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A Comparative Study of TRIZ and Critical Thinking Perspectives in the Design Process with an Emphasis on Architectural Education

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ABSTRACT: Architectural education is one of the most complex forms of education, as it does not rely on predetermined answers; instead, students are expected to propose unique and appropriate solutions through their own creativity. Adopting an appropriate design methodology to clarify the design process is among the most critical factors that enhance students' design quality in architectural studios. Various techniques have emerged worldwide to foster creativity, and their application as design approaches can significantly contribute to the effectiveness of architectural education studios. Among these, the TRIZ theory and the critical thinking approach have proven to be effective architectural design methodologies in the context of architectural education. This study examines and compares these two perspectives, analyzing the results of architectural education through the lens of each. The research employs a descriptive–analytical approach, with data collected through library studies using relevant books, scholarly articles, and documentary data, complemented by the Delphi technique. To this end, in-depth interviews were conducted with professors and experts. Sampling was conducted using the snowball technique, and the study reached a total of 20 interviews, determined by theoretical saturation. Findings indicate that the design process differs significantly depending on which of these two approaches is applied. From the 17 criteria extracted through document analysis and the Delphi study, several similarities and differences emerged. Among the most prominent differences are the approaches to problem definition, assessment methods, and evaluation criteria. A noteworthy point is the substantial influence of the student's personality in determining which method they can engage with most effectively.

Keywords: Architectural design process, TRIZ theory, Critical thinking approach, Architectural education.

INTRODUCTION

Architectural design constitutes the core component of architectural knowledge. In the past, architects underwent an apprenticeship alongside a master builder, acquiring fundamental principles and applying them with only minor modifications in their own architectural works. Over time, however, this tradition evolved, and today, various approaches to design and design education are observed among novice architects. With the rapid advancement of knowledge across all domains, design has also been recognized as a scientific discipline focused on the creation of new tools and systems, resulting in the development of techniques that facilitate the design process.

Research in design studies suggests that methods and techniques should serve as facilitators and enablers of the design process. Since architecture is inherently a creative discipline, the techniques and tools employed to confront architectural challenges may vary significantly (Pagyan Dash, 2021). The architectural design process can generally be divided into three stages: the random placement of objects, the simulation of building design, and the incorporation of real-world constraints into the final design (Zou et al., 2021). On the other hand, some scholars consider design as a "black box" carried out spontaneously by the designer, in which the source of creativity is undefined and may emerge from dreams, inspiration, or experimental practices (Indrosaptono, 2021). Within such an approach, explaining the obtained design is difficult, the creative process remains obscure, and the result

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lacks transparency for critique. Moreover, creative output is heavily dependent on the designer's state of mind.

Conversely, when the design method is transparent and systematic, the process is conducted logically and step by step, allowing for analysis, reversibility of stages, and evaluability of outcomes (Indrosaptono, 2021). Nevertheless, much of contemporary design remains largely taste-driven, often disconnected from architectural identity and cultural context. This widening gap is concerning, given that one of the fundamental functions of architecture is to shape identity within society based on cultural foundations (Labibzadeh, 2022). Without this, architecture risks becoming purposeless, devoid of cultural grounding, and ultimately producing a confused identity.

In this regard, architectural education plays a vital role, as it teaches students how to think and approach design problems. Among the various approaches aimed at fostering creativity in design education, the TRIZ theory and Critical Thinking stand out due to their structured frameworks and applicability in problem-solving processes. TRIZ, with its systematic orientation toward innovation, supports the development of structured creativity, whereas Critical Thinking enhances analytical and evaluative capacities, thereby fostering reflective and flexible creativity.

Recent studies emphasize that design studios, as the core of architectural learning, are most effective when they combine strong collaborative engagement and group critique with structured problem-solving frameworks (Joseph, 2025; Anteet, 2025). These perspectives suggest that integrating structured approaches, such as TRIZ, with analytical and culturally oriented approaches, like critical thinking, can create a robust foundation for developing innovative learning processes in architecture (Hatting, 2025). Accordingly, this study focuses on comparing these two approaches, aiming to propose a comprehensive model for improving architectural design education while offering a clear understanding of the strengths and limitations of each perspective.

A comparative examination of these two theories within the context of architectural education offers a clearer perspective on strengthening design skills among students.

