Research Paper

Co-designing outdoor playspaces with children: A framework for analyzing participant design priorities

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Design processes increasingly embrace participatory methods, yet systematic frameworks for analyzing diverse co-design outputs remain underdeveloped, especially those from children. This study introduces the Priority Experiences of Participants (PrEP) framework, a five-stage analytical approach for synthesizing multimodal co-design contributions into actionable design guidance. The framework employs the lens of affordances to identify "umbrella experiences," high-level experiential priorities. Through mixed-methods triangulation, including content analysis, Q-Sort rankings, and qualitative analysis, the framework systematically synthesizes participant contributions into design guidance. The framework is illustrated through a schoolyard co-design case study with 9- to 10-year-olds. The PrEP framework provides a structured approach and accessible tools to support the effective inclusion of children in decision-making and the authentic translation of their priorities into design solutions.

Keywords: participatory design, design methods, environmental design, children's environments, affordance

Co-design and other participatory design approaches offer valuable opportunities for democratizing design and allowing the marginalized voices of children to be genuinely integrated within the design process. These methods align with the UN Convention on the Rights of the Child, which affords young people the right to influence decisions which affect their daily lives and development, including the design of their everyday settings (November 20, 1989).

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However, children are typically left out of design ideation and decision-making, even when they are the users most impacted by the products of design. While models for design partnership with children have emerged, issues of tokenistic, or worse, manipulative involvement remain (Can & İnalhan, 2017; Loebach et al., 2020). Design practice itself has rarely been critically evaluated for either its inadvertent oversight or intentional marginalization of children. While co-design and other participatory design (PD) approaches have become increasingly valued in environmental design in theory, meaningful involvement of young people in design and planning activities remains limited. Recent scholarship confirms that while the field has advanced significantly in developing tools and methods for child engagement, and the quantity of child-engaged participatory design projects has increased, significant methodological challenges remain in ensuring these processes genuinely empower children and effectively translate emerging knowledge beyond the in-person sharing that occurs during participatory activities (Saiger et al., 2023).

In particular, frameworks for analyzing PD outputs and participant priorities are scarce; existing research focuses primarily on elicitation rather than appropriate interpretation and effective translation of participant contributions (Frauenberger et al., 2015; Saiger et al., 2023). The inability to effectively synthesize participant insights or priorities continues to obstruct the effective translation of PD outputs into design solutions, particularly in participatory processes involving children.

This study aims to advance an analytical framework, the Priority Experiences of Participants (PrEP) framework, which offers a systematic approach for understanding and synthesizing participant preferences and priorities within PD projects, particularly those of young people. The central aim of the study is to demonstrate how this framework can effectively assist PD researchers and practitioners in synthesizing and articulating participant design priorities from the diverse range of data and design artifacts that can emerge during co-design processes with children. The framework is designed to bridge the gap between rich co-design outputs and actionable design guidance, providing designers and planners with both prioritized experiential goals as well as concrete examples of how these experiences might be materially realized. The PrEP approach provides a mechanism for designers to honor the rights of children while also creating design solutions that better reflect the diverse needs and insights of child users. This paper demonstrates the framework's application through an 11-session co-design case study with 20 fifth-grade students (ages 9–10) who collaborated to envision the redesign of their school playspace, with findings systematically translated into design recommendations for the project architects. Beyond this illustrative case study, the framework's structure and detailed methodology are designed to be transferable to diverse co-design contexts, populations, and design domains.

1 Literature review

1.1 Co-design with children

Participatory design (PD) includes "activities where users, designers, and researchers collaborate toward shared goals" (Bødker et al., 2022, p. 3). It originated in 1970s Scandinavia, emerging from the workers' movement and trade unions as a means of integrating input from workers in the development of workplace technologies. PD was further developed through the pioneering work of Henry Sanoff and others, who established foundational principles for community-based design processes (Sanoff, 1999, 2006). Modern PD applications vary widely, but remain rooted in values of mutual learning, empathy, empowerment, and democracy (Bødker et al., 2022; Spinuzzi, 2005). PD is often situated within a broader shift in design research that recognizes expertise as not limited to credentialed professionals, but inherent to users, community members, and stakeholders as well (Sanders & Stappers, 2008). As Spinuzzi (2005) explains, during PD, knowledge is constructed through collaborative research and design activities, rather than through detached observation and analysis by experts. Contemporary PD methodology has evolved significantly to aid this co-created knowledge, incorporating expanded stakeholder engagement strategies such as multimodal approaches, design thinking methodologies, and technology-enhanced collaboration tools (Malinverni et al., 2016; Saiger et al., 2023).

