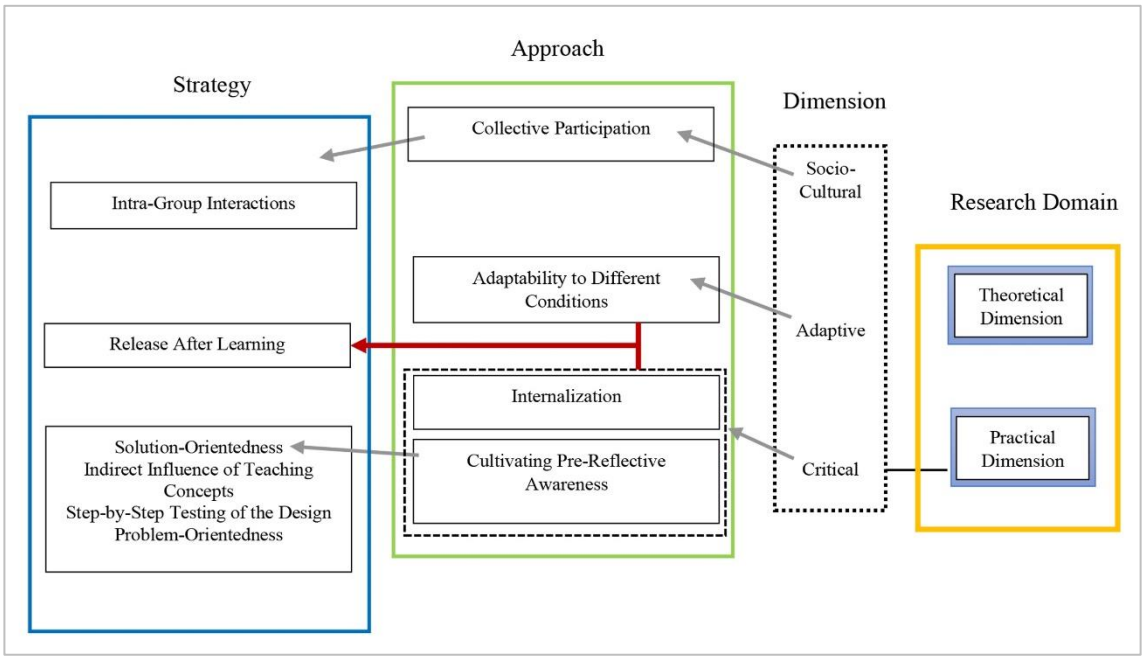


Figure 10: *Theoretical Framework of the Research*

Findings

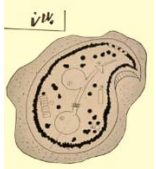
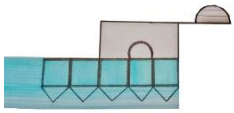
First Strategy: Release After Learning

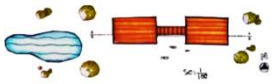
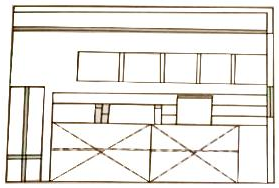
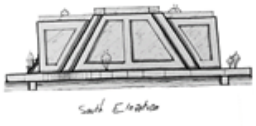
At the outset, on the basis of the criteria of spatial diversity, sensory richness, and spatial proportion, three desirable designs were selected from among 36 student projects (row 1 of Table 3) in order to be compared with two other sets of freshman students' plans and elevations. The first group consists of designs produced through the direct use of articulated rules (row 2 of Table 3), and the second group consists of designs produced after instruction in the proportioning system, at the end of the educational period or in subsequent design semesters (row 3 of Table 3). After an initial review of freshman students' designs, the researchers found that they had improved compared with earlier ones after the students learned the rules of proportioning. However, the designs created by directly applying those rules tended to have rigid and static proportions. These two statements constitute the researchers' hypotheses and must therefore be tested for validity. For this purpose, a Delphi questionnaire was distributed among design experts.