This study, focusing on an in-depth analysis of the TRIZ theory and the critical thinking approach in architectural design education, has developed a three-layer framework for evaluating and comparing design methodologies. The framework comprises three dimensions: "Cognitive–Philosophical," "Design Process," and "Teaching–Learning," constructed through qualitative content analysis of Delphi interviews and documentary studies. From this analysis, 17 key criteria were identified to assess the similarities and differences between these two approaches. These criteria serve as a practical tool for educators and researchers to design educational programs and enhance learning processes in architecture.

Accordingly, this study seeks to answer the following questions: Which of the two theories provides more effective responses in architectural design education? And what are the fundamental differences between them?

Literature Review

In recent years, numerous studies have explored the role of innovative approaches in enhancing the architectural design process, with the TRIZ theory gaining a prominent position in analyzing creativity and problem-solving in architectural education. For instance, (Hamdpoor et al., 2022) n their study "Evaluating the Role of Nature-Based Semiotics Education in Enhancing Architectural Design Creativity through TRIZ Problem-Solving Techniques" demonstrated that integrating TRIZ with semiotics instruction can provide a more structured pathway for creativity, transforming foundational skill-based courses into platforms for innovative idea development. Similarly, Siadati (2022), in "Analyzing Biomimetics Knowledge and TRIZ Problem-Solving in Creative Architectural Design," found that merging TRIZ with biomimetics, a nature-inspired approach, significantly improves the effectiveness of creative design processes. In addition, (Jabal-Ameli et al., 2018) examined the "Application of TRIZ Functionalism in the Architectural Design Process" through a quasi-experimental study, confirming the effectiveness of TRIZ principles in enhancing students' design performance.

In the realm of critical thinking, argue that traditional architectural education limits students' critical thinking, current methods in Iran encourage imitation rather than analysis, and curriculum and teaching approaches need reform to foster critical and creative design skills (Alizadeh et al., 2022). Furthermore, (Zeraati, 2025), in their research "Identifying Factors Affecting the Development of Critical Thinking and Studio Culture in Architectural Design Education in Iranian Universities," investigated the barriers and opportunities for fostering a culture of critique in architectural education, emphasizing how educational structures and teaching methods can either strengthen or undermine this essential skill. Table 1 lists important articles in 2024 and 2025 in the field of TRIZ and critical thinking.

A review of both domestic and international studies indicates that research in architectural education and the design process has consistently revolved around two main themes: first, enhancing students' creativity and problem-solving abilities through structured frameworks such as TRIZ; and second, strengthening analytical thinking and intellectual capacity through approaches based on critical thinking.

Overall, findings from domestic studies suggest that using TRIZ as a systematic method can guide the design process in a structured and measurable manner, while critical thinking, by fostering in-depth analysis, inquiry, and reflection, complements the design process from cultural and humanistic perspectives. Together, these two approaches have the potential to create a more comprehensive model for architectural design

Table 1: Literature Review

No.	Article Topic	Category	Research Method	Substantive Dimension	Procedural Dimension	Source
1	Preparation of Archi-TRIZ Matrix for Accelerating Innovation in Building Design Process	TRIZ	Applied Design Research; data collection through literature review, architectural case studies, and functional analysis to identify contradictions; content analysis and process modeling; validation of matrix through applied design examples.	Development of a TRIZ matrix specifically for architecture (Archi-TRIZ) to identify contradictions and functions in building design, enhancing innovation and creative problem-solving in architectural practice. Practical applications include studio projects and real design processes.	Structured systematically: Introduction → Literature Review → Mapping TRIZ principles to architectural design → Development of Archi-TRIZ matrix → Case study → Discussion & Conclusion. Combines theory and practical application step-by-step.	Hassanijajini et al., 2025
2	Enhancing TRIZ through environment-based design methodology supported by a large language model		Mixed-methods / applied conceptual research; data collection from literature review, design examples, and LLM outputs; quantitative and qualitative analysis; comparative validation with expert-designed solutions.	Integration of TRIZ with Environment-Based Design (EBD) and Large Language Models (LLM) to solve complex architectural design problems, enhancing creativity, speed, and environment-aware decision-making. Practical applications include design studios, urban projects, and sustainable architecture.	Systematic structure: Introduction → Literature Review → Proposed Framework (TRIZ + EBD + LLM) → Case Study / Application → Results Analysis → Discussion → Conclusion. Combines theory, model development, and applied validation.	Mohammadi, (2025)
3	Value-Driven Concept: Achieving Architectural Innovation through Divergent and Convergent Thinking	Critical Thinking	Type: Mixed-methods – conceptual model development. Tools: Literature review + analysis of students' design works + instructor interviews. Sample: Architecture students in studio. Analysis: Qualitative content + comparative analysis.	Focus on divergent and convergent thinking in design; introduces a value-driven concept framework to achieve architectural innovation.	Structure: Introduction → Theoretical Background (divergent/convergent + value-driven) → Conceptual Model → Case Study → Results Analysis. Theoretical approach: Integrates creativity psychology (Guilford, Torrance) with architectural design values.	Al-haddad, 2025
4	Reflective thinking and self-assessment: A model for the architectural design studio		Type: Qualitative – model development. Tools: Questionnaire + qualitative analysis of critique sessions. Sample: Architecture students in a design studio. Analysis: Content analysis.	Focus on reflective thinking and self-assessment in the architectural design studio, aiming to enhance self-awareness and critical thinking throughout the learning process.	Structure: Introduction → Literature Review → Proposed Model → Studio Application → Analysis & Discussion. Theoretical approach: Based on reflective practice theories (Schön and others).	Ersine Masatlıoğlu, Balaban, 2024

