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Teaching model development to enhance the creativity for college students in China

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Creativity, a core competency for self-awareness and problem-solving, remains underdeveloped among Chinese college students, primarily due to insufficient emphasis on innovation cultivation in education. The main purposes of this research are to develop, implement a teaching model based on the cognitive approach to enhance the creativity for college students. The model was designed utilizing 4 main components of "Problem-Ideation-Prototype-Testing" (PIPT) and implemented with 60 freshmen at Guangzhou Panyu Polytechnic, China. The samples were drawn from a cluster sample and formed a quasi-experimental design. Students were divided into an experimental group and a control group for independent samples *t*-tests and paired samples *t*-tests. The data was analyzed using questionnaires, creativity assessments, and *t*-tests. The results revealed that the PIPT model with 6 main components:principles, objectives, syntax, social systems, reactions, and support systems, achieved a teaching evaluation score of 4.61, was at the highest level of applicability. Independent and paired *t*-tests demonstrated the model's superiority over traditional methods in enhancing creativity ($p < 0.05$), affirming its efficacy in achieving educational goals and fostering student creativity.

KEYWORDS

teaching model, creativity, college students, problem-solving, innovation

1 Introduction

Creativity serves as a cornerstone for global progress and individual development, recognized as "a vital aspect of human intelligence, involving the generation of original ideas that hold value" (Gardner, 2011). Beyond fostering innovation, creativity drives economic growth, societal advancement, and transformative thinking (Broden, 2004). For college students, it acts as a catalyst for self-discovery, problem-solving, and exploring novel perspectives, aligning with Csikszentmihalyi's (1996) assertion that creativity provides unparalleled fulfillment in human endeavors. In the 21st century, creative thinking has become indispensable for personal and professional success (Robinson, 2013). Empirical studies emphasize that educational practices significantly shape creative self-efficacy, with teaching models strongly predicting the development of students' creative capacities (Soh, 2017).

China's creativity education landscape, however, reveals systemic challenges. Despite integrating innovation and entrepreneurship courses into the national curriculum since 2012 (Ministry of Education of the People's Republic of China, 2012), standardized educational paradigms often stifle creative potential (Robinson, 2001). Recent (Global Entrepreneurship Monitor (GEM), 2022) reports highlight that China's school-based entrepreneurship education lags behind Asia-Pacific averages, reflecting deficiencies in cultivating creative talent. While policies mandate reformative teaching methods to

prioritize critical and creative thinking (Ministry of Education of the People's Republic of China, 2012), outcomes remain suboptimal. Traditional models, fixated on rote learning, fail to nurture curiosity or imagination—key drivers of creativity (Sternberg and Lubart, 1995). This gap underscores the urgency to address pedagogical limitations hindering creativity development.

Investigating teaching models to enhance creativity holds critical significance. Robinson (2013) argues that flexible, student-centered approaches are pivotal for fostering creativity, a view supported by constructivist theories emphasizing active learning (Mayer, 2004). Literature research reveals that there are still some gaps: Many scholars believe that the ultimate goal of conducting innovation and entrepreneurship courses is to enhance students' creativity. However, there are few empirical research results related to the impact of teaching models on creativity. This study aims to fill this gap by developing and implementing a teaching model of innovation and entrepreneurship course, specifically designed for Chinese college students to enhance their creativity.

The research and development (R&D) process was employed to develop the teaching model, integrating qualitative methods (interviews, thematic analysis) and quantitative methods (surveys, statistical modeling) to address the following objectives:

(1) To design a teaching model aimed at enhancing college students' creativity.

(2) To evaluate the effectiveness of the proposed teaching model in fostering creativity among college students.

This work contributes to the exploration and establishment of a teaching framework that underpins the development of core student competencies, offering insights and strategic recommendations for promoting creativity cultivation within Chinese higher education. The novelty of this study lies in its application of a developmental perspective—commonly adopted in educational research—to conduct longitudinal investigations into the stimulation of individual creativity, thereby enriching the theoretical system pertaining to creativity development.