The Delphi technique is regarded as a group strategy for solving complex problems (Linstone & Turoff, 2002), one that cannot be implemented through surveys of laypersons. The number of specialists participating in the Delphi method varies considerably, ranging from 10 to 1,685, and is determined according to the requirements of the research and the available financial and time resources (Pashaeizad, 2008). Accordingly, based on the research hypotheses, 23 specialists were selected, including 15 design instructors and 8 postgraduate graduates. The questionnaire data were nominal, and the questions included both closed-ended and open-ended items. The nominal data consisted of each specialist's preferred option among 8 designs, selected on the basis of personal judgment, the rules of proportioning, and mental patterns. Because the selections were made on the basis of mental patterns, the questionnaire was regarded as qualitative; accordingly, the validity and reliability of a qualitative questionnaire correspond to credibility, defensibility, and trustworthiness (Johnson, 1997). In qualitative research, the researcher seeks to enhance the credibility of the results for the audience (Abbasi et al., 2024)

Initially, to evaluate trustworthiness, the questionnaire was provided to one Master's graduate and two university faculty members to assess the comprehensiveness of the questionnaire regarding the research objectives through the "theoretical validity" method. One faculty member suggested that the diversity of drawings produced by freshman students could influence the experts' opinions; therefore, standardization was necessary. Consequently, the drawings were refined using AutoCAD and Photoshop. Furthermore, the reliability of the questionnaire was examined using the "peer debriefing" strategy - as proposed by Guba and Lincoln (1989) - and the approach of equilibrating the options. For this purpose, feedback was sought from another faculty colleague. This faculty member noted that due to the lack of explicit reference to the proportioning approach within the questionnaire items, each expert might respond from their own subjective domain, thereby reducing the research reliability. Consequently, the specific approach was integrated into the phrasing of the questions. Additionally, they observed that the options were not equally weighted; some featured extensive detail while others were as simple as a diagram. This could lead experts to subconsciously select the more detailed options. In alignment with these observations, designs 9 and 10 were excluded, and spatial legends were added to the remaining designs. Following these modifications, the questionnaire was re-evaluated by the faculty member, who then verified the equivalence of the options. Once validity and reliability were confirmed, the questionnaire was distributed among the remaining experts. The questionnaire was distributed among the expert panel members over two rounds. In the first round, the questionnaire was initially distributed. Subsequently, in the second round, the frequency of each item (scheme) was presented to the panel members to reach consensus on the items. Owing to the agreement reached on three out of the four main questions, the reduced variation in experts' responses to the four questions compared to the previous round, and the potential decline in respondents' willingness to participate in subsequent rounds (McMillan, King & Tully, 2016), this round was considered the final stage of questionnaire distribution. The results pertaining to this round are elaborated in detail below. Furthermore, due to the nominal nature of the data and the qualitative characteristic of the attitudes assessed in this questionnaire, expert consensus cannot be measured using indices such as kappa. Rather, it is necessary to examine the changes in the frequency of options in each round relative to the previous round. This consideration has been duly noted in this study.

Table 3: *Freshman Students' Exercises Based on the Guidelines of design thinking*

Row	Work Stage	Student Works		
1	Before instruction in proportioning (designs produced before freshman students became aware of the articulated rules)			
		Design 1: Bus Station, by Zahra Hashemi;	Design 2: Hypothetical Island, by Zeinab Nouri Firouzi;	Design 7: Seaside Lodging, by Sara Khayyati

2	Proportioning exercises (drawing plans and elevations through the direct use of the rules of proportioning)			
		Design 9	Design 6: Hut on an Artificial Island, by Mahboubeh Ahmadnia (this design departs more than the others from the constraints of golden proportions, yet some of the rules still hinder spatial diversity, varied views, and improved user interaction);	Seaside Kiosk-Supermarket, by Fatemeh Ahmadzadeh
				
		Design 10		
3	After instruction in proportioning (the indirect effect of the rules of proportioning on the students' final designs)			
		Design 4: Restaurant in the Sea, by Mahboubeh Mahmoudinia;	Design 5: Bicycle Station, by Zahra Hashemi;	Design 8: Residential Fabric, by Solmaz Ahmadi and Niloufar Behfrouz

Examination of the questionnaire showed that the residential fabric design, which the freshman students had drawn at the end of their course of study, was considered by the specialists to be the most desirable option in terms of architectural quality (Figure 11). The specialists' reasons for selecting it were the diversity of open and closed spaces, circulation, absence of confusion, volumetric simplicity, desirable views, spatial rotation, desirable proportion, spatial rhythm and ..., all of which resulted from the freshman students' freedom in applying the rules of proportioning. This freedom enables the freshman student to think about the final product rather than the technique itself and prevents the student from becoming entangled in the complexity of the rules.

