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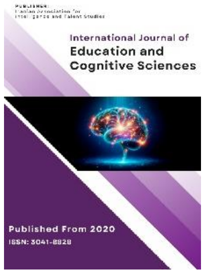

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The Effect of Smart Constructive Games on Visual-Spatial Development in Preschool Children

Rasool Abul Hasani[1], Shabnam Niknejad[2*]

[1] MA, Department of General Psychology, West Tehran Branch, Islamic Azad University, Tehran, Iran.
[2] MA, Department of General Psychology, West Tehran Branch, Islamic Azad University, Tehran, Iran (Corresponding Author).

*** Corresponding author email address**: awesomeshn777@gmail.com

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ABSTRACT

Purpose: This study aimed to investigate the effect of smart game-based interventions on visual-spatial development in preschool children.

Methods and Materials: A quasi-experimental pretest-posttest design with a control group was employed. The sample consisted of 30 preschool children selected through cluster random sampling from two preschools in Tehran, with 15 participants assigned to the experimental group and 15 to the control group. The experimental group participated in eight structured smart game sessions, while the control group received no intervention. Visual-spatial development was assessed using the 51-item Visual-Spatial Development Questionnaire (Wachs, 2014), which includes subscales for sensory and bodily awareness, spatial localization, body-environment interaction, spatial maintenance, logical visual reasoning, and representational thinking. Data analysis was conducted using multivariate analysis of covariance (MANCOVA) to examine the differences between groups while controlling for pretest scores.

Findings: The results indicated significant improvements in all visual-spatial subscales among children in the experimental group compared to the control group. Sensory and bodily awareness ($F = 49.81$, $p < 0.01$), spatial localization ($F = 32.58$, $p < 0.01$), body-environment interaction ($F = 269.3$, $p < 0.01$), spatial maintenance ($F = 71.72$, $p < 0.01$), logical visual reasoning ($F = 173.4$, $p < 0.01$), and representational thinking ($F = 184.9$, $p < 0.01$) all showed significant increases. The total visual-spatial development score also significantly improved ($F = 839.01$, $p < 0.01$), confirming the effectiveness of smart games in enhancing spatial cognitive abilities.

Conclusion: The findings suggest that smart game-based interventions are highly effective in fostering visual-spatial development in preschool children. The integration of interactive, structured smart play in early childhood education can significantly enhance children's cognitive abilities, particularly in spatial reasoning and problem-solving skills.

Keywords: *Smart toys, game-based learning, visual-spatial development, early childhood education, cognitive development, preschool children.*

1. Introduction

In recent years, the role of play in early childhood education has garnered increasing attention, particularly in the context of cognitive, motor, and social development. Play-based learning has been recognized as a fundamental method for fostering creativity, problem-solving abilities, and spatial awareness in young children (Carlos & Losada-Puente, 2024). As digital technology continues to advance, the integration of smart toys into educational settings has emerged as a promising avenue for enhancing various aspects of children's development (Komis & Karachristos, 2022). These smart toys, which incorporate artificial intelligence, interactive features, and game-based learning components, provide children with a more engaging and dynamic learning experience (Akdeniz & Özdinç, 2021). Among the various cognitive abilities influenced by such technologies, visual-spatial development plays a crucial role in early childhood, serving as the foundation for later academic skills, including mathematical reasoning and problem-solving (Asgari, 2023).

Visual-spatial development refers to a child's ability to perceive, analyze, and mentally manipulate spatial relationships between objects and their environment. This skill is essential for everyday activities such as navigation, drawing, and assembling puzzles, as well as for more advanced cognitive processes, including logical reasoning and memory retention (Beaty & Kenett, 2023). Several studies have shown that interactive and game-based learning approaches significantly enhance visual-spatial skills in children by promoting active engagement and problem-solving strategies (Mecan & Gozum, 2023). Traditional methods of fostering visual-spatial development, such as puzzle games and manual spatial exercises, have been widely used in educational settings. However, with the advent of smart toys, researchers have begun exploring their potential to offer more effective and immersive experiences in developing these cognitive abilities (Bergen, 2023).

