Symbolic Mapping as a Pedagogical Tool: Spatial Cognition in Preschoolers' Route Drawings

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ABSTRACT

This study explores the development of spatial cognition in preschool children through their symbolic depictions of routes from home to preschool. Using a qualitative case study approach, the research involved twelve children aged five to six years from a planned residential area and a mixed-development community in Malaysia. It examines how children express environmental knowledge through map drawing activities. Thematic analysis identified three key symbolic strategies: realistic depictions, simplified abstractions, and metaphorical elements. These strategies were shaped by developmental stages and environmental stimuli, with the older children displaying a preference for realism and those from diverse environments exhibiting richer metaphorical content. This study contributes to early childhood pedagogy by proposing a drawing-based instructional framework that integrates spatial reasoning, symbolic fluency and environmental literacy. The findings support the inclusion of place-based visual activities into early learning curricula to enhance cognition growth and spatial understanding

Keywords: spatial cognition, symbolic representation, early childhood pedagogy, qualitative research, route drawing

Abstrak

Kajian ini meneroka perkembangan kognisi ruang dalam kalangan kanak-kanak prasekolah melalui gambaran simbolik mereka terhadap laluan dari rumah ke prasekolah. Menggunakan pendekatan kajian kes kualitatif, penyelidikan ini melibatkan dua belas orang kanak-kanak berumur lima hingga enam tahun dari Kawasan perumahan terancang dan komuniti Pembangunan bercampur di Malaysia. Kajian ini meneliti bagaimana kanak-kanak menyampaikan pengetahuan tentang persekitaran melalui aktiviti melukis peta dari rumah ke prasekolah mereka. Analisis tema mengenal pasti tiga strategi simbolik utama: representasi realistik, mengabstrakkan ringkas, dan elemen metafora. Strategi-strategi ini dipengaruhi oleh tahap perkembangan dan rangsangan persekitaran, dengan kanak-kanak yang lebih tua menunjukkan kecenderungan terhadap gambaran realistic, manakala mereka dari persekitaran yang pelbagai menampilkan kandungan metafora yang lebih kaya. Kajian ini menyumbang kepada pedagogi Pendidikan awal kanak-kanak dengan mencadangkan kerangka pengajaran berasaskan lukisan yang mengintegrasikan penaakulan ruang, kefasihan simbolik dan literasi persekitaran. Dapatan menyokong penggunaan aktiviti visual berasaskan tempat dalam kurikulum awal kanak-kanak bagi meningkatkan pertumbuhan kognitif dan pemahaman ruang.

Kata kunci: kognisi ruang, representasi simbolik, pedagogi Pendidikan awal kanak-kanak, penyelidikan kualitatif, lukisan laluan

INTRODUCTION

Spatial cognition is a foundational dimension of cognitive development in early childhood, enabling children to perceive, interpret, and navigate their environment (Piaget, 1954). In early childhood education, drawing serve as an intuitive and developmentally appropriate method for children to express their understanding of spatial

relationships and the world around them (Soundy, 2015). In particular, route mapping where children's depictions of familiar path offer insight into how they symbolically structure spatial knowledge.

Research increasingly links early spatial competence with later academic outcomes in mathematics, science and geography (Verdine et al., 2014). As children engage with their environment, they develop the ability to mentally represent and manipulate spatial information. Route mapping offers a meaningful method to assess and support this development.

This study examines the symbolic route drawings among Malaysian preschoolers from both standardized and heterogeneous built environments. It investigates how environmental and developmental factors shape children's symbolic spatial representations and considers their implications for early childhood pedagogy.

LITERATURE REVIEW

Research on spatial cognition in early childhood shows that children's understanding develops from egocentric to allocentric perspectives (Newcombe & Huttenlocher, 2003). Recent studies highlight the role of constructive play in fostering this development. Zheng et al. (2024) found that spatial tasks involving manipulation and construction activities significantly improve young children's spatial orientation skills.

