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

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ABSTRACT

Purpose – The purpose of this study was to evaluate the effectiveness of creative problem-solving methodologies, such as TRIZ, in boosting design creativity in high school students in China, considering the role of the teachers' self-efficacy in implementing such interventions. **Design/methodology/approach** –The study employs an experimental or quantitative research methodology to systematically assess the efficacy of the TRIZ intervention and explore the factors characterizing the integration of creative applied methodologies into educational practice. Results demonstrate a significant increase in students' design creativity following the TRIZ intervention, as evidenced by pre- and post-intervention assessments. **Findings** – The study reveals a strong correlation between teacher self-efficacy and the effective implementation of TRIZ. Teachers with high self-efficacy in teaching TRIZ were more likely to create learning environments that enhanced student creativity, thereby maximizing the intervention's impact. Conversely, teachers with lower self-efficacy showed resistance to incorporating TRIZ into their teaching practices, potentially compromising its effectiveness. This study demonstrates the significant potential of the TRIZ methodology for enhancing the design creativity of high school students in China. **Research limitations**– The study has limitations because of its geographical concentration on the Chinese students and teachers. Future research could look into additional regions to validate this notion. **Practical implications** – For effective implementation of TRIZ, teachers should prepare their teaching material that incorporates TRIZ principles systematically.

Keywords TRIZ, Design creativity, Teacher self-efficacy, Creative problem-solving, Chinese education system.

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INTRODUCTION

Design creativity has become an increasingly vital skill in the 21st century as societies face complex economic, social, and environmental challenges that require innovative solutions. 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; Siddiqua et al., 2023). Integrating design creativity within education can unlock students' innovative potential while equipping them for 21st century needs (Cao et al., 2022; Huang et al., 2020; Li et al., 2019). Creative interventions involve structured programs or initiatives intended to develop cognitive skills, behaviors, and motivations associated with creativity through focused learning experiences (Birdi, 2016; Khalid et al., 2020; Mathisen & Bronnick, 2009). TRIZ is Russian acronym for the innovative problem-solving philosophy. This is an analytical, forecasting and problem-solving approach based on reason instead of natural creativity derived from the examination of invention patterns in the worldwide patent literature (Kozan, 2019). The TRIZ framework is built on several key premises that align with foundations of design creativity (Chechurin, 2016; Moehrle, 2005; Mohammadi et al., 2022).

However, as the world evolves, it becomes increasingly vital for Chinese education to embrace creativity and design thinking as cornerstones of its pedagogy, empowering students to become agile, resourceful problem solvers. Nurturing creativity requires moving away from conformity towards valuing divergence, critical thinking, and individual expression (Alkasem & TilfarlioÄŸlu, 2023; Daly et al., 2019; Gong et al., 2022). Many believe the Chinese educational system severely limits pupils' creativity due to its focus on standardized testing and rote memorization. Several studies show that memorizing, high-stakes testing, and established solutions have harmed pupils' creative growth (Kim, 2023). The Chinese education system's longstanding emphasis on rote memorization, high-stakes testing, and uniform solutions has constrained creative development among students (Mullen, 2017, 2019; Mullen & Mullen, 2020; Shen et al., 2021; Wang, 2012). The first objective of this study is to evaluate the changes in design creativity skills among high school students in China resulting from a creative problem-solving intervention program based on TRIZ. Teacher self-efficacy significantly influences the implementation of student-centered, inquiry-based teaching that provides vital scaffolds for creativity. Efficacious teachers who feel assured in their teaching abilities are more likely to create classroom environments that spark student creativity, curiosity, and

