Imagination: A Latent Growth Curve Analysis of STEAM-Based Block Play's Impact on Preschool Creativity

Chia-Pin Kao[1*], Lin, Yung-Chih[2]

[1] Southern Taiwan University of Science and Technology, Tainan, Taiwan
[2] Asia University, Taichung, Taiwan

*Corresponding Author: Chia-Pin Kao, kcp76@stust.edu.tw

Abstract

There is limited research on Science, Technology, Engineering, Arts, and Mathematics education for early childhood children, especially research based on children's hands-on experiences. This longitudinal study examined how preschool children's creativity was affected when they used STEAM building blocks as learning tools to spark their imagination.

The study sample consisted of 90 children aged 4 to 6 years, and the evaluation creativity tendency including creative imagination, and creative building blocks performance consisting of novelty, resolution, and elaboration/synthesis. Creative imagination was measured every month, while creative building blocks performance was measured 17 times, divided by time points, and the scores were calculated as averages for four time points. Finally, Latent Growth Curve Modeling (LGCM) was used for data analysis.

The findings indicate the potential of integrating STEAM teaching strategies into early childhood education to nurture children's creativity and imaginative abilities. The absence of gender-based disparities in the growth of creative imagination suggests that STEAM education can be a generally beneficial approach for fostering creativity in young learners.

Some Implications for practice or policy:

1. This longitudinal study was conducted for six months on 90 preschool children.
2. This study examined how preschool children's creativity was affected when they used STEAM building blocks.
3. This study applied the latent growth curve modeling (LGCM) to analyze young children's imagination.
4. STEAM education can be a generally beneficial approach for fostering creativity in young learners.

Keywords: A Latent Growth Curve Modeling, blocks play, Imagination

1.Introduction

The global emphasis on STEM (Science, Technology, Engineering, and Mathematics) education has gradually expanded to include the arts, resulting in the STEAM approach. This expanded focus acknowledges the role of creativity and imagination as essential components of innovative thinking and learning (Lin et al., 2022). Although STEAM education has gained prominence at higher education levels, its presence in early childhood remains limited, especially in practical classroom applications. Integrating arts into early STEM practices allows children to creatively explore and represent their understanding through hands-on and meaningful experiences (Lu et al., 2022).

In early childhood education, block play is widely used and valued for its ability to enhance motor, spatial, and cognitive skills. However, not all classroom practices maximize block play's potential as a STEAM learning strategy. Bevan (2017) suggests that with proper guidance, even simple materials like blocks can become tools for inquiry-based learning and creative problem-solving. Recognizing and implementing block play within the STEAM framework can transform these everyday activities into powerful opportunities for developing imagination and creativity. This study investigates how structured STEAM-based block play affects the longitudinal development of creativity in preschoolers.

2. Literature Review

2.1 Creativity in Early Childhood Development

Creativity is increasingly recognized as a vital component of early childhood education. It is not only a means for self-expression but also a core competency associated with flexible thinking, curiosity, and resilience. As children play, they actively engage their imaginations, generating new ideas, solving problems, and creating original narratives (Craft, 2005; Gündoğan, 2020). Early experiences that promote imagination are foundational for later creative abilities and innovation.

Research emphasizes the importance of imaginative environments that support divergent thinking and emotional safety. According to Bukhalenkova and Almazova (2023), environments that provide room for play, exploration, and open-ended activities are more conducive to creative growth. These settings encourage children to experiment with possibilities, visualize scenarios, and construct personal meaning from their surroundings.

2.2 Educational Value of Block Play

Block play has long been considered a staple in early childhood classrooms due to its open-

ended nature and capacity to support numerous domains of development. Aksoy and Belgin Aksoy (2023) highlight that engaging in block building encourages children to develop fine motor skills, spatial reasoning, and cooperative play. Block play fosters both individual creativity and collaborative problem-solving.

Different types of blocks, such as LEGO, unit blocks, and modular construction kits like LASY, each contribute uniquely to children's creative exploration (Borriello & Liben, 2018). For instance, LASY blocks allow three-dimensional constructions that emphasize engineering concepts like balance, symmetry, and design. Research by Zhang et al. (2022) suggests that block play positively affects not only creative performance but also cognitive development, particularly spatial awareness and scientific reasoning.

2.3 Integrating STEAM Concepts into Block Play

STEAM-based education incorporates the principles of science, technology, engineering, arts, and mathematics through interconnected activities. When block play is situated within this interdisciplinary framework, it offers children hands-on opportunities to explore scientific concepts (e.g., gravity, force), use engineering design processes, apply mathematical measurements, and express artistic ideas (Sung et al., 2023).

