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Students as spatial agents: an exploration and reimagination of educational environments

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Abstract

Purpose – This research aims to understand the experiences of existing and imagined school environments of students in a socioeconomically disadvantaged district of Istanbul.

Design/methodology/approach – The multi-method approach functioned both as a post-occupancy evaluation of existing schools and a participatory design process generating insights for improved learning spaces. Data were collected through a diverse set of methods, including cognitive maps and in-depth interviews to explore students' experience of their existing schools; image sorting activities to help them select preferred spatial characteristics; wish poems, cognitive maps and an AI-supported tool to express their imagined school environments.

Findings – Content analysis revealed that students' spatial preferences are influenced by psychological and social needs, especially highlighting the themes of "socialization" and "personal development". It indicates that children perceive school spaces not merely as a physical setting but as a social ecology, thereby suggesting inclusive design strategies that actively involve students in the process.

Originality/value – Equality in educational opportunity involves not only providing educational resources but also the inclusion of all students in creative and participatory learning experiences; thus, the project emphasizes the importance of enabling socio-economically disadvantaged students to have a voice in shaping their educational environments.

Keywords Learning environment, Participatory design, Cognitive mapping, Post-occupancy evaluation, AI-assisted visualization, Equality in education

Paper type Research article

1. Introduction

Educational goals have shifted from passive, teacher-centered conventional models to approaches emphasizing active student engagement, requiring responsive learning environments (Scott-Webber, 2012). Instead of linking architectural optimism solely to the appearance and production of things, spatial agency maintains the notion of improvement, but relates it to a more flexible set of processes and social dynamics (Awan *et al.*, 2011). Yet, many existing learning environments fail to meet these evolving needs (Ghaziani, 2008; Scott-Webber *et al.*, 2008; Kepez and Üst, 2017). They need to be designed to simultaneously and adequately respond to the diverse needs of the learning community whose decisions may foster agency by empowering others that provide people with the knowledge and skills needed to address spatial issues on their own as it is exemplified through several educational settings by Awan *et al.* (2011). There can be no single school design that flawlessly addresses the teaching and learning requirements of all school communities (Woolner, 2010). The interactions among these users, as well as between the users and the space itself, collectively constitute the unique ecology of the environment. The effectiveness of the learning environment can be understood through the harmony of interdependent elements – ecology, organization, culture and milieu – that collectively determine environmental quality in schools, a framework first proposed by Owens and Valesky (2007) and later expanded by Gislason (2010). As Capra (1996) discusses, when viewed from an "ecological perspective", the configuration of relational networks within the space and how users position themselves within these networks becomes critical. The stability and continuity of any system rely on intensive interactions among its components, the integration of diverse elements and its capacity for adaptation and learning

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(Holland, 1995). Similarly, the Actor-Network Theory aims to broaden the range of participating entities, reconfigure their interrelations and enable them to function as a coherent and enduring assemblage (Latour, 2005).

Schools are not merely settings where children spend a substantial portion of their day; they function as a "second teacher," fostering interaction, autonomy and development (Sanoff, 2001; Türel and Gür, 2019). They can play a vital role in stimulating students' enthusiasm and motivation for learning, which subsequently supports their academic success, social engagement and overall learning experience (Durán-Narucki, 2008; Earthman, 2004; Kumar *et al*., 2008; Yang *et al*., 2013). Gibson's (1979) Affordance Theory explains how environmental features may promote particular behaviors. Examining the ways the environment shapes students' possibilities for action is particularly valuable for exploring the relationship between space and learning experience. The quality of the school building strengthens emotional bonds to school and learning (Maxwell, 2016). Thus, designing environments that promote place attachment and engagement, supported by frameworks integrating space and pedagogy, is essential (McNeil and Borg, 2018).

This study, which focuses on students at a public middle school located in a peripheral district of Istanbul, Türkiye, provides new insights into the literature. It supports socioeconomically disadvantaged middle school students to express their experiences and expectations regarding both their existing and imagined learning environments through a diverse range of participatory tools (verbal narratives, written reflections, image sorting activities, cognitive maps and wish-poems). In the final stage of the research, the artificial intelligence tool was incorporated to advance a community-centered approach (p. 434), defining AI for social good research that focuses on enhancing the capabilities of the most marginalized members (Bondi *et al.*, 2021). Additionally, AI would enable humans to focus on work that is unpredictable, non-algorithmic and reliant on soft skills such as emotional intelligence, creativity and complex problem-solving (Cropley, 2023). Our main aim is to empower the children as decision-makers through a seven-week collaborative workshop. Equality in educational opportunity involves not only providing educational resources but also the inclusion of all students in creative and participatory learning experiences; thus, the project emphasizes the importance of enabling socio-economically disadvantaged students to have a say in shaping their educational environments. Similarly, Anderson and Graham's (2016) qualitative findings indicate that valuing students' views supports their well-being by fostering equality, respect, safety and a sense of being valued. This is significant for both their individual development and their representation within society.

In addition to students' contributions to the functioning of education, the implementation of rules and the daily routine in their schools, it is essential to consider their spatial needs. Our research aims to develop a method to address the following research question: What are the cyclical connections in the process of children's spatial evaluation of their existing schools (POE) and the reimagination of their ideal schools (PD), and which spatial themes are mostly expressed by children – verbal, graphical (line-based) and written data – within this cycle? It focuses on designing more inclusive learning environments by combining the post-occupancy evaluation method (POE) with a participatory design (PD) approach (Figure 1).

1.1 Post occupancy evaluation and participatory design in learning environments

POE researches the performance of existing environments to inform future design and programming decisions (Zimring and Reizenstein, 1980; Zimring, 2002) and to establish benchmarks and patterns to refine design strategies (Daniels *et al*., 2017) while emphasizing active user involvement, enabling users to contribute to research and its transformative outcomes (Sanoff, 2016).

POE studies focusing on schools in Türkiye have primarily focused on urban spaces (Özsoy *et al*., 1996; Korkmaz and Türkoğlu, 2003; Yıldız and Şener, 2006) and the exterior of