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participation (Rubie-Davies, 2006; Wang et al., 2018; Zhu et al., 2018). Regardless of increasing attention for TRIZ practice in education sector, inclusive research regarding teachers TRIZ ability training is insufficient, it is important to understand TRIZ impact on teaching self-efficacy to train students for innovation. But very limited studies have looked upon this matter and they are not clear about the methods that can improve teacher's self-efficacy, and which programs can benefit them. The second objective of this study is to evaluate the role played by teacher self-efficacy levels in delivering the creative problem-solving intervention in classrooms. Fostering creativity in students is critical for generating innovative ideas and enhancing learning outcomes. Applying the TRIZ paradigm and modifying it for high school pupils depends on teacher direction. Teachers can influence the involvement and creativity of their students by actively participating in creative problem-solving events (Belski, 2019). Engineering students who studied TRIZ developed notably better problem-solving skills than those learning other engineering courses in their four-year program, Apart from improving learners' problem-analysis skills, TRIZ increases their creativity and ability in solution identification, decision, and implementation (Belski et al., 2019). The objective of the study is to explore the teacher perceptions about the effects that TRIZ intervention has on creativity in high school students and the importance of self-efficacy in successful implementation of TRIZ intervention program. Every educational approach has flaws; some of these are usually sacrificed depending on the background idea. The educational theories and methods of student learning in China have been exhaustively examined in this study (Qian, 2023), It has covered the theoretical underpinning of Chinese and Western educational ideas as well as the characteristics, development, pros and cons of Chinese high school education and foreign high school education in China. The Chinese education system faces mounting criticism for its excessive academic pressures, rote learning approaches, and conformity-driven culture. Students endure heavy workloads, cram schools, high-stakes exams, and parental pressures for success, resulting in heavy stress. The intense focus on testing performance and information-dumping teaching methods that are heavily used in Chinese education systems leaves little time for deeper learning or creativity cultivation (Thielmann et al., 2021; Zhang et al., 2022; Zhu et al., 2021). Therefore, the final objective of the study is to identify challenges faced by teachers in implementing the TRIZ intervention and propose strategies to address them. This study intends to compile thorough information on how high school instructors have applied and thought about the TRIZ paradigm to motivate creativity in their pupils.

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Students that apply creative ideas like the TRIZ model can develop their ability to solve problems; thus, this change in the emphasis of education presents a chance to investigate these ideas. Studies on creative problem-solving programs revealed their potential to deliberately cultivate critical creative capacities like divergent thinking, flexible ideation, and creative self-belief in students when thoughtfully designed and consistently implemented over time (Grosser et al., 2017; Meinel et al., 2019; Puozzo & Audrin, 2021; Sun et al., 2020; Sun et al., 2022). Teacher self-efficacy research underscored techniques including targeted creativity workshops, peer feedback cycles, professional learning communities, and tracking student progress data to continually refine teaching practices (Barni et al., 2019; Conradty et al., 2020; Park, 2023; Puozzo & Audrin, 2021; Schunk & DiBenedetto, 2016; Stolz et al., 2022; Zee & Koomen, 2016). Encouragement of pupils to think beyond the box helps educational institutions that appreciate innovation to influence society trends. Through means of this purpose of improving our knowledge of how to efficiently promote creativity via educational interventions, a more creative, dynamic, and resilient society can be reached.

THEORETICAL DEVELOPMENT AND HYPOTHESES DEVELOPMENT

Design Creativity in Education

The concept that creativity is both undefined and identifiable refers to the enigmatic yet visible enchantment that is the source of the creative spark. Design creativity in education means how well students can produce new and cool ideas when they are learning about design. It is about looking at things from different angles, using the latest technology, and working together with others. 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.). According to Amran et al. (2021), the development of creativity, critical thinking, and problem-solving ability are three essential competencies needed to equip students for success in academia and in practical life. When students are able to develop STEM ideas, teachers seldom encourage critical thinking in their teaching environments.

