ASIAN JOURNAL OF EDUCATIONAL SCIENCES
ISSN: 0866-7675
eISSN: 2815-567X
DONG THAP UNIVERSITY JOURNAL OF SCIENCE - DONG THAP UNIVERSITY
https://ajesdthu.vn

DOI: https://doi.org/10.52714/dthu.ajes.12.1950

# Scientific Creativity in Preschoolers (57-68 months): A Mixed-Methods Study

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**Article Info.**

*Received: December 17, 2025*
*Revised: February 10, 2026*
*Accepted: March 23, 2026*

**Keywords**

*Convergent thinking, divergent thinking, early childhood education, scientific creativity, scenario-based assessment.*

**Cite**

Tran, V. N., Nguyen, T. D. M., & Nguyen, T. B. T. (2026). Scientific Creativity in Preschoolers (57-68 months): A Mixed-methods Study. *Asian Journal of Educational Sciences, 1*(1), 95-108. https://doi.org/10.52714/dthu.ajes.12.1950.

**Abstract**

*This mixed-methods study assessed scientific creativity among 40 Vietnamese preschoolers (age range: 57-68 months) using seven culturally adapted tasks grounded on the Scientific Structure Creativity Model (Hu & Adey, 2002). The mean overall performance score was 21.05 (SD = 7.80). Results showed a discrepancy between the imaginative and applied scientific creativity dimensions: children performed significantly higher on tasks related to Scientific Imagination and Product Improvement but performed lower on Scientific problem solving and Creative use. Non-response rates for the latter tasks reached 55%. Nonparametric tests indicated no significant differences in SC scores based on gender or birth order. Qualitative data mirrored these quantitative patterns, showing that while children produced diverse ideas in hypothetical contexts, they often lacked specific strategies to address concrete physical challenges. These data suggest that scenario-based assessments may facilitate the identification of specific cognitive constraints in early childhood. Furthermore, the results suggest that Vietnamese preschool STEM instruction may benefit from targeted scaffolding to help children bridge the gap between imaginative thought and practical, hands-on application.*

## 1. INTRODUCTION

Creativity is increasingly positioned as a foundational competence for 21st-century education because it underpins innovation, critical thinking, and adaptive problem solving (National Research Council, 2012; Tran, 2023; Pinar et al., 2025). Developmental research further suggests that early childhood is not merely preparatory but constitutive: cognitive precursors to creativity emerge early and can be supported through systematic experiences (Yıldız Taşdemir, 2021; Vaisarova et al., 2024; Massy et al., 2026). This perspective challenges the conventional assumption that creative development is best addressed primarily in later schooling (Zimmerman, 2009; Robinson & Aronica, 2015; Glăveanu et al., 2019). In science learning, the relevant construct is scientific creativity (SC), commonly defined as the capacity to generate ideas, processes, or products that are both novel and appropriate within a scientific context (Hu & Adey, 2002; Pinar et al., 2025). Cultivating SC during the preschool years may shape later engagement in STEM learning and contribute to children's readiness to address complex, uncertain problems (Tran, 2023; Pinar et al., 2025; Massy et al., 2026).

SC is typically understood as involving an interplay between divergent and convergent thinking (Cropley, 2006; de Vries & Lubart, 2017; Aschauer et al., 2022; Pinar et al., 2025). Divergent thinking is reflected in fluency (the number of ideas), flexibility (the variety of idea categories), and originality (the rarity or uniqueness of ideas), whereas convergent thinking refers to processes aimed at selecting or refining solutions toward a single, optimal outcome (Cropley, 2006; Runco, 2010; de Vries & Lubart, 2017; Aschauer et al., 2022; Tran & Duong, 2026). Yet, a valid assessment of SC in preschoolers is methodologically demanding. Many conventional instruments rely on written responses or complex instructions, which can disadvantage young children with emerging literacy and limited sustained attention (Pfeiffer et al., 2007; Tran, 2023). For this reason, recent work has moved toward performance-based, developmentally appropriate tasks that elicit children's thinking through activity and interaction rather than text-heavy prompts (Tran, 2023; Vaisarova et al., 2024; Massy et al., 2026).

Hu and Adey's (2002) Scientific Structure Creativity Model offers a robust framework for such assessment by conceptualising SC through dimensions of scientific processes, products, and person-related characteristics. Empirically, tools aligned with this orientation have begun to emerge. For example, the Figural SC Test (FSCT) uses drawing tasks to evaluate preschoolers' creative potential in science (Chin & Siew, 2015). Nevertheless, the current toolkit remains limited: there is still a need for a broader range of validated, scenario-based measures capable of capturing multiple manifestations of SC in early childhood, including the different cognitive demands that tasks may impose (Tran, 2023; Tran & Duong, 2026).