A key aspect to spatial learning is symbolic representation, where children use visual or conceptual symbols to encode and communicate spatial information. Gellel et al. (2024) emphasize that environments rich in symbolic stimuli foster metaphorical thinking, enhance cognitive flexibility and spatial reasoning. Their study indicates that encouraging a range of symbolic expressions, from realistic drawings to abstract, supports the growth of spatial cognitive skills. Building on this, Birbili (2006)demonstrates that concept maps serve as effective tools in early childhood education, enabling children to organize and spatially represent their knowledge and thoughts. By organizing their thoughts graphically, children not only externalize their understanding but also begin to discern relationships between concepts, fostering deeper cognitive engagement with their environments.

Research based on observation has shown that children's ability to understand and interpret space is influenced by the richness and variety of their environment (Nys et al., 2015; Sumiya & Nonaka, 2021; van Liempd et al., 2020) Children who grew up in visually stimulating, landmark-rich settings tend to develop stronger spatial reasoning skills than those in more uniform environments (Nys et al., 2015). Building on this idea, Cristiane and Juliasz, (2022) emphasize that children's drawings serve as meaningful tools for representing and organizing their spatial experiences. Opportunity to explore and interact with complex surroundings play a vital role in nurturing early cartographic thinking.

Bae et al. (2022) introduced the concept of "visualisation literacy", which refers to the cognitive skillset needed to understand and create spatial representations. This idea aligns with Vygotsky's theory of mediated learning or 'tools of the mind' (Bodrova & Leong, 2007), where drawing is seen as a cultural tool that helps develop symbolic thinking. Together, these perspectives highlight the value of using drawing activities in early education to both assess and support the growth of spatial understanding in young children. Visual tools such as maps and diagrams allow children to externalise their thinking and reflect on spatial experiences. In this context, route drawing function as a scaffold for preschoolers to represent, structure, and make sense of their spatial environments.

METHODOLOGY

Research Design

This research employed a qualitative, interpretive case study approach to investigate how pre-school-aged children symbolically represent spatial cognition. The design focused on capturing the subjective experiences and developmental aspects of young children's environmental awareness. A qualitative methodology was chosen to facilitate in-dept exploration of the children's visual expression, personal narratives, and interactions related to their spatial surroundings.

Participants

Twelve preschool children, evenly distributed by age (five and six) and gender, participated in the study. Participants were drawn from two different community type in Malaysia" one from a planned residential area with standardized housing layouts, and the other from a mixed-development area characterized by architectural diversity. Participant identification codes were structured as follows: the first letter represents the neighbourhood type ("P" for planned, "X" for mixed-development), followed by the age (5 or 6), gender ("F" for female, "M" for male), and a unique participant number (1 to 3). This purposive sampling allowed for comparative analysis across age and environmental context.

Data Collection Procedures

The data collection involved a single, interactive session where each child was individually engaged in a drawing activity. Children were provided with A3-sized paper, pencils, and coloured pen and pencils, and were asked to draw their route from home to preschool. while the children were drawing, the research sat alongside them, engaging in a semi-structured conversation to explore the child's thoughts, observations, and symbolic choices.

The researcher asked guiding questions about what the child saw along their route, encouraging them to describe landmarks, experiences, and features depicted in their drawings. The session was video recorded to capture verbal and non-verbal responses, and field notes were taken to document contextual details, expressions, and spontaneous comments made by the child during the process.

Data Analysis

Using ATLAS.ti, data were subjected to thematic analysis through constant comparison. Each drawing and its corresponding verbal transcript were treated as a unit of analysis. Codes were developed inductively and grouped into themes reflecting symbolic strategies. Cross-case comparisons were then conducted to identify patterns based on age and environmental exposure.

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of Sultan Idris Education University (Ref.2021-0418-01, 25 November 2021). Written informed consent was obtained from the parents, and participants were identified by codes only.

FINDINGS AND DISCUSSION

Symbolic strategies in spatial representation

Thematic analysis revealed three principal symbolic strategies in children's route drawings; realistic representation, simplified abstractions, and metaphorical elements. Each strategy reflected cognitive maturity and environmental exposure.

