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Using the TRIZ Method in a Problem-Based Teaching Approach for Industrial Design Education Materials

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Abstract

Despite a four-decade history, industrial design education in Iran faces challenges in equipping students with essential problem-definition and solving skills. This deficiency is critical for cultivating creative designers capable of addressing contemporary societal needs. This study investigates the integration of the Theory of Inventive Problem Solving (TRIZ) and Problem-Based Learning (PBL) as a pedagogical framework to address this educational gap. The research explores how this combined approach can enhance students' problem-solving capabilities and deepen their engagement with real-world industry challenges relevant to Iranian society. Using a descriptive-analytical method, the study reviews TRIZ and PBL applications in global design education and proposes a model for their integration into university curricula. Findings indicate that the combined method clarifies the problem-definition process for students while preserving their creative capacities. This integrated approach can effectively improve their ability to identify and resolve complex societal problems, bridging the gap between academic training and professional practice.

Keywords

Industrial Design Education, TRIZ Method, Problem-Based Learning.

Introduction

Human history has been defined by an inherent capacity for creation and construction. Through the application of intellect, reason, and effort, humankind has consistently taken profound steps toward enhancing the experience of life. The defining characteristic of humanity is the ability to comprehend the surrounding world, identify improvement needs, and enact change for the betterment of oneself and others. It is this creative impulse that sustains human dynamism. In the contemporary era, however, the encounter with modernity has arguably attenuated this innate capability, distancing it from its essential origins. Consequently, a critical mission emerges: to conscientiously revitalize this faculty and transmit it to future generations. Universities play a vital role in society as creators and disseminators of knowledge (Pourang et al., 2015). A central component of any higher education system is the curriculum, which has an undeniable role in fulfilling the qualitative and quantitative objectives of academic institutions. Curricula, therefore, reflect the responsiveness and efficacy of universities in addressing the evolving needs of society (Hatami et al., 2016). A critical consideration in curriculum design is its efficacy and comprehensive relevance to students and their specific discipline. This proves particularly challenging in fields such as art and design, owing to the diverse cognitive and dispositional profiles of students and the disciplines' intrinsic connection to creativity and visualization. A persistent oversight in the pedagogy of applied arts, including industrial design, has been the failure to account for the evolving nature of the subject matter, resulting in homogenized and outdated teaching systems.

In industrial design, the professional landscape has undergone a significant transformation. A pedagogical approach focused solely on designing specific products as a means of skill development no longer adequately prepares students for professional practice; such a narrow focus distances students from the true essence of product design in a contemporary context. Today's rapidly changing society and industry require designers who possess strategic capabilities, the ability to plan, direct product development, and respond to multifaceted design challenges stemming from diverse fields, including environmental science and business planning. Therefore, the responsibility for cultivating such designers lies with educational systems and universities. This necessitates a pedagogical shift away from the mere accumulation and retention of scientific facts toward the acquisition of skills for solving real-world problems. This transition requires strengthening students' creative competencies, which serve as the essential tool for processing learned information and generating practical, viable solutions, a critical imperative for industrial design students as creative thinkers.

The acquisition of creativity, independent of innate talent, is achievable through various creativity-enhancing techniques and proper pedagogical management. Among these, the Theory of Inventive Problem Solving (TRIZ) is recognized as one of the most contemporary methods for improving creative thinking and problem-solving abilities, having been adopted by over 60 universities. Similarly, Problem-Based Learning (PBL) is a prominent strategy employed by leading institutions to foster effective learning, enhance students' self-efficacy in confronting real-world challenges, and strengthen their capacity for complex analysis and problem resolution. The present study aims to investigate the potential of integrating these two methodologies. By analyzing the affordances that TRIZ and PBL offer to students and instructors, this paper explores their combined application as a means of addressing the aforementioned pedagogical challenges and improving the curriculum in the field of industrial design.

Methodology

This study employs a qualitative paradigm with a descriptive-analytical research methodology. The initial phase of the research involved identifying and cataloging the existing needs and deficiencies within the industrial design educational framework. Subsequently, a review of relevant literature, including books and scholarly articles, led to the identification of two innovative pedagogical methods as potential solutions to the identified issues. The promising feasibility of effectively integrating these methods provided the impetus for the present study.

Literature Review

A body of research has addressed the foundational concepts of design education and the challenges inherent in teaching industrial design, including studies by Pourang et al. (2015), Fardanesh and Karami (2008), Chitsaz and Naeini (2021), Ahmad Nedaifard (2011), Adabi (2016), Hatami et al. (2016), Keshavarz and Rahgozar (2010), Garcia et al. (2020), and Meyer and Norman (2020).

Regarding the specific methodologies of interest, the Theory of Inventive Problem Solving (TRIZ) and Problem-Based Learning (PBL), numerous studies have been conducted. Merikhpour et al. (2021) investigated the effectiveness and impact of TRIZ on the ideation process of industrial design students, while Jalali and Fateminia (2020) highlighted the benefits of systematizing the design process for this student cohort. Further research by Naderi et al. (2021), Bahrami et al. (2021), Viskarami et al. (2019), Panikar et al. (2025), and Jabalameli et al. (2019) has explored the positive influence of TRIZ on the performance and efficacy of students across various disciplines, including architecture and engineering. In a related vein, Tandivar and Kafili (2020) examined the application and validity of TRIZ principles in commercially available ceramic products.

