

The Creativity Paradox in Vietnamese Preschools: When an Education Program Enhances Problem- Solving but Diminishes Originality

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Abstract

This study examined the influence of Vietnam's Early Childhood Education (ECE) program on the scientific creativity (SC) of 5- to 6-year-old children, focusing on a potential "creativity paradox" in its implementation. A mixed-methods case study design was employed, combining a one-group pretest–posttest assessment of SC ($N = 30$) with qualitative data from document analysis, classroom observations, and teacher interviews. Quantitative results showed no statistically significant improvement in overall SC after the two-month instructional phase, $t(29) = 0.78$, $p = 0.443$, Cohen's $d = 0.14$. However, a paradoxical pattern emerged: children's creative problem-solving skills (Situation 5) improved significantly ($t(29) = 2.71$, $p = 0.011$, $d = 0.50$), while their originality—a core dimension of creativity—displayed a decreasing trend approaching statistical significance ($t(29) = -1.90$, $p = 0.068$). Qualitative findings suggested that this divergence stemmed from systemic constraints within program implementation, such as an emphasis on convergent thinking, reliance on formulaic activities, and a limited learning environment. These findings imply that, as implemented, the current curriculum enactment may not effectively foster balanced cognitive development, potentially enhancing problem-solving at the expense of originality. The study underscores the need for pedagogical adjustments to promote both analytical and original thinking in early childhood education.

Keywords: Creativity paradox, scientific creativity, early childhood education, Vietnam

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Introduction

Creativity is a foundational competency for both individual and societal development (Amabile, 2018; Guilford, 1950; Üret & Ceylan, 2021). Prior research highlights the importance of nurturing creative thinking from early childhood, with the preschool period identified as a key stage for its emergence (Cremin et al., 2015; Ho, 2022; Sew et al., 2017; Vaisarova et al., 2024). Within science education, fostering scientific creativity (SC) is especially relevant for children aged 5–6, who are forming basic understandings of the natural world and experiencing rapid cognitive growth (Ategoz & Sak, 2021; Sew et al., 2017; Yıldız, 2021). Reflecting this, many education systems have increasingly incorporated Science, Technology, Engineering, Arts, and Mathematics (STEAM) into preschool curricula to promote both creative and scientific thinking.

In Vietnam, the national ECE Curriculum Framework (MoET, 2021) emphasizes competencies such as creative thinking and inquiry skills. However, the implementation of these goals in classrooms often diverges from policy intentions. A persistent tension exists between this policy focus on creativity and long-standing pedagogical practices that emphasize memorization and single-correct-answer learning (Ho, 2024). Previous studies in the Vietnamese context report that, even with the introduction of innovative frameworks such as STEAM, teachers frequently retain a directive role and exhibit limited confidence in facilitating open-ended inquiry (Nguyen et al., 2023; Nguyen & Vu, 2025; Dinh & Nakatsubo, 2025). Such practices constrain opportunities for child-led exploration and the development of genuine creative capacity (Nguyen & Vu, 2025). This gap between curriculum ideals and classroom realities constitutes the central problem addressed in this study.

A key concern is that teaching strategies designed to promote scientific exploration may unintentionally reinforce convergent thinking—steering children toward predetermined answers—while limiting divergent thinking, which underpins originality and idea generation. This concern raises a guiding question: does the ECE program, as implemented, nurture holistic creativity, or does it create a “creativity paradox” by enhancing problem-solving while suppressing originality?

Empirical evidence on the effects of Vietnam’s ECE program on the SC of 5–6-year-olds remains scarce. For instance, Nguyen et al. (2024) examined factors shaping science activities

intended to support SC but did not evaluate changes in children's SC following program engagement. Addressing this gap, the present study pursued four research questions (RQ):

RQ1: What are the baseline levels of SC (fluency, flexibility, and originality) among 5–6-year-olds at the selected preschool before participation in the ECE program?

RQ2: What changes, if any, occur in these SC components after approximately two months of curriculum enactment?

RQ3: What features of instructional practices at the preschool might account for the observed effects on children's SC?

RQ4: How might these implementation factors interact to generate a paradoxical effect on SC—enhancing problem-solving yet diminishing originality?

This study examined the relationship between classroom practices and the SC performance of 5–6-year-old children in a preschool in Hue City, Vietnam. By comparing baseline and post-implementation data and analyzing classroom implementation, the study aims to provide empirical insight into the effectiveness of the national ECE program. It represents one of the first documented examinations of a potential “creativity paradox” within Vietnam's ECE system, highlighting the misalignment between policy aspirations and practical realities. The findings are expected to inform adjustments in pedagogical design to better support the development of SC in early childhood settings.

Theoretical Basis

This study is grounded in a multidimensional theoretical framework for defining, measuring, and interpreting SC in preschool children. Central to this framework is Hu and Adey's (2002) conception of SC as an intellectual ability to generate a product resulting from the interaction of scientific factors, creative thinking, and scientific processes, all serving a specific scientific purpose. For 5–6-year-old children, SC is conceptualized as the capacity to integrate creative and scientific thinking in exploring, explaining, and producing novel yet appropriate ideas, solutions, or artifacts within science-based activities. Accordingly, Hu and Adey's (2002) three-dimensional model of SC—comprising Process, Product, and Trait—provides the analytical foundation for assessing fluency, flexibility, and originality. This model has been effectively

adapted for evaluating creativity among young children (Chin & Siew, 2015; Sew et al., 2017).