2 Literature review

2.1 Teaching model development

Recent developments in educational research have highlighted the increasing importance of teaching models as systematic frameworks that guide instructional practices (Crookes, 2013; Tsai and Chuang, 2019). Joyce et al. (2014) define teaching models as structured plans rooted in pedagogical principles, emphasizing their theoretical underpinnings. Tisana (2012a,b) further stresses the importance of aligning these models with core educational theories to enhance their effectiveness. Tumthong (2016) elaborates that an instructional model is a practical approach designed to achieve specific teaching and learning objectives. These models integrate stable operational procedures with theoretical concepts to facilitate targeted learning outcomes (Marzano, 2007). Moreover, they serve as vital tools to bridge the gap between theory and practice, ensuring consistent classroom implementation (Eggen and Kauchak, 2012a,b). In recent years, with the shift toward student-centered and innovative pedagogies, teaching models have increasingly emphasized personalization and adaptability (Liu, 2018; Zhou and Brown, 2020a). For example, models based on cooperative learning (Johnson and Johnson, 2017) focus on promoting collaborative engagement to deepen understanding, while project-based learning models (Thomas, 2019) aim to foster creativity and problem-solving skills through real-world projects.

In this study, Joyce and Weil's (2014) model was adopted and adapted. It consists of six components: Principles of the Model, Objectives, Syntax and Sequence, Social System, Principle of Reaction, and Support System, which collectively create a comprehensive framework conducive to effective teaching practice.

2.2 Creativity

Creativity, broadly defined as the capacity to generate original and valuable ideas (Guilford, 1950), has been the focus of extensive research employing diverse theoretical models. Guilford's Structure of Intellect model emphasized divergent thinking as a core component of creativity, highlighting the importance of flexibility, originality, and elaboration (Guilford, 1950). Taylor (1962) proposed a three-dimensional curriculum framework that integrated cognitive, affective, and psychomotor domains to foster creativity in educational settings. Building upon these foundations, Treffinger (1980) developed the Multidimensional Creative Learning (MCL) model, which integrates cognitive and emotional dimensions across three phases of learning, emphasizing the synergistic development of creative skills.

Williams (1970a,b) further conceptualized creativity through his Cube C.A.I. Model, which links cognitive and affective behaviors to classroom practices. His research identified four traits characteristic of highly creative individuals: risk-taking, curiosity, imagination, and challenge. These traits were operationalized using the Williams Creativity Tendency Scale, providing a validated measure of creative propensity (Williams, 1970a,b).

Recent studies have expanded the understanding of creativity in educational contexts. For instance, Han and Park (2020) examined the role of teacher-student interactions in promoting creativity and found that environments emphasizing psychological safety significantly increase students' willingness to take risks and explore novel ideas. Similarly, Kim (2019) emphasized the importance of integrating creative problem-solving tasks into curricula to foster divergent thinking and innovation.

Furthermore, Lee and Kim (2021) investigated the impact of creativity-focused pedagogies, such as inquiry-based and project-based learning, and reported that such approaches substantially enhance students' creative self-efficacy and idea generation. According to their findings, nurturing traits like curiosity and challenge is crucial for developing sustainable creative capacities. Cha et al. (2022) demonstrated that emotional engagement and motivation serve as mediators in cultivating creativity, highlighting the importance of fostering positive emotional states alongside cognitive skills.

This study adopts Williams' framework, interpreting creativity as a trait that can be cultivated through education, emphasizing students' agency in developing the four dimensions of creative tendency—risk-taking, curiosity, imagination, and challenge—to foster innovative outcomes.

2.3 Structure of Intellect (SOI) theory

Guilford's SOI model informs pedagogy by leveraging its triadic synergy (operations, content, products) to scaffold creativity development. Educators can design tasks targeting divergent thinking (e.g., idea fluency via symbolic content) and convergent refinement (e.g., evaluating semantic systems), aligning with SOI's emphasis on adaptive problem-solving (Guilford, 1967). Structured interventions—such as multisensory content delivery and transformational product creation—enhance cognitive flexibility, fostering innovation in academic and professional contexts (Kaufman and Beghetto, 2009; Runco, 2010). This framework ensures systematic cultivation of creativity through tailored interventions that bridge theoretical intellect and practical application (Sternberg, 2003).