Smart toys are equipped with sensors, artificial intelligence, and interactive capabilities that allow them to respond to children's actions in real time. These toys are designed to stimulate cognitive processes by providing personalized feedback, adjusting difficulty levels, and engaging children in dynamic play scenarios (Sylla, 2022). Studies have indicated that smart toys can enhance multiple intelligences, including logical-mathematical, kinesthetic, and spatial intelligence, by encouraging hands-on interaction and strategic thinking (Bansod, 2024). Furthermore, research has suggested that such toys not only improve cognitive skills but also foster social and emotional development by encouraging cooperative play and teamwork among children (Estefanidi & Dominiak, 2023).

One of the primary advantages of smart toys in fostering visual-spatial development is their ability to simulate real-world scenarios, allowing children to explore spatial relationships in an engaging and meaningful way (Lin et al., 2020). For instance, digital building blocks and augmented reality games provide children with opportunities to construct virtual structures, manipulate objects, and solve spatial puzzles, all of which contribute to the refinement of their spatial reasoning abilities (Han et al., 2022). Additionally, interactive board games that incorporate digital components have been shown to improve spatial awareness by requiring children to analyze spatial relationships, predict movements, and adjust their strategies accordingly (Mirarab Razi & Fakouri Haji Yar, 2022).

Game-based learning has been identified as an effective approach for enhancing early childhood education, particularly in areas such as motor coordination, executive functioning, and problem-solving skills (Abdelwahed, 2020). Unlike traditional rote learning methods, game-based smart toys provide an engaging environment that fosters curiosity and exploration, which are essential for cognitive growth (Pourfarahmand & Taher, 2020). Research has shown that children who engage in structured play activities with smart toys demonstrate higher levels of creativity, adaptability, and critical thinking skills compared to those who rely solely on conventional toys (Oliveira & Dias, 2018). Moreover, studies have highlighted that incorporating smart toys in preschool settings significantly improves children's ability to perform spatial tasks, such as object manipulation and spatial navigation (Zhang et al., 2020).

The effectiveness of smart toys in visual-spatial development is also influenced by their design and level of interactivity. Studies have emphasized that toys that encourage hands-on interaction and provide immediate feedback yield better learning outcomes than passive digital experiences (Dorafshan, 2021). For example, toys that involve constructing 3D models, assembling mechanical parts, or navigating virtual mazes challenge children's spatial reasoning abilities and encourage them to develop problem-solving strategies (Fizi, 2023). Additionally, collaborative smart toys, which require teamwork and cooperative problem-solving, have been found to enhance children's

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communication and social skills while simultaneously improving their spatial awareness (Z. Zhang et al., 2020).

Another key aspect of smart toy integration in education is their adaptability to individual learning needs. Research has shown that personalized learning experiences, where the difficulty level and instructional approach are adjusted based on the child's performance, significantly enhance engagement and learning retention (Nuri & Calgiltay, 2020). Smart toys equipped with adaptive algorithms can assess children's spatial abilities in real time and modify the complexity of tasks to match their skill level, ensuring that learning remains challenging yet achievable (Sadat Ammareti, 2011). Furthermore, these toys often include multisensory elements, such as auditory and haptic feedback, which reinforce learning and cater to different learning styles (Ayob, 2012).

Despite the numerous advantages associated with smart toys, some challenges must be considered when implementing them in educational settings. One concern is the potential overreliance on technology, which may limit children's opportunities for free play and imaginative exploration (Bansod, 2024). Additionally, issues related to data privacy and security have been raised, particularly regarding toys that collect and store children's personal information (Dorafshan, 2021). Therefore, it is essential for educators and parents to ensure that smart toys are used in a balanced and supervised manner, complementing traditional play activities rather than replacing them entirely (Komis & Karachristos, 2022).

