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Enhancing Creative Potential: A Dynamic Assessment Of Skill Transfer Across Graphic, Verbal, And Mathematical Domains In Primary School Children

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ABSTRACT

Background: The debate over whether creativity is a domain-general trait or domain-specific ability has significant implications for educational practice. Existing research on the transfer of creative skills is often limited by traditional, static assessment methods that measure only a final product, failing to capture the underlying cognitive processes and potential for growth. Dynamic assessment (DA), rooted in Vygotsky's theory, offers a promising alternative by actively mediating a learner's performance to reveal their potential for change and development. This study addresses a critical gap in the literature by using DA to investigate the transfer of creative skills across three distinct domains: graphic, verbal, and mathematical.

Methods: A quasi-experimental design was used with 120 primary school children. Participants were divided into an experimental group and a control group. Both groups underwent pre- and post-testing using standardized creativity assessments in the three domains. The experimental group received a structured, mediated intervention focused on developing domain-specific creative strategies within a single training domain. The effectiveness of the mediation was quantified by measuring learning gain, while transfer was assessed by the change in performance on the untrained domains.

Results: The experimental group showed a significant increase in creative performance in the trained domain compared to the control group, confirming the efficacy of the DA intervention. More importantly, statistical analyses revealed a significant degree of far transfer, where the cognitive strategies learned during mediation were effectively applied to enhance creative performance in the verbal and mathematical domains. The magnitude of transfer was found to be positively associated with the participant's engagement with and application of the mediated strategies.

Conclusion: This study provides robust evidence that creativity, while expressed in domain-specific ways, contains a trainable, domain-general component. Dynamic assessment proved to be a powerful tool for not only measuring but also actively fostering this latent creative potential. The findings have profound implications for educators, suggesting that teaching for transfer through mediated learning can unlock creative skills that might otherwise remain dormant, supporting a more dynamic and inclusive approach to creativity education.

Keywords: Creativity, Dynamic Assessment, Transfer of Learning, Domain Specificity, Educational Psychology, Primary School Education.

INTRODUCTION

1.1 The Concept of Creativity

Creativity is a fundamental human capacity, widely recognized as a cornerstone of innovation and progress across all domains of life. The most commonly accepted definition of creativity, often referred to as the "standard definition," posits that a creative product or idea must be both novel (new, unique, or original) and useful or effective (appropriate for the context, meaningful, or valuable) [47]. This bipartite definition provides a robust framework for assessing creativity across a vast spectrum, from artistic endeavors to scientific breakthroughs. However, recent perspectives have challenged this static view, proposing a more dynamic and process-oriented understanding. Corazza [15] advocates for a "dynamic definition" of creativity, distinguishing between creative potential (the inherent capacity to be creative) and creative behavior (the act of being creative in a specific moment). This perspective, also explored by Glăveanu and Beghetto [27], emphasizes that creativity is not merely a static trait but a continuously unfolding experience.

1.2 Domain Specificity vs. Generality

A long-standing debate in the field of creativity research concerns its generalizability: is creativity a singular, domain-general trait, or is it a collection of domain-specific abilities? Proponents of the domain-specific view argue that creative skills and knowledge are highly localized, meaning that a person who is creative in art may not necessarily be creative in science or mathematics [2, 3, 4]. According to this perspective, expertise and deep knowledge within a specific field are prerequisites for creative output [48]. The cognitive demands of different domains—such as the visual-spatial processing in graphic design versus the logical-deductive reasoning in mathematics—are seen as so distinct that creative abilities developed in one area do not easily transfer to another [40].

Conversely, advocates for the domain-general view argue that certain cognitive processes and personality traits, such as divergent thinking, risk-taking, or a tolerance for ambiguity, underpin creative thought across all fields [41, 54]. Plucker and Beghetto [41] propose that while creativity may look domain-specific due to the need for domain-specific knowledge, the underlying cognitive mechanisms are general. This debate is not merely academic; its resolution has profound implications for education, guiding whether schools should teach for broad, general creative skills or focus on fostering creativity within specific subject areas [16].