Although research on young children's scientific thinking describes their capacity for observation, explanation, and simple experimentation (Gopnik, 2012; Saçkes et al., 2011), focused investigation of SC in preschool populations remains limited, particularly outside Western educational settings (Siew et al., 2017; Yıldız Taşdemir, 2021). Much of the existing evidence base either targets older learners (Pinar et al., 2025; Siew & Ambo, 2020; Yang et al., 2016) or is situated within Western cultural and curricular systems (Massy et al., 2026). As a result, it remains unclear how preschoolers' SC is expressed across diverse contexts, including Southeast Asian countries such as Vietnam (Tran, 2023; Tran & Duong, 2026).

Filling this gap involves more than extending geographic coverage. Classroom norms and broader cultural expectations may shape how creativity is enacted and recognised. Vietnam's education system has been undergoing reform; however, it has historically emphasised structured learning, and cultural expectations may influence children's willingness to take risks, propose uncertain ideas, or persist with open-ended problems (Ho, 2024; Dinh & Nakatsubo, 2025; Nguyen & Vu, 2025). A culturally contextualised account may therefore help inform early STEM initiatives that aim to support SC in ways that are both effective and equitable.

The present study responds to this need by assessing the SC of 5- to 6-year-old children (57-68 months) in Tay Ninh Province, Vietnam. Using a mixed-methods design, this study implemented seven scenario-based tasks adapted from Hu and Adey's (2002) framework and modified for developmental appropriateness and cultural relevance. The study addresses the following research questions:

*RQ1:* What is the overall profile of SC (fluency, flexibility, and originality) among 5- to 6-year-old Vietnamese preschoolers across the seven task domains?

*RQ2:* Do SC scores differ by gender or birth order in this sample?

*RQ3:* What qualitative response patterns characterise children's approaches to tasks designed to elicit SC, particularly regarding the interplay of divergent and convergent thinking?

## 2. METHODOLOGY

### 2.1. Participants and Sampling Strategy

The study was conducted in a public kindergarten in Thanh Hoa District, Tay Ninh Province, Vietnam. The sample comprised 40 preschool children (20 boys, 20 girls), all born in 2019 and aged 57-68 months at the time of data collection (September 2024; M = 62.5, SD = 3.4). This age range corresponds to the final year of preschool education in Vietnam, prior to transition to primary school.

Participants were recruited using purposive sampling with two criteria: (a) a balanced gender distribution to support subgroup comparisons and (b) regular attendance to maximise the likelihood of completing all tasks. Birth order was recorded for exploratory analyses (firstborn = 50%; later-born = 50%).

### 2.2. Instrument: Adapted Scenario-based Scientific Creativity Tasks

SC was assessed using seven scenario-based tasks adapted from Hu and Adey's (2002) Scientific Structure Creativity Model (SSCM). The adaptation was intended to support cultural relevance and developmental appropriateness for Vietnamese preschoolers and proceeded in three phases:

Translation and back-translation: Original prompts and scoring rubrics were translated from English into Vietnamese by two bilingual experts in early childhood education. An independent bilingual expert conducted back-translation to check conceptual and linguistic equivalence. Discrepancies were resolved through discussion.

Cultural modification: A panel of three experienced Vietnamese preschool teachers reviewed the Vietnamese tasks for clarity, cultural relevance, and familiarity of stimuli. Minor adjustments were made to wording and visual supports. For example, the organism in Task 2 was designed to be plausible but not immediately recognisable to local children.

Pilot testing: The revised tasks were piloted with 10 children (60-66 months) who were not included in the main study. The pilot suggested that children could understand the scenarios and that the full set could be completed within approximately 25-30 minutes, supporting the feasibility of one-on-one administration.

The final instrument included seven tasks designed to elicit distinct aspects of SC: (1) creative use of an object (alternative uses for a stainless-steel spoon); (2) sensitivity to a scientific problem (observations and questions about an unfamiliar organism image); (3) improving a product (modifications to a toy bus); (4) scientific imagination (consequences if the sun disappeared); (5) solving a scientific problem (ways to make a bottle cap sink); (6) creative experimentation (criteria-based selection of the "best" crayon); and (7) creative product design (designing a tool to harvest fruit; verbal description with optional drawing).

### 2.3. Scoring Procedure and Reliability

All verbal responses were audio-recorded and transcribed verbatim. Drawings from Task 7 were collected as artefacts. Scoring followed Hu and Adey's (2002) SSCM-based divergent thinking protocol across three dimensions: (1) Fluency: 1 point for each relevant and distinct idea.; (2) Flexibility: 1 point for each distinct semantic category or approach represented; (3) Originality: scored using statistical infrequency within the sample: responses occurring in >5% of the sample received 0 points; responses in 2-5% received 1 point; and unique or near-unique responses (<2%) received 2 points.