education.

In comparison, recent international studies (2025–2024) have adopted a more integrative approach, emphasizing the connection between systematic innovation and critical reflection, with a strong focus on interdisciplinary studio design models. These studies suggest that simultaneously addressing technical–functional and human–analytical aspects in architectural education can significantly improve both learning quality and design outcomes.

The reviewed studies indicate that the architectural design process goes beyond individual activities and involves a combination of analytical thinking, creativity, and group interaction. Creativity is enhanced through both convergent and divergent thinking as well as the use of innovative teaching techniques. Furthermore, architectural education becomes more effective when it emphasizes self-directed learning, critique-based approaches, and the integration of digital technologies. Systematic methods such as TRIZ and biomimetics also serve as effective tools for improving problem-solving skills and generating innovative ideas. Ultimately, by considering social and cultural dimensions and adopting a critical approach, architectural education can be guided toward addressing contemporary societal needs.

MATERIALS AND METHODS

This study employed a descriptive–analytical approach. Data collection combined library research (books, articles, and documentary sources) with the Delphi technique through in-depth expert interviews. Sampling was performed using the snowball method, and theoretical saturation was achieved

after 20 interviews. The research process included reviewing the design process, design methods, the role of thinking, and creativity strategies in architectural education for both TRIZ and Critical Thinking approaches. Finally, the strengths and weaknesses of each were analyzed, along with expert evaluation, enabling a comparative assessment of the two methods in architectural design education.

For the interviews, semi-structured questions were designed to provide a clear framework while allowing flexibility to explore additional details. Participants were selected using a snowball sampling method based on criteria such as teaching or research experience in architectural design and familiarity with the TRIZ theory and critical thinking. Interviews were conducted either in person or online, following prior arrangements, and informed consent was obtained from all participants. Each interview lasted approximately 45 to 60 minutes. The structure of the interviews included an introduction to the research objectives, a discussion of participants' experiences and perspectives on the role of TRIZ and critical thinking in the architectural design process, an analysis of the strengths and limitations of each approach, and recommendations for improving architectural education. The data were transcribed verbatim and analyzed through multiple stages of coding to gain deeper insight into these two approaches, forming the basis for the comparative analysis presented in this study. Figure 1 schematically depicts the research method.

Validity and Reliability of the Research

The validity of the study was ensured through content validity and triangulation. Interview questions were designed based on the theoretical framework and revised with expert feedback. Data were gathered from three sources—literature review, documentary data, and expert interviews—and continued until theoretical saturation was reached (20 interviews).

Reliability was strengthened by documenting all stages of coding and analysis, using double-coding with inter-coder agreement checks, and applying member checking through feedback from several participants.

Based on Lincoln and Guba's (1985) framework, four criteria were addressed:

- Credibility: achieved through expert review, triangulation, saturation, and member checking.
- Dependability: ensured by systematic documentation and inter-coder reliability.
- Confirmability: maintained through transparent coding, grounding interpretations in data, and minimizing researcher bias.
- Transferability: supported by providing detailed descriptions of context, participants, and interview conditions.