2.4 Creative Problem Solving (CPS) theory

Creativity, cultivatable through targeted training, is intrinsically linked to structured problem-solving processes. Guilford (1950) conceptualized creativity as a four-phase cognitive sequence: problem recognition, ideation, evaluation, and solution formulation. This aligns with cognitive psychology frameworks that frame creativity as iterative problem-solving (Basadur, 2006). Parnes (1966) pioneered the CPS model, integrating divergent-convergent thinking principles into five stages: fact-finding, problem definition, idea generation, solution development, and implementation. Subsequent refinements, including Treffinger and Isaksen's (1985) three-component model (problem understanding, ideation, action planning) and Dorval's four-component framework, emphasize adaptability and systematic thinking.

The CPS model's pedagogical value lies in its emphasis on contextualized problem settings, iterative divergence-convergence cycles, and collaborative learning. The teaching framework in this study adopts CPS principles, combining problem-based learning with structured creative exercises to navigate complex challenges through exploration, reflection, and group discourse, thereby enhancing students' creative competencies.

2.5 Theoretical framework

This study's theoretical framework integrates Joyce et al.'s (2014) teaching model with Williams (1970a,b) creativity framework and Guilford's (1950) Structure of Intellect (SOI) theory. The teaching model provides a six-component structure to operationalize student-centered pedagogy, while Williams' framework defines creativity through four cultivable traits (risk-taking, curiosity, imagination, challenge). Guilford's SOI theory underpins the cognitive processes necessary for creative outcomes. Together, these theories establish a synergistic foundation: the teaching model guides instructional design, Williams' traits serve as measurable outcomes, and SOI informs task development to stimulate creativity. Empirical support from recent studies (e.g., Han and Park, 2020; Lee and Kim, 2021) further validates the framework's applicability in Chinese higher education contexts.

This study develops a teaching model with the core goal of cultivating students' creativity. In this study, the six components presented were adapted in developing the teaching model namely (1) principles of the model, (2) objectives, (3) syntax, (4) social system, (5) principle of reaction, and (6) Support system. The improvement of students' creativity level is used as evaluation indicators.

3 Methodology

3.1 Research design

This study was divided into 2 phases, including the development of the teaching model and the implementation of the model. In phase 1, the framework of the teaching model was determined through relevant document, literature and survey reports and the draft of the teaching model was designed and affirmed by five experts in relevant area. In phase 2, 32 class hours of teaching activities were used in this study. The instruments consisted of the teaching model, a teaching manual, established teaching standards and procedures, and pre-test and post-test assessments for creativity.

3.2 Data collection

In Phase 1, the researcher design the framework of the teaching model and submit to expert evaluation. The teaching model created with the valid information available with a high level of appropriateness ($x = 4.34$, S.D. $= 0.85$), was affirmed with connoisseurship from the 5 experts in developing process: including 1 expert in educational technology, 1 expert in curriculum and teaching, 1 expert in educational psychology, 1 expert in research and evaluation, and 2 experts in innovation and entrepreneurship education.

In Phase 2, the developed teaching model was implemented to enhance creativity among 60 students from Guangzhou Panyu Polytechnic (China) during the first semester of the 2024 academic year. They come from different classes of the same major, one is an experimental class that implements a specific teaching model, and the other is a control class that implements a traditional teaching model. The data collection took 32 class hours, consisted of the teaching model, a teaching manual, established teaching standards and procedures, and pre-test and post-test assessments for creativity.

3.3 Data analysis

The data analysis in this study involved a mixed method approach, tailored to assess the effectiveness of the developed teaching model in enhancing creativity among Chinese college students. Data collected from Phase 1 and Phase2 were analyzed using SPSS to calculate the mean and standard deviation. Additionally, the Williams Creativity Tendency Scale was employed

to assess improvements in the students' creativity, Independent and paired *t*-tests were used to compare students' pre- and post-learning achievements.