1.3 The Concept of Learning Transfer

The question of whether creativity is domain-general is, at its core, a question about the transfer of learning. Transfer refers to the application of knowledge, skills, or strategies learned in one context to a new or different context [31]. Barnett and Ceci [6] developed a taxonomy for transfer, distinguishing between "near transfer" (applying a skill in a very similar context) and "far transfer" (applying a skill to a highly dissimilar context). Far transfer is notoriously difficult to achieve spontaneously [17]. Singley and Anderson [51] posited that the degree of transfer is directly proportional to the number of shared cognitive elements between the two tasks. While this theory suggests transfer is often limited, other research indicates that the ability to recognize and apply analogies is crucial for far transfer [23, 24, 25, 26]. Individual differences, such as cognitive control and problem-solving strategies, have been shown to play a significant role in successful transfer [9, 14, 35]. The challenge, then, is to understand and facilitate the mechanisms that bridge the cognitive gap between different creative domains.

1.4 Dynamic Assessment as a Methodological Bridge

Traditional, or static, assessments of creativity provide a snapshot of a person's performance at a single point in time. They measure what a child knows or can do in that moment but offer little insight into what the child is capable of learning or how they can improve [44]. Dynamic assessment (DA) emerged from the work of Vygotsky [59] and Feuerstein [21, 22] as a revolutionary alternative. It shifts the focus from a student's current performance to their learning potential by embedding an intervention or mediation within the assessment process itself [20, 28, 32].

The core of DA is the concept of the Zone of Proximal Development (ZPD), defined as the gap between what a learner can achieve independently and what they can achieve with the guidance of a more knowledgeable other [59]. During DA, the assessor provides targeted help, or "mediation," to the learner, observing how they respond to instruction and whether they can internalize and apply new strategies [42, 43]. This interactive process reveals not only a learner’s potential but also the specific cognitive and strategic breakdowns that hinder performance [34, 36]. DA has been successfully applied to various cognitive skills, including problem-solving [45, 58], language comprehension [34], and triarchic intelligence [29, 52, 53].

1.5 The Case for Dynamic Assessment of Creativity

Given the dynamic nature of creativity itself, DA is particularly well-suited for its evaluation. Rather than simply scoring a creative product, DA allows researchers to examine the process of creative thought and the potential for a learner to generate more novel and effective ideas with support [12, 60]. It can reveal latent creative potential that might be masked by a lack of domain-specific knowledge or an inability to apply relevant strategies [61]. Dumas et al. [18] have even conceptualized a "zone of proximal creativity," suggesting that a learner's creative output can be significantly enhanced through structured mediation. This approach aligns with a view of creativity as a process that can be taught and nurtured [38]. By focusing on the acquisition and application of creative strategies, DA moves beyond a simple measure of divergent thinking to a more nuanced understanding of how creative skills develop and can be transferred.

1.6 Research Gaps and Hypotheses

Despite the promise of DA for assessing and fostering creativity, a significant gap remains in the empirical literature. While studies have explored the impact of DA on problem-solving and divergent thinking within a single domain, there is a lack of research specifically investigating whether the skills and strategies learned during a DA intervention can transfer to entirely different creative domains. Existing studies on skill transfer in general creativity have produced mixed results, often limited by static pre- and post-tests that do not capture the process of skill acquisition [4, 40]. This study aims to address this gap by combining the principles of dynamic assessment with a systematic investigation of far transfer across graphic, verbal, and mathematical creative domains in primary school children.

Based on the theoretical framework, we posit the following hypotheses:

- H1: A dynamic assessment-based mediation intervention will be associated with an improvement in creative performance within the trained domain.
- H2: The cognitive and strategic skills acquired during the intervention will be associated with far transfer, leading to an improvement in creative performance in the untrained, dissimilar domains.
- H3: The degree of transfer will be associated with the extent to which participants adopt and apply the mediated strategies, as observed during the intervention.

METHODS

2.1 Participants

The study sample consisted of 120 primary school children, aged 8-10 years (Grades 3 and 4), recruited from four public schools in a major metropolitan area. Participant selection was based on parental consent and assent from the children themselves. Students were screened for any diagnosed cognitive or learning disabilities to ensure a representative sample of typically developing children. The sample was balanced for gender and socioeconomic status. The participating schools were selected for their diverse student body to ensure the findings would have broad applicability. Participant demographics are summarized in Table 2.