Ponticorvo et al. (2020) emphasize that combining physical materials with digital or narrative tools can enhance creativity, especially in atypical learners. Furthermore, integrating drawing with block-based activities enables children to extend their imaginative thinking and document their understanding visually (Sawyer & Goldstein, 2019). Through project-based learning, children can build, reflect, share, and iterate—key processes in fostering deep learning and innovation.

2.4 Assessment of Creativity in Young Children

Evaluating creativity in preschoolers is inherently challenging due to their developmental variability and limited verbal abilities. Traditional assessments like the Torrance Tests of Creative Thinking (TTCT) may not fully capture young children's creative expressions. Therefore, observational tools and performance-based assessments, such as analyzing children's block creations and drawings, are commonly used (Roberts & Stagnitti, 2018).

The Creativity Assessment Packet (CAP), developed by Williams (1980), has been adapted for use in early childhood settings and provides a structured way to assess creative tendencies such as imagination, originality, and elaboration. This instrument, combined with teacher observations, allows for a holistic understanding of how creativity evolves over time

(Chang et al., 2017; Hsiao et al., 2014). As creativity is context-sensitive, assessments must consider children's interactions, emotions, and the process—not just the product.

3. Method

3.1 Participants

The study was conducted with 90 preschool children aged between 4 and 6 years old from multiple preschools in Taiwan. These children were selected through convenience sampling from classes already implementing STEAM activities in their curriculum. The final sample included an equal distribution of gender (45 boys and 45 girls) and represented a range of socioeconomic backgrounds.

Parental consent was obtained prior to the study, and ethical standards were maintained throughout the research. The study design ensured minimal disruption to regular classroom routines while incorporating structured STEAM-based block play activities as part of the children's learning experiences. The intervention period lasted for six months, with sessions held bi-monthly.

3.2 Procedure

Each bi-monthly session lasted approximately 40 minutes and was facilitated by trained preschool teachers with experience in STEAM education. The intervention used LASY blocks, selected for their flexibility in promoting creativity through three-dimensional construction. Activities included four instructional phases: (1) using both hands to manipulate blocks, (2) imitating sample models, (3) modifying existing structures, and (4) designing original creations.

To capture creativity development, two forms of evaluation were employed. First, teachers completed the Williams Scale at four time points, providing ratings on children's imaginative behavior. Second, children's block creations were photographed and evaluated by trained raters using criteria from the Creative Product Semantic Scale (CPSS), particularly focusing on resolution, novelty, and elaboration/synthesis.

3.3 Instruments

The Williams Scale, based on the Creativity Assessment Packet (CAP), was used to evaluate children's imagination. It includes 48 items rated on a 3-point Likert scale assessing originality, flexibility, elaboration, curiosity, imagination, and complexity. The scale was

adapted for the preschool context and completed by teachers based on observed behaviors during the activities.

In addition, creative performance was assessed using indicators from the CPSS, particularly resolution—defined as how effectively a product fulfills its intended purpose. Block constructions were assessed at each session using a rubric designed for preschool learners.

3.4 Data Analysis

The longitudinal data were analyzed using SPSS AMOS 24. Latent Growth Curve Modeling (LGCM) was used to assess the trajectory of imagination scores over time. Both linear and quadratic growth models were tested for model fit, with the best-fitting model selected based on Chi-square (χ^2), RMSEA, CFI, and SRMR indices. Gender and resolution were included as covariates to test their influence on initial imagination levels and growth rates.

4. Results

4.1 Descriptive Statistics

Imagination scores increased over time. Mean scores at four time points were 1.53, 1.75, 1.73, and 1.70, respectively. Skewness and kurtosis values were within acceptable ranges, confirming normal distribution assumptions. Correlation coefficients between time points were significant, suggesting a consistent developmental pattern.

4.2 Latent Growth Curve Model

A Chi-square test was performed to check the linear model of imagination, which is statistically significant (χ^2=29.12, p<.05), with NFI= .73, TLI=.72, CFI=.79, IFI=.77, RMSEA=.220, and SRMR=.05. Given that most indicators fail to meet the model-fit standards (Schumacker & Lomax, 2016), the current study has modified the model to create a more flexible latent growth curve model. In this revised model, the slope coefficients of imagination toward four indicators are set to be 0, W2, W3, and 1 respectively, whereas the remaining path coefficients are treated as free parameters that need estimation, in order to explore the changes of growth across four time points in Figure 1.