Given the growing body of research supporting the role of smart toys in cognitive development, there is a need for further investigation into their long-term effects on children's learning trajectories (Beaty & Kenett, 2023). While existing studies have demonstrated the short-term benefits of smart toys in enhancing spatial reasoning and problem-solving skills, longitudinal studies are required to determine whether these improvements persist over time and translate into academic success (Estefanidi & Dominiak, 2023). Additionally, future research should explore how different types of smart toys influence various dimensions of cognitive development, including memory retention, executive functioning, and language acquisition (Mecan & Gozum, 2023).

This study aims to contribute to the growing body of literature on the impact of smart toys on early childhood cognitive development by specifically examining their effects on visual-spatial development. By utilizing an experimental design that compares children's spatial reasoning abilities before and after engaging with structured smart toy activities, this research seeks to provide empirical evidence on the effectiveness of game-based learning in preschool settings.

2. Methods and Materials

2.1. Study Design and Participants

This study was conducted to examine the effect of smart games on visual-spatial development in preschool children. To investigate this effect, a quasi-experimental pretest-posttest design with a control group was used. In this study, children from two preschools in District 1 of Tehran were selected using cluster random sampling. Subsequently, 15 children were randomly assigned to the experimental group and 15 children to the control group, and a pretest of visual-spatial development was administered. The measurement tool was the 51-item questionnaire by Harry Wachs (2014), whose reliability and validity had been established in Iran. The experimental group then participated in eight sessions of the independent variable, which involved smart games, while the control group did not receive these sessions. At the end of the study, the visual-spatial development posttest was administered again to both the experimental and control groups.

The inclusion criteria for the study were a preschool age of 3 years, physical and psychological well-being, assessment of mental health status, and the absence of any learning disabilities or intellectual disabilities. The exclusion criteria included missing even one session, parental willingness to cooperate, and obtaining consent from parents and school authorities. After coordinating with the education authorities, the preschool director, and obtaining consent from parents and preschool instructors, the study was implemented. The research intervention involved pretend play sessions conducted over 10 two-hour sessions as part of preschool education in the experimental group.

The design of the intervention sessions in the experimental group was based on two primary principles:

1. The activities had to align with the interests of preschool children.
2. The content had to be derived from and grounded in the theoretical foundations of standardized preschool worksheets.
3. The number of sessions was determined based on quantitative, qualitative, and phenomenological studies, ensuring consistency with the present research design.

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2.2. Data Collection Tools

Harry Wachs developed the Visual-Spatial Development Questionnaire to assess visual-spatial development in children. This questionnaire consists of six subscales: (1) sensory and bodily awareness, (2) spatial localization, (3) body-environment interaction and the relationship of environmental components with each other and with others, (4) spatial maintenance, (5) logical visual reasoning, and (6) representational thinking. This classification is not fixed, and the age spectrum should be calculated more based on developmental age rather than chronological age. The questionnaire helps estimate each child's visual-spatial capacity and assess changes in this foundational capacity over time and throughout development. Understanding visual-spatial capacities is crucial, as it allows for setting reasonable and appropriate expectations for the child. Additionally, if developmental gaps are identified, appropriate interventions can be initiated.

For instance, the simple activity of grasping and placing objects may seem easy. However, for a child who lacks bodily awareness, it may be impossible, as this activity requires knowledge integrated under the visual-spatial profile: (1) sensory and bodily awareness, meaning acquiring knowledge about different body parts and the ability to coordinate them to produce goal-directed movements controlled by the five senses. This means the child should be able to name the body part being touched without looking; (2) spatial localization, referring to the ability to establish relationships between different body parts to move meaningfully within the environment and prepare for activities in broader spaces, such as engaging with others in shared spaces; (3) body-environment interaction and the relationship of environmental components with each other and with others, which pertains to two-way interactions with others and objects, recognizing spatial boundaries and environmental constraints, understanding personal and object territories, and respecting them; (4) spatial maintenance, which involves recognizing different dimensions of space that gradually become more advanced. For example, before the age of one, the child's world is one-dimensional, and by the second year, it becomes three-dimensional. Between ages four and five, children begin integrating time and space; (5) logical visual reasoning, which is designed to facilitate problem-solving and the application of logic to give meaning to visual experiences; and (6) representational thinking, which involves coordinating thoughts and presenting them appropriately in external space.