For Tasks 6 and 7, an additional point (up to 3) could be awarded to capture exceptional conceptual complexity/novel integration, consistent with the scoring rubric used in the adapted instrument. To evaluate scoring reliability, two researchers independently scored 25% of the dataset. Inter-rater agreement was high (Cohen's $\kappa = 0.85$). Discrepancies were resolved through discussion; when needed, a third rater adjudicated scoring differences for final coding. A total SC score was computed for each child by summing scores across all seven tasks; the maximum possible score was 40.

### 2.4. Administration Procedure and Non-response Handling

Data were collected individually by one of two trained female researchers in a quiet room within the kindergarten. Sessions lasted approximately 25-35 minutes. Researchers followed a standardised protocol, used identical materials, and relied on neutral, open-ended prompts to avoid leading children's responses. Children's responses were audio-recorded, and drawings from Task 7 were collected for scoring.

Non-response was treated as an analytically meaningful aspect of task engagement and a measurement constraint. If a child did not provide any idea or strategy after repeated neutral prompts, the response for that task was coded as "no response" and assigned a score of zero for fluency, flexibility, and originality on that task. Non-response frequencies were reported descriptively by task and used to contextualise quantitative patterns and qualitative interpretation of task demands (e.g., tasks requiring concrete solution strategies).

### 2.5. Data Analysis

Quantitative analyses were conducted in Jamovi. Descriptive statistics (means, medians, standard deviations, ranges, skewness, and kurtosis) were computed for total and task-level scores. Normality was assessed using Shapiro-Wilk tests; when normality was not supported, non-parametric tests were applied. Gender and birth-order differences in children's SC were examined using Mann-Whitney U tests. Statistical significance was set at $p < 0.05$.

For the qualitative component, transcripts were analysed using qualitative content analysis. Two researchers independently coded the data to generate initial codes aligned with observable dimensions of children's creative thinking, then refined codes into broader themes through discussion. Quotations were selected to illustrate themes and to support the interpretation of task-level quantitative patterns, including high non-response rates in specific scenarios.

### 2.6. Ethical Considerations

Ethical procedures followed standard principles for research with young children. Written informed consent was obtained from parents/guardians, and children provided age-appropriate assent. Participation was voluntary; children could decline any task or stop at any time without consequence. Sessions were kept brief, conducted in a familiar school setting, and framed as playful activities to minimise burden. All data were treated confidentially and reported in aggregate form.

## 3. Results

This section reports children's SC performance overall and across the seven tasks, followed by comparisons by gender and birth order, and task-level response patterns integrating quantitative scores with descriptive response frequencies.

### 3.1. Overall Scientific Creativity and Performance Across Tasks

The mean total SC score (N = 40) was 21.05 (SD = 7.80), ranging from 8 to 40 (maximum = 40). The distribution was positively skewed (skewness = 0.82; kurtosis = 0.56), with scores concentrated toward the lower end of the scale.

**Table 1. Descriptive statistics for SC scores**

| Scenario | Mean | SD | Min | Max | 1/3 Percentile | 2/3 Percentile | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| 1. Creative Use of Object | 2.10 | 2.70 | 0 | 14 | 0.00 | 3.00 | 2.3246 | 8.707 |
| 2. Sensitivity to Problem | 2.88 | 1.71 | 0 | 7 | 2.00 | 3.00 | 0.5910 | 0.396 |
| 3. Improving a Product | 3.48 | 1.28 | 0 | 6 | 3.00 | 4.00 | -0.0572 | 2.277 |
| 4. Scientific Imagination | 3.58 | 1.82 | 0 | 9 | 3.00 | 3.00 | 0.8872 | 2.260 |
| 5. Solving a Problem | 2.83 | 1.36 | 0 | 8 | 3.00 | 3.00 | 0.3340 | 5.951 |
| 6. Creative Experimentation | 2.85 | 2.71 | 0 | 8 | 0.00 | 5.00 | 0.0613 | -1.589 |
| 7. Designing a Product | 3.35 | 2.34 | 0 | 10 | 4.00 | 4.00 | 0.3139 | 1.007 |
| **Total** | **21.05** | **7.80** | **8** | **40** | **17.00** | **23.00** | **0.8202** | **0.562** |

Table 1 shows that the mean performance varied across tasks. The highest mean scores were observed for Task 4 (Scientific Imagination; M = 3.58, SD = 1.82) and Task 3 (Improving a Product; M = 3.48, SD = 1.28), whereas the lowest mean score occurred for Task 1 (Creative Use of an Object; M = 2.10, SD = 2.70). The largest standard deviations were observed for Task 6 (Creative Experimentation; SD = 2.71) and Task 1 (SD = 2.70), indicating greater dispersion of scores on these tasks relative to others.