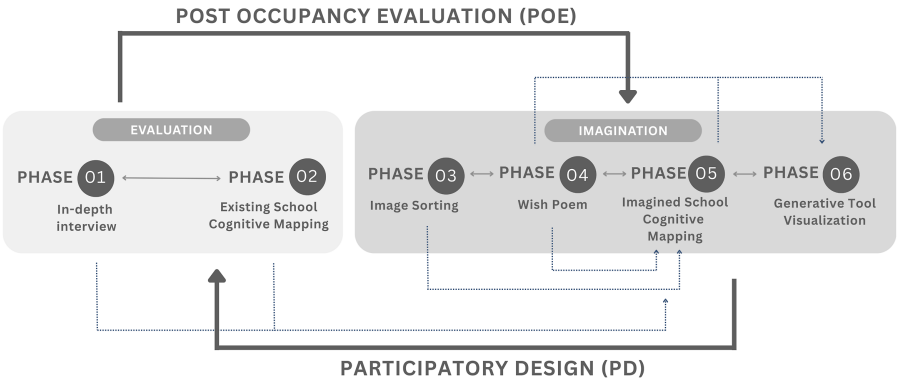

Figure 1. Diagram of methodological framework

university campuses (Ünlü *et al*., 2009; Çubukçu and Işıtan, 2011; Manahasa and Özsoy, 2016). A limited number of interior space studies typically emphasize specific aspects of studio environments, including students' personal space tendencies (Demirbaş and Demirkan, 2000), the relationship between spatial preferences and academic performance (Edgü, 2015) and the spatial impact of different studio types (Gür, 2010; Karslı, 2016). They show that student feedback on learning environments offers vital insights often more relevant than external views, as designers' assumptions may not align with users' needs (Woolner *et al*., 2007). Although children have limited abilities compared to adults, they can participate meaningfully as equal partners in design (Druin, 1999). Thus, frameworks that engage children as designers and use appropriate participatory models remain a key challenge (Manahasa *et al*., 2021). PD emphasizes stakeholder collaboration – including children – and begins with open discussions to align goals and identify group skills (Könings *et al*., 2014; Hart, 1987). In this content, Manahasa *et al*. (2021) noted that children's school experiences can inform child-oriented spaces and that their creativity stems from direct engagement with the building. Thus, the integration of children's emotions, experiences and the practical, innovative solutions they propose adds meaningful value to PD (Manahasa *et al*., 2021). Similarly, Şenyiğit and Memduhoğlu (2020)'s study evaluates 20 middle school exteriors, classrooms and corridors via image sorting, finding preferences for low-rise buildings with gardens, bright, flexible classrooms and wide functional corridors as transitional spaces. Mokhtarmanesh and Ghomeishi (2019) use not only image sorting but also semi-structured interviews to explore children's preferences in school design, finding that playgrounds with fixed structures and ample open space were key to positive perceptions.

2. Theoretical background

The ladder of participation of Roger Hart (1992) has been a critical framework in the children's involvement literature. Building on this model, Shier (2001) developed a five-level pathway to deepen understanding of participation processes: (1) children are listened to, (2) supported in expressing their views, (3) their views are taken into account, (4) involved in decision-making and (5) share power and responsibility in decision-making. From a different perspective, Fielding (2001) defines the levels of student voice as follows: students as a data source, students as active respondents, students as co-researchers and students as student researchers.

Although these studies prioritize student participation in school self-review and improvement, their primary aim is to deepen understanding and learning while disregarding the physical environment of their learning spaces. Flutter (2006) mentions that both educational researchers and practitioners have increasingly acknowledged the importance of

students' insights regarding the physical environment of their learning spaces. This participation is considered under four main titles: (1) understanding students' responses to the learning environment and how it can support or hinder learning; (2) improving school culture and ethos by giving students a voice in decision-making; (3) promoting students' awareness and interest in design and the environment and (4) encouraging a stronger sense of community membership and democracy within the school (Flutter, 2006).

Our study adopts Flutter's (2006) student participation approach by considering students not merely as users but as active members of the learning community whose participation in decision-making processes should be supported. Within the context of a disadvantaged school, this approach was employed to strengthen students' sense of belonging and identity through responsible participation.

3. Methodology

Our study adopted a multi-method approach to comprehensively explore children's interaction with their environment, systematically integrating findings from diverse techniques. It supports Ziegler and Andrews' (1987) argument that a single tool is not sufficient to fully capture children's environmental experiences and creativity.

Our study was based on a six-phase collaborative workshop involving university students and academics from a private university and middle school students from a public school in Istanbul's periphery. The workshop had a seven-week program to be carried out on the university campus between March 10, 2025, and April 28, 2025, with sessions scheduled as 2-h meetings every week. University students acted as catalysts for PD, supported the middle school students in developing a sense of belonging to the research and facilitated the process by establishing communication with them.

The middle school participants in the study were 5th-grade disadvantaged 26 students aged 11 to 12. Since only 8 students attended all six phases, the analysis presented in this study is based exclusively on the data obtained from eight participants. Of these eight, four were girls and four were boys. Given this limited dataset, conducting a meaningful between-group comparison was not analytically feasible within the scope of this study. The initial two phases aimed to gain an understanding of the participants' existing schools (POE), whereas the subsequent four phases focused on facilitating their imagination and creating ideas for new schools (PD).

In the first phase, flexible, open-ended interviews provided first-hand insights into participants' spatial experiences, informing subsequent research phases. As it was challenging to collect direct data from children, it was planned to collect data that do not require verbal skills-except for the first phase, knowing that many children were not verbally proficient but were good at selecting, pointing, drawing and coloring (Sanders, 2000).

In the second phase of the study, students were provided with a blank A4 sheet and a pencil, and were invited to draw their existing schools for a 25-min session. This method, referred to as "cognitive mapping," examines how people collect, process, interpret and store information about their everyday surroundings (Kitchin and Fotheringham, 1997; Hill and Michelson, 1981). According to Zardiny and Hakimpour (2020), mapping is a subjective representation of people's spatial knowledge and cognition, derived from visual observations and verbal communication, through which they visualize the part of the real world most appealing to them. The cognitive mapping studies conducted with children in the literature have mostly focused on urban perception and the wayfinding process (Kosslyn *et al.*, 1974; Herman and Siegel, 1978; Herman, 1980; Halseth and Doddridge, 2000; Fares and Bougdah, 2023; Banerjee, 2023). Our study shifts the focus from the urban scale to a more confined level, enabling students to represent both their existing and imagined school environments.

The third phase employed the image-sorting method, which aims to efficiently broaden students' perspectives (Lantz *et al.*, 2019) by presenting them with images of internationally acclaimed schools. Eight spatial categories – six interiors (classroom, corridor, staircase,

library, sports area, specialized classroom) and two exteriors (schoolyard and façade) – were presented, each with five sample images selected by researchers. Students rated these images from 1 (least liked) to 5 (most preferred) and explained their top choice in one sentence.

"I wish my school" was the opening line of a ten-line wish poem that students wrote in the fourth phase (Sanoff, 2001, 2016), supporting them to articulate their imagined schools in a creative way. They were able to express their spatial preferences with this repetitive structure, which encouraged creative expression (Sanoff, 1978).

In the fifth phase, students were asked to visually depict their imagined school by drawing. While maintaining the same methodological principles of the second phase, the children were this time asked: *"Can you draw a picture of your dream school?"*. Building on verbal explorations, this task allowed students to visually represent their ideas.

Through the last phase, the students' wish poems and imagined school cognitive maps were uploaded to a large language tool, ChatGPT. ChatGPT was chosen because it can interpret the semantic meaning embedded in children's cognitive maps and wish poems and translate these textual and emotional expressions into coherent spatial concepts (Anderson *et al*., 2024; Fan *et al*., 2023). Unlike diffusion-based image generators models such as Midjourney or Stable Diffusion that mainly generate stylistic imagery (Wang *et al*., 2025), ChatGPT supports conceptual reasoning, narrative interpretation and idea development (Tholander and Jonsson, 2023; Van den Broek *et al*., 2024). With the integration of DALL·E 3, this semantic understanding can further be carried into visual form, allowing image outputs that preserve the conceptual intent behind the source text (OpenAI, 2023). Thus, by integrating text and images, students were enabled to see their ideas materialized. This process allowed them to visualize their imagined schools in 3D, fostering design awareness and a sense of belonging (Flutter, 2006).

Prior to AI processing, all text and images were screened to ensure that no signatures, names or personally identifiable marks were present. The drawings were uploaded directly to the ChatGPT (image-input mode) and analyzed with the prompt: "*A drawing of an imagined school and an accompanying wish poem created by an 11-year-old student have been shared. The task is to visualize this imagined school as a single photographic frame. Rather than adhering strictly to the literal lines or proportions in the child's drawing, focus on interpreting the conten – the elements, spaces and ideas the child included. Identify the architectural and spatial components that make up the school in the drawing, and use those to construct a realistic visual representation of the school from the child's perspective by including statements mentioned in the wish poem. Considering both the drawing and the wish poem, reimagine the child's imagined school as a photographic frame. The final image should bring to life the child's vision of an imagined school. Do not write any text on the final image*". The resulting interpretations were cross-checked against the original visuals to ensure accuracy.