Realistic Representations

Realistic Representations refers drawings that closely resemble the actual physical environment, including proportionally rendered elements such as houses (Figure 1), trees, and traffic lights (Figure 2), playground, preschool, apartment and street light (Figure 3). These depictions suggest an emerging spatial awareness influenced by both cognitive maturity and environmental exposure. Six-year-olds included significantly more realistic features in their drawings (n=19) compared to five-year-olds (n=7), indicating a developmental progression towards more accurate visual and spatial representation. Additionally, children from mix-development neighbourhoods produced a higher number of realistic elements (n=16) than those from planned residential areas (n=10), emphasizing the impact of environmental diversity in shaping children's spatial cognition (see Appendix, Table 1).

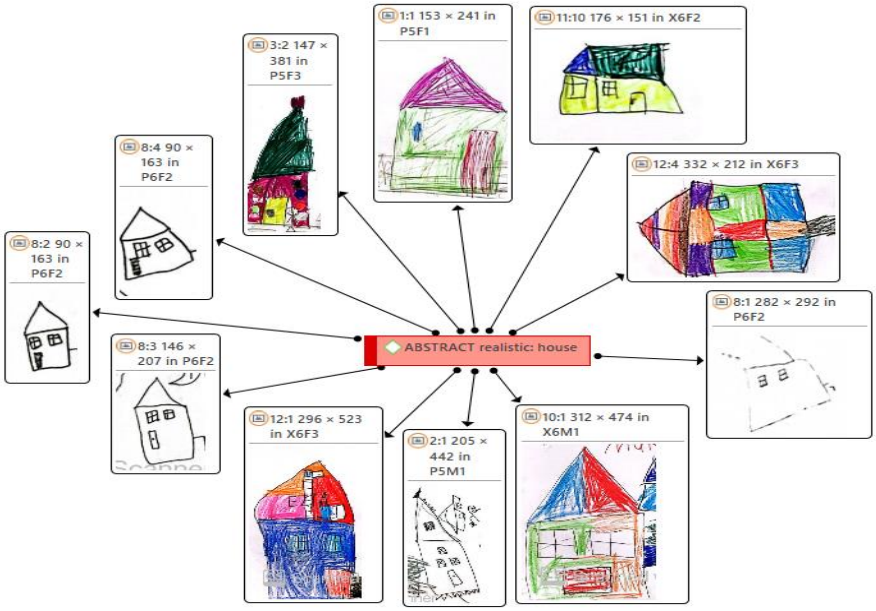

Figure 1. Realistic representation of house in the participants' route map

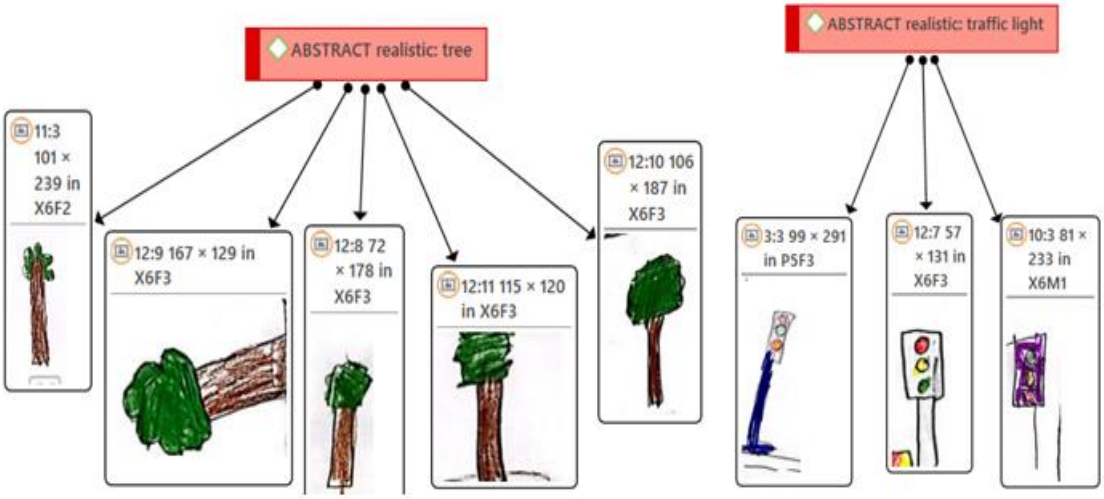

Figure 2. Realistic representation of secondary landmarks in the participants' route map

