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Effectiveness of TRIZ Invention for Enhancing Design Creativity in High School Students: The role played by teacher self-efficacy

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ABSTRACT

As education systems evolve to prepare learners for the challenges of the 21st century, there is an earnest need for a holistic educational approach that embraces creativity, innovation, and empowers both teachers and students to offer new insights and creative ideas to survive in the future era. For this purpose, there are different pedagogical interventions such as TRIZ can bring many incumbent benefits and prosperities in the educational context. However, China has a slow pace towards this beneficial strategy and the major reason behind this factor is their conventional conceptions and resistance of teachers and others to embrace new technology. Therefore, this study has proposed a conceptual framework where the study has illuminated previous literature associated with TRIZ, design creativity, teachers' efficacy and the challenges associated with TRIZ. The study followed a review strategy and explored the last 5 years' papers to gather relevant empirical information from the research. In conclusion, the study has shared that TRIZ is a radical systematic approach that is a great opportunity for educators and policymakers to transform the Chinese educational system and equip educators and students with design creativity and problem-solving skills. However, this beneficial intervention strategy is confined to different conventional challenges and issues as resistance to innovation.

Keywords: TRIZ methodology, Design creativity, Teacher self-efficacy, Creative problem-solving, China.

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INTRODUCTION

Creative design competencies are crucial drivers of innovation, enabling the development of original products, services, processes, and strategies that add novel value for organizations and communities (Kodirova, 2020; Mazla et al., 2020; Petrikova et al., 2015). Design creativity represents a critical mode of thinking and expression that involves conceiving groundbreaking ideas, exploring possibilities, and actualizing inventive concepts to address real-world needs. It encompasses abilities like divergent thinking, envisioning alternatives, intentional risk-taking, and reflecting critically on the design process. Design creativity draws on imagination, empathy, non-linear ideation, and astute observation (Corry & Stella, 2018; Gong et al., 2022). To equip the next generation with these essential design creativity capacities, educational systems must nurture creative potential in students and provide opportunities to apply inventive design practices.

Recent years have seen growing curiosity in creativity within the confines of education, this curiosity also underlies the presumptions that creativity is a necessary ability in a world growing more complex, uncertain, and changing; that creativity can be developed; that educational settings are appropriate environments for that purpose. Moreover, numerous researchers have connected the rise of creativity in educational settings with economic and cultural success (Hernández-Torrano & Ibrayeva, 2020). However, China's education system is renowned for its rigorous academic standards and high achievement levels, it has often been criticized for stifling creativity (Chien & Hui, 2010; Pang & Plucker, 2012; Powell, 2015). The emphasis on standardized testing, rote memorization, and uniformity has left little room for students to develop and express their creative potential. This rigidity has sparked concerns about the system's ability to prepare students for the 21st century, where adaptability, innovation, and creative problem-solving are imperative (Lockette, 2012; Tang et al., 2022; Yuan & Sriraman, 2011).

For this purpose, teacher self-efficacy has been corroborated as the key attitudinal factor impacting instructional quality, adoption of innovations, and student learning (Corry & Stella, 2018; Glackin & Hohenstein, 2018; Pressley & Ha, 2021). Teachers with robust self-efficacy approach difficulties as surmountable through effort and strategy rather than seeing them as out of their control (Barton & Dexter, 2020; Burić & Kim, 2021; Colson et al., 2017). They feel confident in their instructional skills and resourcefulness to meet all students' needs. High teacher self-efficacy manifests in greater openness to new methods, a willingness to

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experiment, resilience in the face of failure, and persistence in motivating struggling learners. On the other hand, teachers with lower self-efficacy may rely more on rote pedagogies, avoid trouble spots, criticize students' deficits, and give up on students more easily (Algarni & Lortie-Forgues, 2023; Colson et al., 2017; Tasadduq et al., 2021). They feel less assured in their capacity to influence student outcomes. Therefore, higher education institutes must emphasize the teachers' efficacy enhancement to keep a unified system of teaching and flourish the students' design creativity.