4. Analysis of workshop output

A comprehensive diagram was created for each of the eight students (MS-05, MS-07, MS-12, MS-15, MS-16, MS-17, MS-18, MS-21) – four girls and four boys – who participated in all six phases. The purpose of generating these diagrams within this cyclical, multi-methodological framework is to analyze each phase completed by each student.

MS-05's in-depth interview, cognitive maps, wish poems and image sorting consistently highlighted football, while canteen references shifted from a valued space to an economic concern, aligning with Burke and Grosvenor's (2003) findings. The AI incorporated wish poem elements, but the layout was mainly shaped by his cognitive map (Figure 2).

MS-07's in-depth interview, cognitive maps and wish poem highlighted his passion for football and computers, with a large football player statue reflecting this interest and aligning with Farag and Badawi's (2019) findings. However, the AI image incorporated wish poem elements without clearly matching his imagined cognitive map (Figure 3).

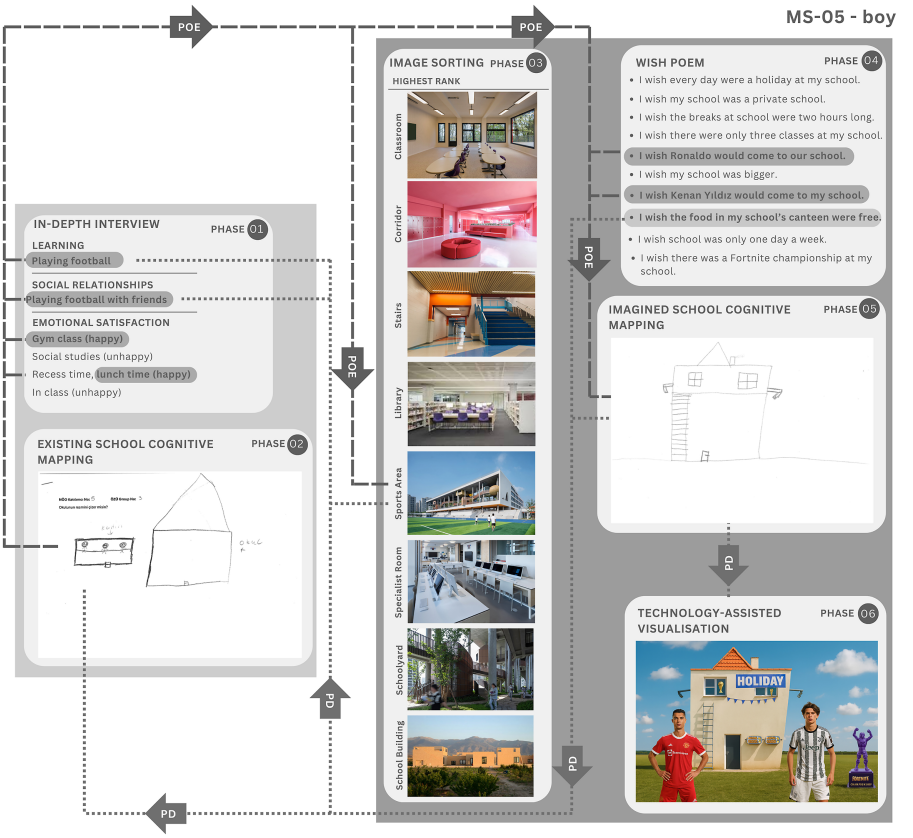

Figure 2. Six phases of the participant MS-05

MS-12 emphasizes socializing and inclusive approaches with her cognitive drawings, and her wish poem reflects interests in sports areas, a library and natural elements, which, as Tanner (2000) notes, evoke a sense of timelessness. ChatGPT's image closely matched her cognitive map, incorporating these spaces along with details from her wish poem, such as a cleaner, a clock and a canteen (Figure 4).

MS-15 enjoyed recess in the schoolyard or canteen, feeling happiest in the yard (Omar *et al.*, 2017), and included benches, a trash bin and security fences in her cognitive map. Reflecting Burke and Grosvenor's (2003) and Dutt's (2012) findings, she wished for larger sports areas, a new canteen and open spaces, while Huang's (2012) and Cozens *et al.*'s (2005) view of fences as boundary markers appeared in her drawing – later reimagined as decorative, flower-covered features. ChatGPT's visual, based on her cognitive map, integrated symbolic elements and wish poem details such as a café, playground and fire extinguisher (Figure 5).

MS-16 enjoyed math, gym and science, wishing for a larger, less colorful school with more sports areas, a garden and technological spaces. Her imagined cognitive drawing and wish poem featured a swimming pool, pizzeria, Ferris wheel, football field and a private "gossip corner" (Tanner, 2000). Lacking a clear façade in her imagined cognitive map, ChatGPT arranged these and other wish poem elements in a balanced interior-exterior setting (Figure 6).

MS-17 highlighted circulation with an interior staircase in his existing school drawing (Tanner, 2009). His wish poem replaced stairs with slides, reflecting a playful approach to movement (Tanner, 2008). ChatGPT kept the façade, applied a monochrome style and added

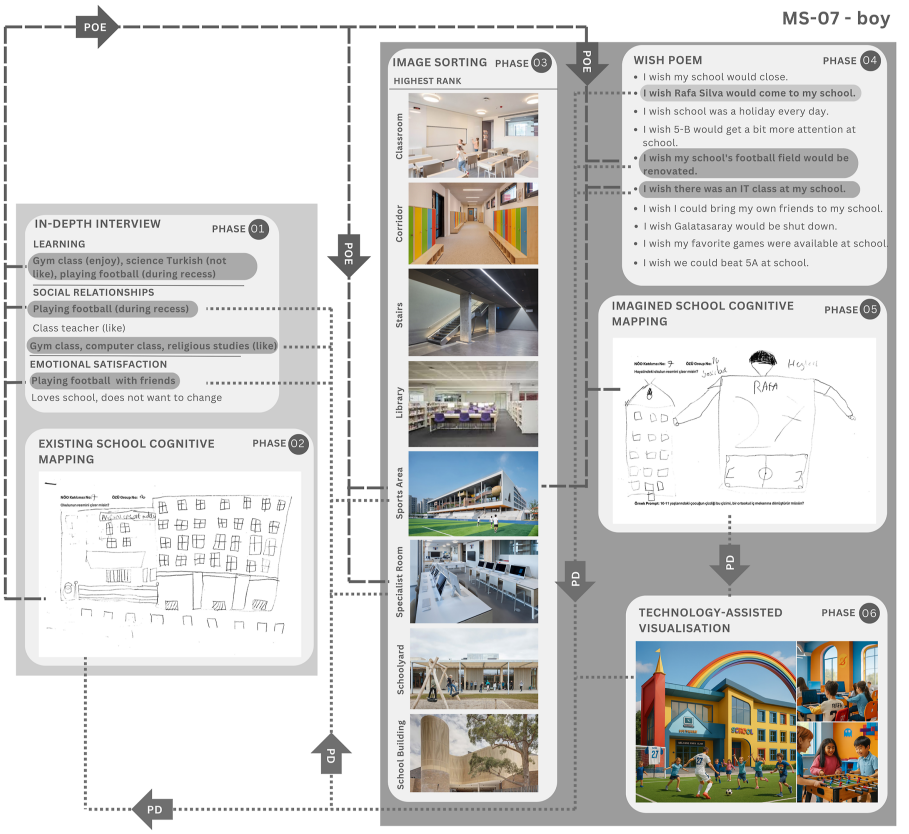

Figure 3. Six phases of the participant MS-07

wish poem elements such as a swimming pool, a Lamborghini, a skyscraper, a Seha patisserie, Ronaldo and a slide (Figure 7).