4 Results

The results of this study is presented on development and implementation of the teaching model aimed at promoting creativity among Chinese college students.

4.1 Results of development of the teaching model

Oriented toward SOI and CPS theories, the study developed the PIPT teaching model, follows the "problem-Ideation-Prototype-Testing" process with the primary objective of cultivating students' creativity. Each with detailed procedural steps to ensure practical implementation (show as Figure 1).

4.1.1 Problem discovery

Teachers mainly serve as organizers and guides while students take the lead in generating solutions. Instructors conduct pre-assessments of learners' prior knowledge through questionnaires and interviews. Interdisciplinary real-world problems (e.g., sustainable campus design) are curated via stakeholder consultations and industry trend analysis. Contextualized scenarios are presented using multimedia case studies and role-playing tasks to foster user empathy. Teachers facilitate guided discussions for problem refinement within thematic boundaries, culminating in user-centered problem statements with explicit evaluation criteria.

4.1.2 Ideation

Divergent thinking is structured using SCAMPER (Substitute, Combine, Adapt, Modify, Put to other uses, Eliminate, Reverse) and mind mapping techniques. Convergent thinking employs affinity diagramming for idea clustering and Pugh matrices for solution prioritization. Teacher-led checkpoint discussions guide groups through iterative cycles of idea analysis, proposal development, and solution optimization. Peer critique sessions evaluate novelty and feasibility.

4.1.3 Prototype

In this stage, students work in teams to produce physical or digital representations of their solutions, emphasizes transforming abstract ideas into tangible, low-fidelity prototypes or models. Execution follows a phased approach:

Phase 1: Rapid paper prototyping (2-h sessions) for conceptual validation.

Phase 2: Refined digital/physical modeling (1-week iterations).

Modular toolkits (e.g., Arduino sets) and just-in-time technical demonstrations support development. Iterative refinement is driven by peer critiques and instructor feedback within problem-feedback-revision cycles.

4.1.4 Testing

Students evaluate their prototypes' effectiveness by collecting data through various feedback channels, such as user testing, interviews, questionnaires, and observation. Solutions are evaluated using a tripartite rubric:

Novelty (0–5 scale: solution originality),

Feasibility (0–5 scale: technical/economic viability),

User Impact (A/B testing via validated usability surveys).

Scores below 3 on any dimension trigger re-ideation or re-prototyping. Feedback from target-user testing, interviews, and questionnaires informs iterative enhancements.

As Figure 2 shows, the teaching model consists of the 6 components: principles, objectives, syntax, social systems, reactions, and support systems.

To verify the accuracy and feasibility of the teaching model to promote creativity, 5 experts evaluated the appropriateness of the model. Table 1 presents that the PIPT model evaluated by five experts in the related area had the high level of quality and appropriateness in theories and principles, objective, syntax, social system, principle of Reaction, support system, and vision of the teaching model, consistency of the teaching model at a very highest level. It could be interpreted that the PIPT teaching model was an appropriate way to promote creativity for college students in China.

4.2 Results of implementation of the teaching model

To assess the impact of the teaching model, pre- and post-tests of creativity was conducted by using a standardized measurement tool. Participants were divided into an experimental group and a control group, and completed the pre-test before beginning the curriculum and the post-test upon implementation.

The researcher compared the pre- and post- test scores of experimental group using the PIPT teaching model, and the results are shown in Table 2.

According to Table 2, It can be concluded that the *t*-test showed a significant difference in the score between pre-and post-tests. The results of the study showed that students' overall level of creativity as well as sub-scores of adventurousness, curiosity, imagination, and challenging were statistically significantly higher after using the PIPT instructional model than before the study. Consequently, the students had a higher creativity achievement after learning through the developed model than that assessed before learning.

The researcher compared the pre- and post-test scores of control group using the traditional teaching model, and the results are shown in Table 3.

According to Table 3, the overall performance of creativity of the students in the control group before and after the implementation of teaching activities is roughly equal and there is no significant difference. And there is no significant difference in the performance of the indicators of adventurousness, curiosity, imagination, and challenge in the table of creative power.