A developmental contextualization of “scientific creativity” is essential for this age group. In this study, SC is understood not as the formal, hypothesis-driven process typical of professional scientists (“Big-C” creativity), but as emergent “little-c” or everyday creativity expressed through scientific exploration (Cremin et al., 2015; Tran, 2023). It encompasses children’s curiosity, capacity to ask “what if” questions, imagine possibilities, and generate original ideas using familiar materials. The emphasis lies on creative thinking processes—curiosity, imagination, and divergent thinking—as they manifest in science-related contexts. These are viewed as early cognitive foundations for structured scientific inquiry in later stages of development.

To clarify the cognitive mechanisms underlying SC, the study incorporates Guilford’s (1950) theory of convergent and divergent thinking. Convergent thinking involves identifying a single correct solution to a well-defined problem, whereas divergent thinking generates multiple, varied solutions from one stimulus. The core SC components measured here—fluency, flexibility, and especially originality—reflect divergent thinking. This theoretical lens suggests that environments emphasizing knowledge reproduction and uniform outcomes may strengthen convergent thinking while constraining divergent thinking.

Beyond individual cognition, the educational environment is also considered critical. According to Amabile’s (2018) Componential Theory of Creativity, creativity results from the interaction between intrinsic factors (expertise, creative-thinking skills, and task motivation) and the surrounding social context. A classroom climate that promotes autonomy, risk-taking, and the expression of new ideas can enhance intrinsic motivation and, consequently, creative potential. Conversely, settings emphasizing compliance and rigid procedures tend to suppress creativity. Amabile’s framework guided the analysis of how social-environmental elements—such as teacher feedback, activity structure, and the availability of open-ended materials—shaped children’s motivation and creative behavior.

This interpretation aligns with Vygotsky’s sociocultural theory, which posits that higher cognitive functions develop through social interaction. From this perspective, a restrictive pedagogical environment can constrain the Zone of Proximal Development (ZPD) for creative exploration. The view also resonates with the Reggio Emilia approach, which conceptualizes the environment as a “third teacher”—an intentionally designed space that invites inquiry,

representation, and creative expression.

In summary, this study employs an integrated theoretical approach. Hu and Adey's (2002) model provides the structure for measuring SC, while Guilford's (1950) and Amabile's (2018) frameworks support the interpretation of cognitive and contextual influences. Together, these perspectives underpin the hypothesis that an educational program emphasizing convergent tasks and lacking a supportive socio-psychological environment may give rise to a "creativity paradox": strengthening problem-solving abilities while weakening divergent thinking and originality.

Methodology

This study employed a mixed-methods approach within a case study design to examine changes in children's SC. The sequential and integrative logic of this design is depicted in Figure 1, which illustrates how qualitative data collection was embedded within the pretest–posttest structure to provide explanatory depth for the quantitative findings. The "program" investigated in this study was not an experimental intervention but the existing implementation of Vietnam's national ECE curriculum in a specific preschool context over a two-month period. The study therefore focused on evaluating how this pedagogical enactment influenced children's SC.

Participants

The study involved 30 children aged 5–6 years (16 boys and 14 girls) from a single class at a public preschool in Hue City, Vietnam. Cognitive development among participants was age-appropriate, with 85.7% classified as developing typically according to the ASQ-3 developmental screening tool. The preschool, established in 1992, follows the national ECE curriculum framework and had begun incorporating Science, Technology, Engineering, Arts, and Mathematics (STEAM)-oriented practices.

In accordance with Vietnam's national framework for public preschools, the children's Monday-to-Friday schedule was organized into defined activity blocks. The morning session

included 80–90 minutes for arrival, free play, and exercise, followed by 30–40 minutes of structured learning. This was succeeded by 40–50 minutes of play in learning corners and 30–40 minutes of outdoor time. Midday activities comprised a 60–70-minute lunch and a 140–150-minute nap. The afternoon included a short snack period (20–30 minutes), a 70–80-minute period of free play or child-initiated activities, and a final 60–70-minute departure window.

Within this daily framework, one 30–35-minute science exploration activity was integrated weekly as part of the structured learning session. Additionally, daily play-based learning—including time in the classroom’s “science corner” and outdoor play—totaled approximately 70–90 minutes.

Ethical Considerations

This study was conducted in compliance with ethical standards for research involving human participants. Ethical approval was granted by the Hue University Research Ethics Committee for Social Sciences and Humanities (Reference No. ECHS-2025-003). Written informed consent was obtained from the preschool administration, participating teachers, and the parents or legal guardians of all children. Verbal assent was also sought from each child prior to assessment. All data were anonymized to ensure confidentiality.

Scientific creativity Assessment Instrument

The primary quantitative instrument used in this study was the SC Assessment Tool for 5–6-Year-Old Children. This tool was adapted from Hu and Adey’s (2002) original test for secondary school students and informed by the preschool-oriented version developed by Chin and Sew (2015). Based on these sources, a new verbal–figure test was designed to assess SC in 5–6-year-old children across three dimensions: fluency, flexibility, and originality.