To address this deficiency among teachers and students, the literature has highlighted a unique concept or strategy known as TRIZ. This technique has been shown to be an effective intervention for increasing teachers' self-efficacy. The Theory of Inventive Problem Solving (TRIZ) framework can help to promote educational creativity by offering disciplined techniques to address problems. TRIZ presents a systematic methodology for nurturing creative problem-solving that holds (Belski, 2019; Cano-Moreno et al., 2021) TRIZ, an acronym for the Russian phrase "Theory of Inventive Problem Solving", was developed by the Soviet inventor and researcher Genrich Altshuller in the 1940s (Al-Jaafreh, 2020; Siddiqua et al., 2023; Sojka & Lepšík, 2020). TRIZ provides tools and techniques for deliberately fostering the cognitive processes underpinning creative thinking and design (Belski, 2019; Ilevbare et al., 2013). The TRIZ framework is built on several key premises that align with the foundations of design creativity (Chechurin, 2016; Moehrle, 2005; Mohammadi et al., 2022). TRIZ equips learners with a toolkit of cognitive techniques, creative heuristics, and visual tools to drive innovative problem-framing and solution-finding (Kaliteevskii et al., 2021; Schöfer et al., 2015; Yilmaz et al., 2016).

Despite this vital proficiency of TRIZ in providing such brilliance to teachers' self-efficacy and a positive push to critical thinking of students, this proposed intervention is vaguely theoretical rather than grounded in students' developmental needs. Secondly, the applicability and efficacy of structured creative problem-solving frameworks like TRIZ in high schools remain under-researched, although research elsewhere shows promise. There are limited studies that have delved into concrete pedagogical strategies and methodologies for enhancing creative thinking in the Chinese context specifically (Barak & Yuan, 2021; X.-x. Liu et al., 2021; Liu et al., 2015; Marcos et al., 2020), but the proposed ideology has been identified as missing in the empirical aspect. Deficient creative education gives rise to multifaceted issues, including hampering student well-being, economic competitiveness, social progress, and innovation capacity.

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Research-backed approaches to systematically nurture youth creativity are thus profoundly needed. Therefore, this study responds by assessing a TRIZ-based creative design intervention for high school students and highlighting the challenges associated with the pedagogical intervention in the system. Therefore, this study offers an important empirical investigation of the potential for structured creative problem-solving methodologies to catalyse educational evolution towards human-centric futures that value imaginative skills. Insights generated could inform policies and teaching practices to cultivate creativity within schools to equip new generations for the complex 21st-century landscape.

METHODOLOGY

This study adopted a review style approach in which the relevant literature and information were scanned to analyse the impact of TRIZ in enhancing the design creativity of students and the teachers' self-efficacy. To gather specific information related to the defined topic, some defined queries were entered into the search engine of the databases. The primary databases were "Web of Sciences", "Scopus" and "Google Scholar". Moreover, "TRIZ", "Design Creativity", "Students' Design Creativity", "Teachers' Self-Efficacy" and "TRIZ Intervention" were used as the main key terms to gather the relevant literature. Other than these key terms, the Boolean operators such as "AND", "OR", brackets as "()", and colons "" were also incorporated to combine and emphasise the key terms and get more accurate information as relevant literature. As per the time frame was concerned, the researcher used a confined tenure of 5 years and used the time limit of 2019 to 2024 to report the latest insights, implications and research studies. But, specifically for the literature exploration for TRIZ, the researcher didn't define any time limit as there is very limited enlightenment on this variable as per the researcher's knowledge. The other empirical literature materials as books, theses and other discussions were not considered in this study as they didn't fit the standard or criteria of research articles and papers.

Theoretical Foundation of Constructivist Learning Theory

Constructivist learning theory by Dewey et al. (1997), developed by influential theorists, has played a pivotal role in shaping modern education. Just like individuals construct fresh knowledge through assimilation and accommodation, students actively participate in creative design tasks to enhance their skills. In the context of design, assimilation may entail integrating novel creative concepts into existing frameworks, underscoring the need to identify and correct

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misconceptions that impede creativity. In this process, teacher self-efficacy assumes a critical role, resembling the teacher's function in supporting and directing students' creative learning journeys.

This theory posits that learners actively build their knowledge and understanding of the world by drawing upon their prior experiences and interactions. In the context of enhancing design creativity among high school students through the use of TRIZ and considering the significance of teacher self-efficacy, constructivism offers valuable insights into how students can effectively acquire and apply creative design skills.