Rationale for Choosing the Research Method

Given the comparative and analytical nature of this research, which focuses on examining the TRIZ theory and critical thinking in the architectural design process, a descriptive–analytical approach and a qualitative method based on in-depth interviews using the Delphi technique were employed. This approach allowed for the extraction of experts' perspectives on complex concepts of design, creativity, and education. Triangulation was achieved by combining data collected from literature reviews, documentary analysis, and targeted interviews, which enhanced the credibility of the findings. Furthermore, snowball sampling was used until theoretical saturation was reached, ensuring the richness and diversity of the data. The use of qualitative content analysis facilitated a more precise, critical, and comparative examination of the strengths and limitations of both approaches within the context

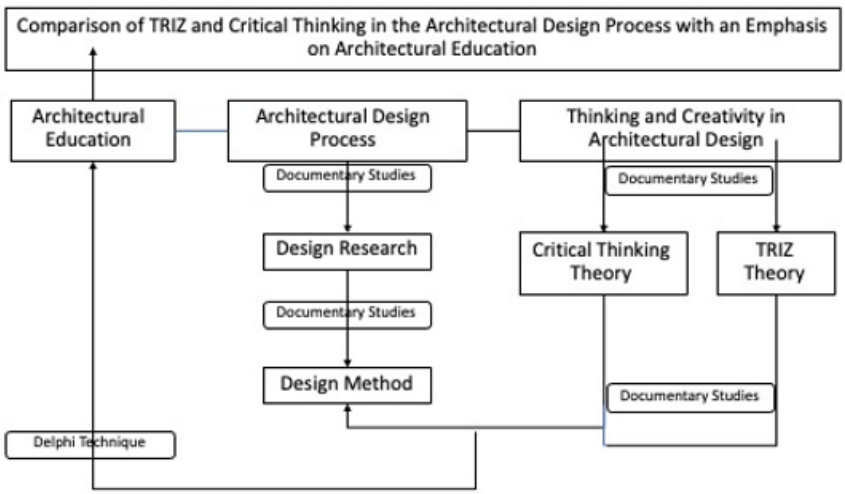

Fig. 1: Research Methodology

of architectural education.

Theoretical Framework

Design Research

Design research began with Marples (1960), and Eastman (1970) initiated the first architectural design study. Since then, design research in architecture has evolved as a fertile and expanding field (Cross, 1999; Talischi, 2009). While some regard architectural design as a subjective and intuitive activity, others see it as a rational, codifiable process, where intuition plays only a supplementary role. This dual view underscores the necessity of detailed investigation into the architectural design process (Jabal-Ameli, 2019).

Design Process

The design process is widely defined as a sequence of actions transforming an existing condition into a desired outcome (Zakeri, 2011). It can be seen as both linear—beginning with a need and ending with a solution (Finkelstein & Finkelstein, 1983)—and nonlinear, where actions occur simultaneously depending on context. Because design inherently engages deeply with problems, it is difficult to describe fully, but its study is crucial for addressing complex challenges such as urban management (Jagtap, 2019).

Design Method

Design is essentially a decision-making activity that transforms an undesirable state into a preferred one (Goodini et al., 2021). Methods provide structured rules to guide this transformation (Hubka, 1983), though each architect interprets and delimits "design" differently (Dash, 2021). Tools such as diagrams and models (Evbuomwan et al., 1996). Make design thinking explicit and support systematic progress. Ultimately, design methods serve to clarify actions, coordinate resources, and connect the creative with the technical (Lee, 2020; Goodini et al., 2024).

Thinking and Creativity in Architectural Education

Creativity is a central component of architectural education, shaping students' ability to engage dynamically in design. Design thinking, understood as a mental habit for problem-solving, is primarily cultivated in design studios where fostering creativity remains a core challenge.

Creativity involves four dimensions—process, product, person, and context (Medqalchi, 2023)—and in architecture, it emerges when design variables are reconfigured to produce innovative outcomes (Talebi, 2021). The creative process typically unfolds through five stages: unconscious preparation, conscious effort, incubation, illumination, and verification (Tayeh, 2021).

To guide students toward innovation, several structured methods are used: brainstorming, mind mapping, Six Thinking Hats, SCAMPER, critical thinking, and TRIZ. While TRIZ has not been fully adapted as an architectural method, it offers systematic support that can complement critical thinking, which is more established in studio practice. The key pedagogical question remains: which approach most effectively elevates the quality of architectural design education? Table 2 shows the types of techniques for increasing group, individual, and individual-group creativity.

TRIZ Theory

The complexity of design problems requires varied modes of thinking, including analytical and creative approaches. TRIZ, derived from the Russian Teoriya Resheniya Izobretatelskikh Zadach, is a systematic framework for inventive problem solving, developed by Altshuller as "systematic innovation" (Pandey, 2021).