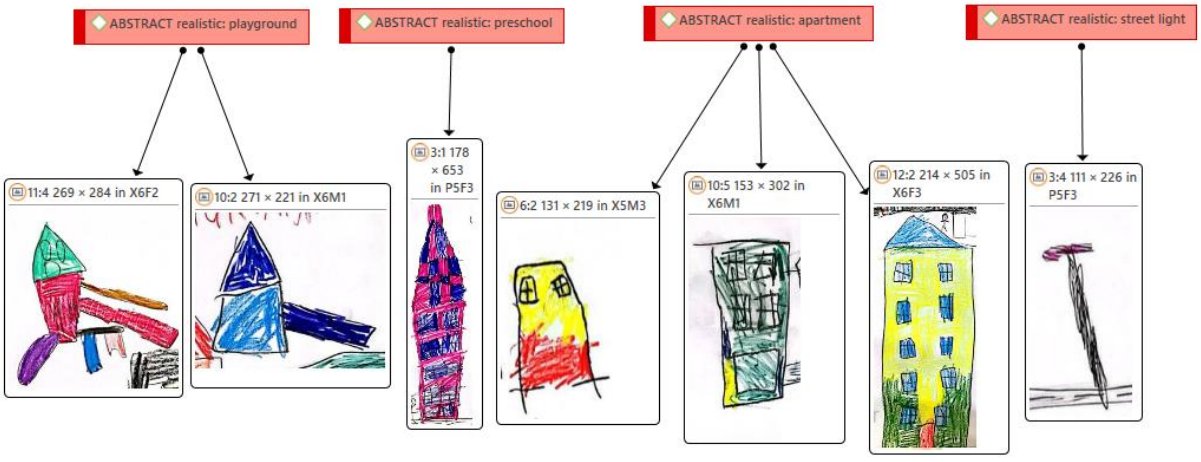

Figure 3. Realistic representation in the participants' route map

Simplified Abstractions

Simplified Abstractions involve the reduction of complex structure into basic, recognizable outlines that highlight only their essential features. In the children's drawings, common simplified forms include houses (n=5) and apartments (n=5), while cars and preschools appeared in a simplified manner in two instances each (Figure 4). Less frequent symbols, such as car parks, shops, roundabout, and human figures were represented only once, suggesting a limited but varied use of detail (Figure 5).

Five-years-old produced slightly more simplified representation (n=8) than six-year-olds (n=7), suggesting that younger children may favour iconic or schematic forms as a strategy for symbolizing their environment. Additionally, children from mix-development neighbourhoods used more simplified elements (n=8) than those from planned areas (n=7), potentially reflecting their adaptation to more visually complex and densely featured urban settings. (see Appendix Table 2)

