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Article

Dynamic cognitive development and creativity enhancement through martial arts movement drawing training and biomechanics: A multidimensional approach

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Abstract: This study investigates the dynamic mechanisms underlying creativity development through martial arts movement drawing training and combined with relevant knowledge of biomechanics, emphasizing cognitive adaptability and neurophysiological engagement. Using experimental methods and independent sample t-tests, we assessed differences across five creativity sub-dimensions—fluency, originality, flexibility, sensitivity, and insight—between an experimental group and a control group. The results showed significant improvements in the experimental group following the training, whereas no substantial changes were observed in the control group. These findings indicate that martial arts movement drawing training not only involves observing, analyzing, and expressing dynamic actions, but also requires participants to coordinate various parts of the body during movement. This biomechanical interaction promotes the body's movement efficiency and coordination, promotes perception, imagination, and cognitive flexibility, thereby enhancing creativity. By integrating creative expression with motor and sensory coordination, this study underscores the potential of dynamic, art-based interventions to enhance cognitive adaptability and functional plasticity. Principles of biomechanics, such as kinematics and kinetics, can further explain how participants' training can promote the development of brain function by optimizing movement patterns and improving motor control. This research offers an innovative approach to creativity development, with implications for interdisciplinary studies in cognition, biomechanics, and artistic training.

Keywords: creativity development; martial arts movements; biomechanics; cognitive adaptability; dynamic systems; artistic training

1. Introduction

Creativity is not only the source of inspiration for solving problems but also the fundamental basis for scientific decision-making. The successful development of creativity has become an important topic in various fields, including management, education, and neuroscience. The term "creativity" originates from the Latin word creare, meaning the creative ability. Galton, known as the founder of modern creativity research, first proposed the "genetic theory of genius" in his book Hereditary Genius in 1869, initiating the earliest studies of creative psychology [1]. Later, Schumpeter introduced foundational concepts of innovation theory in The Theory of Economic Development, emphasizing the role of creativity in economic growth and innovation [2].

Guilford's work in 1950 provided a modern definition of creativity, classifying it into "narrow" and "broad" senses [3]. Creativity in a narrow sense refers to abilities that highlight the traits of highly creative individuals, while broad-sense creativity encompasses personality and organizational features, which are linked to flexible problem-solving and dynamic adaptability [4]. Recent studies have expanded this understanding, emphasizing creativity as a multifaceted construct influenced by cognitive, motivational, and environmental factors [5–7].

The role of physical activity and embodied cognition in enhancing creativity has gained increasing attention. Martial arts, for example, are not only a sport but also a discipline that integrates motor skills, perception, and cultural understanding, fostering both physical and mental development [8,9]. Studies have shown that activities such as martial arts can significantly improve motor coordination, cognitive flexibility, and even executive functions [10,11]. Movement-based practices, like martial arts drawing, engage participants in a combination of sensory perception, physical execution, and imaginative thinking, which are essential components of creativity [12,13].

From a neurobiological perspective, drawing-based training stimulates both hemispheres of the brain, enhancing visual perception, memory, and abstract thinking [14]. According to Betty Edwards' research, activities such as martial arts drawing help relax the dominant left brain and activate the right brain, fostering a state conducive to creative inspiration [15]. These findings align with the theory of embodied cognition, where the interplay between motor actions and cognitive processes creates opportunities for creative problem-solving and functional novelty [16].

Furthermore, the constraints-led approach, widely recognized in sports science, highlights how task-specific challenges can induce functional creativity and emergent behaviors [17,18]. Martial arts drawing training exemplifies this principle by combining structured techniques with opportunities for spontaneous expression. This dual engagement of cognitive and motor systems aligns with research on the creative potential of performer-environment interactions [19,20].

The importance of art education in fostering creativity has long been recognized. The United States Art Endowment's report, Towards Civilization: Art Education Report, emphasized art's role in teaching communication skills and fostering creativity [21]. Harvard University's Project Zero, a pioneering program on arts-based learning, further demonstrated the impact of integrating visual and motor learning in promoting creative thinking [22]. Similarly, martial arts drawing offers a unique pedagogical approach, combining motor execution with artistic expression to cultivate fluency, originality, flexibility, sensitivity, and insight—the five core dimensions of creative thinking [23,24].