The efficacy of PBL in educational settings has been demonstrated by Imanipour et al. (2019), Vasili and Farajollahi (2015), Talaei and Salar (2015), Mohammadi et al. (2017), Yu (2024), Most et al. (2021), and Ata and Dogan (2021). Notably, the work of Darzi-Ramandi et al. (2019) specifically identified the positive impact of PBL on enhancing creativity.

However, to date, no research has investigated the synthesis of these two methodologies, TRIZ and PBL, for the specific purpose of reforming and enhancing industrial design education.

Creative Thinking in Design:

Creativity, as a multifaceted concept, lacks a single, uniform definition. In its specialized sense, the term is described as the emergence of something novel and useful. Given the breadth of this concept, scholars have variously defined it as a method for satisfying unmet customer needs; a way of performing tasks optimally by combining function, knowledge, and creativity; the act of introducing something new; an integration of innovation and risk-taking; or the generation of novel, original, and effective ideas for solving a problem (Merikhpour et al., 2021). Similarly, according to Cambridge Dictionary "creativity" is defined as the act of creating, originating, and bringing into existence.

All tangible and significant changes in contemporary society are products of human creative thought. Recognizing the critical role of creative and intellectual individuals as the primary capital of nations underscores the immense value of their contributions and their way of thinking (Bahrami et al., 2021). Torrance, a pioneering researcher in the field of creativity, posits that all individuals possess a creative talent that can be either nurtured or suppressed. Based on his 15 years of research, he asserts that creativity can be taught. He defines creative thinking as a process of sensing problems, identifying information gaps, forming hypotheses about these deficiencies, testing and evaluating these hypotheses, modifying and re-testing them, and finally, communicating the results (Viskarami et al., 2019; Darzi-Ramandi et al., 2019). Gardner, in turn, believes that a person is creative when they can solve or formulate a problem, or create products or concepts within a domain in a novel way that is accepted in one or more cultural settings

(Rahimi et al., 2014). Scholars contend that creativity can be defined along four main axes: thought, process, idea, and problem (Figure 1).

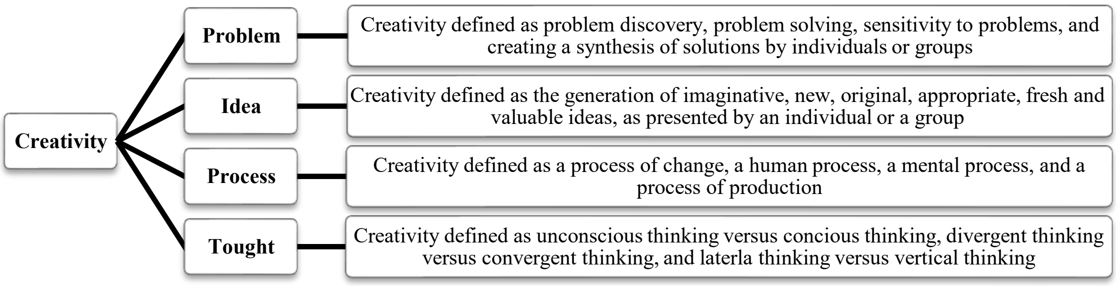

Figure 1: *Definition of creativity from the four perspectives of thought, idea, process, and problem (Tandivar & Kafili, 2020).*

In applied arts such as industrial design, the element of creativity is critically important as a tool for creating works, developing ideas, and achieving innovative solutions. Design is a complex process that originates in the designer's mind to solve a problem. It requires acquiring a wide range of information, integrating it into a cohesive set of ideas, and ultimately realizing the tangible form of those ideas. In design education courses, students are taught how to connect a design problem to a suitable solution by navigating a systematic framework of methodological rules. In essence, they learn to transform their empirical problem-solving process into a methodical one to arrive at a better answer (Jalali & Fateminia, 2020).

The ability to think correctly has been a significant concern for scholars throughout history, and the development of a wide range of thinking skills has now become a primary objective of educational systems. Thinking is the highest form of cognitive and mental activity, manifesting in highly complex human behavior. Among the various types of thinking, critical thinking stands out as one of the most important (Duron et al., 2006). The development of critical thinking skills has evolved over time and remains a desirable goal for students at all educational levels. In its simplest form, critical thinking is defined as the art of analyzing and evaluating thoughts with the aim of improving them (Todd et al., 2019). It is known as a systematic process of skillful reasoning and reaction, serving as a guide for deciding what to believe or what to do. Throughout the learning process, critical thinking determines how individuals process information, make decisions, and solve problems. Consequently, fostering critical thinking skills enables individuals to achieve sound outcomes and make informed decisions (Dwyer et al., 2014).

The ability for critical thinking does not develop in students merely through listening to lectures, reading textbooks, and taking exams without the active guidance of an instructor. Although it is widely recognized as a main pillar in education, the analysis indicates that current methods for teaching it suffer from limitations in several key aspects (Ericson, 2021). In solving industrial design problems, observing and analyzing an issue from multiple dimensions is a fundamental necessity. Achieving this comprehensive perspective requires acquiring critical thinking skills alongside creative thinking, as the analysis and identification of a problem are as important as solving it creatively.

According to Piaget's theory of cognitive constructivism, when individuals encounter a real problem, they experience a disequilibrium in their mental structures. This compels them to engage in intellectual effort to investigate information and examine the idea at hand. In doing so, they must alter their initial egocentric judgment systems and engage with the ideas of others, which leads to a transformation in their thinking skills and critical outlook. Problem-solving methods reinforce skills such as observation, inference, comparison, information organization, variable identification and management, hypothesis formulation and testing, analysis, and judgment, most of which are core components of critical thinking (Naderi et al., 2021).