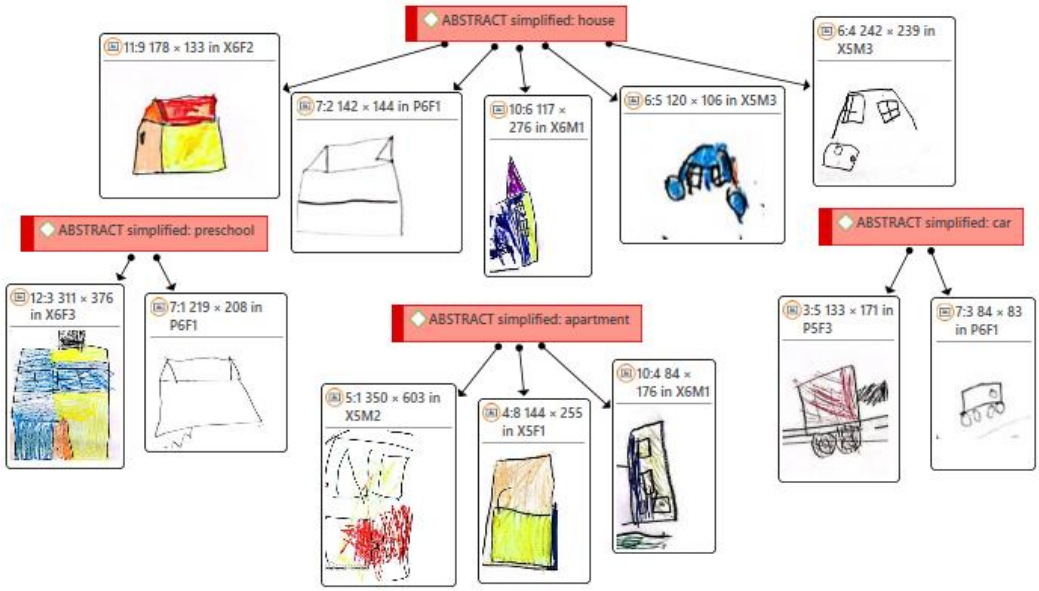

Figure 4 Simplified iconic representation of primary landmarks in the participants' route map

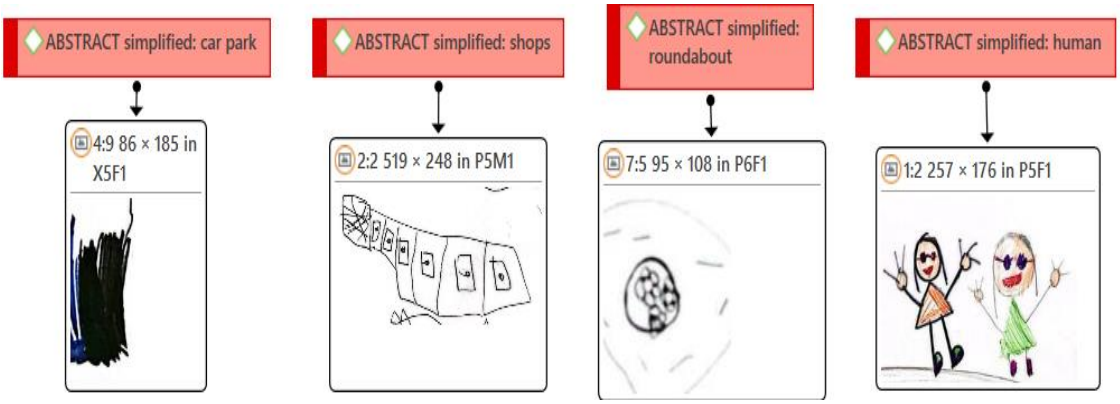

Figure 5. Simplified iconic representation of secondary landmarks in the participants' route map

Metaphorical Elements

Metaphorical Elements in the children's drawings reflect imaginative symbols that convey personal significance or contextual meaning, rather than aiming for visual realism. These representations often move beyond realistic forms to capture emotional, cultural, or associative aspects of spatial experience.

Among all metaphorical symbols, houses emerged as the most frequently depicted (n=5), underscoring their central place in children's spatial narratives and emotional landscape (Figure 6)

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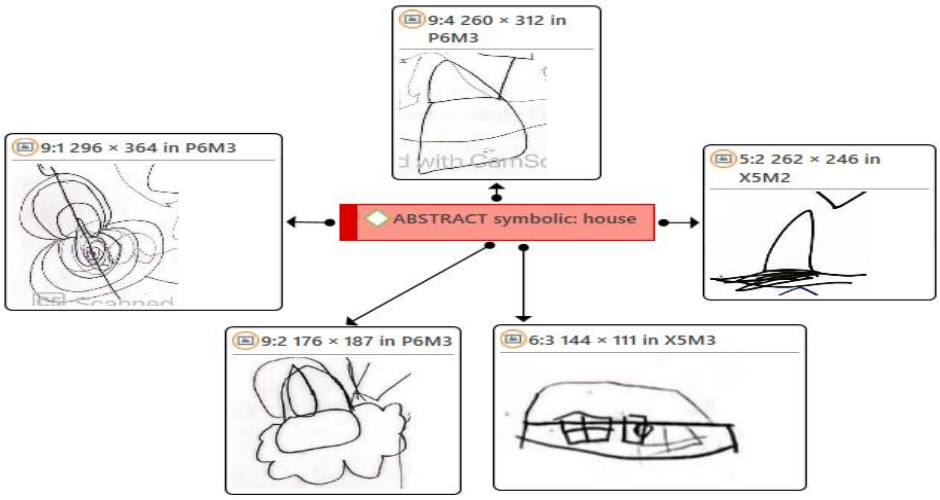

