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Science, Creativity, and Young Children: A Reflective Perspective

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ABSTRACT: In the context of early childhood science learning, the cultivation of creativity plays a crucial role. Accordingly, this paper aims to reflect on and explore the interrelationships among science, creativity, and young children, and to examine how young children's creativity can be enhanced within science learning environments. At first glance, reason and imagination may appear to be in tension; however, in practice, they function as complementary pillars that support both scientific understanding and creative development. Educators should therefore design learning activities that allow children to freely imagine while simultaneously testing their ideas through rational and empirical inquiry. Such an approach fosters innovative thinking and critical capacities that are essential for future citizens. Finally, the paper discusses specific pedagogical strategies for enhancing young children's creativity within science learning contexts.

1. INTRODUCTION

In the context of global education reform, science education is no longer regarded merely as a domain for disciplinary knowledge acquisition; rather, it is increasingly positioned as a crucial arena for cultivating key competencies required of future citizens. The OECD's Future of Education and Skills 2030 framework emphasizes that contemporary education should focus on fostering a wide range of core competencies—including critical thinking, problem solving, creativity, collaboration, and scientific literacy—rather than solely prioritizing the accumulation of factual knowledge. Scientific literacy is defined as the capacity to explain scientific phenomena, design and evaluate scientific inquiry processes, and apply evidence-based reasoning to support decisions and actions (OECD, 2020, 2025). Similarly, UNESCO's educational policy frameworks, such as Education for Sustainable Development and the Global Education Monitoring Reports, stress that science education should enable learners to understand the complexity of the world, develop inquiry-oriented dispositions, engage in critical interpretation, and creatively participate in addressing real-world problems (UNESCO, 2023). These international policy orientations are highly consistent with constructivist learning theories, which argue that learners actively construct knowledge through dynamic interaction with their environment and through processes of inquiry and reflection (Piaget, 1952; Vygotsky, 1978). From this perspective, early childhood science learning goes beyond the memorization of concepts; it should involve young children in authentic scientific

practices, such as asking questions, observing, thinking, and progressively reconstructing and refining their understandings to develop deeper and more sophisticated scientific concepts. Moreover, sociocultural perspectives further highlight that social interaction, dialogue, and teacher scaffolding play a critical and indispensable role in fostering young children's development of scientific reasoning and creative thinking. In the context of early childhood science learning, the cultivation of creativity plays a crucial role. Accordingly, this paper seeks to reflect on and explore the interrelationships among science, creativity, and young children, and think how can young children's creativity be enhanced within science learning environments (Jackson & Messick, 1965; Plucker, Beghetto & Dow, 2004; Shih, 2025a, 2025b, 2026).

2. SCIENCE and CREATIVIYTY: ARE REASON and IMAGINATION in CONCLICT?

Traditionally, science has been positioned within the domains of rationality, norms, evidence, and logic, whereas creativity is often associated with freedom, imagination, and openness. However, when viewed from the perspective of young children, science and creativity are in fact deeply intertwined. Young children's inquiries typically unfold through cycles of hypothesizing, trying, and revising, a process that embodies creative thinking rather than passive reproduction of established knowledge. Their "mistakes" are not merely failures but alternative pathways for meaning making and understanding the world (Gopnik et al., 1999; Runco & Jaeger, 2012; Sawyer, 2012; Shih, 2025a, 2025b, 2026; Shih et al, 2025). Moreover, the scientific explanations children construct through play may not align with adult scientific standards, yet they reflect sophisticated forms of imagination, emerging logic, and personal meaning construction (Fleer, 2009; Vygotsky, 2004). In this sense, early childhood scientific inquiry constitutes a creative meaning-making process rather than a simple imitation of adult scientific reasoning. This view aligns with sociocultural and constructivist perspectives, which emphasize that children actively construct knowledge through exploration, dialogue, and interaction with their environment. Empirical research on early childhood science education similarly demonstrates that playful inquiry, open-ended exploration, and problem-solving activities significantly foster both scientific understanding and creativity development (Eshach & Fried, 2005; Siraj-Blatchford, 2001; Vygotsky, 1978). Therefore, conceptualizing early childhood science learning as a creative and imaginative endeavor provides a more developmentally appropriate and pedagogically meaningful framework for enhancing young children's learning.

3. HOW CAN YOUNG CHILDREN'S CREATIVITY BE ENHANCED WITHIN SCIENCE LEARNING ENVIRONMENTS

3.1 Creating a Learning Culture that Supports Exploration and Questioning

Feedback is widely recognized as one of the most powerful influences on learning and achievement; however, its effects can be either positive or negative. Although its importance is frequently emphasized in the literature on teaching and learning, surprisingly few recent studies have systematically examined what feedback actually means in pedagogical practice (Hattie & Timperley, 2007). In early childhood classroom contexts, teachers' understandings of questioning, open-ended learning, and error fundamentally shape the epistemic culture and power relations of the classroom. When teachers intentionally cultivate children's dispositions to ask questions, they reposition children not as passive recipients of knowledge but as active constructors of meaning. This orientation aligns with constructivist and sociocultural theories, which emphasize that learning emerges through exploration, dialogue, and reflective engagement with experience (Bruner, 1961; Dewey, 1938; Edwards, Gandini, & Forman, 2012; Piaget, 1952; Vygotsky, 1978). Moreover, welcoming open-ended learning situations enables children to engage productively with uncertainty, hypothesis-making, and revision, thereby supporting creativity, problem-solving, and cognitive flexibility. Such environments invite children to explore multiple possibilities rather than seek predetermined answers, fostering a sense of intellectual agency and intrinsic motivation. Conceptualizing errors as productive moments for inquiry rather than indicators of