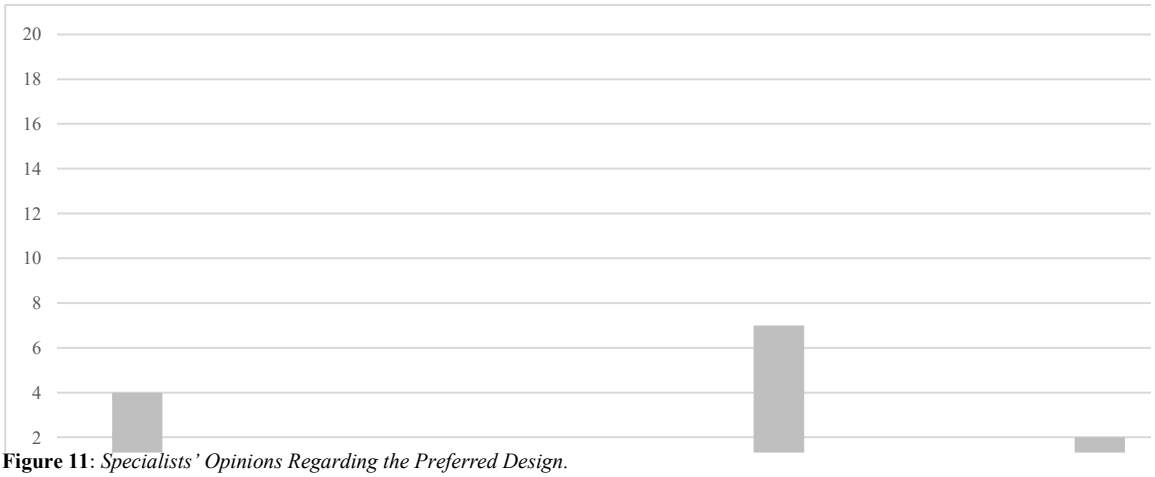
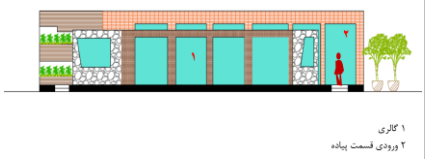
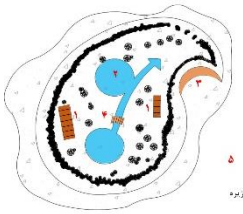
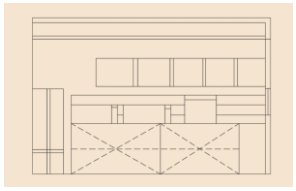
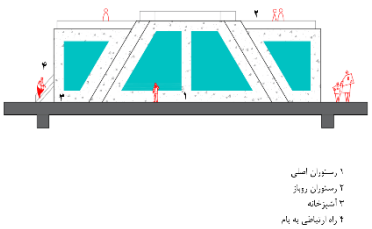
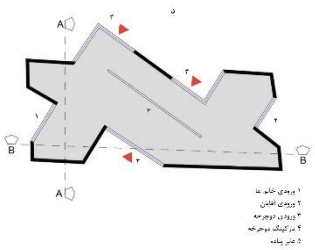
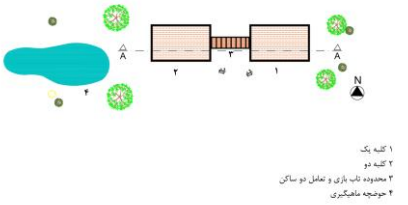
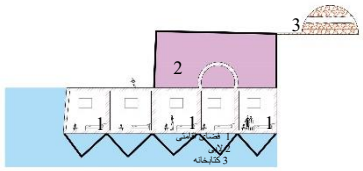
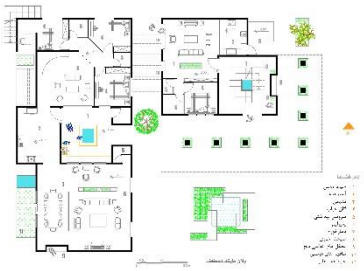