### 3.2. Gender and Birth Order Effects on Scientific Creativity

No statistically significant differences were observed by gender or birth order. Mann-Whitney U tests showed no differences between boys and girls in the total SC score (U = 156.0, p = .238) or in any individual task (all p > .05). Likewise, Mann-Whitney U tests indicated no significant differences between firstborn and later-born children in the total score (U = 186.0, p = .704) or in task-level scores (all p > .05). Effect sizes (rank-biserial correlations) were small for both gender (total effect size = −.220) and birth order (total effect size = .073), suggesting that, in this sample, scientific creativity varied little as a function of these demographic characteristics.

**Table 2. Statistical Test Results for Gender and Birth Order Differences**

| Test (Mann-Whitney U) | Scenario | Statistic | *p* | Effect size |
|---|---|---|---|---|
| Gender | 1 | 181 | 0.577 | 0.0975 |
| | 2 | 168 | 0.373 | -0.1600 |
| | 3 | 172 | 0.395 | -0.1425 |
| | 4 | 154 | 0.152 | -0.2325 |
| | 5 | 193 | 0.810 | 0.0350 |
| | 6 | 185 | 0.651 | -0.0775 |
| | 7 | 189 | 0.751 | -0.0550 |
| | Total | 156 | 0.238 | -0.2200 |

| Test (Mann-Whitney U) | Scenario | Statistic | *p* | Effect size |
|---|---|---|---|---|
| Birth Order | 1 | 187 | 0.714 | -0.0650 |
| | 2 | 185 | 0.671 | 0.0775 |
| | 3 | 196 | 0.903 | -0.0225 |
| | 4 | 155 | 0.165 | 0.2250 |
| | 5 | 174 | 0.345 | 0.1300 |
| | 6 | 186 | 0.672 | 0.0725 |
| | 7 | 175 | 0.449 | -0.1275 |
| | Total | 186 | 0.704 | 0.0725 |

### 3.3. Qualitative and Quantitative Analysis of Responses by Task

Children's responses to each of the seven scenarios were analyzed both quantitatively and qualitatively to understand the nature of their scientific creative thinking.

*3.3.1. Task 1: Creative use of an object (spoon)*

Task 1 showed a low mean score (M = 2.10) and a high non-response rate (42.5%; n = 17). Among children who responded, ideas were largely conventional and closely aligned with the spoon's typical function. For example, nearly 40% of coded suggestions involved digging or scooping dirt/sand (39.1%). More transformative uses (e.g., using the spoon as a drumstick, hoe, or axe) were infrequent, and each occurred in fewer than 5% of responses.

**Table 3. Children's Responses to Scenario 1 (creative use of a spoon)**

| Response | Frequency | Percentage | Originality score |
|---|---|---|---|
| Use as a tool for digging/scooping dirt/sand | 9 | 39.1% | 0 |
| Use for drinking/scooping water/juice | 3 | 13.0% | 0 |
| Use for scooping other objects | 2 | 8.7% | 1 |
| Use for stirring water | 2 | 8.7% | 1 |
| Use for hitting a dinosaur | 2 | 8.7% | 1 |
| Use for feeding fish | 1 | 4.3% | 2 |
| Use as a drumstick | 1 | 4.3% | 2 |
| Use as a cup | 1 | 4.3% | 2 |
| Use as a hoe | 1 | 4.3% | 2 |
| Use as an axe | 1 | 4.3% | 2 |
| No response | 17 | 42.5% | 0 |

*3.3.2. Task 2: Sensitivity to a scientific problem (unfamiliar creature)*

Task 2 yielded a moderate mean score (M = 2.88) and a low non-response rate (7.5%; n = 3). Responses most often involved classification by analogy: 59.5% involved naming the organism as a familiar animal (e.g., "turtle," "crocodile"), and 16.7% described body parts. Inquiry-oriented questions were coded less frequently, including questions about habitat (7.1%) and diet (4.8%); these responses received higher originality scores under the rubric.

**Table 4. Children's Responses to Scenario 2 (sensitivity to a scientific problem)**

| Response | Frequency | Percentage | Originality Score |
|---|---|---|---|
| Named the creature (e.g., turtle, crocodile) | 25 | 59.5% | 0 |
| Explored the creature's parts (e.g., head, legs, tail, eyes, shell) | 7 | 16.7% | 0 |
| Asked about its habitat | 3 | 7.1% | 1 |
| Asked about its food | 2 | 4.8% | 2 |
| Expressed a desire to play with it | 2 | 4.8% | 2 |
| Asked if it was dangerous | 1 | 2.4% | 2 |
| No response | 3 | 7.5% | 0 |

*3.3.3. Task 3: Improving a technical product (toy bus)*

Task 3 was among the higher-scoring tasks (M = 3.48; SD = 1.28) and had a non-response rate of 17.5%. Responses most commonly focused on aesthetic changes (e.g., "decorate/paint it," 45.5%) and conventional functional uses (e.g., transporting children to school/play, 27.3%). Less common responses proposed structural or functional modifications (e.g., "make it bigger," 9.1%; "make it able to run/move," 6.1%). A small number of low-frequency ideas (e.g., "upgrade it," "wash it," each 3.0%) received the highest originality scores.