The TRIZ Methodology for Creativity:

TRIZ represents a paradigm shift in problem analysis and is formally recognized as the Theory of Inventive Problem Solving. Originating from the systematic study of patents, it offers a structured framework that enables problem solvers to approach challenges creatively. Through a defined set of processes, TRIZ guides users toward generating innovative and effective solutions. (Dongna & Sharul, 2024). The word "method" is derived from the Greek Methodes, a combination of meta (meaning "shared") and odos (meaning "way"), and is thus known as "a shared way of doing something." A method is often regarded as a tool for achieving regularity, systematically classifying subjects, or performing an orderly procedure. The term "methodology," which was adapted from the word methodologia in the 18th century and is of more recent origin than "method," refers to the study of the logical structures of a method (Talaei & Salar, 2015). While various methods for increasing innovation exist, they are often based on intuition, with their central axis focused on breaking mental templates.

TRIZ is a practical, step-by-step approach to transforming a real problem into a better solution by transitioning a system from its current “is” state (what you have now) to a desired “should be” state (what you want). It focuses on identifying and resolving contradictions, as well as the trade-offs that hinder improvements, using a four-stage process called the MAI T-R-I-Z meta-algorithm. First, the Trend stage checks the situation and sets a clear goal. Next, the Reducing stage sharpens the problem into an Ideal Final Result (what the perfect solution would do) and frames the core contradiction that prevents that ideal. In the Inventing stage, you generate solutions systematically by applying proven transformation models or “navigators” drawn from a large catalog of past inventions. Finally, the Zooming stage tests and refines the chosen solution at different levels (the device itself, the user, society, etc.) to make sure it really works. The result is a repeatable, knowledge-based method for inventing smarter, less ad-hoc solutions (Orloff, 2017).

From the user's perspective, creativity techniques can be divided into three general categories: individual, group, and individual-group techniques (Table 1). Implementing the TRIZ framework as a means of fostering creativity and enhancing innovation skills in educational systems has gained significant popularity in recent years (Panikar et al., 2025).

Table 1: *Creativity Techniques (Merikhpour et al., 2021).*

Individual-Group creativity techniques	Group creativity techniques	Individual creativity techniques
Forced association	Ideatoon technique	Meditation
SCAMPER	Role Playing	Creative illusion
P.I.C.L	Storyboard	Do it, Do it Technique
P.M.I	T.K.J technique	Doodles
P.P.C	Dialectic technique	Creative Dream
Matrix analyzes	Delphi method	View with mind eyes
What if...?	Synetics	Solving the subconscious
TRIZ	Six thinking hats	Fishbone diagram
	Speculative excursion	Osborn’s Checklist
	Brain storming	
	Brain writing	
	Inverse brainstorming	
	Nominal group	

The word TRIZ is an acronym for the Russian phrase «Teoriya Resheniya Izobretatelskikh Zadach» which translates to "The Theory of Inventive Problem Solving." Accordingly, the TRIZ method can be understood as the theory for solving inventive or innovative problems (Jabalameli et al., 2019). In 1964, Genrich Altshuller, the creator of TRIZ, began his career as a patent expert in the Soviet Navy's patent office. During his time as an expert, Altshuller, along with Raphael Shapiro, examined registered inventions and identified recurring patterns used in innovations. These patterns revealed solutions for resolving contradictions, each demonstrating a repeatable evolutionary path (Tandivar & Kafili, 2020; Gadd, 2016). Altshuller's discovery challenged the claims of scientists who favored conventional solutions by introducing three key elements: 1) the systematization of design evolution, 2) the concept of ideality, and 3) forty inventive principles used in innovations, which together represent a powerful intellectual framework for creativity and innovation (Tandivar & Kafili, 2020).

Based on the analysis of over 40,000 patents, Altshuller found that the strategies and solutions applied to creative problems in one field were frequently adopted and utilized by inventors in many other domains. From this collection of 40,000 patents, he successfully distilled 1,201 standard engineering problems, which he termed "contradictions," and then defined forty core solutions for these contradictions, naming them the "inventive principles" (Viskarami et al., 2019). He defined an inventive problem as one that contains at least one contradiction. Understanding contradictions is essential when dealing with genuinely difficult problems for which a solution is not apparent. A contradiction refers to a situation where there is a conflict in what you want; you either desire the opposite of what you want, or any attempt to improve one feature of a system degrades another. In other words, improving parameter A leads to the worsening of parameter B. For example, increasing a car's acceleration reduces its fuel efficiency (Gadd, 2016; Tandivar & Kafili, 2020).

The TRIZ problem-solving philosophy posits that when solving a specific problem, similar issues have often already been solved by someone else somewhere in the world. Therefore, an individual should find the solution to their problem by searching through the global database of inventions and innovations. To this end, TRIZ provides tools for resolving contradictions, which include: analyzing conflicts, improving the ideality of the final result, predicting problems and their associated solutions, and forty inventive principles that, through the contradiction matrix, can solve problems (Karbassian & Mirbagheri, 2014).

One of the primary tools that TRIZ offers designers is the contradiction matrix. Familiarity with this matrix allows for a thorough examination of a problem. After identifying the worsening and improving parameters that create the contradiction, designers can identify the appropriate principle for this conflict and use the matrix to solve problems efficiently. Thus, using the TRIZ method requires industrial designers to recognize evident design contradictions and the relationship between the innovation principles and the problem at hand (Dumas, 2016). The contradiction matrix is a 39x39 grid where, at the intersection of each row and column, there are 3 or 4 inventive principles from the 40 identified in TRIZ. In total, this matrix presents users with 40 principles to resolve 1,482 types of contradictions identified in the methodology (Stratton & Mann, 2003).