Table 2:Types of Creativity Techniques (Merikhpour, 2020)

Individual-Group Creativity	Group Creativity	Individual Creativity
Forced association /	Ideatoon technique	Meditation
SCAMPER	Role playing	Creative illusion
/ P.I.C.L	Storyboards	Do it, Do it Technique
P.M.I	T.K.J/technique T.K.J	Solving the subconscious
P.P.C	Dialectic technique	/ Creative Dream
Matrix Analyze	Delphi method	View with mind Eyes
What if...?	Synectics	Doodles
TRIZ	/ Six thinking hats	Fishbone diagram
	Speculative excursion	Checklist s'
	Brain storming	
	Brain writing	
	Inverse brainstorming	
	Nominal group	
	Critical Thinking	

TRIZ is defined as both a theory for addressing non-standard problems and a body of knowledge on technical system evolution, offering structured tools for analysis and creativity (Khomenko, 2010; Kucharavy, 2010). Unlike domain-specific methods, TRIZ operates across disciplines, complementing rather than replacing specialized expertise (Cascini et al., 2008).

Core contributions include the laws of technical evolution, the principle of ideality, and 40 inventive principles that guide designers through structured innovation. Importantly, TRIZ challenges the notion that creativity is purely instinctive, framing it as a teachable skill that can be cultivated through systematic classification of solutions, enabling more effective and efficient design outcomes (Merikhpour, 2020). Table 3 lists the 40 principles of TRIZ.

Critical Thinking Approach

Critical thinking is a core principle of higher education, fostering analytical reasoning, reflective judgment, and self-regulation (Alizadeh Mian-Doab, 2021). Freire (1972/1985) contrasts the traditional "banking model" of education—where teachers deposit information into passive students—with a participatory model that empowers learners to analyze reality and challenge social issues. This approach cultivates creativity, agency, and critical awareness.

In architectural education, critical pedagogy emphasizes active engagement in design studios, where students analyze, critique, and respond to societal realities. Teachers act as facilitators rather than authority figures, guiding collaborative problem-solving and expanding the architect's role beyond narrow technical concerns (Shor, 1987; Ghaempanah, 2023).

TRIZ as a Method in the Architectural Design Process

In contemporary architectural design, traditional approaches are often insufficient for addressing complex challenges; therefore, systematic creativity methods such as TRIZ (Theory of Inventive Problem Solving) are increasingly applied. TRIZ is structured around four key principles—functionality, ideality, resources, and contradictions—that guide the design process step by step. Through identifying essential functions, envisioning ideal solutions, utilizing available resources, and resolving project contradictions, TRIZ offers a structured yet creative framework. This systematic approach enhances both innovation and problem-solving capacity in architectural design (Jabal-Ameli, 2019).

Critical Thinking as a Method in the Architectural Design Process

Critical thinking pedagogy replaces teacher-centered instruction with a learner-centered approach, encouraging active participation, critique, and shared responsibility. In design studios, this method reframes the process through collaborative topic selection, peer critiques in early concept stages, and reflective evaluation at later stages. The instructor acts as a facilitator rather than an authority, fostering both creativity and critical analysis. Thus, integrating critical thinking into architectural education enhances students' ability to question, innovate, and regulate their own learning (Sardashti, 2019).

Analysis of Findings

1. Comparing TRIZ and Critical Thinking as Architectural Design Methods

Using the Delphi technique and semi-structured interviews with 20 architectural experts, this study compared TRIZ

Table 3: 40 Inventive Principles of TRIZ (Merikhpour, 2020)

	Principle		Principle		Principle		Principle
1	Segmentation	11	Cushion in advance (protection)	21	Hurrying (quick action)	31	Porous materials
2	Extraction	12	Equipotentiality	22	Blessing in disguise	32	Color change
3	Local quality	13	The other way around	23	Feedback	33	Homogeneity
4	Asymmetry	14	Spheroidality	24	Mediator (intermediary)	34	Rejecting and restoring parts
5	Merging	15	Dynamics	25	Self-service	35	Transformation of physical/ chemical states
6	Universality	16	Partial or excessive action	26	Copying (imitation)	36	Phase transition
7	Nested doll (nesting)	17	Moving to a new dimension	27	Cheap short-life objects	37	Thermal expansion
8	Counterbalance	18	Mechanical vibration	28	Substitution of a mechanical system	38	Strong oxidizers
9	Preliminary anti-action	19	Periodic action	29	Pneumatics and hydraulics	39	Inert environment
10	Preliminary action	20	Continuity of useful action	30	Flexible shells and thin films	40	Composite materials

methodology and Critical Thinking pedagogy. Data were analyzed through content analysis and coding, leading to the following results:

TRIZ Method

• Nature: A systematic, invention-based framework for structured problem-solving.