This study builds upon these theoretical foundations and explores the role of martial arts movement drawing training in fostering creativity. By integrating movement and drawing, this research investigates how perception, imagination, and expression contribute to creative thinking [8,19]. It seeks to validate the effectiveness of such training in improving the five dimensions of creativity through experimental methods and structured evaluation. The study also leverages the principles of embodied cognition and neuroplasticity to provide a comprehensive framework for creativity enhancement [12,16,23].

Existing research often emphasizes either theoretical or practical aspects of creativity development, with limited integration of the two [5,9]. This study bridges this gap by combining theoretical insights with experimental validation, aiming to provide both methodological contributions and practical applications in creativity training. Through martial arts drawing training, individuals can develop observation, memory, attention, and imaginative thinking skills, unlocking their creative potential and fostering functional adaptability [8,10,16,24].

Finally, this research aligns with the growing interest in using movement-based and artistic interventions to enhance cognitive and creative abilities. By investigating martial arts drawing training as a dynamic system, this study contributes to the broader understanding of creativity as an emergent property of complex interactions between cognitive, physical, and environmental factors [12,17,23].

2. Research framework

This article investigates creativity as the dependent variable, comprising five sub-variables: fluency, originality, flexibility, sensitivity, and insight (**Table 1**). The study uses painting exercises as an experimental intervention to evaluate the effects of structured training on creativity. The painting training curriculum is designed around three key components: perception, imagination, and expressive ability.

Table 1. The definition and measurement of creativity child variables.

Child variable	Fluency	Originality	Flexibility	Sensitivity	Penetration
Definitions	That quick thinking, quick response, given the context of the smooth variety of reactions or answers to specific questions	That quick thinking, quick response, given the context of the smooth variety of reactions or answers to specific questions	That quick thinking, quick response, given the context of the smooth variety of reactions or answers to specific questions	That quick thinking, quick response, given the context of the smooth variety of reactions or answers to specific questions	That quick thinking, quick response, given the context of the smooth variety of reactions or answers to specific questions
Topic No.	1, 4, 5, 7, 15, 17, 20, 29, 39, 37, 43	8, 19, 36, 5314, 44, 49	2, 3, 16, 27, 28, 33, 35, 38, 42, 41, 48	9, 10, 11, 12, 24, 25, 32, 34, 40, 45, 5L52	6, 13, 18, 20, 21, 22, 23, 26, 31, 46, 47, 50
Test questions include	Five answers which one is the best analogy? (a)221221122 (b)22112122 (c)22112112 (d)112212211 (e)212211212	Five answers which one is the best analogy? For opponents legs foot equivalent (A)elbow (B)the knee (C)toes (D)the finger (E) an arm	Find a different: N A V H F (a)(b)(c)(d)(e)	If all A is B, B is not a C, then A must not be a prop. This sentence is (A)of the (B)wrong (C)neither right nor wrong	Find a different: (A) pumpkin (B) grapes (C) cucumber (D) Maize (E) peas

2.1. Perception training

Perception training involves developing the ability to accurately observe and analyze objects and their surrounding environments. This is further subdivided into:

Perceiving the boundaries of objects.

Understanding the surrounding environment of objects.

Identifying proportional relationships between objects.

Recognizing hidden parts and how they integrate into the dominant structure of an object.

Interpreting the complete shape of an object as a cohesive whole (**Figure 1**).