When used in innovative processes, the TRIZ method seeks to reduce the time required for invention by transforming specific problems into general ones, rather than relying on trial and error (Viskarami et al., 2019). By learning to view both problems and solutions more generically, one can see how their problems are similar to others' and then move toward reapplying those intelligent solutions to their own situation. When you think more generically, it becomes easier to see how to reuse proven knowledge. In TRIZ, this approach is referred to as "moving around the TRIZ prism" (Figure 2) (Dumas, 2016). What distinguishes the application of this method in the product design process is its systematic and knowledge-driven nature, as it provides access to the validated and innovative solutions of past inventors as a source of inspiration for ideation and a structure for resolving contradictions within an idea.

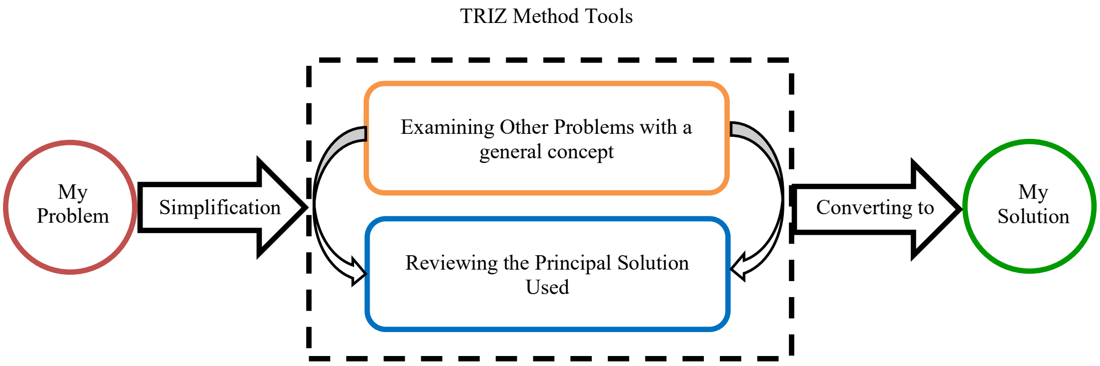

Figure 2: *Schematic diagram of problem-solving using the TRIZ method (The Authors, 2025).*

In recent years, empirical studies have demonstrated the effectiveness of TRIZ-based methods in guiding innovative product and service design processes within academic settings. For example, Yang (2023) applied a TRIZ-based framework to a university design project that developed a Fresh Flower Product–Service System, integrating online and offline user experiences to resolve design contradictions systematically. The study confirmed TRIZ's potential to facilitate creative ideation and structured innovation in educational design contexts (Yang, 2023).

Problem-Based Learning (PBL):

In the history of modern education, the emphasis on cultivating a creative and inquisitive spirit through Problem-Based Learning (PBL) can be traced to the philosophies of John Dewey and William James. A problem arises when an individual, encountering a situation, cannot formulate an adequate response using their existing knowledge and skills. The problem-solving method is an active learning approach consisting of five stages: defining and identifying the problem, gathering information, forming a preliminary conclusion, evaluating and testing the results, and making a decision based on those results (Darzi-Ramandi et al., 2019).

Problem-Based Learning was first introduced in 1969 at the medical school of McMaster University in Hamilton, Canada, and has since gained considerable popularity. Today, universities and colleges worldwide employ this method as a primary teaching approach across numerous disciplines (Moust et al., 2021). Project-based learning (PBL) is a student-centered approach where learners work on real and complex problems over time. It builds knowledge through inquiry and collaboration while also developing creativity, critical thinking, and problem-solving. By focusing on active exploration instead of passive listening, PBL motivates students and prepares them to face real-world challenges (Yu, 2024).

The method is founded on three essential pillars: problem clarification, which promotes active understanding; the activation of prior knowledge through the process of engaging with the problem; and the generation of questions that arise from the problem, creating a need to gather more information. In this approach, students are divided into learning groups of six to ten. During their first meeting, the group is presented with a problem as the starting point for learning before receiving any formal course content. Under the instructor's supervision, they discuss the problem and conduct an initial analysis based on their prior knowledge. This analysis leads to questions regarding ambiguous aspects of the problem, which are then established as objectives for self-directed learning. Students subsequently work individually or collaboratively to meet these objectives by reading books and articles, watching videos, and consulting with professors. Following this self-study phase, students report their findings to the group, sharing what they have learned to collectively assess the extent to which their understanding of the problem has improved (Figure 2) (Moust et al., 2021).

In this process, the instructor acts as a consultant, facilitator, and guide. They address gaps and ambiguities by recommending necessary resources, summarizing the discussion, and only rarely delivering formal lectures (Imanipour et al., 2019). As Ata and Dogan (2021) argue, the studio environment embodies a multi-layered system of social, cultural, material, and temporal components that collectively shape students' learning. Within this framework, the design problem is not treated as an individual task but as a communal challenge addressed collaboratively by students and instructors through interactions with tools, spaces, and traditions. The instructor's role is thus reconceptualized from that of a dominant authority to a facilitator who helps structure and regulate these interactions, enabling richer opportunities for both critical reflection and creative exploration. Furthermore, PBL does not require a large number of instructors to manage the groups, allows more students to be taught in a shorter period, and avoids imposing a significant financial burden on the institution. The application of this method in design sessions helps students develop a deeper understanding of the design problem. By thinking critically about its various elements, they can simplify the problem, thereby increase their productivity when use ideation techniques such as TRIZ.