Figure 11: *Specialists' Opinions Regarding the Preferred Design.*

Table 4: *Specialists' Views on the Disproportionate Design.*

Design	Design Name	Response Frequency	Percentage of Respondents
	Design 1	0	0%
	Design 2	12	52%
	Design 3	8	34.7%
	Design 4	2	8.6%
	Design 5	3	13%

	Design 6	3	13%
	Design 7	9	39.1%
	Design 8	0	0%

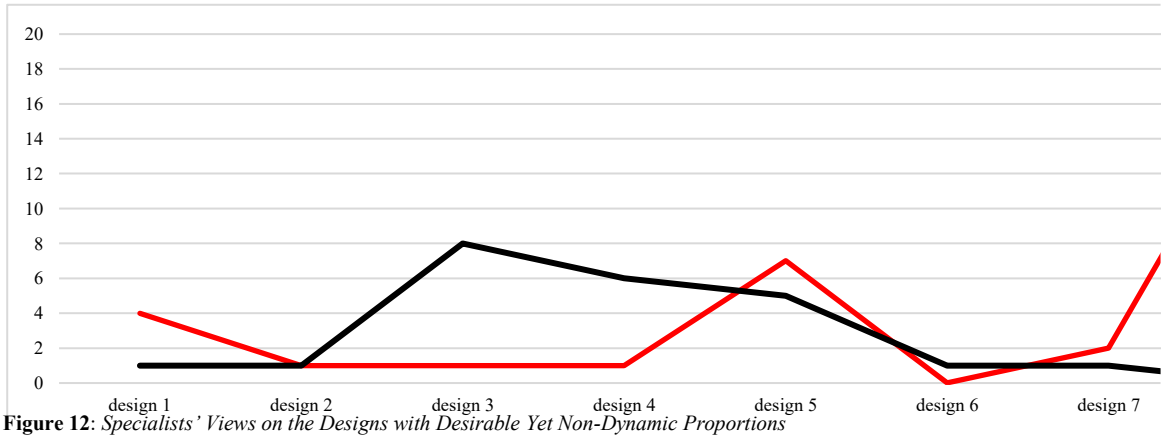


Figure 12: *Specialists' Views on the Designs with Desirable Yet Non-Dynamic Proportions*

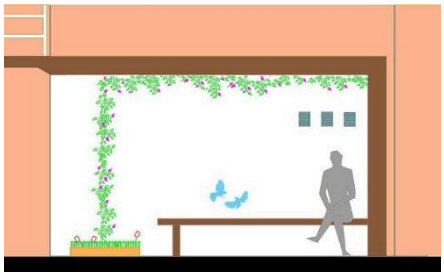
Second Strategy: Teaching Design in the Atmosphere of the Building and the Existing Space

Practical classes are often held in the design studio, apart from the atmosphere of an existing building. This condition leads to the artificial and unrealistic formation of freshman students' designs and, at the same time, hinders the growth of pre-reflective awareness. For this reason, the researchers held some design classes, as well as workshops on construction materials and architectural representation, within the atmospheric setting of distinguished spaces so that, through direct experience, they could strengthen reflective observation in freshman students. Holding classes in such spaces creates a tangible dialogue

between the student and a desirable spatial environment, leading to an increase in tacit knowledge and an expansion of design fundamentals. For example, the design class for seventh-semester architecture students was held in a building located on Sangi Street in Bushehr. After being placed within the atmosphere of a residential space, the students were influenced by the circulation, the spatial elements, and the designer's attention to environmental factors. Under the influence of that building and through an unconscious reading of it, the students drew a residential building whose human scale, pleasant spatial quality, and meaningful details are among its noteworthy features. These components are also observable in the distinguished building on Sangi Street, indicating the indirect influence of that building on the freshman students' design (Table 5).