Constructivist learning theory encompasses several core principles that are highly applicable to this study

Active Learning

Constructivism posits that learning is an active process. It highlights the importance of students' engagement in activities that demand critical thinking, problem-solving, and creativity. To foster design creativity, this implies that students should actively participate in creative tasks and design challenges rather than passively receiving information. According to this, the student directly participates in the process. Hence, contrary to the traditional system of education where learners are presented with knowledge and required to absorb it, constructing meaning involves learners engaging in processes like problem-solving, experimenting, and discussing with their counterparts. This way of teaching promotes enhanced understanding since students have to relate the new lessons to prior learning (Lombardi et al., 2021). Strategizing or integrating implies students participate in assignments and group activities that demand them to employ knowledgeable skills. This process is beneficial to learners in a way that information is retained and applied much better; it also moves from information receiving mode to involve learners in the process. Active participation with the material takes the students from passive receivers of knowledge to problem solvers and improves the chances of the student's ability to generalize knowledge from one learning situation to the other (Özer, 2020). As a form of instruction, active learning can manifest in following categories, which are group activities, debates and simulations and case studies, which make it possible for students to learn in ways which comprise questioning and construction of the meaning of content in an energizing manner.

Social Interaction

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Another fundamental aspect of constructivism is the role of social interaction in the learning process. According to Vygotsky's sociocultural theory discussed by Rahmatirad (2020), learning is inherently a social endeavour, and students benefit from interacting with peers and individuals who possess greater knowledge, such as teachers. In the context of TRIZ and design creativity, collaborative projects and discussions can stimulate creativity as students exchange ideas, receive feedback, and learn from one another. Gricean principles of conversation are essential to the constructivist learning theory because learning is assumed to be social by nature (Sarasua, 2022). This knowledge-building process occurs in social contexts like peers teachers and other members of the community so that learners more constructively acquire knowledge. Social interaction aids in presenting ideas, opinions, and feedback to the community, which in turn assists in the enhancement of thought procession and comprehension. The sociocultural framework goes to the extent of valuing social interaction as a way of building learning since learners construct their knowledge through what they discuss among themselves (Alkhudiry, 2022). This principle calls for the grouping of students, discussions as well as peer teaching in the classroom. Besides knowledge, it is important to focus on the social interaction process that learners take during communication, negotiation, and interpersonal interaction. Unlike the approach of putting forward your ideas to get feedback from the teacher or the lecture, in social learning every student works together with the others to enhance the collective knowledge of the class.

Prior Knowledge

Constructivist theory emphasizes the significance of prior knowledge and experiences in shaping new learning. Students bring their existing knowledge and beliefs to any learning situation, and this prior knowledge affects how they interpret and incorporate new information. In the context of design creativity, it's crucial to acknowledge students' prior experiences and encourage them to build upon their existing design skills, thus enhancing their creative abilities. The application of prior knowledge is well captured in constructivist learning theory which postulates that learning occurs on the background of previous knowledge. This principle holds that the new knowledge that learners acquire is explained and understood concerning what the learners already possess (Brau, 2020). This principle can also be explained by the idea that the obtained knowledge acts as a platform for future information analysis and the inculcation of new ideas. Constructivist educators understand that it is indeed true that every learner comes with his or her own experience hence he or she interprets knowledge differently (Jayasinghe,

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2021). One of the most common instructional approaches denotes the evaluation of students' previous knowledge and interaction between new information and the learner's knowledge subsystems. In this approach, the learners are associated and built on what they already know so that it is easier and more meaningful for them to learn. Thus, recognizing prior knowledge is crucial to make particular adjustments in the process of students' education in which the goal is to increase learners' interest in the subject being taught and, therefore, the efficiency of the learning process.

Zone of Proximal Development (ZPD)

Vygotsky's concept of the Zone of Proximal Development (ZPD) holds a central place in constructivist theory (Moll, 1990). It refers to the disparity between what a learner can achieve independently and what they can accomplish with guidance and support. Teachers play a vital role in supporting students' learning, providing the necessary support and challenges to help them attain higher levels of competence. In the context of TRIZ and design creativity, teachers can support students' creative thinking and problem-solving processes, incrementally guiding them to tackle more complex design challenges. Vygotsky's sociocultural theory has several concepts, of which Zone of Proximal Development (ZPD), as mentioned earlier, is critical indicating the tasks that a learner can perform with support but cannot complete on his own. The ZPD is the distance between the level at which the learner is capable of working unassisted and the level at which the learner can perform working with a knowledgeable adult (Alghamdy, 2024). This principle emphasizes the factors, which should be used to help the learner grow within this zone. Scaffolding means providing directions, means, and comments to enable learners to slowly acquire enough skills to solve enhanced problems on their own (Ikawati, 2020). ZPD has the idea of pointing out that learning is an ever-evolving process where social interaction plays a major role. Thus, owing to the consideration of the learners' ZPD, it is possible to achieve the construction of the proper key with which to open learners' learning potential and motivate them to study actively.

