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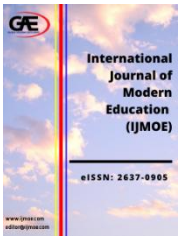

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A PROCESS-ORIENTED CREATIVITY ASSESSMENT FRAMEWORK FOR COMPUTER GRAPHICS EDUCATION IN CHINA: INTEGRATING THE COMPONENTIAL THEORY OF CREATIVITY AND MULTI-SOURCE EVALUATION

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Abstract:

Creativity assessment in computer graphics (CG) education has traditionally relied on product-oriented approaches, which may not fully capture the iterative and process-based nature of creative development. This study draws on the Componential Theory of Creativity. Based on this theoretical foundation, a process-oriented creativity assessment framework is proposed. The framework integrates cognitive, behavioral, and contextual dimensions of creative performance. To operationalize this framework, a multi-source evaluation system was developed, combining student self-report measures, expert-based Consensus Assessment Technique (CAT), and teacher interview data. A design-based research (DBR) approach, combined with a sequential mixed-methods design, was employed to iteratively construct and validate the framework within an authentic CG educational setting in China. A total of 126 undergraduate students and 3 instructors participated in an 8-week intervention.

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Keyword:
Artificial Intelligence; Computer Graphics; Creativity Development; Digital Media Education

Introduction

Creativity has become a core competency for graduates in digital media-related disciplines, particularly in computer graphics (CG), where professionals are expected to integrate technical expertise with innovative visual thinking and conceptual problem-solving (Henriksen et al., 2023; Liu & Chew, 2025). Within the global creative economy, digital media industries increasingly prioritize originality, adaptability, and creative decision-making alongside technical proficiency (OECD, 2023; Su & Mokmin, 2024). As a result, higher education institutions face growing pressure to redesign CG curricula to better support the systematic development of students' creative capabilities (UNESCO, 2022).

Despite these expectations, CG education in many universities remains predominantly technique-oriented, focusing heavily on software mastery, procedural accuracy, and standardized production workflows (Lin & Chen, 2024; Zhang & Li, 2023). Such approaches often limit opportunities for divergent thinking, conceptual exploration, and reflective learning, which are essential for creativity development (Beghetto, 2023). Consequently, students may demonstrate technical competence while lacking confidence in ideation, originality, and independent creative judgment (Henriksen et al., 2023).

In parallel, recent advances in artificial intelligence (AI), particularly generative and intelligent support technologies, have introduced new possibilities for creative education (Zawacki-Richter et al., 2023). AI tools can assist learners in generating visual ideas, exploring design alternatives, and receiving formative feedback throughout the creative process (Su & Mokmin, 2024; Lin & Chen, 2024). When embedded within sound pedagogical structures, AI has the potential to function as a cognitive scaffold that enhances creative thinking rather than replacing human creativity (Kong et al., 2023). However, without intentional instructional design, AI integration risks encouraging surface-level production or overreliance on automated outputs (Holmes et al., 2022).

In response to these challenges, this study develops and evaluates an AI-supported teaching module aimed at fostering creativity in undergraduate CG education. Rather than treating AI as a standalone technological tool, the module embeds AI within a structured pedagogical framework aligned with stages of the creative process (Henriksen et al., 2023). Using a design-based research methodology, this study examines how AI-supported instruction influences students' creative thinking, engagement, and learning experiences, thereby contributing to research on AI-enhanced creative pedagogy in digital media education (Anderson & Shattuck, 2022).

International Journal of Modern Education
IJMOE
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Creativity composition and Creative Learning

Componential Theory of Creativity

To further strengthen the theoretical grounding of creativity assessment, the Componential Theory of Creativity provides a comprehensive framework for understanding the underlying mechanisms of creative performance. According to this perspective, creativity emerges from the interaction of multiple components, including intrinsic motivation, domain-specific expertise, creativity-relevant processes, and environmental support (Viskontas, 2018; Bereczki & Nagy, 2023).

Intrinsic motivation is often considered a central driver of creativity, as individuals are more likely to engage deeply in creative tasks when driven by interest, curiosity, and personal satisfaction rather than external rewards (eun Min & Kim, 2024; Hadley, 2021; Wang & Kamal, 2024). In educational contexts, particularly in computer graphics (CG) courses that require sustained engagement, intrinsic motivation plays a crucial role in maintaining students' persistence and creative involvement.