**Table 5. Children's Responses to Scenario 3 (improving a technical product)**

| Response | Frequency | Percentage | Originality Score |
|---|---|---|---|
| Decorate/paint it | 15 | 45.5% | 0 |
| Use it to transport other children to school/play | 9 | 27.3% | 0 |
| Make it bigger | 3 | 9.1% | 1 |
| Make it able to run/move | 2 | 6.1% | 1 |
| Add stickers | 2 | 6.1% | 1 |
| Upgrade it | 1 | 3.0% | 2 |
| Wash it | 1 | 3.0% | 2 |
| No response | 7 | 17.5% | 0 |

*3.3.4. Task 4: Scientific Imagination (Sun Disappearing)*

Task 4 produced the highest mean score (M = 3.58; SD = 1.82) and had a non-response rate of 20% (n = 8). Responses clustered around immediate perceptual consequences; the most common response was "It will be dark/There will be no light" (65.7%). A smaller set of responses extended to downstream consequences, such as "It will be cold" (6.3%) or "Plants will not grow/will not bloom" (6.3%).

**Table 6. Children's Responses to Scenario 4 (scientific imagination)**

| Response | Frequency | Percentage | Originality Score |
|---|---|---|---|
| It will be dark/There will be no light | 21 | 65.7% | 0 |
| It will be cold | 2 | 6.3% | 1 |
| Plants will not grow/will not bloom | 2 | 6.3% | 1 |
| We can not see the way | 2 | 6.3% | 1 |
| It will rain | 2 | 6.3% | 1 |
| (The sun) has a power outage | 1 | 3.1% | 2 |
| Earthquake and house collapse | 1 | 3.1% | 2 |
| There will be a tornado | 1 | 3.1% | 2 |
| No response | 8 | 20% | 0 |

*3.3.5. Task 5: Solving a scientific problem (sinking a bottle cap)*

Task 5 had a moderate mean score (M = 2.83; SD = 1.36) and a high non-response rate (55%; n = 22). Among children who responded, coded strategies included adding weight (e.g., "put a heavy object on it," 38.5%), applying force (e.g., "press it down," 30.8%), and changing the medium/material (e.g., "pour sand into it," 15.4%; "pour another liquid into it," 38.5%).

**Table 7. Children's Rresponses to Scenario 5 (solving a scientific problem)**

| Response | Frequency | Percentage | Originality Score |
|---|---|---|---|
| Put a heavy object on it | 5 | 38.5% | 0 |
| Press it down | 4 | 30.8% | 0 |
| Pour sand into it | 2 | 15.4% | 0 |
| Tie it with a string | 2 | 15.4% | 0 |
| Pour another liquid into it | 5 | 38.5% | 0 |
| No response | 22 | 55% | 0 |

*3.3.6. Task 6: Creative experimentation (choosing the best crayons)*

Task 6 showed high variability (M = 2.85; SD = 2.71) and a low non-response rate (5%; n = 2). Responses were most often preference-based; 66.7% of children who answered selected a crayon because it was a “beautiful/favourite colour.” A smaller subset referenced more testable criteria (e.g., length/usability 11.1%, newness 7.4%, durability 3.7%) or explicitly referred to the selection process/principle (25.9% and 22.2%), which received higher originality scores in the rubric.

**Table 8. Children’s Responses to Scenario 6 (creative experimentation)**

| Response | Frequency | Percentage | Originality Score |
|---|---|---|---|
| Choose a beautiful/favourite color | 10 | 66.7% | 0 |
| It draws beautifully | 3 | 11.1% | 0 |
| Choose a longer one/can draw more | 3 | 11.1% | 3 |
| Choose a new one | 2 | 7.4% | 3 |
| It will not break | 1 | 3.7% | 3 |
| Mentioned the process of using it | 7 | 25.9% | 3 |
| Mentioned the principle of selection | 6 | 22.2% | 3 |
| No response | 2 | 5% | 0 |

*3.3.7. Task 7: Designing a scientific product (tool for harvesting fruit)*

Task 7 yielded a moderate mean score (M = 3.35; SD = 2.34). Mean flexibility (M = 2.33; SD = 1.59) exceeded mean originality (M = 1.02; SD = 0.86). Verbal descriptions and drawings most commonly relied on a ladder or ladder-like apparatus. Less frequently, children proposed extension poles with nets or baskets to address reach and fruit containment. Some children provided limited detail in their designs and descriptions.