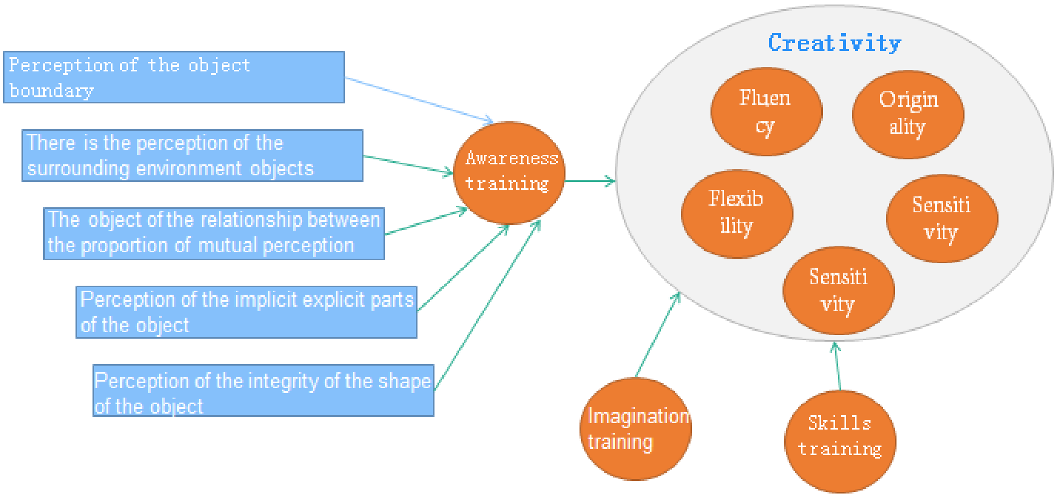

Figure 1. Research framework.

2.2. Hypothesis

The central hypothesis of this study posits that training in perception, imagination, and skills development in painting will significantly enhance students' creative performance. Improvements are measured through the five dimensions of creative thinking: fluency, originality, flexibility, sensitivity, and insight. The study argues that systematic training in these areas facilitates a deeper understanding of objects, sharper imagination, and improved expression, leading to measurable increases in creative performance.

3. Research methods

This study employs an experimental approach to investigate the formation and enhancement of creativity, focusing on the interplay between perception, cognitive processes, and creative thinking. The research evaluates how specific training interventions can foster critical components of creative intelligence through structured painting exercises.

3.1. Research objectives

The study aims to:

Explore the formation of creative thinking and the process of creativity development.

Assess whether targeted interventions in perception, imagination, and expression can stimulate creativity.

Test the hypothesis that specific training methods can significantly enhance creativity through the development of fluency, originality, flexibility, sensitivity, and insight.

3.2. Training content

The experimental intervention includes three main components: perception training, accumulation and preparation, and cultivation of creativity through appreciation and re-creation.

(1) Perception Training

This component focuses on improving observation skills and redefining the way individuals perceive and process visual information. The following subcategories outline the training exercises:

Sideline Perception: Training to observe the boundaries of objects to develop precision in identifying edges and outlines.

Spatial Perception: Training to understand the spatial relationships surrounding objects and their environments.

Proportional Perception: Observing and analyzing the proportions between object components, including fixed and variable relationships.

Light and Shadow Perception: Training to perceive the interaction between light and shadow, distinguishing visible (dominant) parts from hidden (subtle) features.

Holistic Perception: Recognizing the overall structure of objects to appreciate their characteristics and intrinsic nature.

These exercises aim to teach participants how to process visual information more effectively, enhancing their observation, critical evaluation, and attention to detail. Participants learn to adopt a fresh perspective, often neglected in traditional education systems, stimulating right-brain creativity. This aligns with creative process theory by emphasizing information observation and initial processing.

(2) Accumulation and Preparation

The second stage involves preparing participants for advanced creative thinking by engaging in exercises designed to build cognitive flexibility and divergent thinking. These include:

Brainstorm Painting: Rapid, line-based drawing exercises to encourage divergent thinking and quick ideation.

Detail-Oriented Drawing: Slow, meticulous drawing exercises to enhance focus and identify interconnected elements within complex problems.

Reevaluating Assumptions: Training participants to question pre-existing assumptions, recognize previously unnoticed details, and find new directions.

Logical Thinking Exercises: Encouraging participants to rely on logical reasoning while creating drawings to ensure their work is coherent and fact-based.

Dimensional Thinking: Using other art forms such as music, poetry, and prose as inspiration for visual art creations, including painting, relief, and sculpture.

Reverse Thinking: Transforming sculptures into paintings or using specific textures to reinterpret relief works, fostering adaptability in creative problem-solving.

These exercises aim to expand participants' mental models and encourage abstract, logical, and dimensional thinking.

(3) Cultivating Art Appreciation and Creativity

Art appreciation activities are included to deepen participants' understanding of artistic works and enhance their ability to critically analyze and interpret art. Participants are guided to:

Observe art with a fresh perspective, recognizing the nuanced details that traditional observation often overlooks.

Collect and organize visual information effectively to form a comprehensive understanding of artistic elements.

Integrate learned skills into new creative endeavors, fostering an ongoing process of inspiration, reflection, and re-creation.

Through this holistic approach, participants are trained to connect observation with expression, enabling their brains to discover patterns, solve problems creatively, and generate innovative ideas.