A study was conducted within the framework of a validation research project to examine the reliability and validity of the 51-item Visual-Spatial Development Questionnaire by Harry Wachs (2014) on a sample of Iranian children in Mashhad, carried out by Zare Kheibari and colleagues. The questionnaire's reliability and validity were evaluated using descriptive indices and demographic studies in a sample of 385 children, assessed based on four criteria—relevance, simplicity, clarity, and necessity—on a Likert scale ranging from 0 to 3. The findings indicated that the questionnaire demonstrated strong content and construct validity, as well as satisfactory reliability. Confirmatory factor analysis results showed that the questionnaire's structure had an acceptable fit with the data. The factors were categorized similarly to the original study, with the following subscales and the corresponding number of items: (1) sensory and bodily awareness, 10 items; (2) spatial localization, 8 items; (3) body-environment interaction and the relationship of environmental components with each other and with others, 8 items; (4) spatial maintenance, 9 items; (5) logical visual reasoning, 8 items; and (6) representational thinking, 8 items. The internal consistency coefficients for these subscales were reported as 0.83, 0.79, 0.67, 0.80, 0.72, and 0.61, respectively, with an overall visual-spatial development reliability coefficient of 0.82. These results indicate that the Wachs Visual-Spatial Development Questionnaire (2014) can be effectively used as a valid instrument for assessing the construct of visual-spatial development in Iran.

In this study, the Wachs questionnaire was used to assess children's visual-spatial development in relation to smart spatial games.

2.3. Intervention

The intervention protocol consisted of eight structured play activities designed to enhance visual-spatial development in preschool children. The first activity, target ball toss, involved children selecting team colors and attempting to land their balls into a container by bouncing them off the ground, aiming to align four balls in a row to win. The second activity, racing and parking at the space station, featured a multi-level spiral racetrack where children collaboratively assembled and operated a toy space station with cars, lights, and sound effects. The third activity, musical locomotive parking, required children to complete a

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multi-functional toy parking lot, including ramps, an elevator, and a refueling station, while managing four diverse locomotive models. The fourth activity, cash register supermarket, simulated real-world shopping experiences with a toy checkout counter that included a functioning card reader, scanner, and digital scale, allowing children to role-play as cashiers and customers. The fifth activity, musical carousel fishing, involved a standing toy with a rotating water slide, fishing rods, and scoops, where children engaged in catching fish and turtles in a water-based setup, conducted in the preschool yard. The sixth activity, musical educational shape house, incorporated a rotating puzzle, an abacus for counting, and a mini piano, encouraging children to explore geometric shapes and numerical concepts. The seventh activity, musical birthday cake, allowed children to customize a detachable cake, activate birthday music, and simulate blowing out candles, which triggered applause sounds, with two children participating daily. The final activity, football tabletop game, engaged children in a competitive setting where two players used small handles to direct miniature balls toward the opponent's goal, with the first player to score with five balls declared the winner. These interactive activities were systematically implemented in group settings, fostering cognitive, motor, and social skills through structured play.

2.4. Data Analysis

For data analysis, descriptive and inferential statistical methods were employed to examine the effects of smart games on visual-spatial development in preschool children. Descriptive statistics, including mean and standard deviation, were used to summarize the data for both the experimental and control groups in pretest and posttest stages. To test the research hypotheses, multivariate analysis of covariance (MANCOVA) was conducted to compare the dependent variables between the two groups while controlling for pretest scores. The assumptions for MANCOVA, including normality, homogeneity of variances, and equality of covariance matrices, were verified using the Kolmogorov-Smirnov test, Levene’s test, and Box’s M test, respectively. Additionally, effect sizes were calculated to assess the magnitude of differences between the experimental and control groups. All statistical analyses were performed using SPSS version 26, with a significance level set at $p < 0.05$.