MS-18 viewed her school as home-like, adding details such as curtains and a security camera (Farag and Badawi, 2019; Lenzi *et al.*, 2017). Her imagined school, drawn as a colored site plan, featured green spaces and a girls-only pool, reflecting a desire for private spaces (Tanner, 2000). ChatGPT interpreted items individually but integrated wish poem elements like ergonomic features, beanbags and sleeping areas into an interior (Figure 8).

MS-21 enjoyed gym class, technology class and ball games, wishing for more sports courts. His existing school drawings included a canteen, kindergarten and, in the imagined version, a cinema, bicycle area, restaurant and elevator. ChatGPT incorporated these with wish poem features like a water park, sandpit, forest and barbershop, though with spatial inconsistencies such as a cinema near an open space and a bicycle area indoors in a tight zone (Figure 9).

5. Findings

The researchers used content analysis, a qualitative method (Creswell, 2012), to analyze, categorize and organize both visual and verbal materials. Eight diagrams, each comprising six phases from eight students, were analyzed by two independent researchers. Following the analysis, clusters of keywords were identified based on contextual similarities. Then, each cluster was assigned a code to serve as a main category (Table 1). The findings from the five

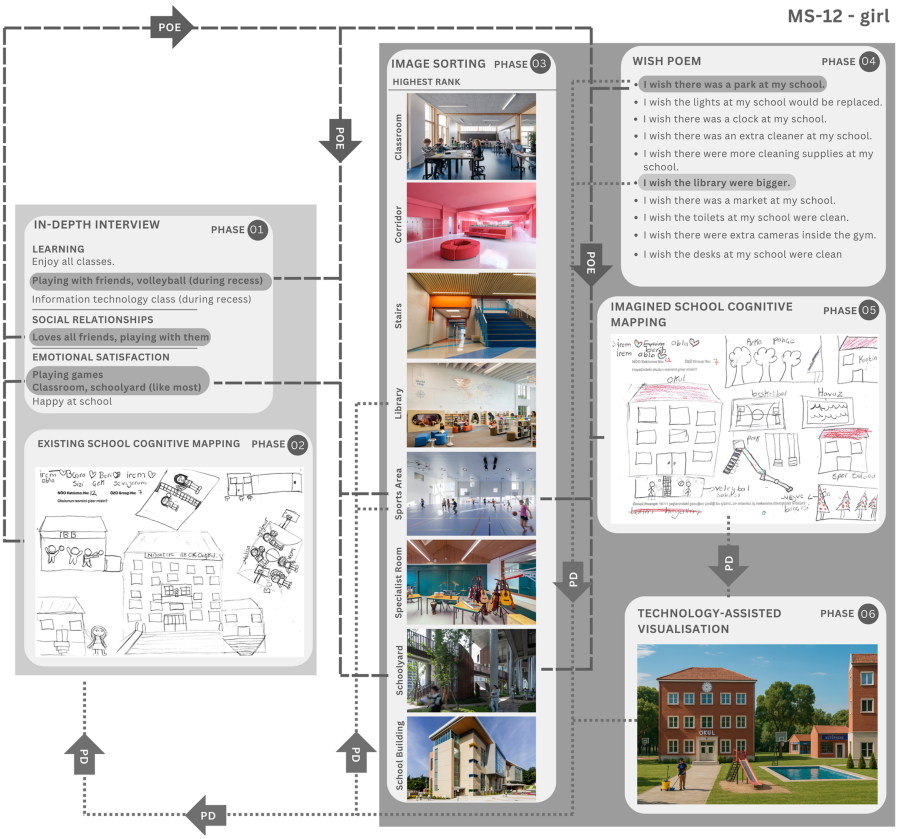

Figure 4. Six phases of the participant MS-12

phases are categorized into three main themes: *Basic Needs*, *Psychological and Social Needs and Spatial Needs* (Table 1).

The AI-generated images produced in Phase 6 were not treated as mere illustrative outcomes; instead, the components in the AI-generated images were evaluated based on the content analysis conducted for the previous five phases. Subsequently, the visual components and written statements collected for all phases were presented in Table 2.

5.1 Findings on basic needs

"Findings on basic needs" include the subthemes most frequently mentioned by students, such as economic concerns, nourishment, cleaning, maintenance and physical activity. Nearly all students, a disadvantaged group attending a publicly funded middle school in the periphery, expressed economic concerns. For instance, MS-17 stated, *"I wish everything at my school was free,"* while MS-18 noted, *"I wish everything in my school's canteen was free."* Additionally, two other students expressed their desire to get their education in private institutions. Research generally indicates that students living in economically disadvantaged households and neighborhoods face a heightened risk of dropping out of school, developing problematic behavioral patterns and encountering other educational challenges commonly associated with low levels of engagement (Ansong *et al*., 2015; Demanet *et al*., 2015; Jariah *et al*., 2004). Therefore, addressing fundamental economic constraints may be a prerequisite to effectively meeting other needs.

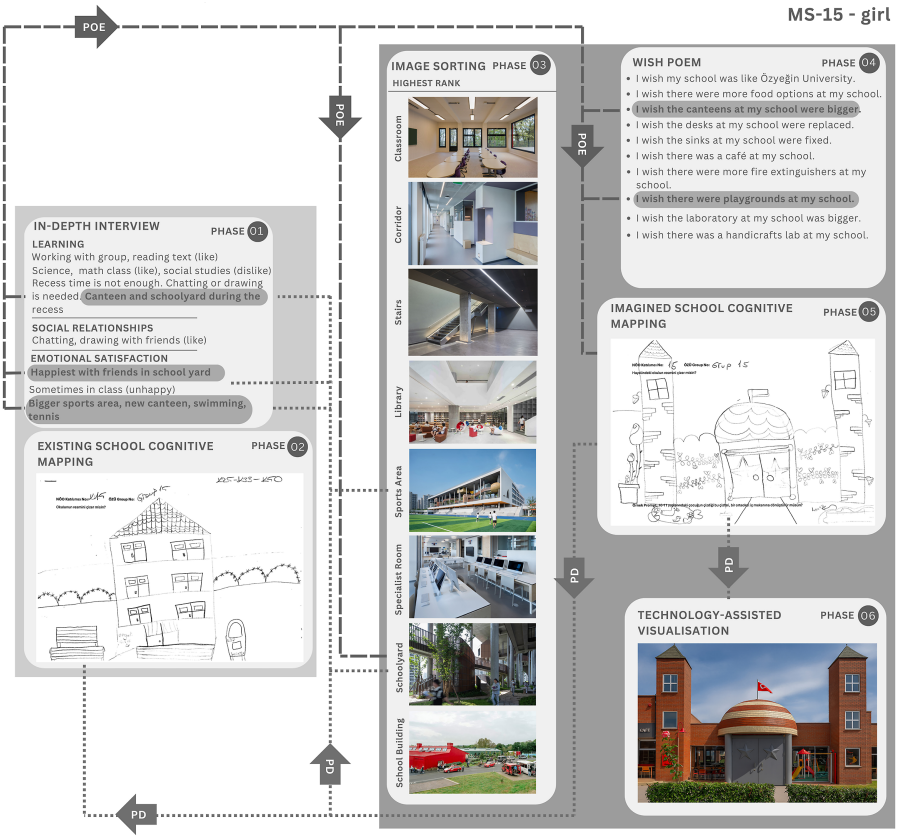

Figure 5. Six phases of the participant MS-15

Nourishment represents another fundamental need that underlies students' well-being and engagement. In their wish poems, more food options (MS-15), meals like those at a nearby patisserie (MS-17) and a cafeteria serving homemade food (MS-18) were mentioned by children. The imagined school cognitive maps illustrate students' tendency for varied food services, as evidenced by MS-16's pizzeria, MS-18's dining hall and MS-21's restaurant.