3.3. The creative process

This study aligns with the classical theory of creativity, where the process is divided into four stages: preparation, incubation, illumination, and verification. The training regimen is structured to guide participants through these stages:

Preparation: Developing observational and cognitive skills to enhance information processing.

Incubation: Allowing accumulated information and experiences to interact subconsciously, fostering connections and insights.

Illumination: Encouraging participants to synthesize learned concepts into innovative ideas.

Verification: Evaluating and refining these ideas to ensure their novelty and practicality.

3.4. Gradual learning approach

The training is designed to overcome cognitive biases and traditional patterns of thinking. Exercises progressively guide participants to observe the world without preconceived notions, challenging them to perceive objects as they truly are, rather than as they assume them to be. By focusing attention solely on specific tasks, participants gradually build the capacity for deep, focused thought and creative problem-solving.

3.5. The role of the brain in creativity

Training interventions are informed by neurocognitive theories emphasizing the brain’s capacity to simplify and reorganize information for efficient processing. As participants accumulate visual and conceptual information, they form more effective thinking patterns. Over time, this culminates in a “magical moment” of creativity, where the brain synthesizes learned concepts into novel insights. This process aligns with Yang’s “brain program” theory, emphasizing the brain’s inherent ability to adapt and generate innovative ideas [19].

The research method incorporates perception training, creative skill development, and art appreciation to stimulate creativity. By guiding participants through structured observation, preparation, and creative thinking exercises, the study demonstrates how focused training can unlock latent creative potential and foster innovative problem-solving skills in daily life, education, and professional contexts.

4. Area of research

This study focuses on experimental research into the factors influencing creativity, the formation of creative thinking, and the evaluation of training interventions. The research examines college students as the target population, leveraging their cognitive and educational characteristics to explore how structured training programs can enhance creativity.

Although college students may face challenges in developing creative thinking skills compared to younger learners, they possess distinct advantages. Unlike primary school students, whose strong intuition and emotional thinking facilitate creativity development, college students exhibit higher levels of self-awareness and conscious learning, making them more receptive to creativity training. For Chinese students, years of examination-oriented education have often suppressed right-brain activity. However, college presents a critical phase for self-directed learning, offering a golden opportunity to cultivate creative potential through structured, purposeful training.

The test subjects included an experimental group and a control group. The experimental group consisted of Environmental Design, Architecture, and Landscape Design students at Southwest Forestry University. Environmental Design students had some basic painting skills, while Architecture and Landscape Design students had no prior drawing experience. A total of 120 students were selected, with 88 completing the test. The control group consisted of Garden Design students at the same university, with 71 selected and 48 completing the test.

The experiment included three parts: pre-test, training intervention, and post-test. In the pre-test phase, both the experimental and control groups were selected through cluster sampling. The Torrance Test of Creative Thinking (TTCT), Williams Creativity Test, Princeton Creativity Quiz, and Eugene Creativity Assessment were used to measure the baseline creativity of both groups.

During the training intervention, the experimental group participated in a structured program consisting of four stages. The first stage involved art appreciation training, where students analyzed and interpreted artistic works to develop observational skills and aesthetic judgment. The second stage focused on perception and cognitive training, which included exercises in drawing and color-based activities to stimulate right-brain creativity. The third stage introduced creativity training, targeting the five sub-variables of creativity: fluency, originality, flexibility, sensitivity, and insight. In the final stage, students applied the learned skills in independent projects, demonstrating their creative growth through original artworks.

The post-test phase involved administering the same set of tests as in the pre-test to both the experimental and control groups. Each experimental session lasted 40 hours, spread over six days, and was conducted in three separate classes focusing on perception, imagination, and expressive abilities. The training took place at the College of the Arts, Southwest Forestry University.

An independent t-test was conducted to compare differences in the five sub-variables of creativity between the experimental and control groups before the intervention. The results showed no significant differences between the two groups, confirming the suitability of the groups for comparative analysis. The t-values and p-values for the sub-variables were as follows: fluency ($t = -0.092$, $p = 0.927$), originality ($t = 1.218$, $p = 0.225$), flexibility ($t = -0.327$, $p = 0.744$), sensitivity ($t = 1.046$, $p = 0.297$), and insight ($t = -0.581$, $p = 0.562$). These findings indicate that the two groups were comparable at baseline, providing a reliable foundation for evaluating the effects of the experimental intervention.