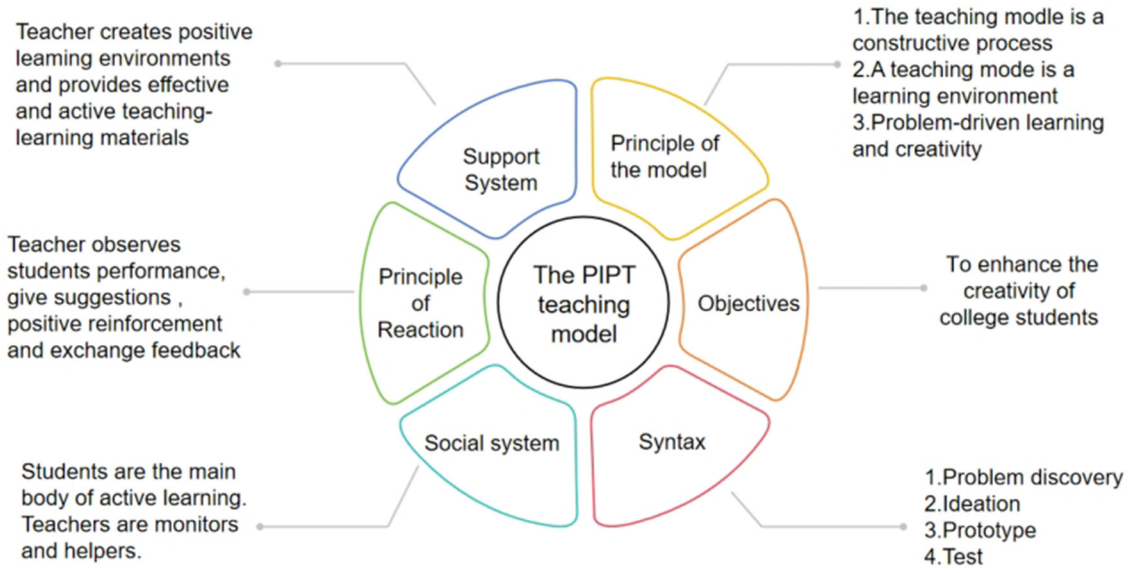

FIGURE 1
Components of the PIPT teaching model.

The results of implementation showed that there is a significant difference in the performance of creativity of students in the experimental and control groups by implementing different teaching modes for the same course. 1. The post-test creativity scores of students in the experimental group were higher than their pre-test scores. 2. The post-test creativity scores was significantly higher in the experimental group than in the control group.

5 Discussion

Analysis in this study identified CPS theory (Parnes, 1987) and SOI theory (Guilford, 1967) as fundamental frameworks underpinning the PIPT teaching model. This structurally sequenced model, which emphasizes contextualized problem-solving, flexible content, and scaffolded creative activities, aligns well with current pedagogical trends in Chinese higher education, particularly in fostering innovative capacities (Zhou and Brown, 2020b). The iterative refinement process ensured that the model effectively addressed learner needs, achieved clear objectives, employed suitable instructional strategies, and incorporated comprehensive evaluation metrics. The integration of Joyce et al.'s (2011) framework, encompassing objectives, syntax, social systems, reaction principles, support systems, and evaluation criteria, further enhanced its validity and applicability across diverse educational contexts. Expert validations confirmed the model's alignment with institutional priorities and its suitability for cultivating innovation-driven competencies.

Empirical results demonstrated statistically significant improvements in students' creativity post-intervention, consistent with prior research on instructional efficacy (Shalley, 2004; Zhang and Sternberg, 2021). The active engagement of teachers in supporting novel ideation and multidirectional thinking not only increased intrinsic motivation but also promoted autonomy and challenge-seeking behaviors, which are crucial for sustained creative development (Deci et al., 2001; Liu and Zhao, 2022). Furthermore, Angela's (2004) research highlights that instructional strategies emphasizing a stimulating learning environment significantly enhance creative motivation, resonating with Joyce et al.'s (2008) emphasis on social-contextual factors and student engagement. Recent studies have also underscored the importance of problem-based learning approaches (Li and Wang, 2019) and multimedia-supported creative activities (Chen et al., 2020) in nurturing higher-order thinking skills essential for innovation, which further validate the pedagogical design of the PIPT model.