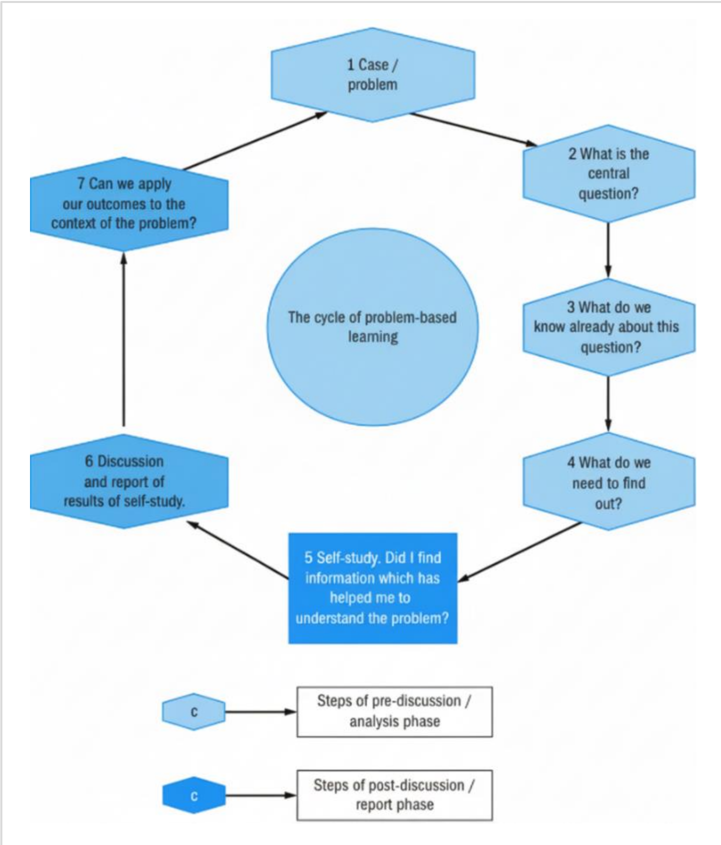

Figure 3: *The learning process in Problem-Based Learning (PBL) (Moust et al., 2021).*

Results:

Industrial Design Education and the Use of Modern Methods:

Industrial design is the discipline concerned with the principles of designing products, environments, systems, and services. It addresses aesthetic aspects and ease of use while integrating criteria such as ergonomics, manufacturing, material selection, innovation, durability, assembly, economics, maintenance, corporate identity, environmental impact, and added value. Throughout the design process, students engage in ideation through elements like combination, modification, creation, redesign, substitution, improvement, refinement, sudden insight, and comparison. In turn, the instructor evaluates and processes these ideas from a critical perspective. A significant challenge in teaching these courses is the lack of standardized resources for instruction, leading to a reliance on the master-apprentice relationship for the comprehension and transfer of concepts. While instructors strive to apply different teaching methods based on their knowledge and experience, the general process remains largely uniform (Pourang et al., 2015).

The most established method for teaching core applied arts courses is traditional studio-based instruction, where students are given projects and focus on solving the problems inherent within them. The design studio is central to many industrial design degree programs. In this setting, students learn through a conventional process that begins with receiving a problem statement from the educational system, which outlines a design topic. Some of these problem statements are so dated and entrenched that a standard set of instructions could be issued for them at any university. To guide students through the design process, dialogue between the instructor and students about the nature of design, along with questions and answers regarding the expected features of the product, remains one of the most crucial tools for a thorough and thoughtful examination of the problem. However, because this approach is instrumental, based on viewing design as a mere science, and inefficient for solving creative problems, a certain bias is often observed in students' work. This manifests as the selection of a method based on an attachment to a specific style or the imitation of a famous industrial designer, which shapes the student's development without proper assessment and evaluation.

A primary concern for the educational system today is the growing mismatch between university instruction and societal needs; it appears that the curricula used in universities have little practical application in the real world (Chitsaz & Naeini, 2021). The mission of any educational system is to produce graduates with scientific insight who are both creative and critical thinkers. This goal cannot be achieved by merely transferring information. Instead, it requires incorporating methods into the curriculum that teach learners how to learn through a structured intellectual framework that they can apply in their lives. Given the prevailing methods in educational environments and their role in student development, these spaces must be organized to engage learners with the real-world problems they will face, rather than encouraging the mere accumulation of scientific facts. Therefore, when teaching creativity methods to industrial design students, it is of paramount importance to ensure the practical application of these methods for generating and developing new design ideas within the context of course projects. A superficial introduction to a method and its potential applications is insufficient (Naderi et al., 2021; Merikhpour et al., 2021).

In the contemporary world of industrial design, what distinguishes a designer is the ability to provide creative and optimal solutions. The problems facing Iranian society today generally lack predetermined solutions, necessitating the integration of creativity into the design and ideation process. The use of the TRIZ problem-solving method introduces students to a structured and novel way of thinking. Alongside its logical and knowledge-based framework, TRIZ stimulates their creative faculties by challenging them to apply its proposed tools and principles, thereby questioning their design perspectives throughout their education. This represents the intersection and bidirectional relationship between TRIZ and creativity: using TRIZ fosters the development of a student's creative mind, while cultivating creativity enhances their problem-solving skills and enables a more effective use of TRIZ tools (Bahrami et al., 2021; Merikhpour et al., 2021).