Teacher Self-Efficacy in Education

Self-efficacy perception, as defined by Bandura (2006), pertains to an individual's belief in their capacity to accomplish desired outcomes. Liu et al. (2021) claimed that teacher self-efficacy is characterized with three facets, including classroom management, efficacy in instruction, and student engagement. It is crucial to examine how teacher self-efficacy connects

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with the adoption of artificial intelligence (AI) technology in education. This investigation is essential because AI has the potential to impact teachers' beliefs and teaching methods. Researching this relationship allows to comprehend how AI shapes teachers' confidence and practices, ultimately affecting the quality of education provided to students (ORAN, 2023). In a study by Kengatharan and Gnanarajan (2023), an interesting discovery was made regarding teacher self-efficacy and student misbehavior. It was found that teachers with higher overall self-efficacy in teaching tended to experience fewer instances of student misbehavior. This finding emphasizes on the potential role of teacher self-efficacy in shaping classroom dynamics and maintaining a positive learning environment. When teachers are confident in their teaching abilities, they may be better equipped to manage and prevent disruptive behaviors among students. Anton and Van Ryzin (2024) state the cooperative learning (CL), a particular type of student-centered education, has been shown to increase satisfaction with teaching and self-efficacy. CL is a method of small-group education that works for all grades and any topic. When properly implemented, the lesson design aspects outlined by CL offer students' chances for social connection while they are studying.

TRIZ and Teaching 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 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; Ting et al., 2022). 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 and Tang (2021) studied that students' support and teacher's self-efficacy are positively correlated with teacher innovation which is a favorable impetus for creativity and innovation.

Hypotheses Development

TRIZ gives an easy understanding of the innovation process by equipping with a multidimensional method which covers demonstration, direct and manual participation, ideas, experimentations, developing prototypes, and exhibition of problem solution. Smith et al. (2018) steered a study in which it was established that teachers testified improved confidence in applying new teaching strategies after getting training in TRIZ devices. So, teachers having

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aptitude to create unique ideas and elucidate problems efficiently are confident enough to take chances and adjust the coaching practices rendering to student requirements. In case, a study piloted by Bagheri and Akbari (2019) observed the properties of a TRIZ-based training program for Iranian mathematics teaching self-efficacy. The consequences signposted major developments in participants' point of view for problem-solving capacities and instruction efficiency after carrying out the program. TRIZ can add in to expanding teachers' self-efficacy over several tools. 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. 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. Based on previous literature and our consideration it can be hypothesized that

H1: Implementation of TRIZ strategies will increase design creativity among Chinese high school students.

H1a: The implementation of TRIZ strategies will improve the perception of creativity ideas among Chinese high school students.

H1b: The implementation of TRIZ strategies will improve the perception of creative problem solving among Chinese high school students.

H2: The implementation of TRIZ will improve the creativity of high school students in China.

H2a: The implementation of TRIZ will increase the fluency of design students.

H2b: The implementation of TRIZ will increase the frequency of design students.

H2c: The implementation of TRIZ will increase the originality of design students.

H2d: The implementation of TRIZ will increase the sophistication of design students.

H3: The TRIZ program will improve the self-efficacy of design teachers.

H4: Teaching self-efficacy will mediate the association between TRIZ and design creativity.

H5: Teaching self-efficacy will mediate the association between TRIZ and creative abilities of students.

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RESEARCH METHOD

Population and Sampling

The sample for the present study consisted of high school teachers and students from the selected high schools among the leading schools in China, which offered courses on design creativity. The study centered on high school students and teachers in China, with a primary emphasis on investigating the impact of TRIZ interventions and teachers' self-efficacy on the design creativity of the students. The present study will be conducted based on the selection of purposive sampling technique as the suitable choice. Purposive sampling is based on the "deliberate choice of sample." There are several justifications for the choice. In the present research, the researcher has selected the sample based on his observations and judgements which has enabled the researcher to utilize purposive sampling technique. In the present study, the researcher seeks to implement a sample size of 100 students to study the effectiveness of TRIZ invention for enhancing the design creativity in high school students in China so that the margin of errors can be reduced in the estimates.