3. Findings and Results

Table 1 presents the descriptive statistics of academic motivation scores in the pretest and posttest stages for the control and experimental groups.

Table 1

Descriptive Statistics Findings

Variable	Group	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Sensory and Bodily Awareness	Experimental	9.46	0.51	11.26	0.80
	Control	9.53	0.51	9.53	0.51
Spatial Localization	Experimental	9.46	0.51	10.6	0.50
	Control	9.53	0.51	9.53	0.51
Body-Environment Interaction and Relationship with Others	Experimental	9.53	0.51	12.6	0.50
	Control	9.53	0.51	9.53	0.51
Spatial Maintenance	Experimental	6.46	0.51	8.2	0.56
	Control	6.53	0.51	6.53	0.51
Logical Visual Reasoning	Experimental	9.33	0.61	12.6	0.73
	Control	9.2	0.67	9.2	0.67
Representational Thinking	Experimental	6.53	0.51	9.46	0.64
	Control	6.6	0.51	6.6	0.51
Total Visual-Spatial Development Score	Experimental	8.41	0.26	10.78	0.17
	Control	8.48	0.25	8.48	0.25

Table 1 provides the descriptive statistics of the mean and standard deviation of multiple intelligence scores for the experimental and control groups at the pretest and posttest stages. As observed, in the control group, the mean scores remain unchanged between the pretest and posttest stages. However, in the experimental group, the posttest scores show a significant increase compared to the pretest scores.

The assumptions for statistical analyses were assessed using Box’s M test, the Kolmogorov-Smirnov test, and Levene’s test. The results of Box’s M test for the equality of covariance matrices indicated a significance level of 0.53,

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confirming that the assumption of homogeneity of covariance matrices was met. The Kolmogorov-Smirnov test was conducted to examine the normality of the distribution of pretest and posttest scores, and the significance levels for all variables were above 0.05, supporting the assumption of normality. Additionally, Levene's test for homogeneity of variances showed that none of the variables yielded significant results, confirming that the assumption of variance homogeneity was satisfied. These findings indicate that the necessary assumptions for conducting multivariate analysis of covariance (MANCOVA) were met, ensuring the validity of the statistical analyses.

Table 2

Results of Multivariate Analysis of Covariance for Comparing the Dependent Variables at the Pretest and Posttest Stages

Effect	Tests	Value	F	Effect df	Error df	Significance Level
Group	Pillai's Trace	0.97	123.85	7	22	0.000
	Wilks' Lambda	0.025	123.85	7	22	0.000
	Hotelling's Trace	39.4	123.85	7	22	0.000
	Largest Root	39.4	123.85	7	22	0.000

As seen in Table 2, the significance level for all four multivariate statistics—Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Largest Root—is zero, which is smaller than 0.01 ($p < 0.01$). Therefore, the null hypothesis is rejected, confirming a significant difference in visual-spatial development scores and total visual-spatial development scores between the pretest and posttest stages. Based on these results, it can be concluded that constructive smart games have a significant effect on visual-spatial development and the overall visual-spatial development score.

To examine the differences between the pretest and posttest stages for each variable, a between-subjects effects test was conducted, and the results are presented below.