Furthermore, using the PBL method as a framework for defining problems and engaging students' analytical abilities strengthens their critical thinking. According to Glasser, critical thinking comprises three essential elements: an inclination to thoughtfully consider problems within the scope of one's experience, knowledge of the methods of logical inquiry and reasoning, and the skill to apply these methods. The PBL stages of problem clarification and question formulation necessitate the analysis and interpretation of the given problem, which reinforces these elements. Simultaneously, the TRIZ process of identifying design contradictions and applying the corresponding principles demands the skills of interpretation, analysis, and inference that are inherent to critical thinking (Naderi et al., 2021). Therefore, the concurrent instruction of TRIZ and PBL cultivates both creativity and critical thinking (Figure 3).

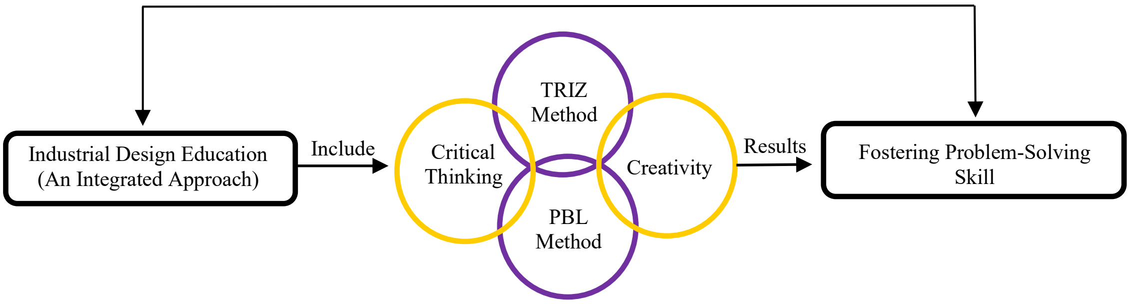

Figure 4: *Conceptual Model of the Research Elements (The Authors).*

Empirical evidence also supports the feasibility of TRIZ-based methods in academic design contexts. For example, Yang (2023) demonstrated a TRIZ-based framework for developing a Fresh Flower Product–Service System within a university design project. That study illustrated how TRIZ principles can structure the design process, helping student teams identify contradictions and generate innovative service concepts in real-world contexts. While the focus there was on applied design outcomes, the present study extends this direction toward pedagogy, emphasizing how TRIZ, when integrated with Problem-Based Learning (PBL), can guide students' learning processes and cognitive development in design education.

From a curricular perspective, the undergraduate program in industrial design features more practical and experimental courses compared to the master's and doctoral levels, making it a more suitable platform for teaching creative problem-solving methods. At this level, the practical courses designed to familiarize students with design projects consist of eight main projects, with the final project taking the form of a thesis. Given its problem-based nature, the integrated TRIZ and PBL method can be implemented in both theoretical and practical units. It is proposed that this combined method be structured into three-hour sessions and integrated into all design projects through diverse and wide-ranging problems, replacing the repetitive and limited topics of the past.

In this model, the instructor would present multiple problems derived from the real needs of society. After students are divided into groups and select a problem of interest, the instructor provides relevant resources. Students then use their critical thinking skills to analyze the problem statement and, under the instructor's supervision and guidance, formulate and share their questions. Through group discussion sessions, they derive outputs relevant to the problem. Subsequently, using the TRIZ method, students redefine the concepts from these PBL outputs as new problems. At this stage, students select some principles from the forty inventive principles of TRIZ and, in consultation with the instructor, use the contradiction matrix for ideation. As a result, they transform the outputs from the PBL phase into creative and viable design concepts (Figure 4).

In this method, interaction between students and the instructor is essential. Each student's approach to research and their intellectual framework is unique; therefore, through the instructor's guidance and their understanding of each student's strengths and weaknesses, a tailored learning model is developed for every individual. As Swanson (2020) notes, "There is no single, correct path for all designers."

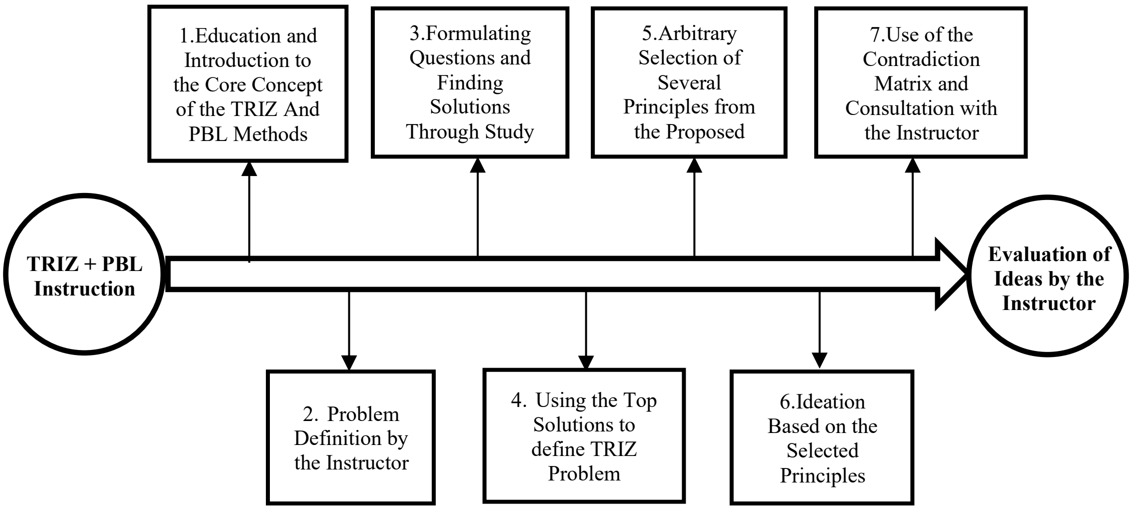

Figure 5: *Conceptual Model for Instructing the Integrated TRIZ and PBL Method (The Authors).*