• Strengths: Identifies contradictions, generates innovative solutions, and supports creativity in complex, constraint-heavy projects.

• Limitations: Requires advanced training; may appear abstract for novices.

Critical Thinking Method

• Nature: A cognitive framework emphasizing evaluation, reflection, and judgment.

• Strengths: Fosters independent reasoning, dialogue, and student autonomy in design studios.

• Limitations: A lack of clear structure may cause hesitation or dispersion, particularly in the early phases.

Synthesis:

TRIZ provides structured mechanisms for systematic innovation, while Critical Thinking nurtures evaluative and reflective capacities. Integrating both offers a balanced framework combining structured creativity with critical evaluation in architectural education (Jabal-Ameli, 2018; Sardashti, 2019).

2. Structured Comparative Framework

Analysis of interview data revealed three overarching dimensions:

1. Cognitive–Philosophical Dimension: theoretical origins, mental structures, and approaches to problem definition.

2. Design Process Dimension: tools for idea generation, contextual engagement, and process integration.

3. Educational–Learning Dimension: roles of students/instructors, studio environment, and evaluation methods.

Within each, thematic subcategories and specific comparative criteria emerged. Experts highlighted the need to distinguish between thought-oriented components (conceptual and reflective) and performance-oriented components (practical execution).

This led to a three-layered framework:

• Layer 1: Macro dimensions (the three domains).

• Layer 2: Thematic subcategories within each dimension.

• Layer 3: Fine-grained comparative criteria.

This structured model provides a systematic basis for comparing TRIZ and Critical Thinking, supporting analytical tables, integrative models, and evaluation of pedagogical methods in architectural design. The conceptual model is shown in Figure 2.

TRIZ and Critical Thinking are both valuable tools for improving architectural education and the design process, yet they originate from distinct foundations and follow different logics. TRIZ, rooted in engineering and industrial innovation, is a systematic theory of problem-solving that provides step-by-step methods supported by inventive principles, algorithms, and a knowledge base of solutions. In contrast, Critical Thinking is a cognitive and analytical framework aimed at cultivating a questioning, self-aware, and flexible mindset.

From a conceptual perspective, TRIZ focuses on technical innovation and finding creative solutions by resolving contradictions without compromise. It is inherently tool-based and structured, requiring mastery of documented algorithms and principles. Critical Thinking, however, emphasizes qualitative analysis, identifying assumptions, and developing reasoning and dialogue-based skills rather than relying on fixed tools. TRIZ is therefore knowledge- and tool-oriented, whereas Critical Thinking has a skill-driven, cultural, and humanistic

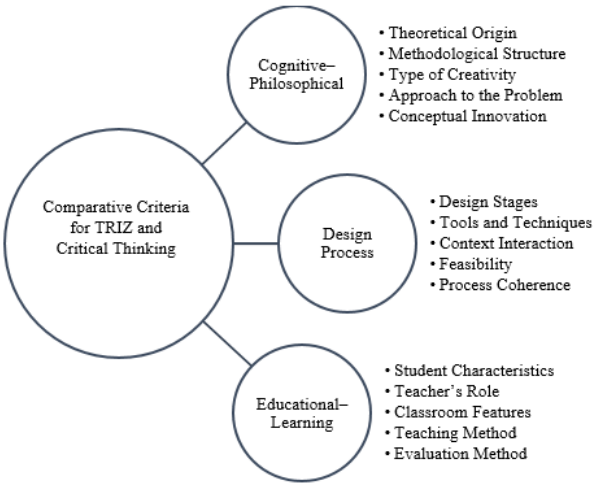

Fig. 2: Comparative Criteria for TRIZ and Critical Thinking Theories Extracted from Interviews. (Authors)

nature.

From a procedural perspective, TRIZ's algorithmic structure makes it highly effective for technical and constraint-driven projects, especially during early design phases and problem definition. It reduces problem-solving time and integrates well with modern technologies, though its structured nature may limit creative flexibility in human-centered fields. Critical Thinking thrives in interactive environments such as design studios, where deep learning, group collaboration, and analytical reasoning are essential. However, it is time-intensive, requires highly skilled educators, and may face challenges in hierarchical or inflexible contexts.