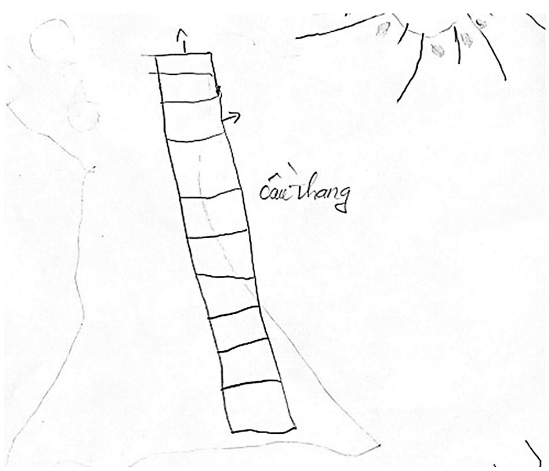


**Figure 1. The Solution Selected by the Largest Number of Children**

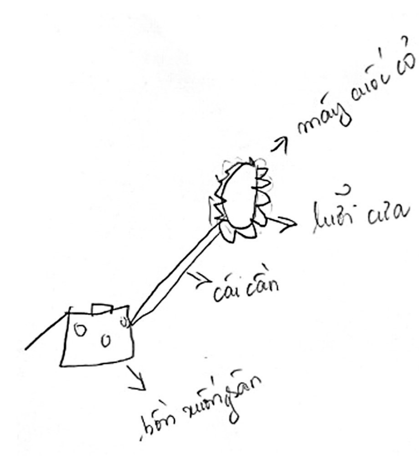


**Figure 2. The Solution Selected by the Fewest Children**

Overall, children’s SC scores indicated moderate performance, with an uneven profile across tasks. Tasks 4 and 3 showed higher mean scores, whereas Tasks 1 and 5 showed lower mean scores alongside higher non-response rates. Gender and birth order were not associated with statistically significant differences in SC in this sample.

## 4. Discussion

### 4.1. Overview of Principal Findings

This study examined SC among Vietnamese preschoolers using seven culturally adapted, scenario-based tasks aligned with SSCM (Hu & Adey, 2002). Overall, SC was moderate (M = 21.05 out of 40), but performance varied substantially among tasks. Children scored relatively highly on Scientific Imagination (Task 4; M = 3.58) and Product Improvement (Task 3; M = 3.48). In contrast, Creative Use of an Object (Task 1; M = 2.10) and Solving a Scientific Problem (Task 5; M = 2.83) appeared more demanding and were characterised by high non-response (42.5% and 55%, respectively). No statistically significant differences were found by gender or birth order, which is broadly consistent with studies suggesting that gender gaps in science achievement tend to widen in later elementary years rather than early childhood (Pfeiffer et al., 2007; Saçkes et al., 2011). Taken together, these results indicate that children's SC is not uniform across domains and may be sensitive to task demands, including the balance between divergent idea generation and convergent, constraint-based solution development (de Vries & Lubart, 2017; Hu & Adey, 2002).

### 4.2. An Uneven Task Profile and the "Imagination-application" Pattern

Across the task set, a recurring contrast emerged between tasks that invited open-ended ideation and tasks that required workable strategies beneath physical constraints. In Task 4, children readily generated consequences of the sun disappearing. Many responses focused on immediate perceptual outcomes (e.g., darkness), and some extended to downstream causal effects (e.g., cold; plants not growing). This comparatively solid performance is compatible with the view that preschoolers can imagine alternatives flexibly when prompts are hypothetical and evaluative demands are relatively low, consistent with Vaisarova et al.'s (2024) description of mini-c creativity at this developmental stage.

By comparison, Task 1 required children to reframe an everyday object (a spoon) beyond its typical use. Responses were predominantly conventional, and the non-response rate was high (42.5%). This pattern aligns with a typical challenge in early creative performance: generating alternatives that depart from familiar functions may require representational flexibility and a willingness to propose "unusual" ideas (Chin & Siew, 2015). Task 3 (improving a toy bus) elicited many feasible suggestions, often aesthetic or incremental, suggesting that children were more comfortable modifying within a familiar frame than transforming the object's purpose. This pattern is consistent with multi-component accounts of SC: at this age, children may show relative strength in ideational expansion under low constraint while still developing the ability to shift frames or operationalise ideas into workable solutions (Cropley, 2006).

The clearest indication of this uneven profile appeared in Task 5 (making a bottle cap sink). Although the mean score was moderate among respondents, over half of the sample (55%) offered no strategy. Among children who did respond, common approaches included adding weight or applying force, suggesting that some children could draw on plausible causal mechanisms. However, the high non-response rate indicates that generating a concrete, testable plan without step-by-step scaffolding may have been difficult for many children in this context, or that some children were reluctant to commit to a single solution in an evaluative setting. As Siew et al. (2017) noted, without support structures (such as cooperative learning or scaffolding), young children commonly struggle to generate complex scientific solutions. This pattern does not necessarily imply an absence of creative potential; instead, it highlights how task demands may differentially elicit divergent versus convergent processes in early childhood SC (de Vries & Lubart, 2017).