Figure 6. Symbolic metaphor of houses in the participants' route map

Other frequently used metaphorical elements include Petronas, playgrounds and preschools, each appearing three times (n=3), cars and restaurants were also commonly included, each represented twice (n=2) (Figure 7).

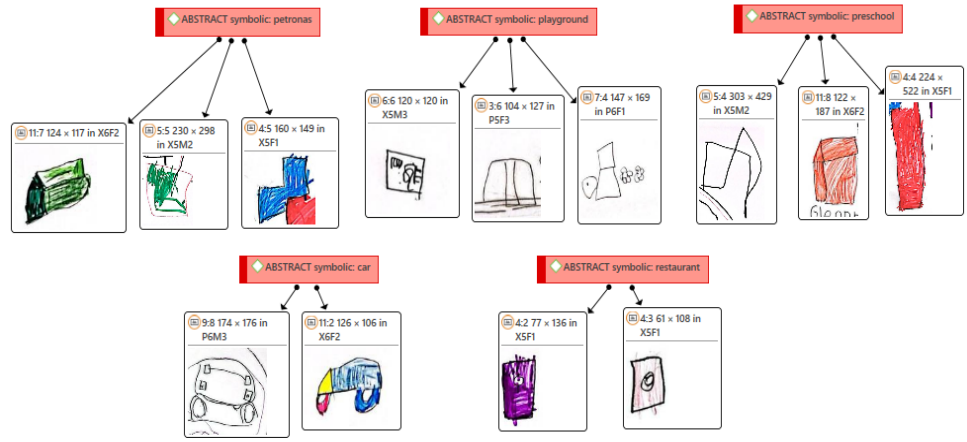

Figure 7. Symbolic metaphor representation of primary symbols in the participants' route map

A variety of additional symbols such as buildings, buses, cat, father, guard house, hotel, lake, shop and tree were each represented once in an abstract or metaphorical forms (Figure 8).

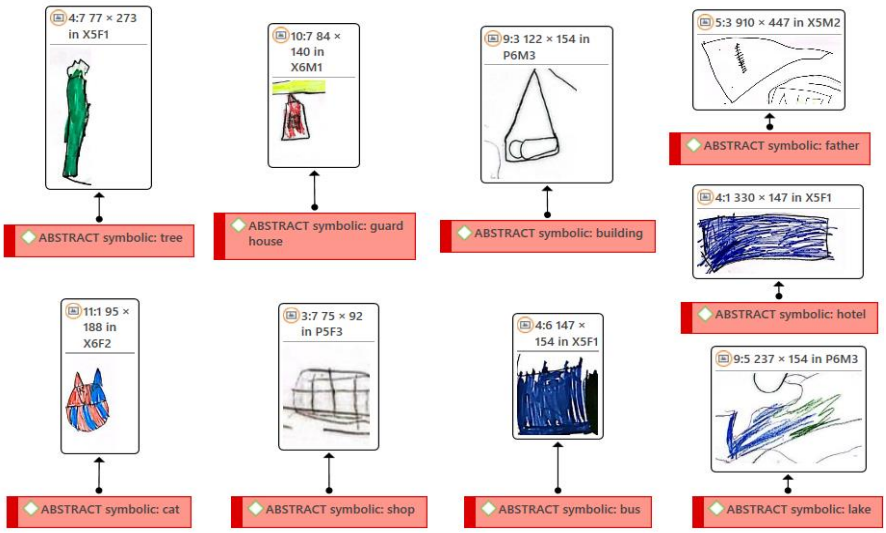

Figure 8. Symbolic metaphor representation of secondary symbols in the participants' route map