Co-design and participatory design are closely related approaches that both emphasize active involvement of end-users and other stakeholders in the design process. Participatory design encompasses a broader range of practices and commitments grounded in the democratic ideal of empowering people to influence design, while co-design practices stem from a more practical orientation towards direct collaboration between designers and users in creative work (Bødker et al., 2022; Sanders & Stappers, 2008). However, co-design is accountable to the same philosophical underpinnings of PD, emphasizing democratic empowerment, trust-building, and mutual learning (Paracha et al., 2019; Reed, 2008; Smith & Iversen, 2018).

Stakeholder participation in design can improve the quality of environmental decision-making (Reed, 2008) and partnering with children specifically can result in more innovative and effective solutions related to their everyday environments (Druin, 2002; Paracha et al., 2019). Embedding children's local knowledge and unique perspective provides new ways of thinking about localized issues, which broadens opportunities for more creative and sustainable development (Tippett et al., 2007). Co-design practices with children can also support environmental justice efforts by uplifting younger voices that are usually neglected or misunderstood in traditional design processes (Can & İnalhan, 2017). Co-design creates a platform whereby children can engage

across multiple stages of the design process in a hands-on way, influencing final design solutions (Druin, 2002; Van Mechelen et al., 2016). Empowerment of this kind aligns with Article 12 of the United Nations Convention on the Rights of the Child (November 20, 1989), which enshrines children's right to be involved in decisions affecting their lives. The design of their everyday physical environments is a key area over which children should have influence, as these settings significantly affect child development and health (Brown et al., 2019; Ferguson et al., 2013).

Participatory methods with children have evolved over time from simple consultation exercises to sophisticated co-creation processes that employ diverse tools and techniques tailored to young people's developmental capabilities and communication preferences (Clark & Moss, 2011). Contemporary approaches often integrate diverse visual methods (drawing, photography, mapping), embodied techniques (role-play, walking tours, model-making), and digital tools (tablet-based design apps, virtual reality environments) (Burke, 2005; Sevón et al., 2025). Despite the advancement in methods and in our understanding of the benefits of co-design with children, most research to date on participation in environmental design has focused primarily on adult perspectives and outcomes (Sullivan et al., 2021; Williams et al., 2023). When children are asked to participate in design, the focus is often strictly on elicitation and not effective analysis and interpretation of the results, which can lead to tokenistic engagements or misrepresentation of the data (Montreuil et al., 2021).

1.2 Gaps in participatory design process analysis and evaluation

Despite rising popularity in research and practice, co-design workshops and other PD approaches often fall short of their goal to deliver innovative design outputs that can be practically realized (Dubois et al., 2024). A central limiting factor is the gap in sufficient analytical frameworks to analyze and then translate PD project outputs into practical design recommendations (Frauenberger et al., 2015). PD work is complex and difficult to analyze because each project produces a diverse range of data that varies based on the setting and participants (Malinverni et al., 2016). A recent scoping review of children's involvement in participatory design and co-design suggested that the field continues to struggle with inconsistent use of PD terminology, inadequate documentation of methods, and limited empirical evaluation of PD approaches, highlighting the persistent need for more systematic analytical frameworks (Saiger et al., 2023). Our review of the literature surfaced only one existing analytical framework intended to support integration of co-design contributions from children: Van Mechelen et al.'s (2017) GLID method for identifying children's values in technology design contexts. The GLID (grounding, listing, interpreting, distilling) method offers an analytical framework for interpreting co-