Reflection and Metacognition

Constructivism places great emphasis on reflection and metacognition, which involve personal thinking and learning processes. Encouraging students to reflect on their design decisions, creative processes, and problem-solving strategies can heighten their awareness of their own learning and creativity. Metacognitive strategies, such as setting goals and evaluating progress,

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can also be valuable in fostering design creativity. The elements of reflection and meta-cognition are inherent in constructivist learning theory as it also underlines the value of learners' control in the learning processes (Formosa, 2024). Metacognition involves a critical analysis of one's learning process, reasoning, and perception in a bid to acquire better insight and enhance them. Meta-cognition is therefore a process of reflectively regulating and assessing one's own learning and thinking processes – planning, monitoring as well as evaluating results (Padmanabha, 2020). They facilitate the development of learners' self and process regulation making them more mindful and purposeful in their learning. Thus, reflective, and meta-cognitive activities imply goal setting; an opportunity to assess one's learning style and its advantages and limitations, as well as ways of improving it. In this way, the learners begin to assume a more personal responsibility for their learning through the process of self-regulation. To foster reflection and meta-cognition, the educator must encourage the students to keep learning journals, self-reflect and be able to engage in discussion that marks the difference between proactive and reflective thinking.

Overview of Key Factors

TRIZ

In today's innovative era, the education sector has also evolved technologically, which has created some problems as well. Therefore, different concepts of this theory are well-suited for training teachers and students, as many studies have highlighted its educational benefits. Despite these studies (Birdi, 2021; Faria, 2019)There is very restricted research focused on TRIZ's influence on educators' ability to solve students' problems in innovation education.

However, the teachers should have the ability to solve problems through inventive problem-solving, which will boost their self-efficacy and help to solve students' problems (Li et al., 2023). The emphasis of the current education system is on observation, creation, testing, and the generation of ideas and data, which is not immune to challenges. Through TRIZ, problems can be located, learners can postulate ideal assumptions, design an experiment, functionalize, and debunk the factors that will be a hurdle for innovation. Moreover, this process can be gone through repeated till the best way out is learned (Shao et al., 2022). As the education sector is in charge of making upcoming inventors who must have innovative and creative skills, TRIZ holds a vital role in developing creative skills among high school students. Guner and Ilker (2020) found that TRIZ increases students' capacity for ingeniously thinking while encouraging

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creative problem-solving skills. Furthermore, inventive problem-solving is an effective way that provide the learners with the policies for creative tasks while signifying their creative skills (McCarthy 2020).

In the 21st century, the Education sector has drastically changed, as high schools and universities in China are giving significant importance to innovation in their education programs (Sun & Sun, 2022). In China, TRIZ has been found useful in developing students' innovative and enterprising disposition. Making use of the principles of TRIZ, students are working on the task, thus they are prepared to solve more problems systematically and creatively (Bozhik et al., 2022; Ting et al., 2022). In this respect, it is focused on the resolution of contradictions and the search for the ideal. It also has a broader impact on educational systems with tensions between the globalization of the educational system and the modernization of the educational system. The introduction of TRIZ in the education system is the shift towards the implementation of activity-based education (Sukackė et al., 2022).

Design Creativity

Design creativity in education means how well students can produce new and cool ideas when they're learning about design. It's about looking at things from different angles, using the latest technology, and working together with others. What students think about creativity in design class can be influenced by things like their friends, the kind of environment they like, and how much they really want to be creative. Teaching creativity in design isn't always straightforward, which means more research is needed to understand it better. If we encourage students to work together and be creative in their design classes, they'll probably come up with more new ideas and feel more confident in facing challenges (Bozkurt Altan & Tan, 2021; Georgiev et al., 2023; McInerney, 2023; Ni et al., 2022; Nugroho et al.). Developing creativity in design education is super important for the future of design and for making sure students get better at it (Bozkurt Altan & Tan, 2021; Georgiev et al., 2023; McInerney, 2023; Ni et al., 2022; Nugroho et al.).