Conclusion:

Despite the four-decade history of industrial design education in Iran and the extensive revisions made to its curriculum, fundamental deficiencies persist within the pedagogical structure of the discipline. Today's industrial design students are often equipped with yesterday's knowledge to address tomorrow's problems. In an information age where access to knowledge is facilitated by the powerful tools of the internet and technology, students require innovative methods that not only strengthen their thinking about contemporary societal issues but also leverage their technological capacity to solve complex challenges.

The integrated use of the TRIZ and PBL methods offers a creative yet systematic process, encompassing personal inquiry, problem clarification, question formulation, knowledge acquisition, and ultimately, the reframing of solutions as new problems for the TRIZ method under instructor supervision. This combined approach serves as a compelling alternative to conventional teacher-centered, student-centered, or curriculum-centered models. As illustrated (Figure 4), the implementation of this integrated method is feasible in both practical and theoretical course units, providing a robust framework for students to develop analytical capabilities and confront a wide range of problems. Furthermore, the authentic and tangible nature of the problems presented in the PBL method, which mirror those students will encounter in a professional setting, allows instructors to identify the unique strengths and weaknesses of each student. By properly guiding the self-directed learning process, instructors can prepare students for industry, thereby enhancing the liaison between academia and the professional world.

Moreover, the integration of these two methods within course units strengthens students' creative and critical thinking faculties. This not only has a significant impact on their self-efficacy and their ability to conduct multifaceted observation and evaluation, but it also fosters the development of unique personal frameworks that equip them with the skills to manage and solve problems in their personal lives. All the aforementioned concepts, creative thinking, critical thinking, and the proposed methods serve the overarching goal of enhancing problem-solving capabilities in students, as facilitated by industrial design instructors (Figure 3).

Instructing this integrated method requires educators to possess managerial and social skills, as well as a profound understanding of their students; the responsibility for correct implementation and comprehensive supervision rests with them. If the educational environment is viewed as a factory, it is the instructor who, through their chosen pedagogical approach and interpersonal skills, determines the success or failure of its components. Consequently, the adoption of these novel methods necessitates not only the empowerment of students but also the training and preparation of instructors to effectively address student uncertainties and errors.

Previous research has shown that TRIZ can effectively support systematic innovation in design projects (Yang, 2023). Building upon such practice-oriented evidence, this study contributes by outlining a conceptual model for embedding TRIZ within educational practice, paving the way for future empirical investigations into its pedagogical impact.

The purpose of this research was to analyze two innovative methods used in academia worldwide and to synthesize them into an effective approach that aligns with the industrial design curriculum in the nation's universities. A topic that warrants further investigation is the establishment of criteria for evaluating and judging student ideas in a manner consistent with the TRIZ method; this is a substantial area of inquiry that requires a separate study.

References

Ata F. Z., & Dogan F. (2021). Architectural design studio as an "extended problem space." In E. Bohemia, L. M. Nielsen, L. Pan, N. A. G. Z. Börekçi, & Y. Zhang (Eds.), *Learn X Design 2021: Engaging with challenges in design education* (pp. 746–755). DRS Digital Library. 10.21606/drs_lxd2021.05.159

Bahrami, N., Hosseini Al-Madani, S. A., Motevalli, S., & Khoini, F. (2021). The effectiveness of creative problem-solving training using the TRIZ method in promoting problem-solving skills, with an emphasis on the mediating role of critical thinking and sense of school belonging. *Innovation and Creativity in Humanities, 11*(1), 161–188.

creativity. (n.d.). In *Cambridge Dictionary*. Retrieved December 27, 2025, from https://dictionary.cambridge.org/dictionary/english/creativity

Chitsaz, S., & Sadeghi Naeini, H. (2021). The master-apprentice teaching approach: The missing link in industrial design education and the university-industry connection. *Rahpooye Honar / Visual Arts Journal, 4*(3), 75–83. https://doi.org/10.22034/ra.2021.535153.1083

Darzi-Ramandi, H., Yousefi-Ramandi, F., & Darzi-Ramandi, M. (2019). The effect of the problem-solving teaching method on creativity. *Research in Curriculum Planning, 2*(36), 163–172. https://doi.org/10.30486/jsre.2019.550743

Dongna, L., & Sharul, A. B. S. (2024). Investigation of the Effectiveness of TRIZ Invention for Enhancing Design Creativity in High School Students: The role played by teacher self-efficacy. *South Asian Journal of Social Sciences and Humanities*, *6*(6), 152-175. https://doi.org/10.48165/sajssh.2024.5511

Dumas, D., Schmidt, L. C., & Alexander, P. A. (2016). Predicting creative problem solving in engineering design. *Thinking Skills and Creativity, 21*, 50–66. https://doi.org/10.1016/j.tsc.2016.05.002

Duron, R., Limbach, B., & Waugh, W. (2006). Critical thinking framework for any discipline. *International Journal of Teaching and Learning in Higher Education, 17*(2), 160–166.