Our findings regarding the challenges in Task 1 (Creative Use of Object) align with recent evidence from Southeast Asia, specifically the Philippines. Fernandez et al. (2025) found that primary school students also scored lowest on the “Scientific Uses of a Piece of Glass” task. However, while Fernandez et al. (2025) attributed this to a lack of scientific knowledge about the object's properties (glass), our data suggest that, for preschoolers, the barrier is primarily “functional fixedness” regarding everyday objects like spoons. Furthermore, a striking contrast emerges in Problem Solving (Task 5). While Fernandez et al.’s (2025) older participants (Grade 6) excelled in this domain ($M = 11.89$) by leveraging formal mathematical knowledge, our preschool participants struggled significantly, recording a 55% non-response rate when faced with a physical challenge such as sinking a bottle cap. This comparison highlights a developmental trajectory in which SC evolves from overcoming perceptual constraints in early childhood to leveraging domain-specific knowledge in primary education, reinforcing the need for age-appropriate pedagogical scaffolding.

### 4.3. Interpreting Non-response: Engagement Signal and Measurement Constraint

Non-response was concentrated in Tasks 1 and 5-tasks that required either reframing a familiar function (Task 1) or generating a physically workable strategy (Task 5). In the present study, non-response was coded and reported by task, and each task was scored as zero to reflect the absence of observable ideational output (Hu & Adey, 2002). Interpretation, however, should remain cautious. Non-response may reflect multiple processes, including difficulty understanding the task, limited experience with open-ended questioning, or low confidence in proposing uncertain answers. As Vaisarova et al. (2024) noted, child characteristics such as self-esteem can be associated with curiosity-driven behaviours, suggesting that non-response may sometimes reflect hesitation to engage in exploration when confidence is low rather than an absence of ability.

This dual interpretation may be especially relevant in the Vietnamese context. Although educational reforms are ongoing, structured learning traditions and classroom norms may shape how children participate in tasks without a single correct answer (Ho, 2024; Dinh & Nakatsubo, 2025). Specifically, recent observations in Vietnamese preschools indicate a prevalence of teacher-centered discourse where teachers predominantly use closed questions and rhetorical statements, leaving limited space for children's open inquiry (Dinh & Nakatsubo, 2025). From this perspective, non-response may function as an engagement signal-may indicate sensitivity to evaluation-rather than simply missing data. Nevertheless, the present design did not include direct classroom observation or experimental manipulation of instructional cues, so causal interpretations should be avoided. The most defensible conclusion is descriptive: scenario-based tasks elicited substantial non-response in specific domains, suggesting that (a) some manifestations of SC may be difficult to elicit lacking targeted scaffolding (Massy et al., 2026) and (b) task design and social context may influence what children are willing or able to express (Tran & Duong, 2026).

Furthermore, interpreting non-response also requires attention to the power dynamics embedded in the assessment context. Data were collected by adult researchers who were relatively unfamiliar to the children. For a 5-year-old, being alone with an unfamiliar adult in a quiet room and asked to perform under evaluation may elicit performance anxiety. Accordingly, the 55% non-response rate in Task 5 may not reflect only difficulty generating solutions; it may also partly be an artifact of adult-child power asymmetry, in which children choose silence to avoid offering an answer they believe could be “wrong” in front of a perceived authority figure.

### 4.4. No Gender or Birth-order Differences in this Sample

The absence of statistically significant differences in SC by gender or birth order suggests that, within this sample, variation in SC aligned more closely with task demands than with these demographic characteristics. This pattern is broadly consistent with standardisation studies of gifted rating scales for preschoolers, which have reported minimal gender differences across intellectual and creative domains at this age (Pfeiffer et al., 2007). It also fits with the view that early creative performance can be highly context-dependent and may be determined by learning opportunities and interactional norms rather than stable individual differences.

Given the modest sample size and single-site design, these null findings should be interpreted as preliminary. However, they align with recent findings in the Central Vietnam context, which also reported no significant gender differences in creative potential among 5-6-year-olds (Vu & Hoang, 2024). This tentatively indicates that efforts to strengthen SC may benefit from focusing on classroom-level practices and task supports rather than assuming subgroup-specific differences (Massy et al., 2026; Tran & Duong, 2026).