The purely drawing-based approach of Chin and Sew (2015) was considered unsuitable for this age group, as 5–6-year-olds often express scientific ideas more effectively through speech than through graphic representation (Ategoz & Sak, 2021). Accordingly, the adapted tool integrated verbal tasks for Situations 1–6 and a drawing task for Situation 7. This format

aligns with established paper-and-pencil instruments for older students (e.g., Hu & Adey, 2002; Tran et al., 2021). Two parallel versions—Test A (pretest) and Test B (posttest)—were developed, each containing seven situations that examined distinct aspects of SC, including: identifying novel uses for familiar objects, demonstrating sensitivity to scientific problems, improving technical products, exercising scientific imagination, solving creative problems, proposing innovative experiments, and designing creative scientific products.

Instrument Adaptation and Validation

The adaptation process followed multiple stages to ensure developmental and cultural appropriateness. Core constructs from Hu and Adey (2002) and Chin and Sew (2015) were synthesized and translated into Vietnamese. To guarantee semantic and conceptual equivalence, a bilingual education expert conducted a translation and back-translation process. This procedure ensured that complex constructs—such as Sensitivity to scientific problems and Scientific imagination—retained their intended meaning for preschool-aged Vietnamese learners.

Following linguistic validation, all prompts were simplified and presented verbally in a conversational, game-like format. Contexts and materials were adjusted to reflect children's everyday experiences, emphasizing toys, household objects, and familiar natural phenomena. For example, Situation 7—originally a task about designing a tool for picking apples—was modified to a task about picking mangoes, a fruit more familiar to Vietnamese children. Similarly, the original fifth situation focusing on mathematical concepts was replaced with problem-solving scenarios adapted from Chin and Sew (2015) to align more closely with both the study's scientific emphasis and participants' developmental stage.

The adapted instrument was piloted with 40 non-participating five-year-olds to confirm clarity and engagement. Reliability testing using Cronbach's alpha demonstrated high internal consistency: 0.901 for Test A and 0.861 for Test B.

Assessment Procedures

Assessments were conducted individually, except for Situation 7 (designing creative scientific products), which involved small groups of five to six children who completed the

task independently. A standardized introductory script was used to create a supportive and non-judgmental environment. Each situation took approximately 3–5 minutes, while Situation 7 required 10 minutes, resulting in a total assessment duration of 30–40 minutes per child.

Children’s verbal responses were recorded verbatim on an assessment sheet. To encourage elaboration and originality, the assessor could use gentle prompts such as, “Do you have any other ideas?” or “Can you think of a unique idea that not many people would think of?” In Situation 7, the assessor discussed each invention with the child to record its name, components, and functions on both the drawing and the assessment form.

To minimize potential bias from differences in verbal ability or shyness, the assessment script emphasized rapport-building and reassurance. Evaluation focused solely on the substance and novelty of each child’s ideas rather than on linguistic fluency or accuracy. Verbal responses were treated purely as vehicles of thought, and assessors were trained to disregard grammatical imperfections. The inclusion of a drawing task provided a complementary, non-verbal channel for creative expression.

Scoring and Data Management

All responses were transcribed and entered into Microsoft Excel for organization, cleaning, and scoring. Scoring followed the analytical procedures outlined by Hu and Adey (2002) and refined through recent methodological contributions from Tran et al. (2021) and Fernandez et al. (2024). The script, translated from Vietnamese, was as follows:

“Hello! Today, we are going to play an exciting game. Your task is to think of as many different answers as possible for the challenges. There are no wrong answers! All your ideas are great. Feel free to say whatever you think. I am looking forward to hearing all your exciting ideas. Are you ready? Let us begin!”

Scores for fluency, flexibility, and originality were determined for each situation according to the criteria outlined in Table 1 below.

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Table 1. *Scoring matrix for the SC assessment tool*

Situation	Target Abilities	Assessed Aspects	Scoring Criteria
1. Using familiar objects for new scientific purposes (e.g., a spoon, a toothbrush)	Using an object for scientific purposes (knowledge)	Originality, Flexibility, Fluency	- Fluency: 1 point/response. - Flexibility: 1 point/approach or knowledge domain. - Originality: 5% frequency: 3 points; 5-10%: 2 points; >10%: 1 point.
2. Sensitivity to scientific problems (e.g., encountering a strange animal or plant)	Sensitivity to scientific problems (Scientific problem)	Originality, Flexibility, Fluency	- Fluency: 1 point/response. - Flexibility: 1 point/approach or knowledge domain. - Originality: 5% frequency: 3 points; 5-10%: 2 points; >10%: 1 point.
3. Improving technical products (e.g., a bicycle, a toy house)	Ability to improve technical products (Technical product)	Originality, Flexibility, Fluency	- Fluency: 1 point/response. - Flexibility: 1 point/approach or knowledge domain. - Originality: 5% frequency: 3 points; 5-10%: 2 points; >10%: 1 point.
4. Scientific imagination (e.g., consequences of the sun disappearing, or no more rain)	Scientific imagination (Scientific phenomenon)	Originality, Flexibility, Fluency	- Fluency: 1 point/response. - Flexibility: 1 point/approach or knowledge domain. - Originality: 5% frequency: 3 points; 5-10%: 2 points; >10%: 1 point.
5. Creative solving of scientific problems (e.g., making a floating bottle cap sink, getting a ping pong ball out of a cup)	Creative solving of scientific problems (Scientific problem)	Flexibility, Originality	- Flexibility: 1 point/approach or knowledge domain. - Originality: 5% frequency: 2 points; 5-10%: 1 point; >10%: 0 points.
6. Performing creative experiments (proposing methods) (e.g., finding the better crayon, the better modeling clay)	Creative experimentation ability (Scientific phenomenon)	Flexibility, Originality	- Flexibility: Tools: 3 points; Principle: 3 points; Procedure: 3 points. - Originality: 5% frequency: 4 points; 5-10%: 2 points; >10%: 0 points.
7. Designing creative scientific products (e.g., a tool to pick high mangoes, a machine to clean a messy house)	Creative scientific product design ability (Technical product)	Flexibility, Originality	- Flexibility: 3 points/distinct function of the product. - Originality: 5% frequency: 5 points; 5-10%: 3 points; >10%: 1 point.