Overall, TRIZ serves as a tool for systematically managing creativity and innovation, while Critical Thinking provides a framework for fostering analytical, reflective, and socio-culturally informed learning. Combining these two approaches could create a comprehensive model for architectural education, strengthening both students' ability to solve complex problems and their critical thinking capacity. Table 4 compares the perspectives of TRIZ and critical thinking in two dimensions: substantive and procedural.

This table compares the TRIZ method and critical thinking across two key dimensions: conceptual and procedural. TRIZ emphasizes structure, tools, and systematic problem-solving, while critical thinking focuses on analysis, reflection, and studio culture to strengthen cognitive skills. Table 5 compares the two perspectives of TRIZ and critical thinking, as outlined in the 3-layer structure derived from the interviews.

Based on the above table, derived from interviews with experts, the criteria for comparing the two design approaches have been identified. These criteria can function as a framework for guiding architectural design education in universities. A deeper awareness of the distinctions between architectural design methods and the consideration of such differences as a means of enhancing the quality of students' design outcomes may uncover new values. By contextualizing and integrating these values, architectural education can be substantially enriched, ultimately fostering students' ability to transform their design work into successful architectural practice.

RESULTS AND DISCUSSION

Architectural education necessitates effective methodologies that clarify the design process, minimize confusion, and improve learning outcomes. In this study, TRIZ and Critical Thinking were compared through documentary research and expert interviews using the Delphi method, resulting in seventeen comparative criteria.

Findings show that neither TRIZ nor Critical Thinking alone can fully address the needs of architectural education. TRIZ, with its structured and problem-solving nature, is effective in early design stages and projects with technical constraints but may be abstract for novice students and limited in addressing cultural–contextual aspects. Critical Thinking, by contrast, fosters reflection, critique, and context-sensitive design, enriching the human and cultural dimensions of architecture, though it can create ambiguity when lacking structured guidance.

In practice, TRIZ is well-suited for small classes and technical problem-solving, with instructors acting as guides. Critical Thinking fits collaborative studios and critique sessions, with instructors as facilitators encouraging dialogue and intellectual independence. Students' responses vary depending on their experience, creativity, and learning style.

The findings of this study indicate that neither the TRIZ methodology nor the critical thinking approach alone can fully address the diverse educational needs of architectural design. Analysis of Delphi interview data and a review of scholarly documents led to the development of a three-layer framework encompassing cognitive–philosophical, design process, and teaching–learning dimensions. Based on this framework, 17

Table 4: Differences Between the TRIZ Method and Critical Thinking in Architectural Education

	Dimensions	TRIZ (Theory of Inventive Problem Solving)	Critical Thinking
1	Ontological (Content and Philosophy)	Rooted in industry and engineering; tool-oriented; relies on algorithms, knowledge banks, and 40 inventive principles; focused on technical innovation and contradiction resolution.	Rooted in humanities and philosophy; skill-oriented; focuses on questioning, qualitative analysis, uncovering assumptions; socio-cultural approach.
2	Procedural (Application and Process)	Structured, step-by-step, formally teachable; suitable for solving complex and constraint-driven problems; integrable with modern technologies.	Flexible, interactive, and time-consuming; suited for open learning environments and design studios; requires high instructor expertise and group interaction.
3	Key Strengths	Accelerates problem-solving process; provides creativity tools; algorithmic and repeatable capabilities.	Enhances reasoning, self-awareness, analytical creativity, and the ability to critique and defend ideas.
4	Key Weaknesses	Complexity for non-technical individuals; reliance on tools and precise data; possible reduction of creative flexibility.	Time-consuming; difficult to document quantitatively; potential for tension and excessive doubt.
5	Application in Architectural Education	Suitable for early design stages and technical projects; facilitates creativity management.	Suitable for fostering analytical, cultural, and critical thinking skills in students; enhances interaction.