Table 3

Between-Subjects Effects Test for Comparing Scales in the Experimental and Control Groups in the Posttest Stage

Variable	Source	Sum of Squares	df	Mean Squares	F	Significance Level	Effect Size
Sensory and Bodily Awareness	Between-Groups	22.53	1	22.53	49.81	0.000	0.64
	Error	12.66	28	0.45			
Spatial Localization	Between-Groups	8.53	1	8.53	32.58	0.000	0.53
	Error	7.33	28	0.26			
Body-Environment Interaction and Relationship with Others	Between-Groups	70.53	1	70.53	269.3	0.000	0.90
	Error	7.33	28	0.26			
Spatial Maintenance	Between-Groups	20.83	1	20.83	71.72	0.000	0.71
	Error	8.13	28	0.29			
Logical Visual Reasoning	Between-Groups	86.7	1	86.7	173.4	0.000	0.86
	Error	14	28	0.50			
Representational Thinking	Between-Groups	61.63	1	61.63	184.9	0.000	0.86
	Error	9.33	28	0.33			
Total Visual-Spatial Development Score	Between-Groups	39.69	1	39.69	839.01	0.000	0.96
	Error	1.32	28	0.047			

Table 3 presents the results of the between-subjects effects test for comparing the scales of sensory and bodily awareness, spatial localization, body-environment interaction and relationship with others, spatial maintenance, logical visual reasoning, representational thinking, and total visual-spatial development scores in the experimental and control groups at the posttest stage. According to the results shown in the table, the obtained F values for all variables are

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significant at the 0.01 alpha level ($p < 0.01$). Therefore, the null hypothesis is rejected, and the research hypothesis is confirmed. Given that the mean scores of the experimental group in the posttest stage are higher compared to the control group, it is concluded that constructive smart games were effective in increasing preschool children's creativity and multiple intelligences. Additionally, the effect size here indicates the percentage increase in each variable.

4. Discussion and Conclusion

The findings of this study demonstrated that engaging preschool children in structured play activities with smart toys significantly enhanced their visual-spatial development. The experimental group, which participated in eight sessions of smart game-based interventions, exhibited notable improvements in sensory and bodily awareness, spatial localization, body-environment interaction, spatial maintenance, logical visual reasoning, and representational thinking. In contrast, the control group, which did not receive these interventions, showed no significant changes between pretest and posttest scores. The statistical analyses further confirmed that the differences observed in the experimental group were significant, with high effect sizes indicating a strong impact of smart games on visual-spatial abilities. These findings align with previous research emphasizing the role of interactive and game-based learning in fostering cognitive and spatial skills in young children (Asgari, 2023; Beaty & Kenett, 2023; Komis & Karachristos, 2022).

One of the most prominent findings was the significant improvement in sensory and bodily awareness among children in the experimental group. This outcome supports previous studies suggesting that smart toys with multisensory features enhance children's ability to process spatial information through touch, movement, and visual feedback (Han et al., 2022; Nuri & Calgiltay, 2020). Research has shown that children exposed to interactive and tactile play activities develop a stronger sense of spatial orientation and body awareness, which is crucial for everyday tasks such as navigating physical spaces and manipulating objects (Lin et al., 2020). The inclusion of digital feedback in smart toys may have further facilitated learning by reinforcing correct responses and encouraging trial-and-error exploration (Mecan & Gozum, 2023).

Additionally, improvements in spatial localization were observed in the experimental group, indicating that children who engaged with smart games were better able to perceive and manipulate spatial relationships. These findings align with research highlighting the effectiveness of digital and interactive play in improving children's ability to estimate distances, recognize object placement, and understand spatial hierarchy (Carlos & Losada-Puente, 2024; Zhang et al., 2020). Studies have demonstrated that activities requiring children to navigate virtual or physical spaces, such as digital mazes or building blocks with augmented reality features, significantly enhance their spatial reasoning abilities (Sylla, 2022). The findings suggest that smart toys may provide an effective tool for developing these critical early cognitive skills.

The study also found significant improvements in body-environment interaction, which refers to a child's ability to coordinate movements and understand spatial relationships between their body and surrounding objects. Research has emphasized that interactive toys that encourage physical engagement, such as smart building blocks and racing games, help children develop spatial awareness and coordination (Dorafshan, 2021; Oliveira & Dias, 2018). Prior studies have indicated that play-based interventions incorporating digital elements not only enhance motor skills but also improve children's ability to predict spatial relationships and respond to environmental changes (Abdelwahed, 2020). The results of the present study confirm these findings and suggest that structured play with smart toys can facilitate the development of spatial cognition through active engagement.