School cleanliness and maintenance emerge as additional key dimensions explored under the theme of "basic needs". While clean environments support teaching, learning, health, safety and morale (Ashkin and Ellis, 2006), deteriorated ones may pose health risks, hinder instruction and discourage attendance (Maxwell, 2016), affecting academic outcomes (Durán-Narucki, 2008). Students' wish poems reflect a clear concern with these material conditions. Clean toilets and desks (MS-12), repaired sinks (MS-15), more cleaning staff (MS-18) and higher-quality facilities (MS-17) were wished. These wishes highlight students' emphasis on hygiene and maintenance – critical not only for daily learning but also for long-term educational impact.

Another theme that emerged under the basic needs category is physical activity, which is the most frequently mentioned theme within this category. It is known that participating in physical activities supports physical well-being, health and vitality, enabling students to focus better on their studies by enhancing cognitive ability and classroom attention (Husain, 2023; Marshall, 2006).

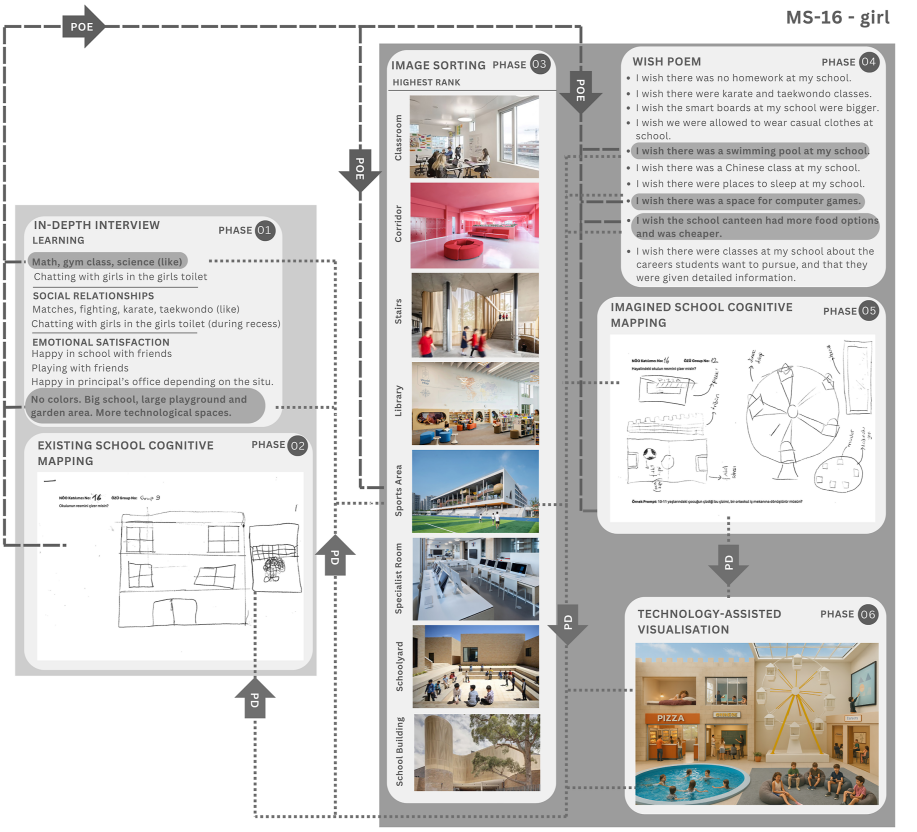

Figure 6. Six phases of the participant MS-16

5.2 Findings on psychological and social needs

The themes expressed by students through the section titled "Findings on Psychological and Social Needs" include socialization, sense of control, feelings of safety and security, personal development (such as technology, handicrafts and language), sense of belonging, privacy and low motivation.

Socialization is the process by which a child becomes a socially accepted individual, acquiring language, skills and the dominant beliefs and attitudes of their society (Harris, 1995). School is a primary context where children socialize, form perspectives and share experiences, with its spaces designed to support their role development in society (Rivlin and Weinstein, 1984). In the first phase, most students reported enjoying team sports and outdoor games during recess, which are associated with physical self-efficacy, positive body image, elevated self-esteem, peer acceptance and academic achievement in both boys and girls (Marsh and Kleitman, 2003). Students predominantly identified the schoolyard as the primary space for play, team sports, recess and socializing. This tendency was further evidenced in the imagined cognitive maps, most of which depicted the school building and the yard from an external perspective. These observations suggest that students' perception of school is strongly associated with a space that facilitates social interaction, physical activity and positive emotional experiences. A noteworthy finding is that students tended to draw their friends while describing their existing school, but their imagined school drawings are more focused on space than on peers or people (MS-12). This may be due to their social acceptance of their existing

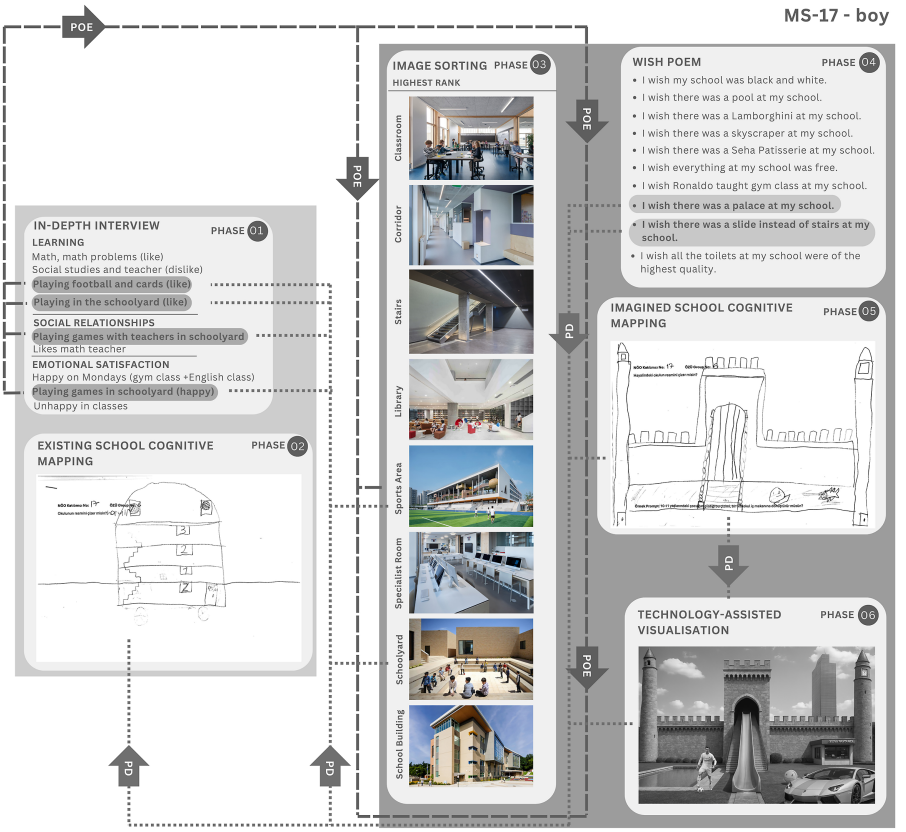

Figure 7. Six phases of the participant MS-17

schools, leading them to focus more on spatial needs than social structures in their imagined schools.