This study leverages college students' cognitive maturity and capacity for conscious learning to investigate the impact of structured creativity training. The experimental design incorporates comprehensive pre- and post-testing to measure the effects of perception, cognitive, and creative training interventions. Preliminary results confirm the suitability of the selected groups for comparative analysis, setting the stage for further exploration of how targeted exercises can enhance creative thinking (**Table 2**).

Table 2. The experimental group and control group before the experiment two groups of scores of comparative.

Before the experiment	**Packet**	***N***	**Means**	**Standard deviation**	***T* value**	***P* value**
Fluency	Control group	48	5.02	1.63	−0.092	0.927
	Test group	88	5.06	2.42		
originality	Control group	48	4.15	1.34	1.218	0.225
	Test group	88	3.83	1.50		
flexibility	Control group	47	6.62	1.79	−0.327	0.744
	Test group	88	6.73	1.90		
Sensitivity	Control group	48	3.02	1.85	1.046	0.297
	Test group	88	2.60	2.41		
Insight	Control group	88	5.27	2.10	−0.581	0.562
	Test group	88	14.56	5.52		

2. The difference in the experimental group analysis:

Table 3. Each experimental group before and after the experiment comparing the scores.

	Mean	***N***	**Std. Deviation**	***T* value**	***P* value**
Before the experiment fluency	5.0568	88	2.42287	−19.984	<0.001
Fluency after the experiment	9.4432	88	1.70097		
Before the experiment Flexibility	6.7273	88	1.90418	−17.996	<0.001
After the experimental flexibility	8.8636	88	1.51757		
Before the experiment sensitivity	2.6092	87	2.42255	−13.767	<0.001
After the sensitivity of the experiment	7.9310	87	2.12840		
Before the experiment originality	3.8295	88	1.50265	−19.470	<0.001
After the experiment originality	6.0227	88	1.23155		
Before the experiment insight	5.2727	88	2.10488	−13.679	<0.001
After the experiment insight	8.1591	88	2.11664		

Compare the difference between experimental groups on five sub creativity variables before and after the experiment. The results showed a significant difference (**Table 3**) before and after the test, before and after the test fluency, originality, flexibility, sensitivity, insight, the *T* values are −19.984, −17.996, −13.767, −19.470,

−13.679, P values were <0.001, <0.001, <0.001, <0.001, <0.001, indicating that painting training intervention significantly improved students' creativity.

4.1. The control group difference analysis

Comparing a control group differences in pre and post-test creativity in the five sub-variables. The results showed no significant difference (**Table 4**) back and forth. Fluency before and after the experiment, originality, flexibility, sensitivity, insight, values of T were −0.304, 1.972, −0.127, 0.401, 1.063, P values were 0.763, 0.055, 0.900, 0.691, 0.293, indicating that two tests itself does not interfere with test results.

Table 4. The control group pre-post-test scores of each comparison.

	Mean	***N***	**Std. Deviation**	***T* value**	***P* value**
Before the experiment fluency	5.0208	48	1.63068	−0.304	0.763
Fluency after the experiment	5.1042	48	2.39893		
Before the experiment Flexibility	4.1458	48	1.33671	1.972	0.055
After the experimental flexibility	3.9167	48	1.45622		
Before the experiment sensitivity	6.6170	47	1.78829	−0.127	0.900
After the sensitivity of the experiment	6.6383	47	1.82287		
Before the experiment originality	3.0208	48	1.85070	0.401	0.691
After the experiment originality	2.9375	48	2.51300		
Before the experiment insight	5.0625	48	1.83820	1.063	0.293
After the experiment insight	4.7708	48	2.21446		

From the above table paired t-test results showed that: divergent thinking, convergent thinking, fluency, flexibility, sensitivity, originality, insight, both before and after the correct number of experiments comparing T values of −23.331, −19.226, −19.984, −17.996, −13.767, −19.470, −13.679, the corresponding P values less than 0.01, statistically significant. That is scattered thinking, convergent thinking, fluency, flexibility, sensitivity, originality, insight, correct mean is higher than before the experiment (**Table 5**). In the control group did not change the answer.

Table 5. The percentage of each dimension of the situation before and after the experiment.