In addition, domain-specific expertise constitutes a necessary foundation for creative expression. Creativity is not entirely generalizable across domains but is closely tied to specialized knowledge, technical skills, and disciplinary practices (Tromp & Baer, 2022; Emami et al., 2023). In CG education, this includes competencies such as visual composition, digital modeling, and software proficiency, which enable students to transform abstract ideas into concrete outputs.

Creativity-relevant processes further explain how individuals generate novel ideas. These processes include divergent thinking, cognitive flexibility, and the ability to shift perspectives when encountering constraints (Giancola et al., 2022; Fuchs et al., 2024). Such cognitive mechanisms are often accompanied by personality traits such as openness to experience, curiosity, and proactive engagement, all of which contribute to creative performance.

Finally, environmental factors play a critical role in shaping creativity. Supportive learning environments characterized by autonomy, collaboration, and constructive feedback have been shown to facilitate creative expression and enhance students' willingness to experiment (Zamana et al., 2025; Lin et al., 2024). In particular, classroom climates that encourage peer interaction, idea sharing, and iterative feedback can significantly influence both the process and outcomes of creative work.

Taken together, the Componential Theory of Creativity highlights that creativity is not a single ability but a systemic phenomenon arising from the interaction between individual, cognitive, and contextual factors. This perspective provides an important theoretical basis for integrating process-oriented and multi-source approaches to creativity assessment, as it underscores the need to evaluate not only creative products but also the motivational, behavioral, and environmental conditions that support creative development.

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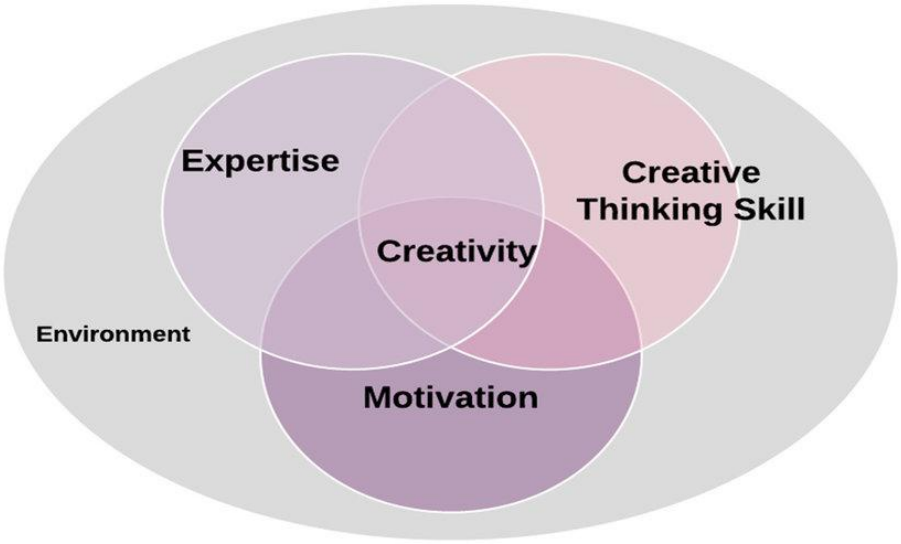

Figure 1 Componential Theory of Creativity

Cultural and Contextual Dimensions of Creativity

Sternberg studied the implicit theory of people's creativity. Through cluster analysis, he found that people's explanation of creativity can be summarized into four dimensions: one is not rigid in thought, good at synthesis and thinking, the other is beautiful appreciation and imagination, decision-making skills and flexibility; the third is strong judgment, achievement motivation and cognitive motivation; the fourth is good at asking questions and intuition. Sternberg studied implicit theories of intelligence, creativity, and intelligence in art, business, philosophy, and physics. The results show that although there are many overlapping elements in the implicit theory of creativity in different fields, they are not the same. In art, imagination, originality and risk-taking are emphasized, and there are a lot of new ideas (Huang et al., 2005).

The implicit theory of creativity highlights the importance of social validity in examining the structure of artistic creativity. Niu and Sternberg (2002) found through comparative research on creativity between China and the West that Western concepts of creativity emphasize aesthetics and humor, which are not considered as elements of creativity in China cultural context (Li & Liu, 2015). This study analyzes the creative elements of CG creation of China digital media art major students. Implicit creativity theory can better control the influence of cultural factors on creativity structure.