Table 5: Criteria for Comparing the TRIZ Method and Critical Thinking Extracted from Interviews (Authors)

Thematic Branch	Criterion	Critical Thinking Method	TRIZ Method
Theoretical Origin	Cognitive–Philosophical	Rooted in educational philosophy, analytical logic, and the humanities	Based on industrial innovation and engineering methods
Method Structure		Nonlinear, flexible, open, and in interaction with free thinking	Step-by-step, algorithmic, with a defined sequence
Type of Creativity		Intuitive, meaning-oriented, and reflective creativity	Tool-oriented creativity, based on resolving contradictions
Approach to the Problem		Continuous redefinition of the problem within the context and the user framework	Focus on functional and technical contradictions.
Conceptual Innovation		Focus on innovation in meaning, context, and human experience	Focus on technical and efficient solutions
Design Stages	Design process	Open, analytical, iterative, with possibilities for revision	Structured, stage-oriented, engineering-based
Tools and Techniques		Critical questioning, multi-layered analysis, writing, and rereading	principles of innovation, Con- 40 tradiction Matrix, ARIZ algorithm
Context Interaction		Deep attention to the social, cultural, and contextual background of use	Focus on performance and structure; less attention to cultural and human aspects
Feasibility		Suitable for conceptual, educational, or context-based projects	Suitable for industrial, technical, and performance-oriented projects
Process Coherence		Fluid process, with repetition and reflection at each stage	Transparent process, documentable, with a clear path
Design Stages		Open, analytical, iterative, with possibilities for revision	Structured, stage-oriented, engineering-based
Student Characteristics	Teaching–Learning	Comprehensible at various levels, fostering analytical thinking	Requires basic technical knowledge, tools are harder to grasp for beginners
Teacher's Role		Facilitator of dialogue, encouraging student independence of thought	Process guide, transferring tools and algorithms
Class Characteristics		Suitable for interactive, group-based, and critique-oriented environments	Suitable for small and controlled classes
Teaching Method		Cultivation of reasoning, analysis, and reflective capacity	Teaching tools and stages of problem-solving
Evaluation Method		Qualitative, based on intellectual coherence, meaning, and depth of analysis	Quantitative, based on success in resolving contradictions or creating technical innovation
Student Characteristics		Comprehensible at various levels, fostering analytical thinking	Requires basic technical knowledge, tools are harder to grasp for beginners

key criteria were identified for evaluating and comparing these two approaches. This framework can serve as a reference for instructors and curriculum planners in selecting or integrating effective teaching strategies in architectural education. Thus, this study contributes a comprehensive analytical and practical model aimed at enhancing the quality of architectural education and fostering students' abilities in problem-solving, critical analysis, and structured creativity.

CONCLUSION

The findings of this study reveal that neither TRIZ nor critical thinking alone can fully address the diverse educational needs of architectural design. By integrating and comparatively analyzing these two approaches, a three-layered framework was developed encompassing the dimensions of cognitive–philosophical, design process, and teaching–learning. Within

this framework, 17 key criteria were identified to enable a systematic and precise comparison. This framework not only provides an analytical tool for educators and curriculum designers but also supports the development of more flexible and structured pedagogical models. Ultimately, it contributes to cultivating students who combine systematic problem-solving and creativity with critical analysis and cultural reflection. In doing so, this research advances the quality of architectural design education and fosters convergence between technical innovation and human-centered perspectives in the learning process.

The study highlights two core competencies in architectural design education:

• Cognitive–Theoretical Competence: critical analysis, conceptual ideation, theoretical reflection, and contextual interpretation.

• Practical–Executive Competence: structured problem-solving, application of tools, and process management.

TRIZ primarily contributes to executive competence, whereas Critical Thinking develops theoretical competence. The research concludes that integrating both approaches provides a balanced model, strengthening students' capacity for systematic innovation and critical evaluation, and guiding education toward a comprehensive "thinking–doing" framework in architectural design. Figure 3 shows the architectural design capabilities.

Suggestions for Future Research

This study recommends an integrated model in architectural design education that applies TRIZ in the early stages for problem analysis and idea generation, and Critical Thinking in later stages for refinement and contextual critique. Instructors should flexibly shift between structured guidance and facilitation, while students learn to balance technical analysis with cultural–spatial reflection.

Future research may focus on:

1. Testing the integrated model in design studios at different academic levels.
2. Evaluating its effectiveness in improving design quality compared with other methods.
3. Examining cultural and local contexts, especially in Iranian universities.
4. Developing practical tools (guidelines, worksheets, software) to support this integration.

AUTHOR CONTRIBUTIONS

M. Abdolhamidi: Literature review, conceptualization, data curation, model training, validation, preparation of main manuscript, and editing. V. Fooladi, Z.Zarabadi: Supervision, Project administration, Formal analysis.

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CONFLICT OF INTERESt

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the authors have acknowledged the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy.

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