The design studio for another group of students in *Introduction to Architectural Design 1* was held in a semi-natural setting adjacent to the Bushehr pier. The principal characteristics of this space were its human scale, natural proportions, and distance from the disorder of the city. The desirability of these features created a positive disposition in the students to reflect them in their own designs, to the extent that some freshman students undertook the re-creation and construction of an artificial island in the middle of the sea. This indicates the indirect effect of design experiences on the students' cognitive-practical trajectory, occurring through the spatial reading of a structured place. In addition to the experience of a distinguished space, the apprenticeship approach also enhances freshman students' pre-reflective awareness of spatial proportions, as explained in the following section.

Table 5: *The Influence of Spatial Atmosphere on Student Design*

Row	Visited Space	Student Design	Effects on the Freshman Student
1			A space with human proportions, which the freshman student created under the influence of a distinguished space. Student 1's comment: "After experiencing this space, our perspective on spatial quality, spatial proportions, and residential design changed." Student 2's comment: "How much attention was paid, in determining the O.K.B. level of the windows, to the surrounding environment."
2		 	Under the influence of experiencing the organic space adjacent to the Bushehr Port Office, the students tended toward creating organic proportions.

Third strategy: The Master-Apprentice Approach

The discourse between teacher and student in the architectural studio is understood as an apprenticeship relationship. In some academic settings, including the Faculty of Fine Arts, the studio instructor is regarded as the students' mentor. That is, students place complete trust in the instructor, and the instructor's thought and artistry are fully accepted (Sepehri & Hojjat, 2020). In this approach, the instructor sometimes makes use of freehand sketches. However, beyond drawing such sketches, teachers must also cultivate the freshman student so as to guide the student from imitation toward creativity. They should use verbal explanation during the sketching process so that strategies of thought can be made explicit. In other words, if they encounter a new problem during the design process, they should explain verbally how the problem is resolved (Sadram & Nadimi, 2015).

This strategy was tested with freshman students at Payame Noor University of Bushehr through the demonstration of the plan diagramming of the Rachofsky House (Figure 13). During this exercise, the researchers explained that the proportion between the entrance space and the bedroom should be considered as 1 to 9; in addition, the details of the principal spaces, the reasons for locating the main entrance on the upper floor, and the rationale for incorporating large expanses of glass throughout the building were clarified.

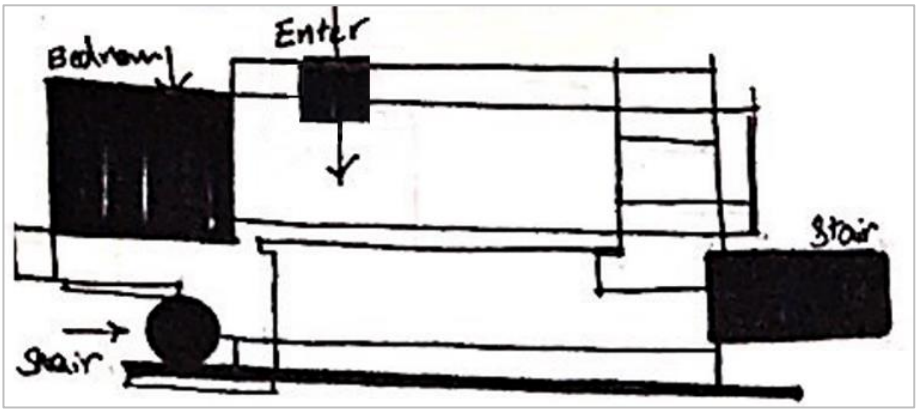


Figure 13: *Diagramming of the Rachofsky House*

At the end of the residential fabric design course, the effect of demonstrating the plan diagramming of the Rachofsky House on the freshman students' designs was examined. On the basis of the pre-reflective awareness derived from the plan diagramming of the Rachofsky House, the freshman students created a building in which the bedroom dimensions were 3.66 by 3.66. If the students had applied that lesson literally, the bedroom dimensions would have been 3.75 by 3.75 (Figure 14).