design outcomes with children through multimodal methods and a focus on the values held by children. However, GLID was developed specifically for technology design contexts and focuses primarily on identifying children's values at a high level of abstraction rather than translating these insights into actionable design priorities that can guide environmental design decision-making. The fact that there are almost no studies to date which provide direction on how to effectively analyze and integrate the diverse verbal, visual, and embodied outputs emerging from a co-design process with children into clear participant and design priorities may relate to PD's philosophical underpinnings. Bossen et al. (2016) observed that PD's opposition to a reductionist, positivistic worldview may have contributed to the scarcity of systematic and robust processes for evaluating PD outputs. They argued that increased transparency and rigor in analytical methods are needed to enhance understanding and to help substantiate the value of participatory methods in public and private sectors (Bossen et al., 2016). However, child-engaged participatory design scholarship reveals little heed to this call to date.

Some scholars have also highlighted the tendency toward surface-level analysis within PD processes, and called for methodologies that center interpretation around deeper values, meanings, and aspirations of participants (Derboven et al., 2015; Iversen et al., 2010). Because there can be a significant divide between child participants and adult designers based on power dynamics and language (Yip et al., 2017), child-oriented PD necessitates an even greater need for effective methodologies to synthesize and interpret the unique outputs and perspectives of these participants. Despite this, the gap in robust analytical processes is particularly apparent for child participant populations.

This study aims to address these gaps by advancing and testing a framework which has been specifically developed to analyze child participant design priorities emerging from a multimodal co-design process. The Priority Experiences of Participants (PrEP) framework aims to effectively identify and explain children's priority experiences as a reflection of their deeper needs and values, and to translate these into clear design preferences and priorities. This approach responds to calls for both rigorous and value-sensitive PD processes that evaluate the deeper values of participants as opposed to remaining at surface-level descriptions of desired features or characteristics (Iversen et al., 2010). By detailing an approach that balances analytic rigor with the constraints of design practice, we outline a process that can be applied by researchers and PD facilitators alike to understand and synthesize priorities of child co-designers.

1.3 Theoretical foundations

Experience-centered design approaches have gained prominence across design research, emphasizing how users engage with and derive meaning from

designed environments and artifacts (Hassenzahl, 2010; McCarthy & Wright, 2004). However, these approaches have typically focused on adult users and technology contexts, with limited application to environmental design with children. The challenge of translating experiential insights into design guidance is particularly acute when working with child participants, whose experiential preferences may be expressed through non-verbal modes and require robust analytical approaches (Malinverni et al., 2016).

To address these challenges, the PrEP framework draws on Gibson's (2014) theory of affordances as particularly well-suited for understanding how children perceive and experience their environments. The physical and social environment is perceived by individuals in terms of possibilities for action that align with one's needs and interests (Gibson, 2014). This approach to understanding human—environment interaction provides a theoretical lens for interpreting children's design contributions not merely as requests for specific features, but as expressions of desired functionality and interactions with their environment (Heft, 1988; Kyttä, 2004). We propose that children's co-design contributions can be understood as expressions of their desired affordances, surfacing the preferred experiences they would like the designed environment to allow or encourage. Building on Heft (1988) who described the functional, affordance-based lens as "more psychologically meaningful" than traditional "form-based classification of environmental features" (p. 29), we argue that the affordance lens elevates the discussion beyond just that of design elements and characteristics to a higher level where the focus is on the broader experiences these elements and characteristics are intended to afford to children.

Children's perception and valuation of environmental affordances differ meaningfully from those of adults due to developmental, physical, and experiential factors. Children's smaller stature and developing motor skills drive them to perceive possibilities for action that adults may overlook, such as crawling through small spaces or climbing onto elevated surfaces, while adults may prioritize affordances related to supervision, safety, and maintenance (Heft, 1988; Kyttä, 2004). These differences in affordance perception underscore why it is critical to directly engage children in design processes rather than relying on adult assumptions about children's environmental needs and preferences.