Recent research emphasizes the importance of cultural and contextual factors in creativity assessment (Guo et al., 2025). In non-Western contexts, creativity is often associated not only with novelty but also with cultural appropriateness and social value (Xu & Xiao, 2025). This perspective challenges universalist models of creativity and highlights the need for localized assessment frameworks (Tam et al., 2023). Integrating cultural dimensions into assessment can therefore provide a more accurate representation of creative performance in specific educational contexts (Guo et al., 2025).

Creativity Assessment Models

Creativity assessment has evolved from single-dimensional product evaluation toward multidimensional frameworks that incorporate cognitive processes. Among the most influential

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
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approaches, the Consensus Assessment Technique (CAT) remains a widely accepted method, emphasizing expert judgment of creative products based on novelty and appropriateness (Baer, 2022). However, recent research highlights that product-oriented approaches alone are insufficient to capture the dynamic and process-oriented nature of creativity, particularly in educational settings (Li et al., 2024).

Measures of creative processes are related to the cognitive processes associated with creativity and predict an individual's creative potential through the performance and completion of activities in creative tasks. Divergent thinking tests are the most commonly used to assess creativity, such as the Torrance Test of Creative Thinking (TTCT), which assessesfour indicators of an individual's creativity dimensions fluency, flexibility, uniqueness, and sophistication.

To address these limitations, contemporary studies increasingly integrate multi-level creativity measurement tools, including cognitive, behavioral, and achievement-based instruments. For instance, the Williams Creativity Assessment Packet (WCAP) evaluates both creative thinking ability and affective tendencies, incorporating dimensions such as fluency, flexibility, originality, and elaboration, alongside motivational traits such as curiosity and risk-taking. This dual-structure model reflects the interaction between cognitive processes and affective dispositions, aligning with multidimensional theories of creativity (Runco & Jaeger, 2012).

Similarly, the Runco Ideational Behavior Scale (RIBS) emphasizes everyday creative behavior, focusing on the frequency and intensity of idea generation, curiosity, and problem-solving activities. Unlike traditional ability-based assessments, RIBS captures "little-c creativity," highlighting creativity as a habitual cognitive-behavioral process rather than an exceptional outcome (Runco & Jaeger, 2012). This perspective is particularly relevant in educational contexts, where the development of creative thinking habits is more critical than measuring high-level achievements.

In addition, behavior-oriented instruments such as the Creative Behavior Inventory (CBI) assess the frequency of engagement in creative activities across domains, reflecting creativity as observable action rather than latent ability. Empirical studies suggest that such behavioral measures are strongly associated with intrinsic motivation and domain engagement, making them valuable for capturing students' creative participation over time (Li et al., 2024). However, these instruments often require contextual adaptation to specific disciplines, such as computer graphics, where creative behaviors are closely tied to digital production practices.

Achievement-based measures, including the Creative Achievement Questionnaire (CAQ) and Creative Achievement Scale (CAS), focus on externally validated accomplishments such as awards, publications, or exhibitions. While these tools are effective in assessing "Pro-c" or "Big-C" creativity, they are less suitable for short-term educational interventions, as students may not accumulate significant achievements within limited timeframes (Karunarathne & Calma, 2024). Consequently, their applicability in classroom-based research is limited.

Another relevant instrument is the Creative Domain Questionnaire (CDQ), which evaluates individuals' self-perceived creativity across different domains. Although CDQ provides insights into creative self-concept, it primarily reflects subjective perception rather than actual

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 30 (June 2026) PP. 361-376

creative performance, thereby limiting its validity as a standalone assessment tool (Li et al., 2024).

Taken together, these measurement approaches reveal a shift toward multi-source and multi-dimensional creativity assessment, integrating cognitive, behavioral, and product-based perspectives. However, existing frameworks often lack coherence, as different instruments operate at separate levels without forming an integrated evaluation system (Karunarathne & Calma, 2024). Moreover, few studies explicitly connect these measurement tools with pedagogical frameworks such as design thinking, which emphasize process-oriented creativity development.