4.3 Gender and Creative Performance as Predictors

Gender had no significant effect on either the intercept or slope, indicating that both boys and girls experienced similar growth in imagination. However, resolution scores significantly predicted the slope of imagination ($\beta = .12$, $p < .001$), though not the intercept. This suggests that children whose block creations demonstrated higher functional clarity also exhibited greater growth in imaginative abilities.

5. Discussion

The present study offers compelling evidence that STEAM-based block play can foster the development of preschoolers' imagination. The findings align with prior literature indicating that hands-on, interdisciplinary activities support cognitive flexibility and creativity (Craft, 2005; Gündoğan, 2020). LASY blocks, as a tangible and versatile tool, provided children with opportunities to plan, construct, modify, and reflect—mirroring the engineering design process central to STEAM education (Lu et al., 2022). The use of Latent Growth Curve Modeling confirmed a non-linear trajectory in the growth of imagination, suggesting that imagination flourishes when children are engaged in iterative, developmentally appropriate learning over time (Duncan et al., 2019).

The lack of significant gender differences is consistent with previous research emphasizing that when learning environments are inclusive and rich in open-ended materials, all children benefit equally (Aksoy & Belgin Aksoy, 2023). This supports calls for gender-equitable pedagogy in early childhood STEAM education, where both boys and girls are encouraged to explore, design, and create. The finding that resolution—a measure of functional effectiveness in creative block constructions—predicts imagination growth echoes Borriello and Liben's (2018) suggestion that adult scaffolding and meaningful challenges enhance children's spatial and symbolic development.

This study also validates the integration of artistic and narrative components—such as drawing and storytelling—into STEAM activities. These components not only complement block-based construction but also provide additional modalities for expression, as recommended by Ponticorvo et al. (2020) and Sawyer and Goldstein (2019). Children's narratives revealed how their imaginative thinking extended beyond physical construction into symbolic play and communication. These multimodal experiences align with the holistic nature of early childhood development, engaging emotional, cognitive, and creative domains simultaneously (Sung et al., 2023).

In terms of assessment, this research underscores the importance of using both process-based observations and product-based evaluations. As Roberts and Stagnitti (2018) argue, relying solely on one measure may obscure the full scope of a child's creative potential. The combined use of the Williams Scale and the CPSS allowed for a nuanced understanding of how imagination unfolds and is reflected in children's constructed artifacts. The role of the teacher as both facilitator and evaluator was also critical, reinforcing the importance of professional development in observation and documentation practices.

However, several limitations should be acknowledged. The sample consisted exclusively of children from Taiwanese preschools and was selected via convenience sampling. Cultural and contextual factors may influence how STEAM activities are perceived and enacted. As such, the findings may not generalize across different educational systems or cultural settings. Additionally, variability in how teachers implemented the block play sessions, despite shared training, may have introduced inconsistencies in children's experiences and outcomes (Bevan, 2017).

Future studies should consider expanding to more diverse contexts and using a mixed-methods approach to triangulate quantitative findings with qualitative insights from children’s voices, teacher reflections, and video analysis. Investigating the longitudinal impact of STEAM play beyond six months could also illuminate how imagination and creative thinking evolve with sustained exposure. Moreover, exploring the role of family environments and digital tools (Bukhalenkova & Almazova, 2023) in supporting STEAM learning may yield valuable insights into how to bridge school-home learning in creative development.

6. Conclusion and Implications

This study concludes that STEAM-based block play has a meaningful and positive effect on the development of imagination in preschool children. Over a six-month intervention, children's imaginative abilities showed a significant upward trajectory, with evidence of non-linear growth suggesting that imagination flourishes most when learning is iterative, engaging, and grounded in meaningful play. The resolution of children's creations was also found to predict imagination growth, reinforcing the connection between functional creativity and conceptual development.

From a practical standpoint, early childhood educators are encouraged to integrate structured STEAM learning into their daily routines, particularly through guided block play. These activities should be designed to provide both challenge and autonomy, allowing

children to express their ideas freely while developing critical thinking and problem-solving skills. Additionally, educators should include reflective practices such as drawing and storytelling to enhance metacognitive awareness and emotional engagement.

Policymakers and curriculum developers should consider supporting teacher training and resource development that enable effective implementation of STEAM education in early childhood. Future research should explore longitudinal effects beyond one academic year and examine how teacher-child interactions mediate the relationship between STEAM experiences and creativity development. Ultimately, this study contributes to a growing body of evidence highlighting the transformative potential of STEAM pedagogy in fostering creativity, equity, and holistic learning in the early years.

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