Notably, five-year-olds included more metaphorical elements in their drawings (n=15) than six-year-olds (n=12), suggesting a development tendency among younger children to rely more heavily on imaginative or intuitive forms of representation. Additionally, children from mixed-development neighbourhood produced a higher number of metaphorical depictions, which may be attribute to the stimulating and symbol-rich nature of their environment that encourage symbolic association and creative expression (see Appendix Table 3)

Comparative Insights

The comparative analysis highlights how both age and environmental context distinctly influence children's symbolic mapping strategies. Older participants tended to produce more detailed and **realistic** depictions of landmarks such as houses and traffic lights, indicating a developmental progression toward visual accuracy and allocentric spatial thinking (Piaget, 1954). In contrast, five-year-olds frequently employed **simplified** abstraction, using basic geometric forms such as squares with triangle roofs for houses, rectangle for building and mixed shapes for cars; represent objects in their drawings. These instances of abstraction reflect emerging symbolic categorization, indicating that younger children prioritize conventional forms over accurate depiction of their actual environment. This suggests a conceptual approach in where familiarity and symbolic function takes precedence over visual realism. Notably, children from the mixed-development community exhibited a greater variety and frequency of **metaphorical** symbols, such as branded landmarks (e.g. Petronas), and culturally or personally significant figures (e.g. father and cat). This trend aligns with research indicating that diverse and visually rich environment foster imaginative spatial reasoning and symbolic flexibility (Gellel et al., 2024; Mulder et al., 2017; Yang et al., 2020)

CONCLUSION

This study explored how preschool-aged children express their spatial understanding through symbolic route drawings, identifying three primary representational strategies: realistic, simplified, and metaphorical. These strategies were differentially employed based on children's age and environmental context. Six-year-olds frequently produced detailed, realistic depictions, whereas five-year-olds tended to favour abstraction and imaginative symbolism. Moreover, children from mixed-development neighbourhoods demonstrated richer symbolic diversity and metaphorical content, likely shaped by the visual and structural complexity of their surroundings. The findings highlight the pedagogical significance of symbolic mapping in early childhood education. Drawing serves not only as a form of creative expression but also as a cognitive and diagnostic tool, enabling children to externalize spatial thinking, develop symbolic reasoning, and make sense of their environment (Surber, 1984). Integrating drawing-based spatial tasks into early learning curricula offers educators valuable insight into children's perceptual and cognitive processes, while fostering spatial awareness and symbolic fluency. Theoretically, this research reinforces Vygotsky's concept of cultural tools in learning and Piaget's framework of developmental stages in spatial reasoning. From a pedagogical perspective, it advocates for the deliberate use of symbolic drawing activities to support early spatial literacy. Future studies should adopt longitudinal methodologies and explore varied cultural and urban settings to further investigate the developmental and contextual dimensions of symbolic spatial representation in younger learners.

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Table 1 Distribution of realistic representations in participant's route-map drawings by age and neighbourhood

Symbolic Abstraction	Participant ID												Totals	Age group		Neighbourhood Context	
	Age 5						Age 6										
	P5F1 Gr=9	P5M1 Gr=8	P5F3 Gr=11	X5F1 Gr=10	X5M2 Gr=10	X5M3 Gr=8	P6F1 Gr=7	P6F2 Gr=5	P6M3 Gr=8	X6M1 Gr=17	X6F2 Gr=16	X6F3 Gr=24		Five-year old Gr=56; GS=6	Six-year -old Gr=77; GS=6	Planned Neighbourhood Gr=48; GS=6	Mixed-Development Neighbourhood
Apartment Gr=3	0	0	0	0	0	1	0	0	0	1	0	1	3	1	2	0	3
House Gr=11	1	1	1	0	0	0	0	4	0	1	1	2	11	3	8	7	4

Playground Gr=2	0	0	0	0	0	0	0	0	0	1	1	0	2	0	2	0	2
Preschool Gr=1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Street Light Gr=1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Traffic Light Gr=3	0	0	1	0	0	0	0	0	0	1	0	1	3	1	2	1	2
Tree Gr=5	0	0	0	0	0	0	0	0	0	0	1	4	5	0	5	0	5
Totals	1	1	4	0	0	1	0	4	0	4	3	8	26	7	19	10	16