Data Collection and procedure

The stage of data collection is considered important and critical in research and its importance cannot be ignored. It serves as the foundations upon which the researchers conduct their studies and draw authentic results. . For the purpose of data collection through quasi-experimental design, the data will be collected through the pre-test and post-test technique fundamental in experimental research (Rogers & Revesz, 2019; Siddiqua et al., 2023). For this purpose, the pre-test session will be conducted with the students at high school to assess their design creativity along with the investigation of self-efficacy of teachers. After interventions, data will be collected again to assess the differentiation observed due to the implementation of TRIZ on the performance of students and the self-efficacy of teachers. This will be done to measure the differentiation between student's performance and the self-efficacy of teachers that can influence the performance of students.

Data Analysis

After the data collection through experiments, the independent sample t-test will be applied. The independent sample t-test is a widely used statistical test in the experimental research. This is done to analyze the statistically significant difference between two groups.

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Ethical Considerations

Ethical considerations are central to any research. Similarly, the present research will also be conducted by considering the fulfilment of all moral obligations. As the present research involves human participants so no biasness regarding gender or any other preferences regarding research participation and data collection will be observed. Before conducting the experiments, a brief research purpose will be communicated to the respondents to gain adequate response. This will also be done to enhance their clarity regarding the research topic. A prior permission from the high school management and authority will be attained to ensure their consent and volunteer research participation.

DATA ANALYSIS AND FINDINGS

Data Screening and Normality

Screening of data as well as checking for normality were crucial since they made sure that the data was in a form that was fit for some of the statistical tests. Descriptive statistics were assessed in this study with the objective of identifying the distribution of the variables, as shown in Table 4.1, whereby the mean, standard deviation, skewness, and kurtosis are presented.

Table 4.1: *Descriptive Analysis*

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PINCR1	177	1	5	3.59	1.226	-.620	.183	-.738	.363
PINCR2	177	1	5	3.55	1.167	-.478	.183	-.931	.363
PINCR3	177	1	5	3.56	1.177	-.461	.183	-.963	.363
PINCR4	177	1	5	3.56	1.142	-.483	.183	-.824	.363
PINSE1	177	1	5	3.73	1.253	-.850	.183	-.409	.363
PINSE2	177	1	5	3.79	1.206	-.779	.183	-.512	.363
PINSE3	177	1	5	3.89	1.136	-.917	.183	-.107	.363
PINSE4	177	1	5	3.77	1.189	-.762	.183	-.468	.363
PINSE5	177	1	5	3.75	1.181	-.791	.183	-.363	.363
PINSE6	177	1	5	3.72	1.251	-.765	.183	-.534	.363
POCR1	177	1	5	3.94	1.251	-.896	.183	-.350	.363
POCR2	177	1	5	3.79	1.356	-.722	.183	-.786	.363
POCR3	177	1	5	3.89	1.296	-.817	.183	-.596	.363
POCR4	177	1	5	3.97	1.215	-.761	.183	-.726	.363
POSE1	177	1	5	3.53	1.489	-.536	.183	-1.221	.363
POSE2	177	1	5	3.53	1.526	-.569	.183	-1.225	.363
POSE3	177	1	5	3.48	1.512	-.516	.183	-1.250	.363
POSE4	177	1	5	3.75	1.429	-.807	.183	-.761	.363

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POSE5	177	1	5	3.53	1.504	-.532	.183	-1.235	.363
POSE6	177	1	5	3.57	1.464	-.564	.183	-1.167	.363
Valid (listwise)	**N**177								

"PINCR = Pre-Intervention Creativity; PINSE = Pre-Intervention Self-Efficacy; POCR = Post-Intervention Creativity; POSE = Post-Intervention Self-Efficacy"

Descriptive Statistics

The four variables studied in this analysis were Post-Intervention Creativity or POCR, Post-Intervention Self-Efficacy or POSE, Pre-Intervention Creativity or PINCR, as well as Pre-Intervention Self-Efficacy or PINSE. The standard deviations stood between 0.97 to 1.21, which meant that the fluctuations in the responses were moderate. In distributional analysis, the measures of skewness and kurtosis were checked to determine normality of the data set. In the dataset, skewness values were between –0.424 and –0.605, which indicated that the variables were slightly skewed negatively as it indicated frequency of high ratings. The kurtosis values ranged from -0.363 to -0.931. The results indicated that the distribution of data was more leptokurtic than the normal distribution.