Two interconnected themes of sense of control and sense of belonging can be considered in the process of children adapting to new environments. Established methods such as naming, humanizing, controlling, personalizing and marking memory cues are commonly used to foster a sense of belonging and attachment to place(Korpela, 1989; Dönmez, 2022). Elements supporting students' sense of control were identified within the scope of this study as the ability to manage recess time according to personal preferences (MS-15, first phase), the perception of time through the use of a clock (MS-12, fourth phase) and the option to attend school in casual clothes (MS-16, fourth phase). MS-18's cognitive map, curtains on classroom windows symbolized familiarity and a sense of belonging to the school.

Students' emphasis on the sense of security can be observed both in their existing school cognitive maps and in their wish poems. MS-12, MS-15 and MS-18 included features like a security booth, cameras and fences in their existing school drawings. Identifying these kinds of elements, enhancing students' sense of safety at school, is essential, as this knowledge can guide the development of well-informed and impactful programs (Lenzi *et al.*, 2017).

Students' psychological and social needs were accompanied by a desire to develop practical and cognitive skills in areas like digital literacy, handicrafts and language learning. Desires to have an IT class (MS-07), a handcraft atelier (MS-15), bigger smart boards (MS-16), a space for computer games (MS-16) and carrier classes (MS-16) can be associated with the

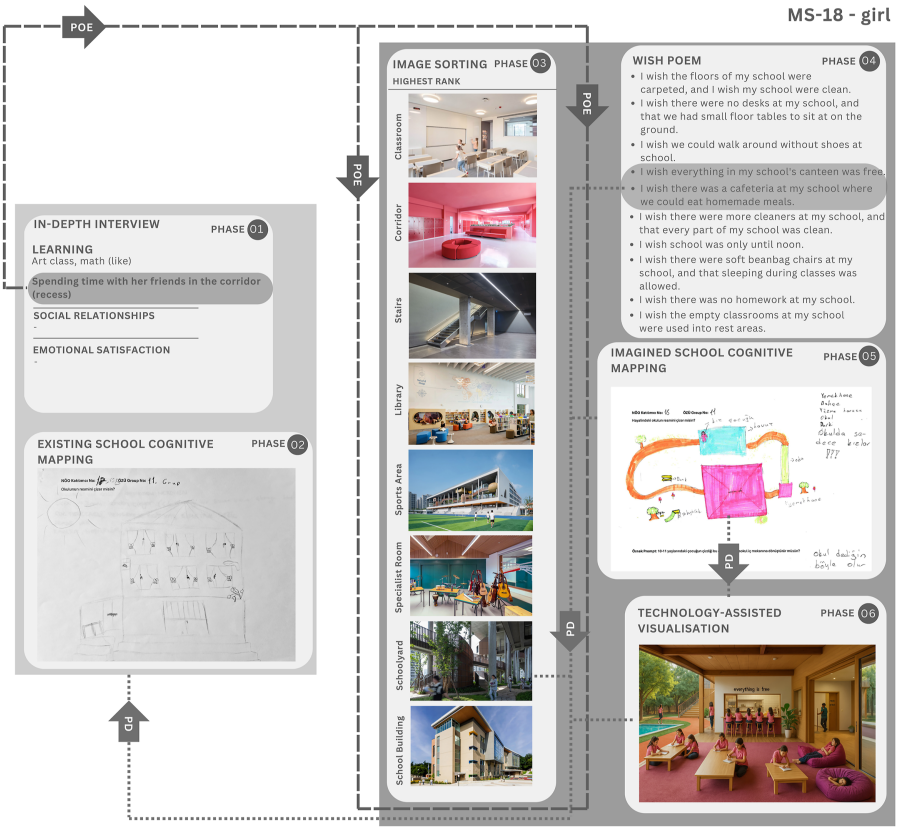

Figure 8. Six phases of the participant MS-18

theme. Compared to traditional classrooms, flexible, tech-integrated spaces strongly enhance students' learning perceptions and engagement (Scott-Webber, 2012; Byers *et al.*, 2014; Kepez and Üst, 2020). In the image-sorting phase, five out of eight students chose the computer lab image among five different specialized rooms, supporting their wish poems.

A closer look at students' expressions of psychological and social needs also reveals emerging gender-related differences, particularly in how girls and boys envision their imagined school environments. In the wish poem, MS-21 states, *"I wish there were separate fields for girls and boys at my school,"* while MS-18 includes a swimming pool only for girls in her imagined school drawing. Similarly, MS-16's wish for a "gossip corner" may reflect a desire for a private space with friends. In contrast, no gender-related wishes were expressed by the boys in any phase of our study. This may reflect girls' needs for more gender-based spaces or safety boundaries with a stronger sense of safety than boys; consistent with Niemi *et al.*'s (2024) research (2024).

The theme of "privacy" emerged for two students; MS-16 chose the library for its capacity to provide both collaborative work and individual privacy, describing it as a place to "hide" (Kepez and Üst, 2020) and MS-17 demonstrated a similar inclination in the cognitive map of his imagined school, illustrating a highly secure and enclosed environment with limited connection to the outside, reflecting a strong preference for protected and private spaces (Wolfe and Laufer, 1975; Wolfe, 1978) which promote the development of competence,

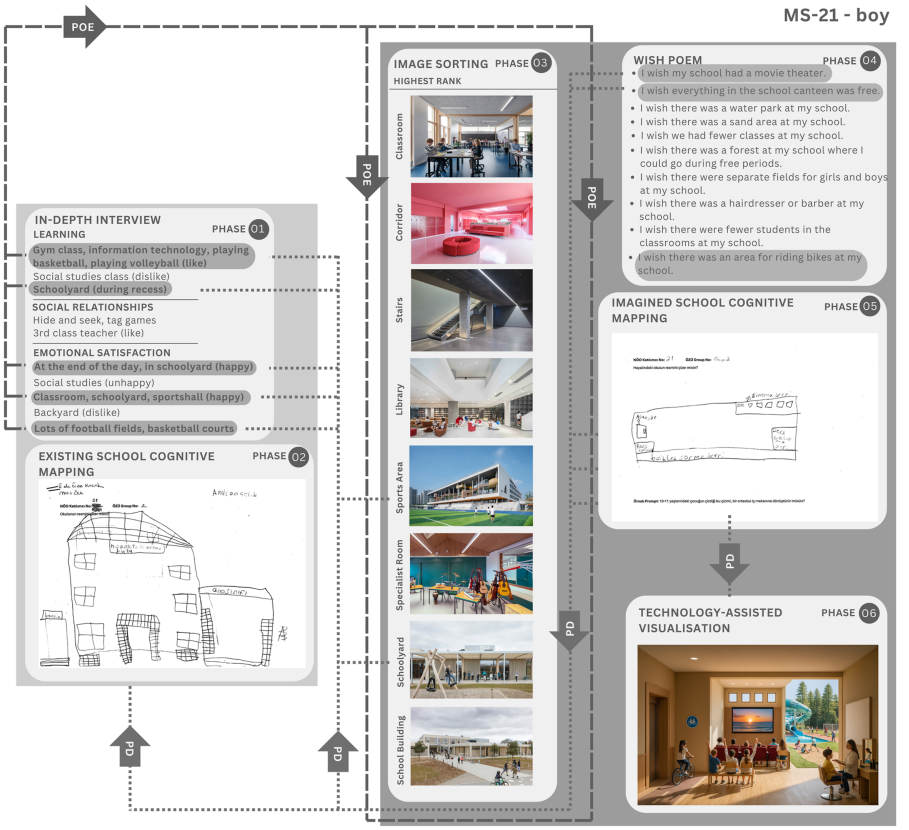

Figure 9. Six phases of the participant MS-21

providing opportunities for growth, supporting a sense of security and trust and allowing for both social interaction and privacy (David and Weinstein, 1987).