The scoring criteria for fluency (total number of responses) and flexibility (number of distinct categories) followed conventional divergent-thinking procedures grounded in Guilford's (1950) framework. Originality was scored according to statistical infrequency—a method established by Hu and Adey (2002) and widely adopted in subsequent studies (e.g., Tran et al., 2021; Fernandez et al., 2024)—where less common responses received higher scores.

Qualitative Data Collection

The qualitative component of the study was conducted concurrently with the quantitative data collection. It included document analysis of educational and lesson plans, direct observations of classroom science exploration activities, and semi-structured interviews with the two teachers responsible for the participating class. One teacher held a bachelor's degree and the other a three-year college diploma; both met the national qualification standards established by the Vietnamese Ministry of Education and Training. Their average teaching experience was ten years.

Although both teachers regularly attended general professional development workshops, they reported not having received specialized training in fostering SC or in implementing STEM/STEAM-oriented pedagogies. While they were informed of the study's general focus on scientific exploration activities and had provided informed consent, they were not briefed on the specific components of the creativity assessment (fluency, flexibility, and originality) or the study's hypotheses. This approach was designed to minimize potential Hawthorne effects—changes in participant behavior that may occur when individuals are aware of being observed.

Research Procedure and Data Analysis

The research proceeded in three main stages (Figure 1): (1) an initial assessment using Test A in early March 2025, (2) a monitoring phase that included observation of program implementation and contextual data collection from March to April 2025, and (3) a final assessment using Test B in late April 2025. All assessments were administered by two trained

research assistants who were not the children's regular teachers, thereby minimizing potential assessor bias. Both assistants received training in the standardized assessment protocol to ensure procedural consistency and reliability.

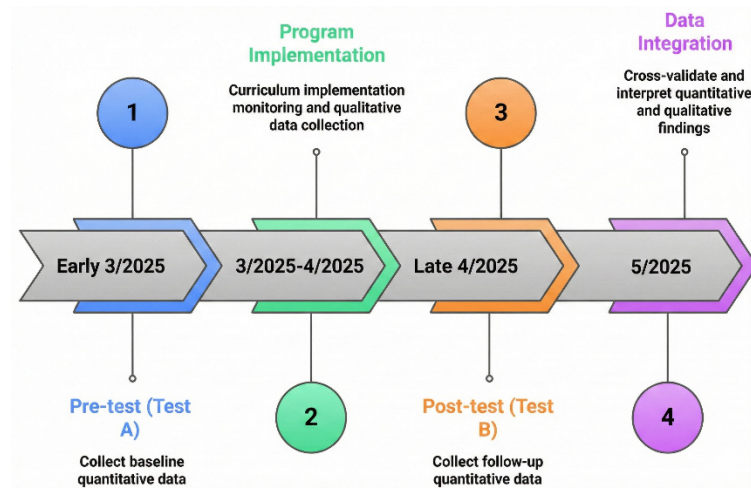


Figure 1. Research study phases and data collection

Data from the assessments were compiled and categorized for scoring. To ensure scoring consistency, a second independent rater—trained in the standardized assessment protocol—evaluated 20% of the anonymized data. Inter-rater reliability, calculated using Cohen's Kappa, demonstrated strong agreement ($\kappa = 0.88$). Any discrepancies were discussed and resolved by consensus prior to final analysis.

For the quantitative analysis, descriptive statistics and paired-sample t-tests were conducted using Jamovi software (version 2.5.5), with the significance level set at $\alpha = 0.05$. Qualitative data from document analysis, classroom observations, and teacher interviews were coded and analyzed thematically. Finally, quantitative and qualitative findings were triangulated to enhance validity and provide a comprehensive understanding of the results.

Limitations

This study adopted a one-group pretest–posttest design within a case study framework. While

this approach was appropriate for conducting an in-depth, exploratory investigation within a specific educational context, several inherent limitations must be acknowledged. The absence of a control group precludes definitive causal inference; thus, observed changes—or their absence—cannot be attributed solely to the ECE program. Potential confounding factors, such as natural developmental maturation or testing effects from repeated assessment, may also have influenced the outcomes.

Accordingly, the findings should be interpreted as a context-specific analysis of the program's implementation and its observable impact, rather than as generalizable causal claims. Nonetheless, a notable strength of this study lies in its mixed-methods design, which enabled a rich and contextualized interpretation of the quantitative results.

Results

Impact of Current ECE Practices on Children's Scientific Creativity

Table 2 presents the comparison of children's total SC and its component scores (fluency, flexibility, and originality) before and after the program implementation. The Shapiro–Wilk test for pre-test and post-test SC scores yielded $W = 0.953$, $p = 0.205$, indicating that the normality assumption was not violated; therefore, a t-test was appropriate for comparing mean scores between the two assessments.