To capture deeper, tacitly held values of child participants, we also adopt the theoretical lens of multimodality, which recognizes that meaning-making occurs across multiple modes of expression, including visual, gestural, spatial, and linguistic (Jewitt, 2013; Kress, 2010). Multimodal analysis has been proposed as an appropriate strategy for more holistic interpretation of participant contributions during PD activities (Derboven et al., 2015; Jewitt, 2013; Malinverni et al., 2016). As embedded in the PrEP framework, it stresses the need to provide and examine multiple modes of communication (e.g., visual,

verbal, material) to effectively capture meaning. Prior research has demonstrated that multimodal approaches can also enhance inclusion and mitigate power imbalances by allowing participants to express preferences and emotions beyond just verbal articulation. In the case study outlined, children's priorities were intentionally solicited and analyzed through diverse modalities, including verbal, written, and graphic/visual forms (detailed in Table 1). In the fourth stage of the PrEP framework, we outline how nonverbal forms of information stemming from design artifacts and participant interactions can be integrated with language-based findings to develop a more holistic understanding of participant intent.

The integration of affordance theory with multimodal analysis provides a robust theoretical foundation for understanding children's design priorities as expressions of desired environmental experiences that can be captured and analyzed through co-design. Building on this foundation, a key concept introduced in the PrEP framework is the idea of 'umbrella experiences', which acts as a bridge between PD's emphasis on user voice and on the need to translate participant insights into actionable design guidance. This concept follows established design research practices of grouping related user insights to identify broader patterns, similar to how affinity diagramming clusters observations or how persona development synthesizes individual characteristics into archetypal user types (Cooper, 1999; Lucero, 2015). Umbrella experiences function as an intermediate level of specificity that preserves the richness of children's contributions while providing designers with coherent concepts to guide planning and decision-making. This approach aligns with calls in design research for frameworks that can address the gap between user insights and design solutions (Sanders & Stappers, 2008), while honoring participatory design's commitment to authentic representation of participant values (Iversen et al., 2010).

1.4 Research question and framework goals

The methodological inquiry presented in this paper was guided by the research question: how can the design priorities of children that emerge through co-design be systematically analyzed, understood and translated? Based on affordance theory and existing participatory design literature, we developed the PrEP framework to provide a clear, robust process for effectively revealing children's design priorities at multiple levels, from specific desired elements to broader experiential preferences. We also expected that triangulating multiple analytical methods would provide more robust insights than a single-method approach, and that children's priorities that emerged would reflect both their physical and social-emotional needs. Additionally, we anticipated that a multimodal approach and systematic analysis would uncover tacit and minority preferences.

Table 1 Summary of co-design program

Phase	*Activity*	*Purpose*	*Data Output*
Introduction & orientation	Intro to design thinking	Learn process for identifying problems, exploring solutions, and expressing creativity	Image (prototypes); text (worksheets); audio (presentations)
Evaluation & data collection	Photovoice	Use photography and associated narratives to share likes and dislikes of current playspace	Image (photos); text (captions); audio (presentations)
	Ideal playspace drawing	Visually express personal playspace preferences	Image (drawings); text (drawing labels)
	Site assessments	Evaluate current playspace in terms of activities (e.g., places of conflict) and environment (e.g., shady places)	Image (annotated base maps); audio (presentations)
	SWOG analysis	Identify strengths, weaknesses, opportunities, and gaps of current playspace	Text (sticky notes)
	Peer and staff interviews	Structured questions to gather insights from staff and younger students to inform future playspace design	Text (interview notes); audio (discussion)
	Designing for play lecture	Gain knowledge about existing play research	N/A
	Designing for outdoor environments lecture	Gain knowledge about outdoor space design, including materials and plant types	N/A
	Dot democracy	Review diverse range of photos from other playspaces; place dot stickers to vote on favorite images	Number (votes by image); audio (discussion)
Design development & priority synthesis	Bubble diagramming	Explore design ideas and spatial relationships using circles of varying sizes to represent desired spaces and elements	Image (diagrams); text (diagram labels)
	Q-sorting	Identify most and least important play experience priorities	Number (scalar value)
	Design development	Craft and label final team design plans; state design vision, present designs to peers, architects, and school board	Image (designs); text (labels and worksheets); audio (presentations)
Analysis and translation (PrEP framework)	Identifying elements & experiences	Collect and synthesize participant input about priority elements and experiences through co-design activities detailed above.	Element and experience lists
	Identifying umbrella experiences	Use iterative content analysis to group elements and experiences into broader "umbrella experiences."	Code system with code frequencies
	Prioritization and triangulation	Rank umbrella experiences using multiple methods: code frequency analysis, Q-sort mean scores, and team rankings.	Rank sorted lists
	Qualitative integration	Integrate design artifacts and detailed observations to provide rich context and illustration of highest priority experiences.	Annotated artifacts; thick description
	Translation to design guidance	Consolidate the previously analyzed quantitative and qualitative information into clearly articulated design guidance.	Design brief or recommendations