Table 4.2: *Descriptive Statistics*

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Skewness**		**Kurtosis**	
	Statistic	**Statistic**	**Statistic**	**Statistic**	**Statistic**	**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
PINCR	177	1.00	5.00	3.5664	.96651	-.504	.183	-.363	.363
PINSE	177	1.00	5.00	3.7759	.96955	-.605	.183	-.322	.363
POCR	177	1.00	5.00	3.8955	1.11279	-.516	.183	-.931	.363
POSE	177	1.00	5.00	3.5640	1.21412	-.424	.183	-.919	.363
Valid (listwise)	**N**177								

"PINCR = Pre-Intervention Creativity; PINSE = Pre-Intervention Self-Efficacy; POCR = Post-Intervention Creativity; POSE = Post-Intervention Self-Efficacy"

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Sphericity and Sampling Adequacy

It is crucial to check the sphericity and the sampling adequacy for trying to determine whether the obtained dataset is suitable for performing factor analysis in order to gain some understanding regarding the factors that underlie the variables at hand (Shrestha, 2021). Table 4.4 presents the "Kaiser-Meyer-Olkin (KMO)" measure as well as "Bartlett's test of sphericity" relating to these aspects.

Table 4.3: *KMO and Bartlett's Test*

Kaiser-Meyer-Olkin	Measure of Sampling Adequacy.	.861
Bartlett's Test of Sphericity	Approx. Chi-Square	3069.615
	df	190
	Sig.	.000

Association Testing

Association testing is the major step in the quantitative data analysis. In association testing, the significance level between the designed associations is utilized to finalize their acceptance and rejection and extract the major contributions of the study. It is the primary test of association testing. A correlation analysis highlights the association between all variables present in the empirical model. To assess the correlation or relationship between constructs at the primary level, the study used the Pearson correlation analysis with a significance level of 0.05 and 0.01. The study performed the correlation analysis of pre- and post-intervention creativity and self-efficacy.

Table 4.4: *Correlation between Pre-intervention Constructs*

		PINCR	**PINSE**
PINCR	Pearson Correlation	1	.461**
	Sig. (2-tailed)		.000
	N	177	177
PINSE	Pearson Correlation	.461**	1
	Sig. (2-tailed)	.000	
	N	177	177

"PINCR = Pre-Intervention Creativity; PINSE = Pre-Intervention Self-Efficacy"
*"** Correlation is significant at the 0.01 level (2-tailed)."*

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Table 4.5: *Correlation between Post-intervention Constructs*

		POCR	POSE
POCR	Pearson Correlation	1	.339**
	Sig. (2-tailed)		.000
	N	177	177
POSE	Pearson Correlation	.339**	1
	Sig. (2-tailed)	.000	
	N	177	177

"POCR = Post-Intervention Creativity; POSE = Post-Intervention Self-Efficacy"
*"** Correlation is significant at the 0.01 level (2-tailed)."*

Pre and Post Test Analysis

Pre-Intervention Creativity

Regression analysis is a statistical technique incorporated to assess the impact of teachers' self-efficacy on creativity with significance evaluation at pre-intervention. The first table highlights the defining power or variance power of the model or the influence of all exogenous variables on the endogenous variable. The R-square has been known as the coefficient of determination and according to empirical scholars, if the R-square is higher than 0.10 it is considered a good model variance (Ozili, 2023).

Table 4.6: *Coefficient of Determination*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.461a	.212	.208	.86032

Next, the analysis has computed and reported the ANOVA table. The ANOVA table highlights the significance of the model.