Table 2. Comparison of children's total SC and SC components at pre-test and post-test

Creativity Component	Assessment Time	Mean (M)	Standard Deviation (SD)	t-value (df=29)	p-value (2-tailed)	Cohen's d (z)	Meaningful change/trend direction
Total SC	Pre-test	35.63	19.99	0.78	0.443	0.142	Not significant
	Post-test	44.45	20.62				
Fluency	Pre-test	9.97	5.40	0.18	0.856	0.033	Not significant
	Post-test	10.13	3.41				
Flexibility	Pre-test	10.97	4.08	1.18	0.248	0.216	Not significant
	Post-test	11.57	3.41				
Originality	Pre-test	32.77	18.00	-1.90	0.068	-0.347	Not significant
	Post-test	29.00	15.60				

The analysis of data from 30 preschool children showed an increase in the mean total SC score from the pretest ($M = 35.63$, $SD = 19.99$) to the posttest ($M = 44.45$, $SD = 20.62$). However, a paired-samples t -test indicated that this difference was not statistically significant, $t(29) = 0.78$, $p = 0.443$. The calculated effect size (Cohen's $d = 0.14$) was negligible, consistent with the lack of statistical significance.

At the component level, the fluency ($p = 0.856$) and flexibility ($p = 0.248$) scores showed no statistically significant change, suggesting that the pedagogical practices had limited influence on these aspects of SC. In contrast, the originality component showed a downward trend that approached statistical significance ($t(29) = -1.90$, $p = 0.068$), indicating a possible decline in original idea generation following the instructional period. This component also exhibited the lowest baseline performance and the highest inter-individual variability, suggesting that originality in scientific thinking may require more targeted or sustained pedagogical support.

Figure 2 provides a visual summary of pre- and post- implementation mean scores across the three SC components, highlighting the divergent trends that form the core of the study's interpretive focus.

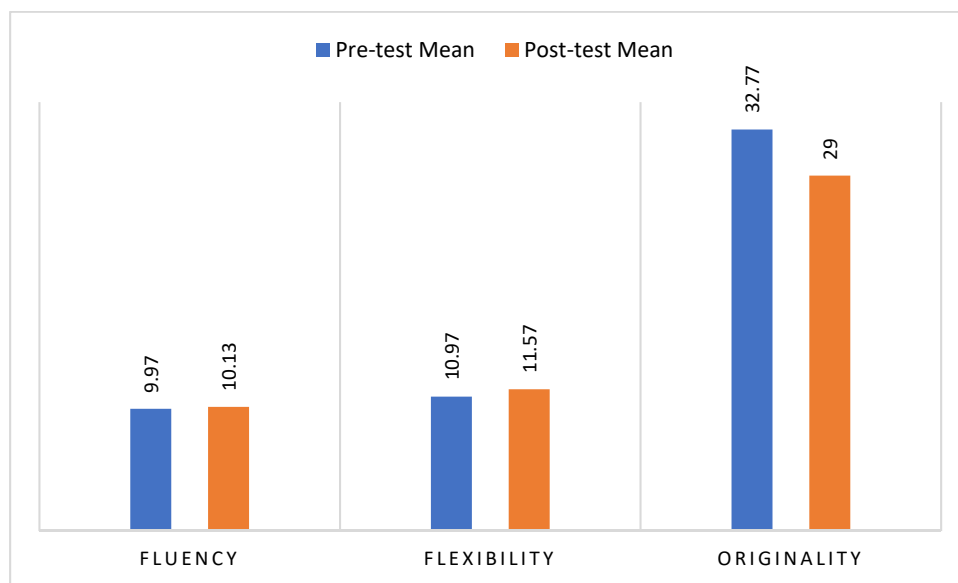


Figure 2. Comparison of mean scores of SC components at pre-test and post-test

To gain a more detailed understanding of the changes in the children's SC, an analysis was performed on the seven specific assessment situations. Table 3 presents a comparison of the children's mean SC scores for each situation at the baseline (Test A) and post-instruction (Test B) time points.

Table 3. *Comparison of mean scores for SC by situation at pre-test and post-test*

Situation (S)	Mean (Pre- test)	Mean (Post- test)	t-value (df=29)	p-value (2- tailed)	Cohen's d (z)	Direction of Significant Change
S1: Using familiar objects for scientific purposes	4.57	5.62	1.61	0.118	0.294	Not significant
S2: Sensitivity to scientific problems (asking questions)	5.00	6.21	1.09	0.284	0.199	Not significant
S3: Improving technical products	6.07	7.00	0.16	0.871	0.029	Not significant
S4: Scientific imagination (predicting consequences)	5.50	6.55	1.01	0.321	0.184	Not significant
S5: Creative solving of scientific problems	4.83	6.31	2.71	0.011	0.495	Significant Increase
S6: Performing creative experiments (proposing methods)	2.77	2.55	-0.14	0.888	-0.026	Not significant
S7: Designing creative scientific products	6.90	10.21	1.20	0.284	0.219	Not significant

The statistical analysis of pre- and post-test data (Table 3) revealed varied effects across the seven assessed dimensions of scientific competence (SC). Over the two-month implementation period, only limited statistically significant changes were observed. For six of the seven situations (S1, S2, S3, S4, S6, and S7), no statistically significant differences were found ($p > .05$). The corresponding effect sizes (Cohen's $d = -0.03$ to 0.29) were negligible to small, indicating minimal impact in these specific aspects of SC.