	Percentage of correct before the experiment	**Percentage of correct before the experiment**
Divergent thinking	40.19	75.29
Convergent thinking	44.53	71.17
Fluency	42.14	78.69
Originality	47.87	75.28
Flexibility	61.16	80.58
Sensitivity	21.69	66.09
Insight	43.94	67.99

4.2. Discuss

After the experiment, it was confirmed that the five dimensions of creativity—fluency, originality, flexibility, sensitivity, and insight—can be significantly enhanced through painting-based training in arts education. This finding underscores the importance of integrating artistic practices into educational curricula, as they provide students with valuable tools to express their thoughts and ideas more effectively. By engaging in painting, students not only develop their artistic skills but also cultivate their cognitive abilities, which are essential for problem-solving and innovation. While scientific and artistic thinking differ in their approaches, they are deeply interrelated and complementary. Both are essential for holistic intellectual development, and mastering these forms of thinking simultaneously is crucial for achieving well-rounded cognitive growth. Moreover, this dual mastery can lead to breakthroughs in various fields, as individuals who can think creatively and analytically are better equipped to tackle complex challenges.

Engineering students should not assume they lack creativity or dismiss their artistic potential with statements like, "I am not artistic." Recognizing that creativity exists in many forms can empower these students to explore their artistic inclinations, which may enhance their engineering skills and lead to innovative solutions. Likewise, liberal arts students should not consider themselves incapable of analytical or abstract thinking. By embracing both artistic expression and analytical reasoning, they can enrich their understanding of the world and contribute meaningfully to diverse fields. Such stereotypes create unnecessary barriers, limit personal potential, and hinder interdisciplinary growth. Breaking down these barriers can foster a more inclusive educational environment, encouraging collaboration and creativity across disciplines.

This study draws inspiration from the renowned "Project Zero" at the Harvard Graduate School of Education, founded in 1967 by philosopher Nelson Goodman. Goodman challenged traditional views of symbolic systems and their role in expression and communication. He proposed that the understanding of art extends beyond mere emotional expression; it encompasses cognitive processes that influence how we perceive and interact with the world. This perspective invites a deeper exploration of how artistic practices can enhance cognitive functions, such as critical thinking and problem-solving. He argued that art is not solely an emotional or intuitive domain but also has significant cognitive dimensions. According to Goodman, artistic thinking is rooted in logic and follows processes similar to scientific discovery, analysis, and problem-solving. He emphasized the substantial overlap between logical and image-based thinking and highlighted how these two modes of cognition can complement and enhance one another. Despite their importance, society often undervalues image-based thinking and arts education, favoring more traditional logical frameworks.

Goodman's ideas align with Gardner's theory of multiple intelligences, which posits that individuals possess diverse intellectual capacities, including artistic and logical intelligences. To realize their full potential, individuals must integrate both scientific and artistic thinking. As Nobel laureate Li famously remarked, "Science and art are two sides of the same coin; neither can exist without the other."

The findings of this study highlight the urgent need to address the gap in creativity training among Chinese college students and adults. Painting-based training in arts education offers an effective and promising solution to this deficiency. Beyond its application to student populations, this training model has the potential to evolve into an innovative framework for professional development, enhancing creativity and problem-solving skills in the workforce.

Future research should further validate these conclusions by expanding the scope and diversity of participants. Broader application of these methods across varied populations could lead to the development of comprehensive, interdisciplinary training programs that foster creativity and innovation in both educational and professional settings.

5. Conclusion

This study demonstrates that the five dimensions of creativity—fluency, originality, flexibility, sensitivity, and insight—can be effectively enhanced through structured arts education. Using painting training based on martial arts movements as an intervention, the research confirms that targeted programs can improve perception, imagination, and expressive abilities, significantly enhancing creative thinking. The training program integrates artistic and scientific thinking, establishing a balanced mechanism that synchronizes left and right brain activity while combining divergent and convergent thinking to foster overall creativity.

The painting training incorporated observation exercises such as spatial awareness, proportional understanding, and holistic perception, alongside imagination and expressive development. The results reveal that martial arts movement drawing activates right-brain vitality, promotes balanced brain coordination, and enhances students' fluency, flexibility, sensitivity, and originality, ultimately elevating their overall creativity.

This study not only validates the feasibility of enhancing creativity through arts education but also introduces a novel approach by integrating artistic practices with physical movement. It broadens the perspective on creativity cultivation, emphasizing the potential of combining artistic training with physical dynamics to achieve comprehensive development. Future research can extend the application of this approach to diverse educational and professional contexts, exploring its capacity to further promote creativity and innovation on a broader scale.

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