failure reflects a shift from performance-oriented to inquiry-oriented classroom cultures. Errors reveal children's underlying thinking processes and provide important entry points for pedagogical dialogue and conceptual growth (Beghetto, 2019; Black & Wiliam, 2009; Deci & Ryan, 2000; Hattie & Timperley, 2007; Russ, 1993). When teachers respond to errors through observation, questioning, and formative feedback rather than correction alone, they support deeper understanding and the development of learning resilience (Boaler, 2016; Dweck, 2006; Stein, 1953).

3.2 Promoting Multiple Forms of Expression to Foster Diverse Thinking in Children

In early childhood education contexts, encouraging multiple forms of expression is not merely a pedagogical technique but an epistemological stance regarding how learning occurs. When classroom cultures recognize that young children can communicate and make meaning through diverse representational forms—such as language, drawing, movement, construction, dramatic play, and symbolic activity—learning is no longer confined to a single correct answer or linear pathway. Instead, it becomes an open-ended process of meaning-making (Edwards, Gandini, & Forman, 2011; Malaguzzi, 1998). This perspective resonates with the Reggio Emilia philosophy of the "hundred languages of children," which emphasizes that children possess multiple ways of knowing and expressing the world, and that educators' responsibility is to create learning environments in which these forms of expression are made visible, listened to, and pedagogically responded to. From the perspectives of cognitive development and creativity research, multiple representations and cross-representational transformations contribute to deeper conceptual understanding and creative problem solving. Studies suggest that when children are supported in translating experiences across action, visual, and linguistic systems, they develop greater metacognitive awareness and cognitive flexibility (Ainsworth, 2006; Beghetto, 2019). In inquiry-based science contexts, such transformations enable children to reorganize experience into hypotheses, models, or narratives, thereby supporting creative reasoning and explanatory competence (Rinaldi, 2006; Sawyer, 2014). Moreover, encouraging multiple forms of expression also has implications for classroom power relations and educational equity. Providing diverse channels for participation reduces the exclusionary effects of linguistic dominance and cultural mismatch, enabling a broader range of children to engage in knowledge construction processes (González, Moll, & Amanti, 2005). When teachers replace unidirectional evaluation with dialogic and formative feedback practices, children are more likely to develop agency and self-efficacy as learners (Black & Wiliam, 2009; Boaler, 2016). Therefore, in early childhood science learning environments oriented toward creativity and inquiry, promoting multiple forms of expression should be understood as a core pedagogical principle rather than a peripheral technique.

3.3 Enabling Children to Construct Understanding through Hands-on Experiences

Providing children with materials that they can touch, manipulate, dismantle, compare, and experiment with is fundamental to effective science learning in early childhood. From a constructivist perspective, young children actively build knowledge through direct interaction with their physical and social environments. Hands-on engagement allows children to test ideas, observe outcomes, and revise their thinking, which are core components of scientific inquiry. Research in early childhood science education emphasizes that learning is most meaningful when children participate in prediction, observation, and reflection processes embedded in authentic activities (National Research Council, 2012; Piaget, 1952). Moreover, experiential learning aligns with Dewey's (1938) principle of "learning by doing," which views knowledge as emerging from purposeful activity and reflection. When teachers emphasize learning through action rather than passive reception, children are more likely to develop curiosity, persistence, and problem-solving skills. Empirical studies further indicate that hands-on, inquiry-based approaches enhance young children's conceptual understanding and engagement in science (Fleer, 2019). Therefore, designing science activities that prioritize manipulation, experimentation, and idea revision supports both cognitive development and the formation of scientific thinking habits in young learners.

4. CONCLUSION

Classrooms are spaces where both students and teachers can demonstrate creativity. Creativity scholars have noted that classrooms are ideal environments for expressing and developing creative thought and action. In early childhood science education, classrooms provide children with opportunities to construct understanding through hands-on exploration and experimentation, allowing them to actively engage with materials and phenomena. Such exploration encourages children to coordinate imagination and reason—imagining possibilities, forming hypotheses, and testing ideas—thereby fostering scientific thinking alongside creative problem-solving. However, classroom structures, curriculum constraints, and an overemphasis on "correct" answers can limit the development of creativity. Therefore, in early childhood science learning, where exploration, embodied experience, and the coordination of imagination and reason are central, educators must consider how to understand and promote creativity (Beghetto, 2019; Shih, 2025c, 2025d).

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