Students' negative attitudes toward school and disengagement from the system appear to be linked to the theme of low motivation. Desire for longer recesses, fewer school days and continuous holidays (MS-05), wish to close the school (MS-07), spending less time in school (MS-18) and having fewer classes (MS-21) were expressed by students. While these may also reflect a desire for greater control, they suggest reduced engagement. Although further analysis is needed, prior research highlights the school's physical environment, social climate and teacher support as key factors influencing student motivation and academic performance (Durán-Narucki, 2008; Maxwell, 2016; Lenzi *et al*., 2017).

5.3 Findings on spatial needs

In the section titled *"Findings on Spatial Needs"*, students frequently highlighted elements related to physical comfort – such as lighting, acoustics – as well as spatial dimensions, form, color, size, ergonomics, schoolyard/green space and circulation within the school environment.

The physical environment comfort components impact the learning process of the student by providing auditory, visual and thermal comfort in the space. Krüger and Zannin (2004) state that occupant comfort depends on perceiving all physical environment factors as a whole.

Table 1. Main themes obtained from each phase

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Total
MS-05	A5, B1, B8	A2, B8, B1	A5, B1, B4, C2, C2, C2, C2, C2, C2, C2, C2, C5, C5, C5	A1, A1, B1, B1, B1, B8, B8, B8, B8, C2	B3, C6	A2, B1, B1, B1, B3, B8, C6	
MS-07	A5, B1, B4	A5, B1, C6	B4, C2, C4, C4, C4, C4	A4, B1, B1, B1, B4, B8, B8	A5, B1	A5, B1, B1, B4, C2	
MS-12	A5, B1, B4, C5	A2, A5, A5, A5, B1, B1, B1, B3, C6	A5, B1, B1, B4, C2, C2, C2, C2, C5, C6	A4, A4, A4, A4, A4, A4, B1, B2, B3, C2	A2, A5, A5, A5, A5, A5, B1, C5, C5	A2, A3, A5, A5, A5, B2, B4, C5	
MS-15	A5, B1, B2, C2, C5	B3, C6	B1, B4, C2, C2, C2, C2, C2, C2, C3, C4, C4, C4, C4, C4, C5, C5	A2, A2, A2, A4, A4, B1, B3, B4, C2, C2	A5, B3, C1	A2, A5, B3, C1, C5	
MS-16	A5, B1, B4, B5, C2, C5	A5	A5, B1, B4, B4, B7, C1, C2, C2, C5	A1, A5, A5, B2, B4, B4, B4, B4, C1	A2, A5, A5, B1, B1, B1	A2, A5, B1, B1, B1, B4, B4, B7, C3	
MS-17	B1, C5	C6	A5, B1, B1, B4, C1, C2, C4	A1, A2, A4, A5, B1, B1, C2, C6	B3, B7	A1, A2, A5, B1, C2, C6	
MS-18	B1	B3, B6, C1, C6	A5, B3, B4, C1, C2, C2, C5	A1, A2, A3, A3, A3, B8, B8, C1, C3, C3	A2, A5, A5, B5, C5, C5, C5, C6	A2, A3, A3, A5, C3, C3, C5, C6	
MS-21	A2, A5, B1, B4, C1, C5	A2	A5, B1, B1, B4, C1, C2, C2, C3, C4, C4, C5	A1, B1, B1, B1, B1, B1, B5, B8, C5	A2, A5,B1, B4, C6	A1, A5, A5, A5, B1, B1, B1	
A- Basic Needs	*7*	*8*	*6*	*26*	*15*	*23*	*85*
B- Psychological and Social Needs	*15*	*10*	*20*	*34*	*12*	*21*	*112*
C- Spatial Needs	*8*	*6*	*55*	*11*	*9*	*12*	*101*
TOTAL	***30***	***24***	***81***	***71***	***36***	***56***	

(*continued*)

Table 1. Continued

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Total
A- BASIC NEEDS	***B- PSYCHOLOGICAL AND SOCIAL NEEDS***			***C- SPATIAL NEEDS***		
Economic Concerns - A1	Socialization - B1			Physical Comfort (Light, Acoustics, etc.) - C1		
Nourishment - A2	Sense of Control - B2			Size/Form/Color - C2		
Cleaning - A3	Personal Development (Technology, Handicrafts, Language, Music, Art, etc.) - B4			Ergonomics - C3		
Maintenance - A4	Gender Based Needs - B5			Aesthetic Comfort - C4		
Physical Activity - A5	Sense of Belonging - B6			Schoolyard/Green Space - C5		
	Privacy - B7			Circulation - C6		
	Low Motivation - B8					

Table 2. Components and statements derived from the six phases

A- BASIC NEEDS	
A1 - ECONOMIC CONCERNS	Luxury car, cheap food, private school
A2 - NOURISHMENT	Cafe tray, canteen, cafeteria, pizzeria, patisserie, market, more food options, home-made meals
A3 - CLEANING	Cleaning staff, trash bin, cleaning stuff, clean toilets
A4 - MAINTENANCE	Renovating school furniture, renovating sinks, toilets, higher quality, fixed sinks, light replacement
A5 - PHYSICAL ACTIVITY	Playing football, swimming pool, basketball court, park area, tennis

B- PSYCHOLOGICAL AND SOCIAL NEEDS	
B1 - SOCIALIZATION	Game events, football player, games with friends, team sports, cinema corner, water games, cinema, bicycle area
B2 - SENSE OF CONTROL	Clock, casual dress
B3 - SENSE OF SAFETY AND SECURITY	Camera, shark, watch tower, fire extinguisher, fences, lock
B4 - PERSONAL DEVELOPMENT	Computer lab, library, Chinese language course, career corner, musical equipment, handcraft atelier, karate and taekwondo classes, technology, smartboard
B5 - GENDER BASED NEEDS	Swimming pool only for girls, school only for girls, separated areas for girls and boys
B6 - SENSE OF BELONGING	Homelike curtains on the school windows
B7 - PRIVACY	Castle, private space in school, hiding place, sleeping space
B8 - LOW MOTIVATION	Holiday, boring, no class, no homework, two-hour breaks, fewer classes, school once a week

C - SPATIAL NEEDS	
C1 - PHYSICAL NEEDS	Street lighting, led lights, lit
C2 - SIZE/FORM/COLOR	Colorfulness, color preference, bigger, narrow, tight, red
C3 - ERGONOMICS	Comfortable furniture, soft flooring, sitting units, soft cushions, carpet, chairs with wheels, walk around without shoes
C4 - AESTHETICS COMFORT	Beautiful, plain, not beautiful, like a box, very bad, modern, attractive
C5 - SCHOOL YARD/GREEN SPACE	Orchards, garden, tree, nature, forest
C6 - CIRCULATION	Stairs, slide, staircase, elevator

MS-18 included lighting elements in her existing school drawing, and similarly, MS-16, MS-17, MS-18 and MS-21 emphasized brightness as a key factor in their preferences during the image sorting phase (Brubaker *et al*., 1998).