A comparison between these two figures shows that, according to the freshman students, at the time of drawing they did not remember the diagramming of that house or the spatial proportion in question, and the design took shape spontaneously in their minds. Nevertheless, the closeness of these proportions indicates that the instructor's teachings had been recorded and processed in the unconscious like a route map and, at the moment of designing, emerged unconsciously through the hand. Another point is that the dimension of 3.66 is as valid as 3.75. The difference is that if the designer intends to apply all the rules consciously and exactly, pleasant spatial diversity and an exciting space will no longer be attainable. The rules must therefore be transferred from reflective awareness to pre-reflective awareness so that, during the act of designing, the student thinks only about the refinement of the design itself.

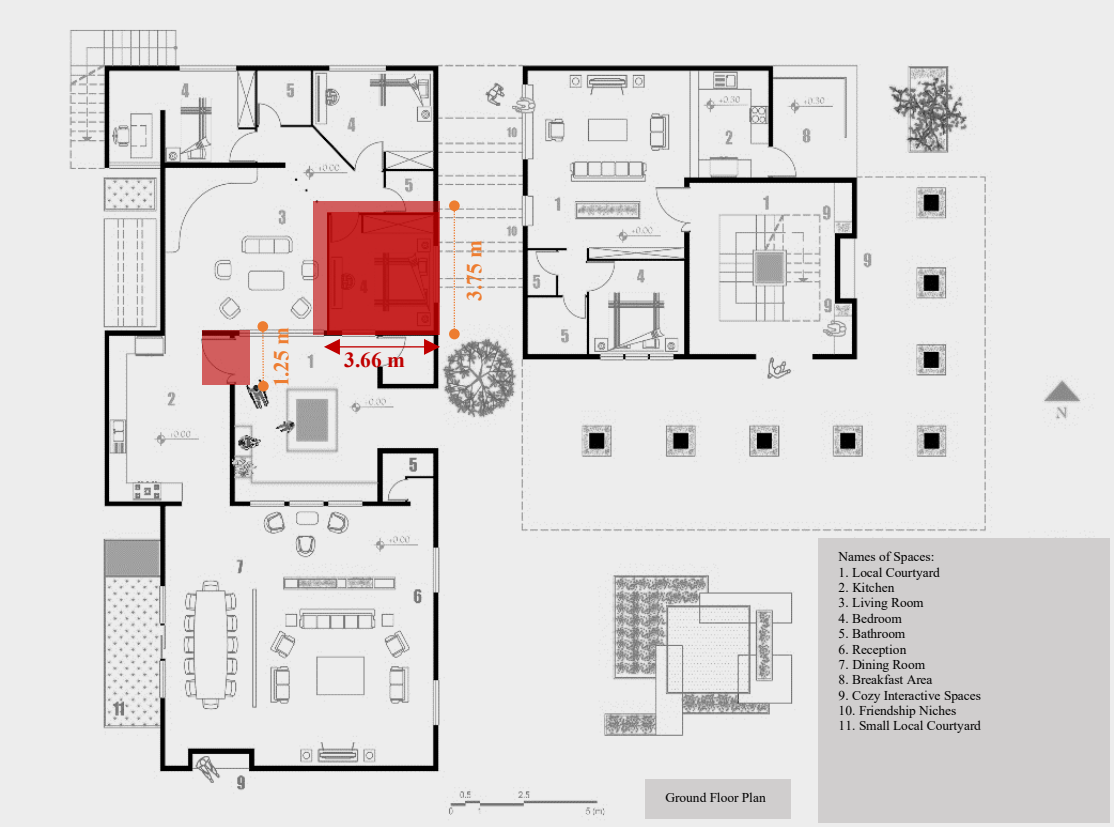


Figure 14: *Validation of the Student's Proportions in Residential fabric designed by Solmaz Ahmadi and Niloufar Behforouz*

Fourth Strategy: Intra-Group Interactions

After examining the role of distinguished space in freshman students' designs and teaching the rules of proportioning through the apprenticeship approach, the role of group interactions among the project stakeholders in internalizing the rules of proportioning was investigated. Group interactions among stakeholders are a fundamental pillar for discovering and analyzing users' needs (Bokharaei & Outokesh, 2025). In one of the residential fabric design sessions, the instructor observed a deficiency in the freshman students' proposed design and pointed it out. The students made repeated efforts to resolve the problem. Their efforts did not succeed, and the problem remained in the final design. At this stage, through further elaboration of the issue, the instructor reframed the problem from other angles. This reframing led to the formation of a preliminary idea in the students' minds, an idea that ultimately resolved the project's principal deficiency. After the instructor's limited intervention, the students stated that their design was the product of three-person teamwork; that is, they regarded the instructor as part of their design group. Group interactions do not play the principal role in teaching the proportioning system, but they do create an empathetic relationship between the instructor and the freshman student, a factor that leads to greater acceptance of the instructor's guidance.