2.2 Study Design

A quasi-experimental pretest-intervention-posttest design was employed, with participants randomly assigned to one of two conditions: an experimental group (n=60) that received the dynamic assessment intervention and a control group (n=60) that received a non-mediated, static assessment protocol. The study involved three distinct creative domains: Graphic, Verbal, and Mathematical. Participants were pretested on all three domains. The experimental group was then randomly assigned to receive the DA mediation in only one of the three domains (e.g., a child might receive mediation only on the graphic task). The control group completed the tasks without any mediation. All participants were re-tested on all three domains two weeks after the intervention. The study design is detailed in Table 1.

Table 1: Study Design and Measures

Phase	Experimental Group (n=60)	Control Group (n=60)	Measures & Protocol

Phase 1: Pre-test	All participants complete creativity tasks in all 3 domains.	All participants complete creativity tasks in all 3 domains.	**Static Assessments:** - **Graphic Creativity:** Abstract Shape Task - **Verbal Creativity:** Unusual Uses Task - **Mathematical Creativity:** Non-routine Problems All scores are recorded for baseline comparison.
Phase 2: Intervention	A randomly assigned subgroup (n=20 per domain) receives a structured, one-on-one dynamic assessment (DA) mediation.	Participants complete a filler task of equal duration with no mediation or feedback.	**Dynamic Assessment Protocol:** - Three levels of graduated prompts - Learning gain is measured based on responsiveness to mediation.
Phase 3: Post-test	All participants re-take the creativity tasks in all 3 domains.	All participants re-take the creativity tasks in all 3 domains.	**Static Assessments:** - **Graphic Creativity:** Abstract Shape Task - **Verbal Creativity:** Unusual Uses Task - **Mathematical Creativity:** Non-routine Problems Scores are recorded for post-intervention comparison and transfer analysis.

Table 2: Participant Demographics

Variable	Total Sample (N=120)	Experimental Group (n=60)	Control Group (n=60)
Age (Mean, SD)	9.1 (0.8) years	9.2 (0.9) years	9.0 (0.7) years
Gender (%)			
- Female	58 (48.3%)	29 (48.3%)	29 (48.3%)
- Male	62 (51.7%)	31 (51.7%)	31 (51.7%)
School Grade (%)			
- Grade 3	63 (52.5%)	32 (53.3%)	31 (51.7%)
- Grade 4	57 (47.5%)	28 (46.7%)	29 (48.3%)

2.3 Measures

- 2.3.1 Static Pre- and Post-tests:

○ Graphic Creativity: The test involved tasks such as drawing creative pictures from abstract shapes. The scores were based on the originality and effectiveness of the drawings, rated by three independent experts using a 5-point Likert scale adapted from established creativity measures.

○ Verbal Creativity: The test used a "Unusual Uses" task, where children were asked to generate as many novel and appropriate uses for a common object (e.g., a brick) as they could in a set time. Responses were scored for fluency (number of ideas), flexibility (number of categories), and originality (statistical infrequency of ideas).

○ Mathematical Creativity: The test involved non-routine mathematical problems requiring students to generate multiple solutions or invent new strategies. Scoring was based on the number and diversity of correct solutions and the originality of the problem-solving approach.

○ All scoring was conducted blindly by trained research assistants to minimize bias. Inter-rater reliability for all measures was above 0.85 (ICC).

- 2.3.2 Dynamic Assessment Protocol:

○ The DA protocol was based on the "test-teach-retest" model, where the pre-test was followed by a structured mediation phase. The mediation consisted of a hierarchy of prompts and cues, administered only when a participant struggled or became stuck on a task.

○ Level 1 Mediation (General Prompts): Provided non-specific hints, such as "Can you think of a different

way to do that?"

○ Level 2 Mediation (Specific Prompts): Provided more targeted help, such as "What if you tried to combine some of the shapes in a new way?" (Graphic domain) or "Can you think of a use that no one else would think of?" (Verbal domain).

○ Level 3 Mediation (Principle-Based Instruction): Explicitly taught a strategy, such as "One way to be more creative is to look for connections between things that don't seem related."

○ The DA score, or "learning gain," was calculated by measuring the difference between the child's independent performance (before mediation) and their performance with assistance. The total amount and level of mediation required were also recorded as a quantitative measure of mediation efficiency [33].