Table 4.7: *Model Fitness*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	34.881	1	34.881	47.128	.000b
	Residual	129.526	175	.740		
	Total	164.407	176			

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The table below reports the main association results. In the table, the results have highlighted that teachers' self-efficacy has a significant and positive association with design creativity with B=.461, p= .000<.001, therefore, this association was considered significant.

Next, the independent sample t-test first reported the data normality with Levene's test with a significance level greater than 0.5, followed by the insignificant impact of TRIZ intervention on pre-intervention design creativity with 0.475 by assuming equal variances.

Table 4.8: *Independent Sample T-test*

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PINCR	Equal variances assumed	1.006	.317	-.716	175	.475	-.15217	.21249	-.57154	.26721
	Equal variances not assumed			-.804	33.757	.427	-.15217	.18917	-.53670	.23237

Post-Intervention Creativity

Similar to the previous section discussion, this section has also discussed the impact of TRIZ and self-efficacy on design creativity but at the post-intervention level. For this purpose, a new regression model was run, and the analysis highlighted the R-square and adjusted R-square greater than the recommended threshold of 10%.

Table 4.9: *Coefficient of Determination*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.339a	.115	.110	1.04990

Next, the ANOVA table reported the model fitness with an f-value of 22.17> 4.0 and verified the model being significant.

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Table 4.10: *Model Fitness*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	25.041	1	25.041	22.717	.000b
	Residual	192.901	175	1.102		
	Total	217.941	176			

Next, to analyze the impact of TRIZ intervention on design creativity, the study again performed the independent sample t-test.

Table 4.11: *Independent Sample T-Test*

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
POCR	**Equal variances assumed**	.091	.763	-1.738	175	.084	-.42218	.24292	-.90162	.05726
	Equal variances not assumed			-1.750	30.827	.090	-.42218	.24120	-.91422	.06985

DISCUSSION AND CONCLUSION

The key objective of the study was to study the effect of TRIZ on high school students design creativity in China based on pre- and post-implementation. The study aimed to ascertain the responses of Chinese high school pupils toward the TRIZ approach concept development. We investigated using a pre- and post-intervention experimental framework the impacts of TRIZ on students' creative capacity. Participants' degrees of self-efficacy clearly associated with their degrees of creative output both before and after TRIZ. The study found that only after the intervention did TRIZ significantly raised students' inventiveness. One could argue that the approach was insufficient when used by itself since pupils' creative output did not rise straight after the TRIZ principles' acceptance. But when pupils grasped TRIZ and its techniques, their degree of inventiveness grew. Although TRIZ's advantages are not immediately obvious, this lag period helps one to see them with persistent use. TRIZ offers a framework for resolving design challenges by means of tools for discovering and fixing inconsistencies. The study

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(ElAdl & Polpol, 2020) reveals that students in the experimental group acquire strong creative problem solving and academic self-efficacy as compared to those in the control group. Our study findings is consistent with the study (Liu et al., 2020), the results of this study show that an intervention program in creativity can boost teaching behaviors as well as views of self-efficacy about teaching for creativity, therefore promoting student creativity. These results have significant ramifications for educational environments since they imply that the curriculum should include the workshop and reinforcement of learning with hands-on guidance in creativity with interdisciplinary teaching, so facilitating student creativity by increasing teaching behaviors and boosting self-confidence regarding teaching creativity. These studies demonstrate that TRIZ is a useful tool for guiding students toward creative thinking, problem-solving, and technical skill application; hence, they demand its higher use in the classroom.

A secondary objective was to analyze how teacher self-efficacy impacts the success of the intervention in boosting design creativity. TRIZ is a new paradigm for viewing the problem and can be accurately described as a Theory of Inventive Problem Solving. Based in the science of patents, TRIZ provides a framework by which to systematically approach and solve problems more creatively. TRIZ is packaged into a framework and has a certain number of processes that problem solvers go through in order to come up with innovative solutions (Russo & Spreafico, 2020). 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). 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). The self-confidence that they have in their ability to teach helps them to create an environment where the students are not just mere receptacles waiting to be filled with knowledge but real actors in their learning process. These teachers are also likely to incorporate the use of TRIZ in the classroom and are most probably able to take the students through the process of defining contradictions, a key principle in TRIZ.