The aim of the PrEP framework, which was developed to address our guiding research question, is to provide a clear, robust analytical process for synthesizing and interpreting the design priorities of child co-designers so they can be effectively integrated into design solutions. Specifically, this paper seeks to: (1) establish a systematic methodology for organizing and analyzing diverse outputs from co-design with children; (2) demonstrate techniques for identifying participants' highest priority experiences through mixed-methods triangulation; and (3) illustrate how these insights can be translated into actionable design guidance. Note that the co-design activities and child preferences demonstrated through this case study are detailed to the extent that they may serve to illustrate the framework in use and are not intended to be the focus of the study.

2 Priority Experiences of Participants (PrEP) framework: illustrative case study

The structure and use of the PrEP framework will be presented here in the form of an illustrative case study. The setting for this case study is a co-design program carried out in 2023 with students at Fall Creek Elementary (FCE) school in Ithaca, New York. This site was selected based on opportunity; the school district approached author Loebach to engage the school students to gather their ideas for the redesign of the school's outdoor playspace, which was slated for renovation in 2025–26. Loebach received permission from school administrators and staff to deliver a co-design program with students to help reimagine their schoolyard, creating an opportunity for their play priorities and design visions to guide design development. The designers contracted by the school district to redesign the playspace agreed to integrate the priorities and preferences of the students. In consultation with school staff, both Grade 5 classes (aged 9–10 years) were selected to be the primary participants. Class 1 (20 students) participated in an 11-session program over a three-month period; Class 2 (19 students) engaged in a three-session program over the course of three weeks. The different length programs were intentionally delivered in order to assess the impacts and outcomes from shorter versus longer engagements; these results are presented in a separate publication. For the purpose of demonstrating the PrEP analytic framework only the results from the 11-session program are included in this illustrative case study; these students represent about 25 % of all students who utilize the schoolyard being redesigned.

With the support of the classroom teachers, both co-design programs were integrated into the curriculum. All students from both classes were therefore invited and eligible to participate. A Letter of Information about the program's activities, expected outputs, benefits and risks was sent home to all parents/guardians. Since the program was delivered as class content all 20 students in Class 1 and 19 students in Class 2 participated. However,

parents/guardians could opt their child out of research surveys, which were utilized in separate studies related to the program. Children were also given the opportunity to assent to participate in the program and could choose to opt out of any or all activities. Child assent and parental consent forms were collected at the beginning of the study, and the process was approved by both the Institutional Review Board at Cornell University (IRB#0147490) and by the Research Ethics Coordinator for the school district. Child assent was obtained from all children who contributed to codesign processes utilized in this paper, while a small portion of students did not receive parental consent to participate in supplementary surveys or have photographs or videos taken during the program. The research team was aware of these students and ensured these choices were honored throughout the project.

2.1 Existing FCE outdoor playspace

The current FCE outdoor playspace includes a large bespoke wooden play structure, an asphalt surface with basketball courts, a small grass field, and additional play features (see Figures 1 and 2). The central community-built wooden structure, described as "iconic" by child participants, had become unsafe due to age, prompting a larger renovation.