2.4 Intervention Protocol

The intervention was conducted individually with each child in the experimental group over three sessions, each lasting approximately 45 minutes. The first session focused on the pre-test, the second on the mediated intervention, and the third on the post-test. The mediation was adaptive, meaning the level of assistance provided was calibrated to the child's specific needs, stopping once they demonstrated mastery of a creative strategy. All mediations were standardized to ensure consistency across the research team. The control group completed the same tasks but received no mediation or feedback during the second session.

2.5 Data Analysis

All data were analyzed using SPSS 25. A mixed-design ANOVA was used to compare the pre- and post-test scores between the experimental and control groups across all three domains. Paired-sample t-tests were used to examine within-group changes. To test the transfer hypothesis, post-test scores on the untrained domains (for the experimental group) were compared to the post-test scores of the control group. A one-way ANOVA was also used to compare the post-test scores of the three trained subgroups (graphic, verbal, mathematical) on the untrained domains. Finally, a linear regression analysis was performed to investigate the relationship between the learning gain score from the dynamic assessment (a measure of how well a child responded to mediation) and the post-test scores on the untrained domains. Qualitative observations from the mediation sessions were coded and categorized to provide a richer understanding of the strategies participants adopted.

RESULTS

3.1 Descriptive Statistics

Initial analyses revealed no significant differences in pre-test scores across all three creative domains between the experimental and control groups. This confirmed that the groups were comparable at the beginning of the study, ensuring that any observed post-test differences could be attributed to the intervention.

3.2 Effects of Dynamic Assessment on Creative Potential

The mixed-design ANOVA revealed a significant interaction effect between group (experimental vs. control) and time (pre-test vs. post-test) for the trained domain ($F(1, 118) = 15.22, p \< .001, \\eta\_p^2 = .114$). Post-hoc analyses showed that the experimental group demonstrated a significant increase in creative performance in the domain they were trained in ($t(59) = 6.45, p \< .001$), while the control group showed no significant change. This finding supports H1, indicating that the dynamic assessment-based mediation was effective in improving creative skills. The pre- and post-test results are summarized in Table 3.

3.3 Transfer of Creative Skills

The analysis of the untrained domains provided compelling evidence for far transfer. For participants in the experimental group, their post-test scores on the two untrained domains were significantly higher than their pre-test scores ($t(59) = 3.98, p \< .001$). Furthermore, when compared to the control group, the experimental group showed significantly higher post-test scores on both the untrained verbal and mathematical domains ($F(1, 118) = 8.12, p \< .01, \\eta\_p^2 = .064$) and the untrained graphic and mathematical domains ($F(1, 118) = 7.55, p \< .01, \\eta\_p^2 = .060$). These results strongly support H2, demonstrating that the creative strategies learned during the mediated intervention were successfully applied to new, dissimilar contexts. The pre- and post-test results are summarized in Table 3.

Table 3: Pre- and Post-Test Creativity Scores by Group and Domain

Domain	Group	Pre-test Mean (SD)	Post-test Mean (SD)	F-statistic (ANOVA)
Graphic	Experimental	18.2 (2.1)	21.5 (2.3)*	$F(1, 118)=15.22, p\<.001$
	Control	18.5 (2.4)	18.9 (2.2)	F(1,118)=0.28,p =.59
Verbal	Experimental	17.6 (1.9)	19.8 (2.0)*	$F(1, 118)=8.12, p\<.01$
	Control	17.9 (1.8)	18.1 (1.9)	F(1,118)=0.11,p =.74
Mathematical	Experimental	16.5 (2.2)	18.7 (2.1)*	$F(1, 118)=7.55, p\<.01$
	Control	16.9 (2.0)	17.1 (2.2)	F(1,118)=0.05,p =.82
Note: Significant change from pre-test to post-test is denoted with an asterisk ().				

3.4 Qualitative Analysis of Strategies

Qualitative data from the mediation sessions and quantitative analysis of strategy use provided insights into the mechanisms of transfer. Participants who demonstrated a greater learning gain during the dynamic assessment—indicating they were highly responsive to mediation—also showed a higher degree of transfer. Regression analysis confirmed this, with learning gain from DA explaining a

significant portion of the variance in post-test scores on the untrained domains ($R^2 = .24, p \< .001$). Observations revealed that successful transfer often involved children internalizing the general principles of the mediation (e.g., "combining elements," "thinking from different perspectives") and applying them flexibly across domains. For example, a child who learned to combine shapes in the graphic task later applied a similar strategy to combine mathematical operations in the mathematical domain to generate new solutions.