A statistically significant improvement was identified only in Situation 5 (S5), which assessed creative problem-solving in scientific contexts. The analysis revealed a significant positive change, $t(29) = 2.71$, $p = .011$, with mean scores increasing from 4.83 to 6.31. This result was supported by a moderate effect size (Cohen's $d = 0.50$), suggesting measurable educational impact in this domain. Creative problem-solving skills may therefore be more responsive to this type of pedagogical practice than other SC dimensions.

In contrast, Situation 6 (S6)—which evaluated children's ability to propose creative

experimental methods—showed consistently low performance at both measurement points (pre-program $M = 2.77$; post-program $M = 2.55$) and no significant change ($p = .888$). This pattern may reflect limitations in curriculum focus or developmental constraints within this cognitive domain.

The limited number of significant findings across multiple dimensions raises questions about the current pedagogical approach. The two-month period may have been insufficient to produce measurable changes in a complex cognitive process such as SC, which might require a longer developmental trajectory for observable improvements to manifest.

Implementation Practice of the Education Program and Potential Influencing Factors

In addition to the quantitative results, the study also analyzed program documents, observed pedagogical activities, and conducted teacher interviews to better understand the implementation practices of the national ECE curriculum. Key findings revealed several significant limitations.

Regarding educational objectives, specific goals for developing SC and its components were neither clearly defined nor prioritized in educational and lesson plans. The primary focus remained on children's understanding and reproduction of basic scientific knowledge. This lack of an explicit focus on creativity from the outset may have limited the intentional fostering of these abilities.

The content of science exploration activities was often organized around familiar themes and followed a linear sequence, offering few opportunities for children to pose their own questions or explore topics in diverse directions. This pedagogical approach was evident in the analysis of a lesson on "Water Transportation", which followed a highly structured sequence: the teacher introduced the topic, asked children to identify boat parts from pictures, provided definitions and comparisons, and concluded with a classification game. There are few opportunities for student-led inquiry, hypothesis testing, or creative problem-solving. This structure reinforces knowledge reproduction rather than creative knowledge construction. Additionally, the level of interdisciplinary integration, in line with the STEAM approach, was limited in practice, potentially hindering the development of a holistic and creative approach to scientific inquiry.

Although teachers reported using methods such as experiential activities and experiments, direct observation indicated that traditional methods (e.g., explanation, modelling, and Q&A with closed-ended questions) still predominated, especially when introducing new knowledge. The thorough application of child-centred methods was limited, and questions designed to stimulate creative thinking were not frequently employed. Specifically, activities designated as “experiments” were often fully prepared by teachers, with children following pre-determined steps. This approach provided limited opportunities for children to engage in authentic scientific inquiry by posing their own research questions or proposing their own procedures, both of which are crucial for developing SC.

Concerning the learning environment, the “science corner,” although equipped with some basic tools, was not effectively utilized as a space for free exploration and inquiry. There was a lack of open-ended materials, and the learning space was primarily confined to the classroom. Indeed, the semi-structured interviews revealed that teachers were keenly aware of these limitations, identifying a series of interlocking challenges that constrained their pedagogical choices. A significant issue identified through teacher interviews was a common misconception regarding the purpose of this space. As one teacher shared: *“We often think of the science corner as also being the nature corner, so we focus on caring for plants and raising small animals. However, this limits children’s interaction to simple phenomena and prevents them from freely exploring other scientific areas, such as physics, chemistry, or technology.”* This misunderstanding led to the underutilization of the corner for diverse scientific exploration, restricting experiences beyond basic biology and limiting opportunities for individual or small-group investigations that could foster broader scientific thinking and creativity.

Teachers also reported challenges related to resources and pedagogical guidance. One teacher commented on the difficulty of diversifying activities: *“Due to a lack of materials and specific guidance, I find it difficult to design rich science activities for each small group or individual. Most activities are general and easy to implement but less stimulating for curiosity and individual creativity in each child.”*

Moreover, practical classroom constraints were identified as significant barriers. One teacher described the impact of class size: *“With a large and crowded class, organizing small groups for science exploration activities is very difficult. Usually, I can only conduct them with the*

whole class, making it hard for each child to have a chance to develop creativity and autonomy in exploration. If adequate space and materials were adequate, it would facilitate deeper exploration for children.”

The need for targeted professional development was another recurring theme. One teacher expressed a desire for more specialized training: *“We really want to receive in-depth training on creative science teaching methods and how to design activities suitable for each group of children. Currently, most teachers are still confined to traditional methods due to a lack of support regarding materials and specific guidance.”*

The pressure to adhere to the curriculum was also seen as a factor that could stifle creative exploration. As one teacher explained: *“To develop SC, children need to be encouraged to ask questions, propose their own ideas, and experiment in their own way. However, in reality, due to curriculum and assessment pressures, teachers often prioritize completing the plan rather than creating space for children to explore freely.”*

The psychological environment within the classroom may also not have been consistently safe or encouraging enough for children to express unique or unconventional ideas freely.

Regarding assessment, the evaluation of children’s SC was primarily based on general behavioural observation and was not treated as a distinct and systematic assessment area. Teachers expressed difficulties identifying and assessing SC manifestations due to the absence of specific tools and criteria. One teacher highlighted this challenge: *“The lack of specific assessment tools makes me very confused when I want to measure the development of SC in children. We need clear criteria and observation templates to record and assess more objectively.”*

Finally, teachers consistently reported facing challenges such as large class sizes, insufficiently flexible classroom spaces, a shortage of specialized science learning materials, and a lack of detailed professional development programs focused on SC development.