6 Conclusion and recommendation

Create is classified as a higher-order cognitive skill for students according to Rum's classification of teaching objectives. In this research, a teaching model was developed to study students' creativity. The results indicated that the developed teaching model with six components had the highest level of quality and appropriateness, and students' creativity skills had improved. Based on the above research results, some recommendations will be proposed.

6.1 Suggestions for the implementation of the teaching model

(1) The teaching model was determined to be appropriate for improving creativity of college students comprised of 6 components including principles, objectives, syntax, principle of reaction, and support system. A higher learning achievement for college indicated that the developed model was productive in enhancing their creativity skills.

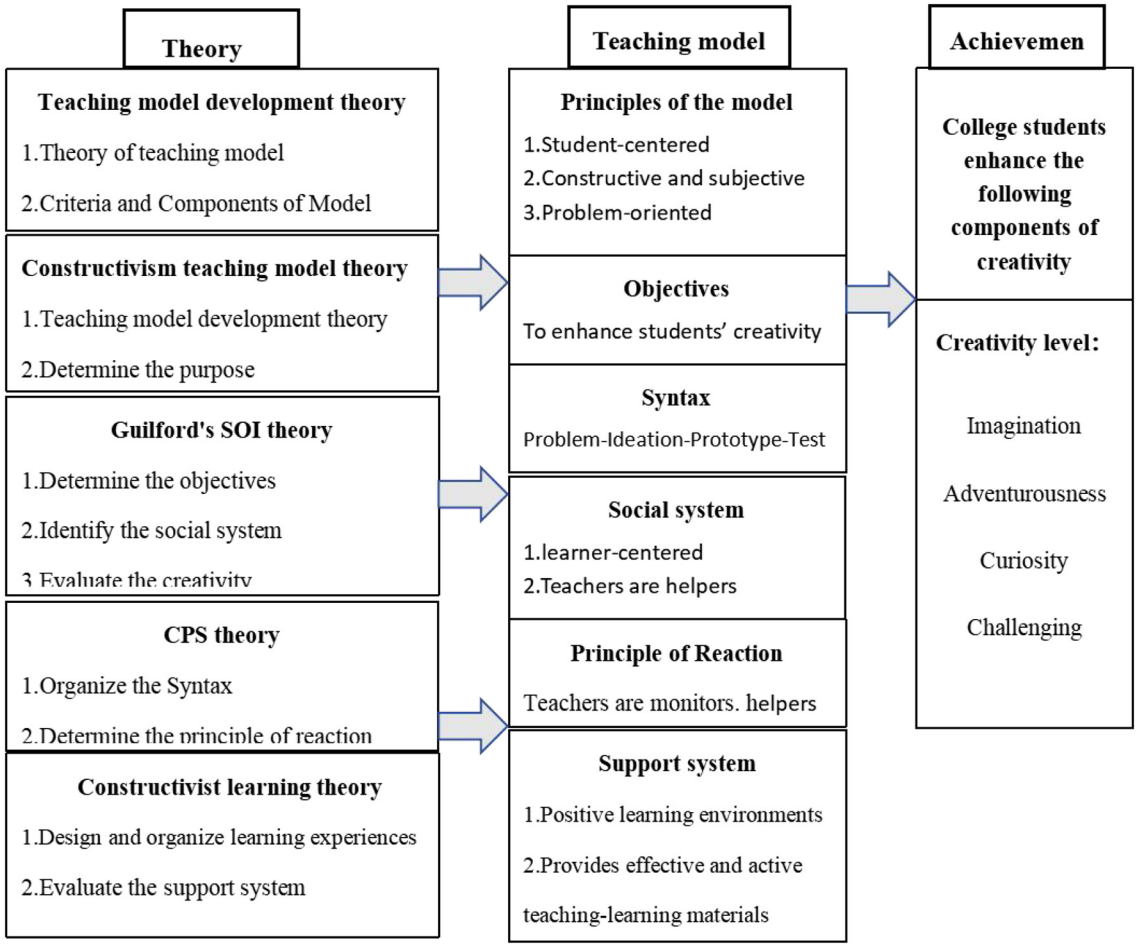

FIGURE 2
Conceptual framework.