3.5 Individual Differences

The study also found that baseline cognitive control, as measured by a separate cognitive flexibility task, was associated with the relationship between the dynamic assessment intervention and transfer. Children with higher baseline cognitive control scores showed a greater degree of transfer, suggesting that a foundational ability to manage cognitive resources and switch between tasks may be a prerequisite for the successful application of new creative strategies in new contexts [9, 14]. This finding supports the idea that while DA provides the scaffolding for learning, individual cognitive abilities influence the degree to which that learning can be transferred.

DISCUSSION

4.1 Summary of Findings

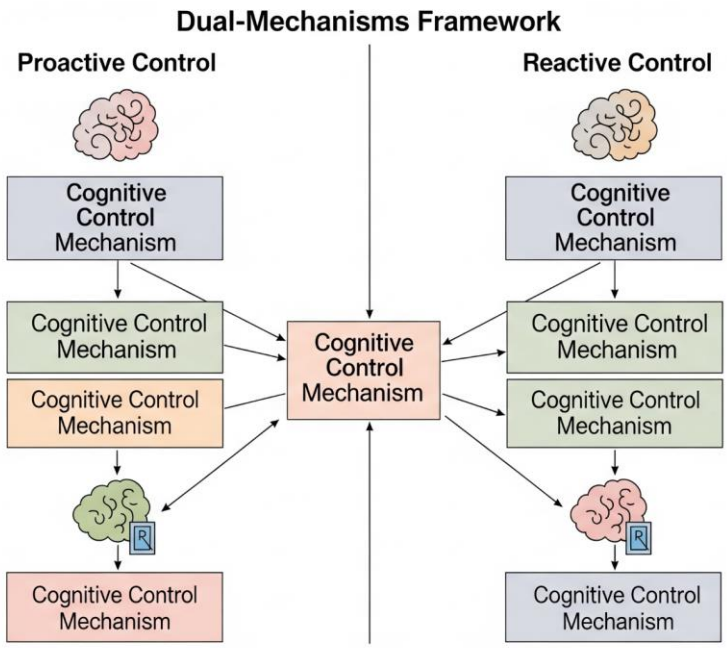
This study successfully demonstrated that a dynamic assessment-based intervention can be associated with improved creativity and, crucially, facilitates the far transfer of creative skills across traditionally distinct domains. Our findings were consistent with all three hypotheses: the mediation was associated with an improvement in creative performance in the trained domain (H1), this improvement was associated with transfer to other domains (H2), and the degree of transfer was tied to the participant's responsiveness to the mediation and ability to internalize and apply new strategies (H3).

4.2 Theoretical Implications

The findings of this study offer a significant contribution to the enduring debate on the domain-generality versus domain-specificity of creativity. By using dynamic assessment, we were able to move beyond a simple, static measure of creative output to observe the underlying cognitive processes in action. The successful transfer of creative skills observed in our study suggests that while creative abilities may be expressed through domain-specific skills and knowledge, there are indeed trainable, domain-general cognitive mechanisms that can be applied across different contexts.

Our results lend strong support to the perspective that a key component of creative cognition is a flexible, executive control system that allows for the deliberate and strategic application of thought processes [8, 14]. This is particularly relevant when considering the successful far transfer of skills, which is widely recognized as a difficult cognitive feat [17]. The ability to transfer a skill from one domain to another requires a cognitive system capable of abstracting a general principle or schema from a specific context and then mapping it onto a new, dissimilar problem [10, 26]. The fact that our participants were able to do this after a relatively brief mediated intervention strongly implies that this mapping ability is not an inherent talent but a trainable skill.

This perspective is highly compatible with the dual-mechanisms framework of cognitive control proposed by Braver [9]. This framework posits two distinct modes of cognitive control: proactive control and reactive control. Proactive control is a sustained, anticipatory process in which a person actively maintains task goals and rules in mind to guide their behavior and prevent interference. In the context of our study, proactive control would be a participant's ability to maintain the "creative goals" taught during mediation (e.g., "be flexible," "combine ideas in unusual ways") even when faced with a new, untrained task. Reactive control, in contrast, is an on-demand, late-corrective process that is triggered when a conflict or interference is detected. It is a more reactive, less efficient form of control.