2.2 Co-design program & procedures

Our approach to co-design with children was built upon the six core PD principles outlined by Luck (2018), including encouraging mutual learning, prioritizing democratic practices, and providing participants with effective tools and techniques to express their needs and visions. To honor this last principle, we intentionally integrated activities throughout the program that offered the

Figure 1 Aerial view of fall creek elementary playspace

Figure 2 View of fall creek elementary wooden play structure

children diverse modes of expression of their needs and preferences. This included expression through captioned photos, hand drawings, written text (e.g., sticky notes, worksheets), and verbal contributions through discussion and presentation. Children were also given opportunities to share their perspectives in groups, pairs, and as individuals to ensure that minority voices and opinions were not lost (For a detailed guide on implementing this co-design approach, see the Co-Design Playbook provided in the Supplementary Materials).

The co-design program with Class 1 included 11 sessions (~1.5–2 h each) involving diverse playspace assessment and design visioning activities held over the course of three months (See Table 1 for a breakdown of the 12 co-design activities and five analytical activities carried out over the course of the co-design program). These activities are organized by program phase: a) introduction and orientation, b) evaluation and data collection, c) design development and priority synthesis, and d) analysis and translation. After several sessions focused on evaluating the existing space, preliminary design ideation activities, and introducing students to common playspace design practices, children were divided into design teams of four to five students, each of which was charged with producing and presenting a detailed design proposal. With insights from the assessment and visioning activities, teams were prompted to consider and discuss which play elements (i.e., play features like slides or ball courts) and experiences they wanted to emphasize in their playspace design. Designs were then iterated and refined over the course of multiple sessions, moving from conceptual bubble diagrams and rough plan sketches into full (scaled) annotated site design plans. In the final stages of design development, each team completed a group worksheet that asked them to articulate their design vision for the playspace and identify the top

five play elements and top five play experiences that were most central to their design. The interactive phases of the co-design process concluded with students presenting their design plans for the playground renovation to school board administrators as well as the project architects.

The analysis and translation phase of the process began alongside the earlier phases but culminated after the conclusion of the co-design activities with a final synthesis and translation of program outputs contributing to a Design Brief with actionable design strategies. It is important to note that the co-design activities described in this case study represent just one potential program structure for co-designing with children; this study does not aim to evaluate the efficacy or value of these particular activities but rather to illustrate how the PrEP framework was utilized to understand and synthesize children's design priorities that emerged from the outputs of these activities. The framework for co-design analysis that is the focus of this paper could be overlaid on multimodal co-design programs of varying length and activities to understand participants' priority experiences and inform design recommendations.

Building on previous research (Frauenberger et al., 2015; Heft, 1988; Kyttä, 2004), our approach to both co-design and analysis focused on higher-level experiential needs and values of child participants (e.g., being thrilled/challenged), rather than lower-level design features (e.g., swings) and functionalities (e.g., running) desired within the playspace. To achieve this, we centered our approach around understanding 'umbrella' play experiences, which we define as those highest-level priority play experiences of the child co-designers. For example, the desired play experience of being able to pop out in different places and the play element tunnels might both be categorized under a desired umbrella experience of 'using shortcuts and secret passageways'.

2.3 Co-design program analysis using the PrEP framework

The PrEP framework for analyzing participant contributions in co-design processes divides analysis into five stages. Stage 1 entails identification and documentation of priority elements and experiences as they emerge during co-design activities. Stage 2 involves content analysis of these element and experience sets to identify higher-level umbrella experiences. Stage 3 focuses on the application of mixed methods to apply rankings to each umbrella experience to assess their relative priority for participants. In Stage 4, contextual pieces of data, such as design artifacts and participant quotes, are integrated with the umbrella experiences findings to convey deeper meaning and nuance behind what these experiences mean for participants. Finally, Stage 5 involves the summarization of previously analyzed data into clearly articulated design guidance. See Figure 3 for a summary of the five stages in the PrEP framework.