Dwyer C. P., Hogan M. J., & Stewart I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity, 12*, 43–52. https://doi.org/10.1016/j.tsc.2013.12.004

Ericson J. D. (2021). Mapping the relationship between critical thinking and design thinking. *The Review of Education, Pedagogy, and Cultural Studies, 43*(2), 154–179. https://doi.org/10.1007/s13132-021-00733-w

Gadd K. (2016). *TRIZ* for dummies. *John Wiley & Sons.* ISBN: 978-1-119-10748-4

Hatami J. et al. (2016). Industrial design curriculum requirements in Iran. *Journal of Visual and Applied Arts, 9*(18), 123–147. https://doi.org/10.30480/vaa.2017.408

Imanipour et al. (2019). Problem-Based learning approach in medical education in Iran: A systematic literature review. *Iranian Journal of Nursing Research, 14*(3), 1–9. https://doi.org/10.21859/ijnr-14301

Jabalameli, M., Mozafar, F., Ghasemi, V., & Karimi, M. (2019). Using TRIZ functionality in architectural design process. *Journal of Fine Arts: Architecture & Urban Planning, 23*(3), 83–94. https://doi.org/10.22059/jfaup.2019.263204.672083

Jalali, V., & Fateminia, M. (2020). An exploration of the design methods adopted by industrial design students before and after academic educations. *Journal of Fine Arts: Visual Arts, 25*(1), 135–142. 10.22059/jfava.2019.270482.666089

Karbassian, M., & Mirbagheri, S. M. (2014). Designing a model for enriching the productivity cycle using the TRIZ approach. *Police Organizational Development Quarterly, 11*(49), 11–40.

Merikhpour, Z., Chopankareh, V., & Samiei, S. (2021). Evaluation the effect of applying TRIZ method on creativity and conceptualization of product redesign training by industrial design students. *Iranian Journal of Engineering, 23*(89), 65–85. 0.22047/ijee.2021.247595.1777

Moust J., Bouhuijs P., & Schmidt H. (2021). Introduction to problem-based learning (4th ed.). *Routledge.* ISBN 9789001877866

Naderi M., Safari A., & Gheshlaqi S. (2021). The TRIZ problem solving skills on creative and critical thinking skills of the elementary students in district 5 of Tehran, Iran. *Journal of Educational Studies, 7*(22), 77–96. 20.1001.1.27172260.1400.7.22.6.4

Orloff, M. A. (2016). ABC-TRIZ: introduction to creative design thinking with modern TRIZ modeling. *Springer, Switzerland.*

Panikar, P., Milligan, C., Al Bulushi, A. H., Rizwan, S. M., & Al Balushi, N. (2025). Empowering future innovators: a triz-integrated design thinking approach to engineering prototyping and entrepreneurship in Oman. *International Journal of Learning, Teaching and Educational Research, 24*(2), 322–351. https://doi.org/10.26803/ijlter.24.2.17

Pourang, H., Haji Mohammadzadeh, Y., & Sadeghi Naeini, H. (2015). The role of practical student projects in effective engineering education (Case study: Industrial design). *Proceedings of the First International Conference and Fourth National Conference on Engineering Education*, Shiraz University, 1–6. https://civilica.com/doc/433723/

Rahimi, H., Yazdkhasti, A., & Hassanpour, R. (2014). An analysis of the relationship between multiple intelligences and creative thinking among students. *Journal of the Center for Studies and Development of Medical Education, 11*(3), 350–359.

Stratton, R., & Mann, D. (2003). Systematic innovation and the underlying principles behind TRIZ and TOC. *Journal of Materials Processing Technology, 139*, 120–126. https://doi.org/10.1016/S0924-0136(03)00192-4

Swanson, G. (2020). Educating the designer of 2025. *She Ji: The Journal of Design, Economics, and Innovation, 6*, 101–105. https://doi.org/10.1016/j.sheji.2020.01.001

Talaei, A., & Soleimani Salar, R. (2015). A new strategy for architectural design education using the PBL method. *Proceedings of the International Conference on Research in Engineering, Science and Technology. https://civilica.com/doc/398592/*

Tandivar, S., & Kafili, N. (2020). The function of TRIZ in detecting Innovative Design in contemporary applied ceramics of Iran. *Journal of Fine Arts, 25*(3), 99–110. https://doi.org/10.22059/jfava.2019.245135.665800

Todd, C. L., Ravi, K., & McCray, K. (2019). Cultivating critical thinking skills in online course environments: Instructional techniques and strategies. *International Journal of Online Pedagogy and Course Design, 9*(1), 19–37. https://doi.org/10.4018/IJOPCD.2019010102

Viskarami, H., Beyranvand, Z., & Beyranvand, Z. (2019). The effectiveness of TREZ training on the philosophical mindfulness and metacognitive strategies of girl students. *Advances in Cognitive Science, 21*(4), 128–141. 10.30699/icss.21.4.128

Yu, H. (2024). Enhancing creative cognition through project-based learning: An in-depth scholarly exploration. *Heliyon, 10*(3), e27706. https://doi.org/10.1016/j.heliyon.2024.e27706

Yang, W. (2023). Fresh flower product–service systems designed with TRIZ-based method. *Journal of Design Thinking*, *4*(2), 203–218. https://doi.org/10.22059/JDT.2024.377558.1124