Our dynamic assessment intervention can be viewed as a powerful tool for fostering proactive control in creative thinking. By explicitly teaching strategies and providing a scaffold for their application, the mediation helped participants internalize a "creative problem-solving schema." For example, when a child learned to combine simple geometric shapes in novel ways during the graphic task, they were not just learning a domain-specific skill. They were learning a general principle: combination is a viable creative strategy. When faced with a new verbal or mathematical task, a child who had internalized this principle could proactively apply it. For instance, in the mathematical domain, they might combine different operations (e.g., multiplication and addition) or mathematical concepts in a new way to arrive at a unique solution. Similarly, in the verbal domain, they might combine two unrelated words to generate a new, creative use for an object. This goes beyond mere reactive problem-solving; it is a deliberate, goal-oriented approach.

The quantitative finding that children with higher baseline cognitive control scores showed a greater degree of transfer further strengthens this argument. This suggests that while our mediation provided the necessary scaffolding, a foundational capacity for cognitive flexibility was a critical moderator of the intervention's success. This aligns with research by Kubricht, Lu, and Holyoak [35], which found that individual differences in cognitive abilities are associated with spontaneous analogical transfer. Our study extends this by demonstrating that even in the absence of a high baseline capacity, DA-based mediation can serve as a catalyst for developing and applying these crucial skills.

Furthermore, our findings challenge the notion that creative skills are purely a function of domain-specific expertise. While expertise is undoubtedly important for high-level creative production, our study with primary school children suggests that the fundamental processes of creative thinking can be cultivated independently and then mapped onto new domains. This supports the concept of creativity as a process of "bootstrapping the mind" [24], where analogical reasoning and the abstraction of general principles are associated with the construction of new mental schemas. The mediation in our dynamic assessment served as the initial boost, providing the scaffolding necessary for children to form these schemas, which they then independently applied to new problems.

This work also has significant implications for the definition of creativity itself. While the standard definition of novelty and effectiveness [47] remains a useful endpoint, our study supports a more dynamic, process-oriented view [15, 27]. We show that a child's creative potential can be revealed not just by their final product, but by their responsiveness to intervention and their ability to internalize and generalize creative strategies. The "zone of

proximal creativity" [18] is not a static measure but a dynamic space where the potential for creative growth can be observed and nurtured. This approach provides a more holistic and equitable way to identify and support creative talent, moving beyond a simple "test score" to a richer understanding of a child's capacity for innovation.

4.3 Practical Implications

The findings of this study have profound implications for educational practice. The results challenge the traditional, static approach to assessing and teaching creativity, which often fails to identify students with high learning potential. By incorporating the principles of dynamic assessment, educators can not only get a more accurate picture of a student's creative abilities but also actively guide their development [52]. The study provides a compelling argument for moving away from rote learning and towards instructional methods that explicitly teach for transfer. This could involve, for instance, designing classroom activities that help students identify and abstract problem-solving strategies from one subject (e.g., a verbal creative writing exercise) and consciously apply them to another (e.g., a creative mathematics problem). This approach would not only foster creativity but also enhance students' meta-cognitive skills and their ability to become more independent learners [57].

4.4 Limitations and Future Research

This study has several limitations that should be addressed in future research. First, the sample was limited to primary school children in a single metropolitan area, which may limit the generalizability of the findings to other age groups or cultural contexts. Second, while the study used distinct domains, future research could investigate transfer to an even wider range of creative fields, such as musical or scientific creativity. Finally, while we were able to observe the transfer of skills, the cognitive and neurological mechanisms underlying this transfer were only inferred. Future studies could employ neuroimaging techniques, such as fMRI or EEG, to directly observe the neural activity associated with the transfer of creative thought and cognitive control [8]. This would provide a more detailed understanding of the brain-based processes that support far transfer.

CONCLUSION

In conclusion, this research provides strong evidence that creativity is a dynamic capacity that can be assessed and fostered through a mediated, process-oriented approach. By using dynamic assessment, we demonstrated that the ability to apply creative strategies is not confined to a single domain but is associated with successful transfer to dissimilar contexts. These findings challenge the narrow view of creativity as a fixed, domain-specific trait and highlight the power of educational interventions that explicitly teach for learning transfer. This work represents a significant step forward in understanding the development of creativity and provides a clear pathway for educators to unlock the creative potential of all learners.

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