Design creativity in education has been a source of concern and inquiry in China. It emphasized the need to emphasize design creativity in education in China to stimulate innovation and fulfil the demands of a changing economic landscape. There is evidence that creativity and associated subjects in Chinese higher education have been disregarded (Gong et al., 2022). A study investigates the practical consequences and issues associated with contemporary design creativity thinking initiatives in the sector of education. It examined the fundamental aspects

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of present design creativity thinking activities in k12 education in China. However, recent progress suggests that the focus on innovation in higher education in China is shifting. This study also emphasizes how this framework is evolving constantly. It continues to evolve and iterate based on the input of fresh data and new elements in the follow-up "Creativity Initiative" project study and practice (Li & Fu, 2020). In China's educational system, design thinking activities have been highlighted as a potential driver of innovation. In the framework of developing competencies for learning, creative problem-solving abilities are crucial. These abilities include interpersonal interaction, collaboration, inventiveness, and analytical thinking. The process of exchanges, information sharing, and suggestions that occur during cooperative engagements and result in novel concepts, methods, and discoveries is known as collective creativity (Tang et al., 2020a).

Moreover, by emphasizing problem-solving skills in addition to learning, this learning technique takes an active stance to promote maximum student engagement in the learning process, which can accelerate the development of cognitive capacity (Zulyusri et al., 2023). Working in a group on a team task allows for greater flexibility, efficiency, and originality than one might anticipate from an individual working alone, making it an excellent way to investigate collective innovation. Criteria that support the interaction's collaborative aspect, as demonstrated by the teamwork and collective inquiry. The main focus of the Design experience is teamwork on an actual problem. It is not an easy procedure to cultivate critical thinking via intricate problem-solving. By challenging newly developed ideas, debating which one to pursue, and practising informed decision-making, it fosters both critical and creative thinking (Tang et al., 2020b).

In Chinese higher education, the focus on creativity and associated courses has shifted, with disparities in participation rates, examinations, and methodologies used compared to industrialized countries (Bozkurt Altan & Tan, 2021). In comparison to other nations, design creativity education in China began late. The evolution speed of Chinese design education is not synchronized after more than 40 years of progress. A study discovers a means to optimize the teaching mode and training mechanism for innovation and entrepreneurship in the design creativity discipline by developing the "LCS training model" for innovation and entrepreneurship skills (Ding et al., 2020).

Teachers Self-Efficacy

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Self-efficacy shapes a person's confidence in their ability to achieve goals and influences their perseverance when facing difficulties. Y. Liu et al. (2021) claimed that teacher self-efficacy has three facets: classroom management, instruction efficacy, and student engagement. According to Lazarides and Warner (2020), an educator's evaluation of their own ability to influence desired student participation and educational outcomes even in the face of challenging or uninspired students is considered their teacher self-efficacy. Several studies have delved into teacher self-efficacy within high school education. In a study by Marschall (2023), it was revealed that aspiring high school math teachers develop their teaching confidence through multiple sources. These sources encompass their practical teaching experiences, interactions with others (such as colleagues or mentors), and their emotional well-being. It implies that to hold and boost teacher confidence effectively, these diverse elements should be considered rather than concentrating on just one. Fundamentally, it highlights the difficult nature of the origins of teacher confidence and the significance of comprehending these influences comprehensively. In another study by Handrianto et al. (2023), researchers validated and put to use the Teacher Self-Efficacy (TSE) Scale to gauge the confidence levels of high school teachers, particularly those instructing on drug education. This research highlighted the significance of evaluating teachers' self-assurance within the unique context of drug education. It stressed the importance of understanding how confident teachers are in their capacity to teach sensitive topics like drug education effectively. This evaluation can be beneficial in enhancing teaching methods and providing appropriate support to teachers in this specific educational area.

A bibliometric analysis exposed that teacher self-confidence in elementary schools has been a prominent research area for the past thirty years, with countries like Australia, China and Turkey being the most prolific contributors to this field (Wulandari et al., 2023). In a study by Teng and Wang (2023), the focus was on teacher self-assurance in the context of livestream teaching, particularly among English as a foreign language (EFL) instructors. It revealed that these teachers possessed a moderate to high level of self-confidence, with a particularly strong belief in their technological competence compared to their confidence in instructional skills. Teachers' classroom management practices may be influenced by the Confucian legacy culture, which emphasizes deference to authoritative figures and regulation. It is feasible to get additional insight into the dynamics of education in China by doing an investigation into the relationship between work satisfaction and classroom management in this cultural context (Zhang & Varela, 2024).