Table 1: Overview of Major Creativity Assessment Approaches

Measurement Level	Instrument	Core Dimensions	Assessment Focus	Strengths	Limitations
Product-based	Consensus Assessment Technique (CAT)	Novelty, appropriateness (expert judgment)	Creative products	High ecological validity; domain-relevant evaluation	Ignores process; subjective; limited behavioral insight
Cognitive (process-oriented)	Torrance Tests of Creative Thinking (TTCT)	Fluency, flexibility, originality, elaboration	Divergent thinking ability	Widely validated; captures creative potential	Decontextualized; limited domain specificity
Cognitive + Affective	Williams Creativity Assessment Packet (WCAP)	Fluency, flexibility, originality, elaboration; curiosity, risk-taking	Thinking ability + affective traits	Integrates cognition and motivation	Complex scoring; limited accessibility
Behavioral (everyday creativity)	Runco Ideational Behavior Scale (RIBS)	Idea generation frequency, curiosity, problem-solving	Creative cognitive-behavioral habits	Captures "little-c creativity"; suitable for longitudinal use	Self-report bias; requires contextual validation
Behavioral (activity-based)	Creative Behavior Inventory (CBI)	Frequency of creative activities	Observable creative behavior	Easy administration; reflects engagement	Needs domain adaptation; requires factor validation
Achievement-based	Creative Achievement Questionnaire (CAQ)	Domain-specific achievements	Pro-c / Big-C creativity	Strong external validity	Not suitable for short-term educational contexts

International Journal of Modern Education
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IJMOE
Volume: 8 Issue: 30 (June 2026) PP. 361-376

Achievement-based	Creative Achievement Scale (CAS)	Awards, publications, exhibitions	Recognized creative outcomes	Objective indicators	Time-dependent; not suitable for classroom studies
Self-perception	Creative Domain Questionnaire (CDQ)	Self-perceived creativity across domains	Creative self-concept	Captures self-efficacy and identity	Subject: weak link to actual performance

Building on the theoretical foundations discussed above, it is necessary to operationalize these concepts into a measurable and applicable framework. To address this need, the present study develops a process-oriented creativity assessment model and examines its effectiveness in a real educational context.

This study builds upon existing measurement models by integrating self-report scales, expert-based evaluation (CAT), and contextualized assessment dimensions into a unified framework. By doing so, it addresses the gap between fragmented measurement approaches and the need for a comprehensive, process-oriented creativity assessment system in computer graphics education.

Research on Creativity Evaluation Model Combining Creative Components and Multidimensional Evaluation

Problem Analysis of Existing Creativity Assessment

Existing creativity assessment in computer graphics (CG) education remains largely dominated by product-oriented approaches that prioritize final outcomes while overlooking the dynamic processes through which creativity develops (Baer, 2022; Karunarathne & Calma, 2024). Such approaches tend to reduce creativity to static indicators of novelty and appropriateness, thereby failing to capture its iterative and process-based nature (Runco & Jaeger, 2012). In addition, current assessment practices often lack process-oriented measures capable of reflecting students' cognitive strategies, exploratory behaviors, and iterative refinement during creative tasks (Li et al., 2024; Xu & Yu, 2023). This limitation is particularly evident in CG education, where creativity emerges through cycles of ideation, experimentation, and revision (Chen et al., 2025; Guaman-Quintanilla et al., 2025). Furthermore, many existing frameworks rely on single-source evaluation methods, which may introduce bias and limit the reliability and validity of assessment outcomes (Wang & Kamal, 2024). Finally, insufficient attention has been paid to cultural and contextual factors, despite growing evidence that creativity is shaped by sociocultural environments and value systems (Guo et al., 2025; Xu & Xiao, 2025; Tam et al., 2023). Taken together, these limitations suggest the need for a more integrated, process-oriented, and multi-source creativity assessment framework in CG education.

This study employed a design-based research (DBR) approach, combined with a sequential mixed-methods design. The DBR approach guided the iterative development and refinement of the creativity assessment framework within an authentic educational setting, while the mixed-methods design enabled the integration of quantitative and qualitative data to evaluate

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 30 (June 2026) PP. 361-376

its effectiveness. Specifically, quantitative data were collected through a self-report creativity scale and CAT-based expert evaluation, while qualitative data were obtained through teacher interviews. This integrated design allowed for a comprehensive understanding of both the outcomes and processes of creativity development.