Conclusion

The main research objective guiding this study was to investigate the effects of the TRIZ methodology on high school students' design creativity in China, also, to establish whether teacher self-efficacy influences the effective implementation of creative problem-solving interventions. It was therefore research that embraced the experimental or quantitative research.

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The effects of teacher self-efficacy and the factors that characterize the integration of creative applied methodologies into practice. The results of this work shown that increase of students' design creativity resulted in the use of the TRIZ intervention in pre- and post-intervention phases. It was observed that the students of the creative thinking course made significant enhancement in the idea generation & critical thinking part that further indicated the utility of even fundamental problem-solving frameworks in enhancing creativity. Teachers with a high level of self-efficacy in teaching TRIZ developed an environment for learning that enhanced the creativity of children thus maximizing the effects of the intervention. On the other hand, teachers with lower self-efficacious responded negatively towards the use of TRIZ in their teaching and learning wherein the effectiveness could be sometimes compromised. The effectiveness of the intervention, however, depends on the perceptions of teachers and their beliefs about their ability to teach creatively known as teacher self-efficacy underscores the need for professional development of teachers in the context of creativity problem solving interventions.

RESEARCH IMPLICATIONS

Theoretical Impactions

The study contributes to the theoretical frameworks on the creative problem-solving by integrating TRIZ which is an innovative method. TRIZ has been effectively used in the field of engineering and for teaching engineering. TRIZ10 enhances creativity in engineering design by using several metrics and objective methods which can measure both personal creativity and generated ideas. 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. Teacher self-efficacy operates within a feedback loop where the successful implementations of creative methods enhance the self-efficacy of teachers. This has significant implications for understanding how the beliefs of teachers in their capabilities can be strengthened by using innovative teaching practices and methods and which leads to a dynamic model of teacher effectiveness. The study also highlighted the importance of context-specific self-efficacy regarding the implementation of TRIZ. It suggests that the self-efficacy theories are accountable for specific teaching methods and contexts, and it cannot be treated as a generalized construct.

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Practical Implications

The research offers with practical strategies for integration of TRIZ in high schools. TRIZ principles can be incorporated in existing subjects for engaging students in design creativity and for enhancing their creativity. For effective implementation of TRIZ, teachers should prepare their teaching material which incorporates TRIZ principles systematically. This involves designing of activities which align with TRIZ's problem-solving techniques which are inventive such as the use of contradiction elimination and innovative solutions. BY implementing TRIZ in the classrooms students are facilitated with structured techniques and approaches for solving design problems. Students need skills for identifying and resolving contradictions and for applying inventive principles and systematic algorithms to handle complex problems in an effective way.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

The limitations are regarding the research design, method, sample, as well as contextual aspects that might have influenced the study results and their generalizability. The other limitation is external validity because the population sample selected in this study has been selected in a particular way. China is the country which has the education system focused on rote learning and aimed at examinations (Zhu & Chang, 2019), and these peculiarities most likely have affected the implementation and reception of TRIZ as well. Hence, the outcomes could not be compared with those of people from other educational systems or different cultures. Another source of bias in the study is its intervention period. This time may have been inadequate for establishing any likenesses in the overall extent of creativity in the students' designs utilized in the TRIZ implementation process. However, there are still some areas of research that have not been investigated enough and should be considered in the future. An area that requires further research is the effect of TRIZ on the students' creativity in the long term. Most of the previous research, including the works of Al′tshuller (1996), Cano-Moreno et al. (2021) , and others, is based on assessing the direct or, at best, short-term impact of TRIZ interventions. Moreover, further studies should be conducted on teaching TRIZ using other methodologies. It has been presented that TRIZ might be used as an independent learning method (Sojka & Lepšík, 2020), but using it in conjunction with other teaching methods might have a greater impact on creativity.

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