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Another research effort by H. Liu et al. (2021) explored the connections between individual teacher self-efficacy, collective efficacy, and work engagement among Chinese educators. The findings demonstrated that both teacher self-efficacy and collective efficacy were predictive of teachers' levels of engagement in their work, suggesting that teachers with higher levels of self-confidence were more actively engaged in their teaching responsibilities. Furthermore, Yang (2021) has indicated that teachers who have high levels of self-confidence tend to be more receptive to adopting innovative teaching methods, setting ambitious goals, demonstrating effective planning and organizational skills, and adapting their teaching approaches when faced with challenges. These actions have positive outcomes for both educators and students, resulting in increased motivation, improved academic adaptation, and enhanced academic performance.

Challenges and Barriers

Applying TRIZ in education sector rears many challenges that significantly limit the accomplishment of TRIZ in Education by creating hurdles. As these challenges are entangled so one challenge impact other challenges. Most common challenges are shortlisted in this paper like usually educators give more importance to field-specific subjects for students as compared to problem solving methodologies (Ilevbare et al., 2013). Moreover, teachers who retain adequate TRIZ proficiency to transfer it to students are in very small number lack of this expertise results in lack of TRIZ understanding among students. Another problem is lack of TRIZ literature overall as there is no proper TRIZ course books and curriculum for students. Subsequently it evokes ambiguity in what exactly to learn and teach. Tools for TRIZ are apparently very easy to use however it requires important preceding knowledge and broad experience for comprehension. Many students tend to express the concern that there is no consistent practice direction for the procedure. Because when there is plenty of options methods and multiple tactics for problem solving choosing one specific tool that is suitable. (Iouri, 2015) This approach is very designed and centric this technique is not flexible for optical or in-built thinking that necessitates uncommon obligation and zeal and requires time to understand the composition. Another issue is cultural difference as this theory was conceptualized in Russian context and there is difference between Russian and western systems that cause problem. Therefore, there is a need to address these challenges for better TRIZ application in Education system. These challenges can be solved by using different tactics, first of all it should have standardized guide that provides uniform strategies. Plus, it should be

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considered as a proper subject that has curriculum and books. Researchers should work on increasing literature regarding TRIZ intervention in education. High schools and colleges should introduce training programs for teachers to equip them with requires expertise, knowledge, and comprehension.

TRIZ as a Predictor of Design Creativity in Students

For fostering student's creativity and thinking, a practical way is offered by TRIZ theory, through which students can solve the numerous technical problems coming across the innovation process. Guner and Ilker (2020) established that TRIZ increases the capacity of thinking ingeniously between the students while encouraging creative problem-solving skills. Furthermore, inventive problem-solving is an effective way that provide the learners with the policies for creative tasks while signifying their creative skills (McCarthy 2020). Like Cremin and Chappell (2021) scrutinized the effect of teacher's views about learner creativity on real student actions on creative jobs. The study discovered that where teachers reported higher self-efficacy for their capability to raise student's creativity, students formed more inventive designs paralleled to those trained by trainers with lower self-efficacy views.

Liu et al. (2023) in his study emphasized that self-efficacy is important for creativity based on establishing that People with advanced creative self-efficacy are more open for testing diverse ideas and sources to execute tasks while facing difficulties. Moreover according to Payne and Whitworth (2022) A persons self-belief on creativity is positively related to creative outcomes in designing new products and terminating issues. TRIZ is a tool that provides a direction to solve problems by developing unique ideas which enhance creativity administered a study to check inventive problem solving effect on engineers' creative performance and found significant positive relationship among these variables. Stoletova (2019) presented a solid connection between creativity and TRIZ thus it is concluded that with support of TRIZ searching problems, breeding, and implementing a strategy is stress-free. That finally mend features of product in design phase because creative thinking enables one to improvise the situation with ideal solution that is also a feature of TRIZ.