Student Level：Self-Report Creativity Scale

To capture students' process-oriented creativity in computer graphics (CG) practice, this study developed a domain-specific self-report creativity scale grounded in Componential Theory of Creativity, the 4P model, and the implicit theory of creativity. Creativity is widely understood as emerging from the interaction between domain-relevant skills, creativity-relevant processes, and intrinsic motivation (Amabile, 1983, 1996), while also being shaped by sociocultural context and evaluative standards (Sternberg, 1985; Rhodes, 1961). Accordingly, the scale was designed to assess observable and reportable creative behaviors rather than static traits, aligning with recent calls for process-oriented creativity assessment (Runco & Jaeger, 2012; Li et al., 2024).

The scale consists of 25 items across five dimensions; each measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). By focusing on behavioral frequency and engagement, the instrument captures students' actual participation in creative processes rather than relying solely on subjective perceptions (Karunarathne & Calma, 2024).

Table 2: Dimension Design of Computer Graphics Creativity Scale

Dimension	Behavioral Indicators	Description	Theoretical Basis
Conceptual Innovation and Originality	Developing unique visual themes; combining unrelated concepts; avoiding conventional templates; generating multiple solutions; expressing abstract ideas visually	Measures students' ability to generate novels, diverse, and meaningful ideas in CG design, emphasizing originality, abstraction, and divergent thinking	Amabile (2011); Palmiero et al. (2015); Kohn et al. (2011); Steffens et al. (2016)
Exploration and Cognitive Flexibility	Switching between styles; testing multiple approaches; abandoning initial solutions; critically evaluating ideas; seeking new perspectives	Captures flexibility in thinking and the ability to explore alternative design strategies, reflecting cognitive adaptability and problem restructuring	Egner & Siqi-Liu (2024); Amabile (1996); Le Masson et al. (2017)
Adventure and experimental spirit	Persistence under difficulty; self-initiated projects; iterative refinement; preference for challenging solutions; real-world application	Assesses willingness to engage in uncertain, challenging, and exploratory creative activities, highlighting experimentation and persistence	Wu & Koutstaal (2020)

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 30 (June 2026) PP. 361-376

Technical Practice and Skill Application	Learning advanced tools; integrating multiple techniques; applying aesthetic principles; refining technical details; studying exemplary works	Evaluates domain-specific skills and the ability to transform ideas into high-quality outputs through technical and aesthetic competence	Amabile (1983, 1996); Cross (1982);; Emami et al. (2023)
Cultural Value and Contextual Appropriateness	Integrating cultural elements; applying cultural aesthetics; adapting to audience/context; generating social value; cultural representation	Captures sociocultural dimensions of creativity, emphasizing appropriateness, cultural relevance, and value-oriented expression	Amabile (1983); Sternberg & Lubart (1999); Niu & Sternberg (2002); Guo et al. (2025); Tam et al. (2023)

The scale was developed through a theory-driven approach, ensuring alignment with multidimensional models of creativity. Items were designed to reflect observable behaviors in CG practice, thereby enhancing ecological validity. Content validity was established through expert review, ensuring domain relevance and clarity of measurement items.

Importantly, the scale functions as one component of a broader multi-source assessment system, alongside CAT-based expert evaluation and teacher interviews. While the self-report scale captures internal processes and behavioral tendencies, it is triangulated with external evaluations to improve construct validity and reduce potential bias (Creswell & Plano Clark, 2007; Wang & Kamal, 2024).

Product Level：CAT-Based Expert Evaluation

To complement the process-oriented self-report scale and capture the quality of creative outputs, this study adopts the Consensus Assessment Technique (CAT) as a product-level evaluation method. Originally proposed by Amabile (1982), CAT is based on the premise that creativity can be most validly assessed through the consensual judgments of domain experts, rather than through predefined objective criteria. According to this approach, a product is considered creative to the extent that it is recognized as such by knowledgeable evaluators within the relevant field (Baer & McKool, 2009).

Consistent with widely accepted definitions, creativity in CAT-based evaluation is operationalized as the combination of novelty and appropriateness, reflecting both originality and contextual value (Runco & Jaeger, 2012; Harvey & Berry, 2023; Kanematsu & Barry, 2016). Unlike process-based measures, CAT focuses exclusively on creative products, emphasizing outcome quality rather than the behaviors or cognitive processes of the creator. This distinction makes it particularly suitable for evaluating students' final CG works within authentic design contexts.