Another key finding was the enhancement of logical visual reasoning in the experimental group. Logical visual reasoning involves the ability to analyze visual patterns, solve spatial problems, and apply logical thinking to visual tasks. This result is consistent with previous research indicating that children exposed to smart toys with problem-solving elements, such as digital puzzles and interactive construction sets, demonstrate significant improvements in reasoning and problem-solving abilities (Akdeniz & Özdinç, 2021; Estefanidi & Dominiak, 2023). Studies have shown that digital play, particularly when involving goal-directed tasks, promotes executive functioning and logical analysis (Z. Zhang et al., 2020). The present findings suggest that structured smart play can enhance children's ability to process and interpret complex spatial relationships, preparing them for future academic challenges.

Representational thinking, which refers to the ability to mentally visualize and manipulate objects, also showed significant improvement in the experimental group. These results align with research demonstrating that digital and

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interactive play environments support the development of representational skills by allowing children to experiment with spatial transformations in a controlled setting (Bansod, 2024; Lin et al., 2020). Prior studies have found that children who engage in activities requiring mental rotation, such as digital assembly games and smart puzzles, exhibit higher levels of representational thinking compared to those who rely solely on traditional play methods (Pourfarahmand & Taher, 2020). The findings of this study further support the idea that structured smart play can effectively enhance children's ability to visualize spatial structures and manipulate them mentally.

Furthermore, the overall visual-spatial development score in the experimental group showed a substantial increase from pretest to posttest, confirming that smart play interventions are effective in promoting spatial cognitive growth. These findings support the broader body of research suggesting that interactive digital play enhances multiple cognitive domains, including spatial intelligence, executive functioning, and creativity (Ayob, 2012; Beaty & Kenett, 2023). The ability of smart toys to provide immediate feedback and adaptive learning experiences may have contributed to these improvements by reinforcing correct strategies and allowing children to explore different spatial configurations (Komis & Karachristos, 2022).

Despite the significant findings, this study has several limitations. First, the sample size was relatively small, limiting the generalizability of the results to larger populations. A broader sample covering diverse socio-economic and cultural backgrounds would provide a more comprehensive understanding of the effects of smart toys on visual-spatial development. Second, the study focused exclusively on preschool children, and the findings may not be directly applicable to older age groups. Future studies should examine whether similar interventions yield comparable benefits in older children or children with developmental delays. Additionally, while the study employed a structured intervention, it did not measure long-term retention of visual-spatial skills. Longitudinal research is needed to determine whether the observed improvements persist over time or diminish without continued exposure to smart play activities.

Future research should explore the long-term effects of smart toy interventions on children's cognitive development. Longitudinal studies tracking children's spatial skills over several years could provide valuable insights into the lasting impact of smart play. Additionally, studies comparing different types of smart toys, such as AI-driven toys versus traditional interactive playsets, would help identify which features contribute most to cognitive enhancement. Investigating the role of parental involvement in structured smart play could also provide further understanding of how guided interactions influence learning outcomes. Moreover, research should examine whether smart play interventions can be effectively adapted for children with learning disabilities, as these tools may offer new opportunities for tailored cognitive development strategies.

Educators and parents should consider integrating smart toys into preschool curricula to enhance children's visual-spatial development. Structured play sessions using interactive and game-based learning tools can provide engaging and effective learning experiences for young children. However, it is essential to maintain a balance between digital and traditional play to ensure that children develop a range of cognitive and motor skills. Teachers should receive training on how to effectively incorporate smart play into classroom activities, ensuring that these tools are used to complement, rather than replace, hands-on learning experiences. Finally, policymakers should consider funding and supporting research on the educational benefits of smart toys to guide evidence-based decisions on their implementation in early childhood education programs.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the interview and participated in the research with informed consent.

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