Note. "Gr" is the total number of quotations and 'GS' is the total number of documents

Table 2 Distribution of simplified representations in participant's route-map drawings by age and neighbourhood

Symbolic Abstraction	Participant ID												Totals Totals	Age group		Neighbourhood Context	
	Age 5						Age 6										
	P5F1 Gr=9	P5M1 Gr=8	P5F3 Gr=11	X5F1 Gr=10	X5M2 Gr=10	X5M3 Gr=8	P6F1 Gr=7	P6F2 Gr=5	P6M3 Gr=8	X6M1 Gr=17	X6F2 Gr=16	X6F3 Gr=24		5 Years Old Gr=56; GS=6	6 Years Old Gr=77; GS=6	Planned Neighbourhood Gr=48; GS=6	Mixed-Developmentb Neighbourhood Gr=85; GS=6
Apartment Gr=3	0	0	0	1	1	0	0	0	0	1	0	0	3	2	1	0	3
Car Gr=1	0	0	1	0	0	0	1	0	0	0	0	0	2	1	1	1	1
Car Park Gr=2	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1
House Gr=4	0	0	0	0	0	2	1	0	0	1	1	0	5	2	3	1	4
Human Gr=1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Preschool Gr=2	0	0	0	0	0	0	1	0	0	0	0	1	2	0	2	1	1

Roundabout Gr=1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0
Shops Gr=1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Totals	1	1	1	2	1	2	4	0	0	2	0	1	15	8	7	7	8

Note. "Gr" is the total number of quotations and 'GS' is the total number of documents

Table 3 Distribution of symbolic metaphor representations in participant's route-map drawings by age and neighbourhood (continue)

Symbolic metaphor abstraction	Participant ID												Totals	Age group		Neighbourhood Context	
	Age 5						Age 6										
	P5F1 Gr=9	P5M1 Gr=8	P5F3 Gr=11	X5F1 Gr=10	X5M2 Gr=10	X5M3 Gr=8	P6F1 Gr=7	P6F2 Gr=5	P6M3 Gr=8	X6M1 Gr=17	X6F2 Gr=16	X6F3 Gr=24		5 years old Gr=56; GS=6	6 years old Gr=77; GS=6	Planned neighbourhood Gr=48; GS=6	Mixed-dev neighbourhood Gr=85; GS=6
Building Gr=1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0
Bus Gr=1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1
Car Gr=2	0	0	0	0	0	0	0	0	1	0	1	0	2	0	2	1	1
Cat Gr=1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1
Father Gr=1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1
Guard House Gr=2	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1
Hotel Gr=1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1
House Gr=5	0	0	0	0	1	1	0	0	3	0	0	0	5	2	3	3	2

Table 1 (continued)

Symbolic metaphor abstraction	Participant ID												Totals	Age group		Neighbourhood type	
	Age 5						Age 6										
	P5F1 Gr=9	P5M1 Gr=8	P5F3 Gr=11	X5F1 Gr=10	X5M2 Gr=10	X5M3 Gr=8	P6F1 Gr=7	P6F2 Gr=5	P6M3 Gr=8	X6M1 Gr=17	X6F2 Gr=16	X6F3 Gr=24		5 years old Gr=56; GS=6	6 years old Gr=77; GS=6	Planned neighbourhood Gr=48; GS=6	Mixed-development neighbourhood Gr=85; GS=6
Lake Gr=1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0
Petronas Gr=4	0	0	0	1	1	0	0	0	0	0	1	0	3	2	1	0	3
Playground Gr=3	0	0	1	0	0	1	1	0	0	0	0	0	3	2	1	2	1
Preschool Gr=3	0	0	0	1	1	0	0	0	0	0	1	0	3	2	1	0	3
Restaurant Gr=2	0	0	0	2	0	0	0	0	0	0	0	0	2	2	0	0	2
Shop Gr=1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0
Tree Gr=1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1
Totals	0	0	2	7	4	2	1	0	6	1	4	0	27	15	12	9	18

Note. "Gr" is the total number of quotations and 'GS' is the total number of documents