Discussion

The findings of this study reveal a paradox in the development of SC within Vietnam’s ECE program. After approximately two months of implementation, the educational activities

did not produce a statistically significant improvement in children’s overall SC. However, closer examination showed a divergence between creative dimensions: children’s scores in creative scientific problem-solving (S5) increased significantly, while their originality—a core element of creativity—displayed a downward trend. Although this decline did not reach statistical significance ($p = 0.068$), it provides an important empirical signal when interpreted alongside the qualitative data. The results suggest that classroom practices may have fostered convergent, problem-focused thinking at the expense of divergent, original thought.

The purpose of this discussion is to explain this paradox by integrating quantitative outcomes with qualitative insights from classroom implementation. Figure 3 illustrates a conceptual model describing how observed instructional practices—shaped by systemic pressures and a focus on convergent outcomes—interacted to produce this paradoxical pattern: improved problem-solving but reduced originality. When viewed through this lens, the increase in creative problem-solving (S5) likely reflects children’s growing ability to apply familiar strategies to well-defined problems rather than an enhancement of divergent problem-solving capacity.

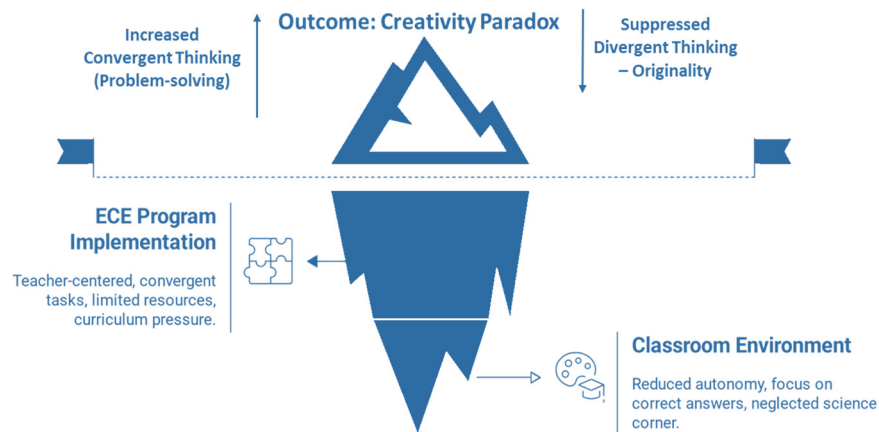


Figure 3. *Conceptual Model: The Paradox of Creativity in the ECE Program*

The explanation for this creativity paradox lies in the gap between the ECE curriculum framework’s goals and its classroom implementation. Qualitative data revealed that instruction remained largely teacher-centered, emphasizing explanation and modeling rather

than inquiry-based exploration (Nguyen et al., 2023; Nguyen et al., 2024). Activities described as “experiments” were frequently procedural, guiding children through fixed steps to reach a single correct outcome. Such practices promoted convergent thinking, explaining the improvement in problem-solving (S5). Simultaneously, this approach constrained originality. Lessons followed linear sequences, the “science corner” was underutilized for free exploration, and the limited availability of open-ended materials reduced opportunities for divergent thinking.

These instructional patterns should not be viewed as teacher shortcomings but as adaptive responses to systemic constraints. The qualitative evidence points to contextual limitations, including large class sizes, scarce specialized materials, and administrative pressure to complete a dense curriculum. These conditions encouraged a “teaching-to-the-plan” approach, privileging predictability over open exploration. As one teacher noted, the emphasis often meant “completing the plan rather than creating space for children to explore freely.” Consequently, the classroom climate implicitly rewarded correctness and compliance over originality, accounting for the decline in measured creativity.

This paradox also reflects a deeper cultural dimension. Within Vietnam’s collectivist value system, which prioritizes social harmony and mastery of correct outcomes, creativity linked to risk-taking or personal expression may be perceived as less desirable. The preference for convergent, task-oriented instruction thus mirrors a broader cultural orientation that values utility and conformity over novelty and disruption.

Comparable patterns have been reported elsewhere in Asia. Tee (2022) observed that Malaysian preschoolers often become “accustomed to closed-ended questions with fixed answers,” leading to dependence on adult direction. Similarly, Yıldız and Yıldız (2021) found that instructional quality—particularly the use of open-ended questioning—has a stronger effect on cognitive development than the mere duration of preschool attendance. These findings emphasize the need to integrate creative thinking with scientific process skills.

Importantly, this paradox is not irreversible. Recent experimental studies in Vietnam demonstrate that structured pedagogical innovations can enhance originality. Nguyen and Vu (2025), for instance, reported that an intervention using the 5E-EDP model (Engage, Explore, Explain, Elaborate–Engineering Design Process, Evaluate) produced greater gains in creativity—including originality—than the conventional 5E framework. Consistent with

international evidence supporting project-based learning, the 5E-EDP model's success suggests that the creativity paradox arises primarily from implementation practices, not from the national curriculum itself.