Conclusion

The proportioning system is one of the key and widely used techniques through which designers translate their inner conceptions into objective architectural form. In this regard, design thinking offers guidelines and strategies for strengthening this technique, suitable for both expert designers and novice designers, the population addressed in this research. The findings of the study show that, compared with positivist-rationalist approaches, the educational strategy for teaching the technique of proportioning on the basis of design thinking entails essential and fundamental complexities, underscoring more than ever the need to adopt innovative approaches. This research sought to answer the following question: "What teaching

strategy, based on design thinking, can develop a proportioning mechanism in freshman students in such a way that it forms a system within their pre-reflective awareness, one capable of generating dynamic space while also preserving freedom of action?" A review of the research background and the literature on design thinking showed that the strategies of release after learning, solution orientation, Intra-Group Interactions, teaching design concepts and their indirect effect on the creation of innovative ideas, step-by-step testing of the design, and problem orientation assist design instructors in fostering an internal understanding of proportion in freshman students. Testing these methods on freshman students showed that the instructor, as the student's mentor, serves as a trusted guide, while the novice, through emulating the instructor's words and lines, internalizes and personalizes them within the self. On the other hand, the architecture teacher should not force the freshman student to move directly from rules to design. The rules and their essential subtleties should be examined, after which the student should be allowed to engage personally in inquiry and mental representation, drawing upon one or more techniques according to the atmosphere and conditions of each stage. Indirect instruction proves more fruitful than direct methods in elevating and internalizing the teachings of proportioning and contributes to the development of the designer's unconscious understanding of the proportioning system. In sum, this research extracted strategies and guidelines for the indirect teaching of proportioning concepts through the direct and tangible experience of freshman students, intended to serve as a toolbox for other researchers teaching the proportioning system (Table 6).

Table 6: *Research Guidelines*

Dimension	Approach	Strategy	Guideline
Socio-cultural	Collective participation	Intra-group interactions	The instructor should become part of the student groups so that motivation for learning increases through an empathetic relationship.
Adaptive	Adaptability to different conditions	Release after learning	In teaching design, the principles of proportioning should not be translated directly and mechanically into the design.
Critical	Internalization		Each freshman student should be taught in accordance with their own disposition and condition.
	Cultivating the designer's pre-reflective awareness	Teaching architecture in the atmosphere of the building	Classes should be held within the environment of a distinguished building.
		Master-apprentice approach	While respecting the freshman student's freedom, it is at times necessary to demonstrate the principles directly.
			While drawing, the teacher should articulate their thinking aloud so that the freshman student unconsciously learns how to confront the project's problems.

However, numerous difficulties remain in teaching techniques on the basis of design thinking, and it is recommended that future researchers investigate ways of addressing these issues. The first issue is students' reluctance to undertake assignments grounded in design thinking. Owing to the current one-dimensional educational approach, most contemporary students prefer instructors to transmit a large amount of information and show little inclination toward personal exploration or creative ideation. As a result, they tend to be reluctant to complete assignments and may even perceive the instructor as inexperienced. It is therefore recommended that future researchers examine strategies for increasing freshman students' motivation toward design thinking. The second issue is that this research was conducted within the academic community, whereas it should also be examined among expert designers. It is recommended that the guidelines of this study be tested in professional architectural offices so that a comparative analysis of these strategies may be undertaken between the academic community and design offices.

Acknowledgement

This manuscript is extracted from the first author's doctoral dissertation entitled "*Euphoria in the Design Process: Examining Effective Techniques for Nurturing the 'Inner Human' as the Most Essential Pillar of the Author-Architect,*" which is currently being conducted under the second author's supervision at the Kish Campus of the University of Tehran.

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