While CAT provides a robust general framework, its application often requires contextual adaptation to specific domains and cultural settings. Previous studies have demonstrated that cultural context significantly influences both creative production and evaluation criteria (Niu & Sternberg, 2001). In particular, research on Chinese artistic creativity suggests that

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 30 (June 2026) PP. 361-376

evaluators tend to emphasize not only originality but also technical proficiency, aesthetic quality, emotional expression, and cultural appropriateness (Li Jipin & Liu Xiuli, 2015).

The adapted CAT instrument includes seven core dimensions, each rated on a five-point scale (1 = very low, 5 = very high):

- Comprehensive Impression – overall evaluation of the balance between novelty and value, reflecting holistic creative performance
- Creativity (Originality) – degree of novelty and conceptual innovation in the work.
- Imagination – richness and depth of imaginative expression and conceptual breakthrough.
- Artistic Quality – visual aesthetics, composition, and expressive quality of the work.
- Technical Refinement – level of technical execution and detail completion.
- Communication Clarity – effectiveness of visual language in conveying meaning or narrative.
- Appropriateness and Cultural Significance – alignment with cultural context, social value, and audience relevance.

These dimensions extend traditional CAT evaluation by incorporating cultural and contextual factors, which are increasingly recognized as essential components of creativity assessment (Niu & Sternberg, 2001; Guo et al., 2025).

Role within the Multi-Source Assessment Framework

Within the overall research design, CAT serves as the product-level component of the multi-source assessment system. While the self-report scale captures students' creative behaviors and internal processes, CAT provides an external and outcome-oriented evaluation of creative performance. This complementary relationship enables a more comprehensive assessment of creativity by integrating process, product, and contextual perspectives (Creswell & Plano Clark, 2007; Wang & Kamal, 2024).

Furthermore, the inclusion of culturally grounded evaluation criteria strengthens the contextual validity of the framework, ensuring that creativity is assessed not only in terms of originality but also in relation to sociocultural meaning and applicability.

International Journal of Modern Education
IJMOE
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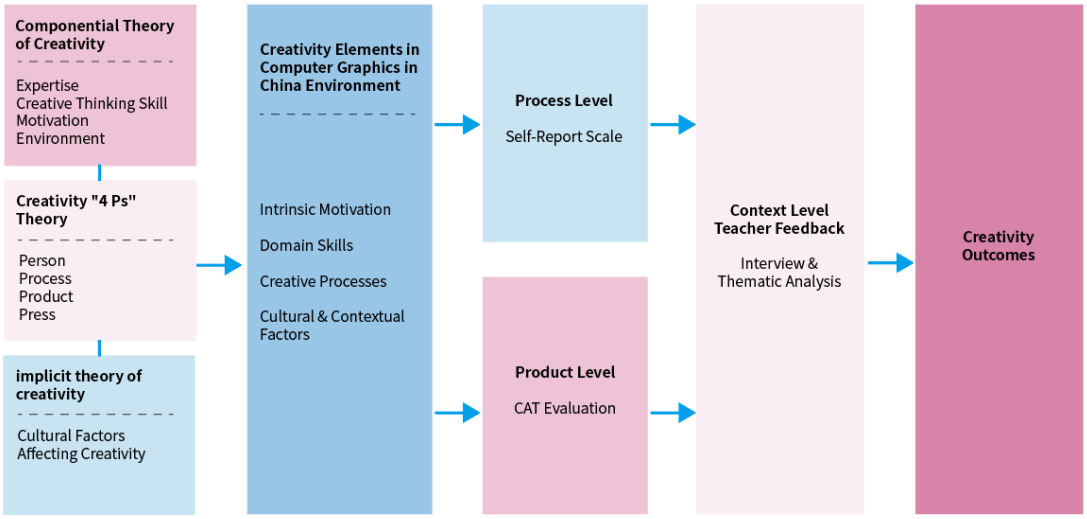

Figure 2: A Process-Oriented Creativity Assessment Framework

Related Algorithms and Applied Practical Methods

To operationalize the proposed process-oriented creativity assessment framework, this study integrates a set of quantitative algorithms and applied analytical methods to ensure the reliability, validity, and interpretability of the evaluation results. These methods support the transformation of qualitative creative performance into structured and analyzable data, thereby bridging the gap between subjective evaluation and empirical measurement.

Reliability and Internal Consistency Analysis

To assess the internal consistency of the self-report creativity scale, Cronbach's alpha coefficient was employed. Cronbach's α is widely used in educational and psychological measurement to evaluate the extent to which items within a scale measure the same underlying construct (Cohen, 2022).