Ergonomics in school settings plays a role not only in optimizing new designs but also in enhancing existing spaces, practices and equipment to promote greater comfort, safety and usability (Bennett *et al*., 2006). Research also shows that ergonomic and more comfortable furniture helps students concentrate better and engage more actively during lessons (Knight and Noyes, 1999; Espey, 2008; Harvey and Kenyon, 2013). Wish for beanbag chairs and low tables (MS-18), preference for ergonomic furniture (MS-15 and MS-21), suggest awareness of ergonomics and a need for diverse seating.

The theme of circulation was analyzed through students' awareness and suggestions on spatial movement in the vertically structured school. MS-07, MS-12 and MS-18 included the front stairs in their existing school cognitive maps, while MS-12 and MS-15 also depicted the adjacent ramp. MS-17 included interior stairs to the façade drawing and, in the wish poem, he imagined replacing stairs with a slide, suggesting a similar result of the study of Aminpour (2023). In cognitive maps of imagined schools, circulation appeared as stairs (MS-05), connecting paths (MS-18) and an elevator (MS-21), indicating student sensitivity to spatial mobility and circulation.

The students expressed statements associating aesthetics with comfort only in the image sorting. Students MS-07, MS-15, MS-17 and MS-21 explained their reasons for choosing their preferred space using expressions such as "beautiful," "attractive," "different," "original," and "very good," which can be considered subjective aesthetic evaluations.

In addition to expressing their aesthetic preferences, students frequently commented on the size, form and color of their school environments. In their wish poems, several students expressed size-related desires, such as a bigger school (MS-05), library (MS-12) and laboratory (MS-15). Students' need for larger spaces may stem from overcrowding, as laboratories and libraries used beyond capacity can be perceived as spatial inadequacy. In the wish poem and image sorting phases, students often chose spaces for color and spaciousness, showing these preferences' impact on their perception of the learning environment. Color preferences are among the variables considered in this study that can influence students' learning (Dehvari *et al*., 2024). Research indicates that color can have significant effects on cognition and behavior (Elliot and Maier, 2014), as well as on performance (Küller *et al*., 2009).

Students frequently identified the schoolyard as the area where they spent the most time during recess and felt happiest. Research has noted the affordances of green outdoor spaces to support informal learning without the interventions of teachers during unstructured times (Titman, 1994; Moore and Wong, 1997; Stan, 2010). In walking tours with students aged 8–13, Aminpour (2023) found that outdoor terraces, open hallways and retreat subspaces enhanced satisfaction in vertical schools. Similarly, students' cognitive maps of existing schools were usually drawn from an external perspective and included schoolyard elements. In the image sorting phase, the schoolyard – having greenery and shaded areas – was most selected (Moore, 2006). Wish for a forest to spend free periods (MS-21), and imagined school drawings with green spaces in the schoolyards (MS-12 and MS-18) can also be exemplified accordingly.

6. Discussion and conclusion

This research aimed to reveal cyclical connections in the process of children's spatial evaluation of their existing school environment (POE) and the reimagination of their ideal schools (PD), through children's verbal, graphical (line-based) and written expressions.

The results of this multi-dimensional study can be classified into three dimensions:

(1) Feedback from completed projects would be a helpful tool for designers to challenge decision-makers' assumptions and improve future project outcomes. The participation of the learning community not only enriches PD practices but also ensures that a diverse range of needs and expectations is recognized and addressed throughout the process. Providing the learning community with appropriate tools to express their ideas helps clarify their support for the design development process. The methodological implications of this research reveal that employing a multi-method approach, especially in child-centered research (Hart, 1992; Shier, 2001; Fielding, 2001), enhances the depth and variety of data by accommodating diverse modes of obtaining children's perspectives. Results reveal that the six different methods employed with students demonstrated varying levels of depth in student responses concerning both existing and imagined school environments. Data from the image sorting and wish poem activities show that these methods enabled students to express their thoughts more clearly, in greater detail and with richer expression than in other study phases. Limited expressions in children's interviews and cognitive maps may stem from unfamiliarity with articulating and visualizing ideas, possibly influenced by socio-economic disadvantage. Furthermore, the study suggests that the POE method and PD approach are better understood within a cyclical rather than linear framework. Evidence derived from student contributions indicates that these two frameworks operate through iterative and mutually reinforcing processes, shaped by multi-directional interactions rather than a fixed sequence.

(2) The findings were derived through thematic coding and frequency analysis of the verbal, graphical (line-based) and written data generated by participating students. In the final phase of the analysis, students' cognitive maps of their ideal schools were interpreted using an AI-based spatial visualization tool, and the visual themes that emerged were incorporated into the corresponding thematic categories. The content analysis results indicate that the most prominent themes emphasized by the students align with their psychological and social needs. Socialization and personal development emerge as the primary themes of this set of needs. It underscores the notion that children perceive physical space as embedded within a relationship with others (Swaminathan, 2004), wherein they actively construct and negotiate their self-identity.

(3) The results on the AI-supported visual interpretation of multimodal data reveal that the multimodal inputs – *wish poems* and *imagined schoo*l *cognitive maps* – uploaded to ChatGPT for the purpose of visual interpretation were processed according to an implicit spatial hierarchy inferred by the AI. When a student's cognitive map depicts an exterior façade, the AI prioritizes it as the primary architectural framework, with interior elements from the wish poem selectively incorporated or entirely omitted. Furthermore, in instances where students did not explicitly define an external enclosure, the AI tended to generate interior spatial configurations, while still incorporating a degree of spatial connectivity with outdoor environments. These findings suggest the AI's interpretation is shaped by representational cues in students' multimodal data, emphasizing enclosure, spatial hierarchy and integration in machine-mediated visualization. Despite occasional representational deficiencies in the AI-assisted visualization of students' drawings (Wardono *et al.*, 2025), the inclusion of this technology in research frameworks can offer several notable advantages. This study highlights several potential contributions of artificial intelligence to integrating students into the design process via participatory design principles: enhancing students' awareness of their role as decision-makers in school design; enabling the integration of AI with methods such as wish poems and cognitive maps and improving time efficiency in the conceptual design phase while strengthening designer–user collaboration. Future research should explore combining conventional methods with AI-based tools to develop and assess multifaceted approaches in educational space design.

This study has several limitations. First, only eight of the 26 students who were supposed to attend the workshop did, leading to fragmented data and limited comparability. The irregularities in the students' attendance can be associated with the fact that the study was conducted in a peripheral district and within the context of a public school. Due to the small sample size ($n = 8$), the findings may not be broadly generalizable. However, as a preliminary study testing a multi-step participatory methodology, this sample allowed for a detailed, step-by-step analysis of each participant's contributions and provided valuable insights for future larger-scale research. Nevertheless, the research method may serve as a basis for future planned multi-dimensional studies on educational environments. Second, post-generation evaluations of the AI-generated images were not possible due to time constraints, which limited our understanding of how students interpreted the images that were generated by AI. Third, even though it is instructed to remove text, ChatGPT frequently replicated text from children's cognitive maps, which impacted the clarity of the images. Inconsistent image generation also made standardization and analysis more difficult; outputs occasionally contained collages rather than a single image.

The implications of the findings are threefold. First, integrating participatory design methods with AI-supported tools can serve as an effective way to engage learning communities in rethinking their own environments. Second, incorporating student voices into spatial policy and design processes offers actionable insights for architects, educators and policymakers. Third, applying similar studies across different contexts may generate a cumulative knowledge base that can inform the development of more systematic guidelines for participatory school design.

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