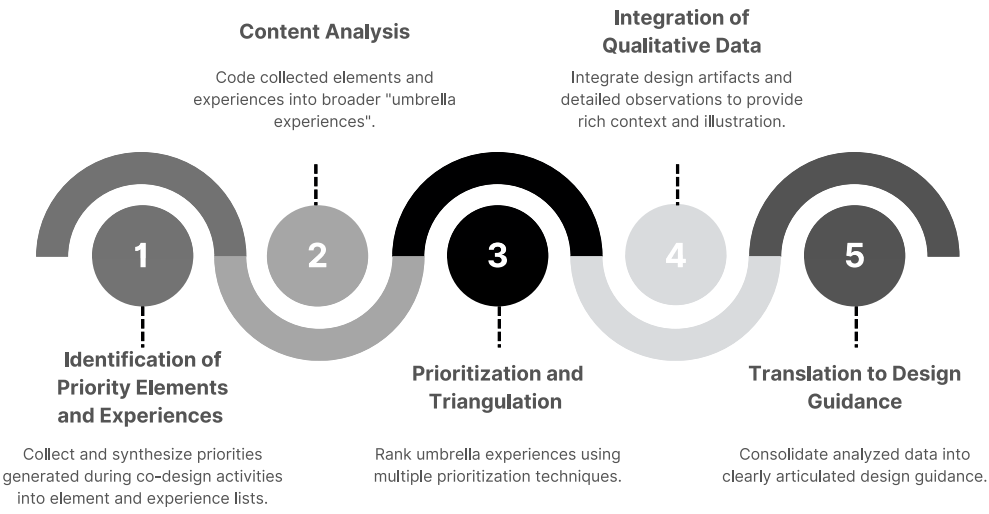

Figure 3 Summary of the PrEP Framework's five stages

For a detailed visual guide on implementing this process of co-design analysis, see the Co-Design Playbook in the Supplementary Materials.

Stage 1: Identification of Priority Playspace Elements and Experiences

During co-design activities, a broad range of participant contributions were generated, such as insights from assessments of the existing playspace design, peer and staff interviews, Photovoice images with captions, playspace image voting, and design drawings and models (see Table 1). The aim of this first stage is to capture and organize the children's priorities expressed through these contributions. To address the complexity and diversity of data types and limit facilitator bias, we structured data around two variables:

i. Play Elements: which describe features, physical objects, or spaces; generally in the form of nouns (e.g., slides, benches)
ii. Play Experiences: which describe potential actions, activities, or functionalities; generally gerunds ending in "-ing" (e.g., sliding, sitting with friends) or experiential adjectives (e.g., dangerous, thrilling)

This bivariate structure, which formed the basis of our analytical framework, is grounded in affordance theory, which ties physical design features and characteristics to possibilities for action and interaction. Priority play elements and experiences were collected at the conclusion of each co-design activity via synthesis exercises, during which child participants made decisions about which emergent priorities were important to document from the activity. These priority elements and experiences were faithfully recorded by the research team on large poster papers or projected on slides visible to all participants. We

opted for this in-situ, real-time approach directly following each co-design activity, as it supports empowerment of participants as decision-makers and is easily replicable. An alternative approach might entail generation and coding of activity transcripts after the fact by researchers, but coding lengthy, multi-speaker transcripts requires more time and training.

The synthesis exercises differed depending on the co-design activity (e.g., drawing, Photovoice), but in general involved participants reflecting on what they heard, saw, or created during the activity. For example, for the ideal playspace drawing activity, children were asked to label the play elements and experiences embedded in their individual drawings and then copy these onto sticky notes, which were then collected by researchers and compiled into synthesized lists or diagrams, which were shared back with participants.

Over the course of the evaluation and data collection activities with Class 1, this cohort of children identified a total of 129 desirable play elements, including conventional play elements such as swings and slides as well as more novel elements, such as tunnels and ramps, and 61 sought-after play experiences, such as spinning, hiding and using short-cuts (see Appendix B for a complete list of identified elements and experience). This synthesized list of desired elements and experiences was then used as the basis for the iterative content analysis described in Stage 2.

Stage 2: Content Analysis to Identify Umbrella Experiences

Content analysis was used to translate the wide set of priority play elements and experiences generated across all activities into a condensed set of desired umbrella experiences. The PrEP framework uses a constant comparative method of analysis (Lincoln & Guba, 1985), whereby umbrella experience categories are iteratively identified and reorganized across co-design sessions as new data emerges. This process involves three key steps: (1) initial coding of individual elements and experiences based on the priorities elevated during synthesis exercises, (2) iterative grouping of codes that serve similar experiential functions into higher-level umbrella categories, and (3) refinement of umbrella experience categories following participant feedback sessions. For a full tabular version of the coding system, see Appendix B.