TABLE 1 The evaluation of the PIPT teaching model.

No.	Content for evaluation	$\bar{X}$	S.D.	Grade
1	Vision of the teaching model	4.51	0.82	Most
2	Theories and Principles	4.41	0.72	More
3	Objective of the teaching model	4.41	0.72	More
4	Syntax of the teaching model	4.44	0.76	More
5	Social system	4.49	0.8	More
6	Principle of reaction	4.42	0.75	More
7	Support system	4.49	0.8	More
8	Consistency of teaching elements	4.51	0.82	Most

(2) Teachers should have enough comprehensive cognition to cultivate students' creativity, that is, it is reasonable and effective to cultivate creativity by designing appropriate creative teaching practice and creative thinking training.

(3)According to the teaching objectives, teachers should create a learning environment and support system of learning activities in real situations, and master interactive and collaborative learning methods.

(4) Creativity classrooms should be free, collaborative, and relaxed, and teachers should use methods that encourage, instruct, and encourage rather than force or pressure. Teachers should be able to adjust flexibly according to the actual situation.

(5)When evaluating students' creativity, evaluators should adopt diversified evaluation indicators and pay attention to process evaluation methods, so as to fully understand the purpose of teaching evaluation.

TABLE 2 Pre- and post-test results of the experimental group.

Creativity indicators	Group	*N*	Mean	*t*	sig
Adventurousness	Pre-test	30	3.4435	−4.23*	0.00
	Post-test	30	4.0634		
Curiosity	Pre-test	30	3.3918	−6.00*	0.00
	Post-test	30	4.1710		
Imagination	Pre-test	30	3.2354	−4.69*	0.00
	Post-test	30	4.1562		
Challenging	Pre-test	30	3.5530	−5.25*	0.00
	Post-test	30	4.3157		
Total Creativity Score	Pre-test	30	3.4059	−5.81*	0.0.00
	Post-test	30	4.1765		

*Statistical Sig.00.

TABLE 3 Pre- and post-test results of the control group.

Creativity indicators	Group	*N*	Mean	*t*	sid
Adventurousness	Pre-test	30	3.4492	0.04	0.97
	Post-test	30	3.4435		
Curiosity	Pre-test	30	3.3424	−0.42	0.68
	Post-test	30	3.3918		
Imagination	Pre-test	30	3.1742	−0.43	0.67
	Post-test	30	3.2354		
Challenging	Pre-test	30	3.3480	−1.45	0.15
	Post-test	30	3.5530		
Total creativity score	Pre-test	30	3.3285	−0.67	0.50
	Post-test	30	3.4059		

6.2 Suggestions for future research

(1) Increasing the sample size of the study.
(2)More diverse participant backgrounds.
(3) Expanding the application of technological tools.

7 Limitations and future directions

Despite the positive outcomes, this study has some limitations. The sample size may not fully represent the diversity of Chinese college students, and the generalizability of the results to other populations should be approached with caution.

Furthermore, the long-term impact of the teaching model on students' creativity beyond the scope of this study remains an area for further investigation. Continuous evaluation and refinement of the model are essential to ensure its sustainability and relevance. Additionally, comparative studies could investigate the effectiveness of this model in different cultural contexts and educational settings. Further research could also focus on the development of assessment tools and metrics to measure creativity more comprehensively.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

This research application has been reviewed and approved by the Ethics Committee for Research Involving Human Subjects, Mahasarakham University, Thailand. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JH: Data curation, Writing – review & editing, Writing – original draft. JC: Data curation, Writing – review & editing. CC: Writing – review & editing, Supervision.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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