TRIZ as a predictor of Teachers' Self-Efficacy

The emphasis of current education system is on observation, creation, testing, and creation of ideas and data which is not spared from challenges. Through TRIZ, problems can be located, learners can postulate ideal assumption, scheme an experiment, functionalize, and debunk the

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factors that will be a hurdle for innovation. Moreover, this process can be gone through repeatedly till the best way out is learnt (Shao et al., 2022). A problem solution should have a positive and confident approach toward resolving the conflicts rather than focusing on specific outcomes of that conflict. To reach at this point, teacher's role cannot be overlooked, they are responsible for giving students different opportunities where they can observe, idealize, discover, try, and craft ideas under their guidance, feedback, and support during the complete procedure (Belski et al., 2019). Teacher's understanding with innovation principles is irrespective because its self-efficacy in educational context is main requirement for boosting creativity and problem-solution among students. Furthermore, students and teachers who are already familiar with innovation in education and understands it process tend to adapt changes swiftly. Moreover, who have previously interacted with new ideas and designs expected to solve problems creatively by using TRIZ. TRIZ makes design process easier by delivering an essential consideration of invention process. It encourages to put on multidimensional method that includes demo, hands-on activities, trials, prototyping, functionality and management (Park, 2023).

When a new design comes it is accompanied by some level of difficulties as well, if a teacher who has experienced same problem in past there are chances that he is in a better position to teach his students how to handle the issue, how they can look upon contradictions and solve the puzzle with creative thinking. Many studies (Hwang & Oh, 2021; Tossavainen et al., 2021) have prorogued that exploring inventive problem solving method and actual solution together can speed up the growth of Self-efficacy that is an integral skill for future problem solving as well. Moreover,(Cai & Tang, 2021) studied that students' support and teacher's self-efficacy are positively correlated with teacher innovation which is a favourable impetus for creativity and innovation. As per (Park, 2023) findings it is observed that TRIZ method leaves positive impact on Teachers self-efficacy, because when a challenge is resolved ideally with creative thinking, it gives them a sense of achievement thus teachers start appreciating their creativity. It will upgrade their skills and enable them to transfer their skills to other as well. In addition, inventive problem-solving deteriorates suspicions that create hurdles in the way of innovation. This process will reshape the perception of creativity, and teachers become more confident of developing creativity in others due to their own development.

Conceptual Framework

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Based on the afore-discussed literature and reported studies, this study has proposed the following conceptual framework:

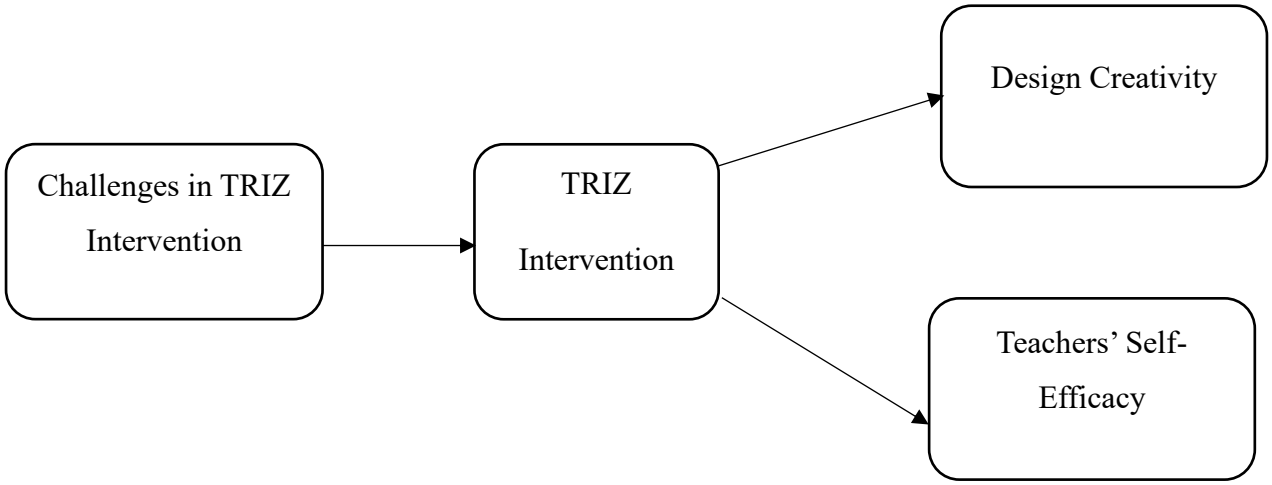

Figure 1. Conceptual Framework

CONCLUSION

TRIZ is a new paradigm for viewing the problem and can be accurately described as a Theory of Inventive Problem Solving. Based on the science of patents, TRIZ provides a framework by which to approach and solve problems more creatively and systematically. Created in the middle of the twentieth century by Soviet inventor Genrich Altshuller, TRIZ differs from the conventional experimental methods, such as brainstorming and correction by trial and error, which do not satisfy in complex problem-solving (Amer et al., 2023). TRIZ stands as a solid base that can be applied to any industry, since the nature of industries changes with time, and individuals and groups need a framework that would allow them to tackle certain problems based on certain principles (Orloff, 2020). Another notion tightly connected with TRIZ is the notion of contradictions and their means of solving. TRIZ has a well-defined but also very open approach to problem-solving, which can easily be adapted to reacting to change (Duan). TRIZ empowers students to compare and analyse a system in order to obtain optimal solutions into the contradiction (Becker, 2024); at TRIZ it is the norm to get heaped solutions to a problem. Another key element of TRIZ is resource analysis, where the problem-solving resources available are considered (Shao et al., 2022). This is as per the principles of TRIZ in which resources are not restricted only to the materials, but also energy, information, and time. Resource analysis involves identifying and utilising such resources with an aim of developing exceptional value addition and low-cost solutions (D'Oria et al., 2021).

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TRIZ provides a systematic approach to invention, distinct from the conventional approaches (Sojka & Lepšík, 2020). On the contrary, TRIZ works on students' critical thinking and systematic approaches rather than memorization of knowledge. This method encourages students to look at any system, analyse the reason it can be contradictory at some point and find a way to resolve it to encourage divergent thinking. Many lessons taught in TRIZ also hold ideas of structure creativity that help students analyse problems from different perspectives and push them out of their comfort zone and think of many more possible creative solutions (MalAllah et al., 2022). The analysis of differences in specifics of using TRIZ between traditional and innovative schools revealed several critical aspects that are directly associated with teacher self-efficacy. The results showed that the teachers' self-efficiency has the positive relation to attitudes toward challenges connected with implementation of TRIZ in the teaching process, appreciating its potential to develop students' creativity.

They believe in their capability to create conditions where learning propels invention and are more ready to use and modify methods that are outside of conventional ones. High self-efficacy teachers have the ability to assist the students to follow and complete the TRIZ process so that they will enhance their ability in design creativity acquired through critical thinking (Cano-Moreno et al., 2021). Among these factors, the element of teacher self-efficacy can be recognised as playing a critically significant part in relation to these various approaches to problem solving. High self-efficacy teachers better understand the importance of creative innovative type of education and are in a better position to promote it among students (Puozzo & Audrin, 2021). On the other hand, teachers who had low level of self-efficacy might encounter difficulty in change from the effective teaching strategies to that of using TRIZ strategies (Reyes-Huerta et al., 2023). This might make them conservative and avoid changing how they teach in a certain way, for they feel they are unable to handle TRIZ adequately. the low self-efficacy teachers may not be able to grasp the potential learning outcome TRIZ to the optimal level (Reyes-Huerta et al., 2023). Their lack of confidence may result in a much more conservative implementation of TRIZ, which removes its innovative and experimental aspects. This can lead students to get a less potent solution of TRIZ. While using TRIZ in educational contexts, one inevitably faces major structural problems stemming from the very nature of the educational system.

With this vigorous research, this research has added many useful insights into the empirical literature. The study contributes to the theoretical frameworks on the creative problem-solving

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by integrating TRIZ which is an innovative method. The research provides with empirical evidence that how TRIZ influences design creativity and offers new dimensions to the theories on the structured creativity techniques and their effectiveness in the educational settings. TRIZ detects various contradictory situations in the problems and offers creative solutions to them through contradictions. The research also implies that the alignment of TRIZ with teaching and learning is critical, is ensured by the teachers, and other supporting elements in an educational setting. If the level of complexity is perceived as too high in teaching and learning material, it is a considered a burden on both teachers and students as they cannot achieve their desired level of problem-solving skills. This involves the design and complexity of TRIZ framework and tools which are necessary for problem-solving activities in an educational setting. TRIZ framework can be embedded into the existing problem-solving programs such as the Problem Based Learning (PBL) which provides guidance to the teaching and learning processes.

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