### 4.5. Implications for Early STEM Teaching and for Assessing Scientific Creativity

Two practical implications might be drawn from the uneven task profile observed in this study. First, early STEM pedagogy may benefit from more explicit support for bridging imaginative ideation and hands-on problem solving. Children's comparatively stronger performance on imagination-oriented scenarios and weaker engagement with constraint-based tasks suggests that some learners may need help moving from "many ideas" to "workable strategies." In practice, this could entail (a) modelling multiple possible approaches, (b) encouraging prediction-and-testing cycles, and (c) normalising uncertainty and revision during problem solving. These approaches are consistent with work linking guided, project-based, and inquiry-oriented experiences to young children's scientific learning and creativity (Pinar et al., 2025; Siew et al., 2017). Specifically, integrating engineering design processes into science activities (e.g., the 5E-EDP model) has shown effectiveness in enhancing originality and flexibility for Vietnamese preschoolers (Nguyen & Vu, 2025).

Second, the findings show the potential value of scenario-based assessment in early childhood. Relative to purely figural or drawing-based measures (Chin & Siew, 2015), the present task set appeared to differentiate demands related to imagination, modification, and physical problem solving and also made non-response patterns visible. For research and practice, this suggests that SC assessment may benefit from using multiple task formats; a small battery spanning multiple domains may provide a more informative profile of children's strengths and support needs (Hu & Adey, 2002; Massy et al., 2026).

In sum, Vietnamese preschoolers in this study demonstrated moderate SC overall but an uneven profile across task domains. Scenario-based tasks indicated comparatively stronger performance when children were invited to imagine consequences or propose product modifications, and weaker engagement-often expressed as non-response-when tasks required reframing familiar functions or generating concrete, constraint-bound strategies. These patterns are consistent with accounts of SC that emphasise both divergent and convergent processes (Cropley, 2006; de Vries & Lubart, 2017) and point to the potential importance of pedagogical scaffolding that connects imaginative thinking with practical problem solving in early STEM learning (Pinar et al., 2025; Siew et al., 2017).

## 5. CONCLUSION

This study assessed SC among Vietnamese preschoolers (57-68 months) using seven culturally adapted, scenario-based tasks grounded in Hu and Adey's (2002) SSCM. Overall, children showed a moderate level of SC, but performance was uneven across task domains. Scores were relatively higher for tasks that invited imaginative consequences and product modification (Scientific Imagination; Product Improvement). By contrast, tasks requiring functional reframing and constraint-based problem solving (Creative Use of an Object; Solving a Scientific Problem) were associated with notably high non-response rates. SC scores also did not differ significantly by gender or birth order in this sample.

These findings deliver context-specific evidence on early SC in Vietnam and reinforce the potential value of multi-domain, scenario-based assessments for recording diverse manifestations of creativity in early childhood. In practical terms, early STEM learning may benefit from supporting children's transition from generating ideas to developing workable strategies-for example, by normalising uncertainty, scaffolding testing and revision, and establishing classroom norms that make it acceptable to voice tentative solutions. Given the modest, single-site sample, these conclusions should be interpreted as indicative rather than definitive. Subsequent research might extend this work by using larger, more diverse samples, incorporating direct observation of classroom practices, and examining how instructional cues and learning environments shape children's engagement-particularly in tasks that call for convergent, constraint-sensitive problem-solving (Hu & Adey, 2002).

## DECLARATIONS

**Funding:** This study was funded by Hue University, grant number DHH2024-03-201.

**Institutional Review Board Statement:** Ethical review and approval were waived for this study. The data were collected as part of an instrument-testing pilot conducted under the supervision of the master's thesis committee at the University of Education, Hue University, prior to the commencement of the funded research project (DHH2024-03-201) for which formal ethics approval was subsequently obtained. The pilot involved a separate sample at a different site from the main project. All data collection adhered to standard ethical principles consistent with the Declaration of Helsinki, including written informed consent from parents/guardians, age-appropriate assent from child participants, voluntary participation with the right to withdraw at any time without consequence, and confidential treatment of all data. The study posed no more than minimal risk to participants.

**Transparency:** The authors confirm that this manuscript presents an accurate and transparent account of the research conducted. All essential aspects of the study design, data collection, analysis, and findings have been fully reported.

**Competing Interests:** The authors declare no competing interests.

**Authors' Contributions:** T.V.N.: Conceptualization, Methodology, Formal Analysis, Investigation, Writing - Original Draft. N.T.D.M.: Investigation, Data Collection, Resources. N.T.B.T.: Conceptualization, Supervision, Writing - Review & Editing, Project Administration, Funding Acquisition. All authors have read and agreed to the published version of the manuscript.

**Disclosure of AI Use:** AI writing assistance tools such as Chat GPT ChatGPT (GPT5.2, OpenAI) and Grammarly were used in preparing portions of this manuscript for language editing purposes. All AI-assisted content was reviewed and verified by the authors, who take full responsibility for the accuracy and integrity of the work.

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