From this perspective, the downward trend in originality ($p = 0.068$) acquires substantive meaning when interpreted within its context. Although not statistically significant at the $\alpha = 0.05$ level, the result indicates a learning environment that may inadvertently suppress divergent thinking. In practical terms, it signals a systemic risk that warrants pedagogical attention. Moreover, the two-month implementation period underscores the temporal dimension of creative development: while convergent reasoning can improve through short-term instruction, originality depends on sustained exposure to psychologically safe, learner-centered environments (Amabile, 2018)—conditions largely absent in the observed classrooms.

Despite limitations such as the one-group pretest–posttest design, short period of instruction, single-class case study, and the inherent challenges of assessing SC in young children, this study provides valuable empirical insight into the functioning of the ECE program as implemented in this context. It identifies specific pedagogical bottlenecks and highlights the need for instructional innovation to support the balanced development of SC in Vietnamese preschools.

Finally, this “creativity paradox” raises an ethical question concerning the fundamental goals of early childhood education. By prioritizing measurable, convergent outcomes—such as accuracy in solving known problems—the system may inadvertently constrain children's creative agency. This emphasis may prepare them for current assessment demands but fail to cultivate the divergent, innovative, and resilient thinking required for future challenges. Recognizing and addressing this paradox is therefore essential to align early education with its broader purpose: nurturing curiosity, imagination, and the capacity to think beyond the given.

Conclusion and Recommendations

Conclusion

This study provides the first empirical evidence of a “creativity paradox” within Vietnam's

ECE context. The findings indicate that, as implemented in the studied preschool, the pedagogical implementation produced a paradoxical outcome. Over the two-month period, the curriculum enactment did not lead to a statistically significant improvement in children's overall SC. Instead, it generated a divergent pattern in core creative abilities: while children's creative scientific problem-solving skills improved significantly, their originality showed a downward trend that, although not statistically significant at the $\alpha = 0.05$ level, represents a meaningful systemic signal when interpreted alongside the qualitative evidence. These findings suggest that the prevailing instructional approach may have strengthened one cognitive domain while constraining another.

The underlying cause of this outcome appears to stem from a persistent gap between the national curriculum's intended framework and classroom practice. The observed implementation was shaped by systemic limitations, including a predominant reliance on teacher-led instruction rather than child-centered inquiry, the use of procedural experiments with predetermined results, and an environment offering limited opportunities for open exploration or expression of novel ideas.

The "creativity paradox" identified in this preschool reflects broader tensions observed in education systems worldwide, echoing debates on "teaching to the test." In such systems, the emphasis on measurable, standardized outcomes may enhance task-specific proficiency while diminishing holistic and creative capacities. The present findings illustrate how educational programs—even those designed with constructive objectives—risk cultivating learners who can efficiently solve known problems but are less prepared for the divergent and innovative thinking necessary to address future challenges.

Recommendations

Drawing on the study's conclusions, the following recommendations are proposed to enhance the effectiveness of educational programs in developing SC among 5–6-year-old preschool children. These recommendations aim to bridge the gap between policy and classroom practice, aligning implementation more closely with the creative and inquiry-based goals outlined in Vietnam's national ECE Curriculum Framework (MoET, 2021) and with international initiatives promoting holistic and innovative learning, such as UNESCO's

Futures of Education (2023).

For educational institutions and policymakers

Educational institutions and their governing bodies should integrate SC-related objectives—fluency, flexibility, and originality—more explicitly into curriculum design and educational planning. Teachers should be supported in adopting learner-centered pedagogies such as learning through play, inquiry-based learning, and project-based learning with authentic STEAM integration. To facilitate these approaches, investment is needed to improve the physical learning environment, including the provision of open-ended, science-focused materials and flexible learning spaces.

Professional development must go beyond theoretical orientations to emphasize practical application. Training should be grounded in evidence-based frameworks; the 5E-EDP model (Engage, Explore, Explain, Elaborate–Engineering Design Process, Evaluate) has demonstrated effectiveness in fostering creativity in Vietnamese preschools (Nguyen & Vu, 2025; Nguyen et al., 2024) and can serve as a foundation for teacher capacity-building. Such programs should develop teachers' skills in facilitating inquiry, posing open-ended questions, fostering psychologically safe learning environments, and assessing creative processes.

For preschool teachers

Teachers are encouraged to shift their role from knowledge transmitters to facilitators of exploration. They should design open-ended learning activities that promote problem-solving and allow children to propose, test, and refine unique ideas. The structure of science experiments should be revised to increase children's participation across all stages of inquiry. Prioritizing thought-provoking, open-ended questioning in daily interactions—and maintaining a respectful stance toward all ideas—can enhance children's confidence and intrinsic motivation. Flexible, process-oriented assessment practices can further reinforce this creative learning climate.

For parents

Active collaboration between schools and families is recommended to support children's SC development. Schools should communicate regularly with parents about the importance

of creativity and provide guidance on how it can be nurtured at home. Parents can help by creating stimulating home environments that value curiosity, supplying simple materials for exploration, and encouraging children's original ideas with positive reinforcement.

For future research

Further studies are needed to strengthen the empirical foundation of SC education. More rigorous research designs—including the use of control groups and longer implementation periods—would allow clearer assessment of causal effects. The development and validation of SC assessment tools suited to the Vietnamese cultural and educational context would also be a valuable contribution. Future research should explore specific pedagogical strategies to address the weaknesses identified in this study and employ longitudinal designs to examine the sustainability of SC development over time. Finally, cross-cultural comparative research—particularly within the ASEAN region—could provide insight into how different educational contexts shape the implementation and outcomes of creativity-focused curricula.

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