In this study, reliability analysis was conducted for both the overall scale and each sub-dimension. A threshold of $\alpha \geq 0.70$ was considered acceptable, while values above 0.90 indicate high reliability. This analysis ensures that the scale provides stable and consistent measurements of students' creative behaviors.

Construct Validity and Factor Analysis

To examine the structural validity of the proposed scale, exploratory factor analysis (EFA) was applied. EFA is commonly used to identify latent constructs and verify whether the observed variables align with the intended dimensional structure (Creswell & Plano Clark, 2007).
The analysis included:

Kaiser-Meyer-Olkin (KMO) test for sampling adequacy.
Bartlett's Test of Sphericity for factorability.
Principal component extraction with rotation.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 30 (June 2026) PP. 361-376

This procedure allowed for the validation of the six-dimensional structure of creativity, ensuring that each dimension reflects a distinct yet related aspect of creative performance.

Inter-Rater Reliability of CAT Evaluation

Given that the CAT-based evaluation relies on expert judgment, inter-rater reliability (IRR) was calculated using the Intraclass Correlation Coefficient (ICC). ICC is an appropriate statistical method for assessing the degree of agreement among multiple raters evaluating the same set of objects (Baer & McKool, 2009).

In this study, ICC values above 0.75 were considered indicative of good reliability, while values above 0.85 reflect strong agreement. This analysis ensures that expert evaluations are consistent and not significantly influenced by individual bias.

Qualitative Analysis and Thematic Coding

To complement quantitative findings, qualitative data from teacher interviews were analyzed using thematic analysis. This method involves identifying, coding, and categorizing recurring patterns in textual data (Creswell & Plano Clark, 2007).

The analysis process included:

- Open coding of interview transcripts.
- Axial coding to identify thematic relationships.
- Cross-case comparison to identify consistent patterns.
- This approach enables a deeper understanding of how the assessment framework influences teaching practices and student creativity development.

Data Triangulation and Multi-Source Integration

To enhance the validity of the findings, this study adopts a data triangulation strategy, integrating three sources of data:
Self-report creativity scale (process level).

- CAT-based expert evaluation (product level).
- Teacher interviews (context level).
- Triangulation is widely recognized in mixed-methods research as a means of improving construct validity and reducing bias by cross-verifying findings across multiple data sources (Creswell & Plano Clark, 2007; Wang & Kamal, 2024).

Through this integration, creativity is assessed as a multi-dimensional construct, encompassing behavioral engagement, product quality, and contextual interpretation.
To evaluate the effectiveness of the proposed framework, both quantitative and qualitative data were collected and analyzed. The following section presents the results of this analysis.

Results

The results indicate that the proposed scale demonstrates high internal consistency (Cronbach's $\alpha = 0.93$), exceeding the recommended threshold of 0.70 and suggesting strong

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 30 (June 2026) PP. 361-376

reliability. In addition, the CAT-based evaluation showed high inter-rater agreement (ICC = 0.87), indicating consistent expert judgment across raters.

Furthermore, independent samples t-tests revealed that students in the experimental group achieved significantly higher creativity scores than those in the control group ($p < 0.01$). The effect size was large (Cohen's d = 0.82), suggesting that the intervention had a substantial impact on students' creative performance.

Qualitative findings further support these results, indicating increased student engagement, iterative design behavior, and enhanced awareness of cultural context.

Discussion and Implications

The findings suggest that creativity assessment should be reconceptualized as a process-oriented construct rather than a static outcome, which is consistent with recent theoretical developments in creativity research (Runco & Jaeger, 2012). By integrating design thinking into assessment, this study extends existing frameworks and demonstrates how process-based evaluation can enhance both learning and assessment.

Furthermore, the use of multi-source data addresses limitations of single-method approaches and improves the reliability and validity of creativity assessment, supporting arguments from mixed-methods research (Creswell & Plano Clark, 2007). The inclusion of cultural dimensions also aligns with emerging perspectives on contextualized creativity, particularly in non-Western educational settings (Guo et al., 2025).

From a practical perspective, the framework provides educators with a structured yet flexible tool for assessing creativity in CG courses. It also highlights the potential of integrating AI-assisted evaluation in future research, which has been identified as a promising direction in educational technology (Xu & Yu, 2023).

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International Journal of Modern Education
IJMOE
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