Umbrella patterns were identified when multiple specific elements or activities appear to serve similar high-level experiential functions. For example, when children repeatedly expressed a preference for using tunnels, gaps in fences, or other means of playful movement through the schoolyard, these were grouped under the umbrella experience of 'using shortcuts and secret passageways' because they all afforded similar experiences of discovery and connected and/or covert movement through the space.

As play elements and experiences began to emerge during co-design activities, initial codes were assigned to capture key features or characteristics. Code names were developed by the lead author drawing directly from the language of participants. For example, the code 'slides' was applied to participant-generated text segments, such as "slide" and "slide that doesn't get wet." (See Figure 4). In instances where participants suggested play elements that included descriptors (e.g., "high, twisty slide" or "dark tunnels"), researcher judgment was used to determine whether to code the adjectives as intrinsic to that specific element and/or as a separate priority. For example, "high, twisty slide" was coded as both "twisty slide" and "tall/high elements" because "twisty" was a descriptor used only with regard to slides, whereas participants regularly emphasized desire for tall or high elements.

Individual codes were then grouped into umbrella experiences when multiple specific elements or experiences appeared to serve similar high-level experiential functions. For example, as shown in Figure 5, the umbrella experience 'using shortcuts and secret passageways' emerged when children repeatedly highlighted the importance of elements like tunnels, gaps in fences, shortcuts, and experiences like "popping out in different places," and "having multiple paths to same place." Despite differences, these lower-level elements and experiences all afforded similar high-level experiences of discovery, non-linear movement, and covert navigation through space. Similarly, elements including monkey bars, platforms, rock climbing wall, and approved climbing zones

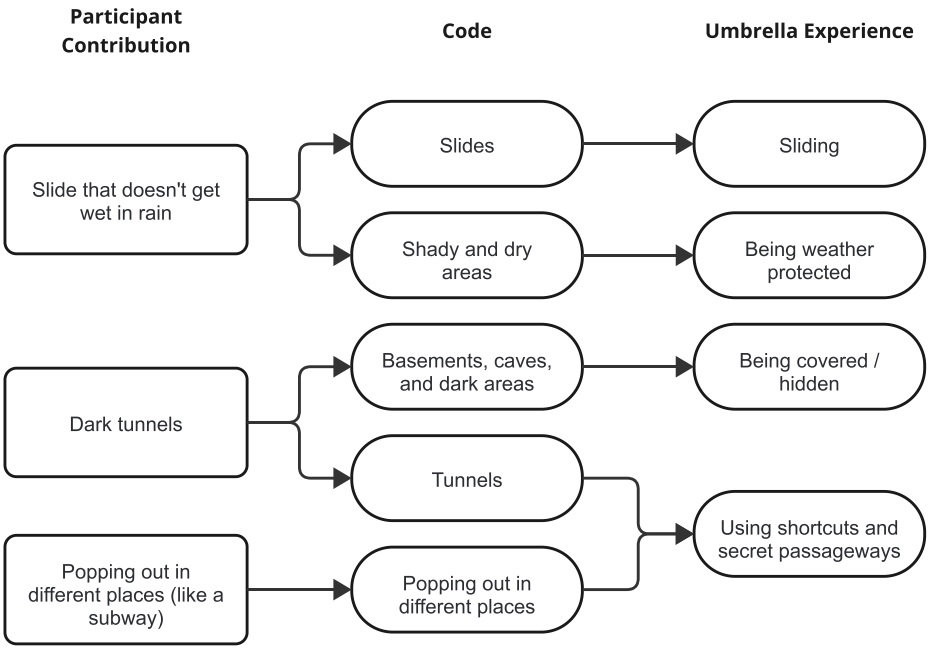

Figure 4 Examples of coding participant contributions into umbrella experiences

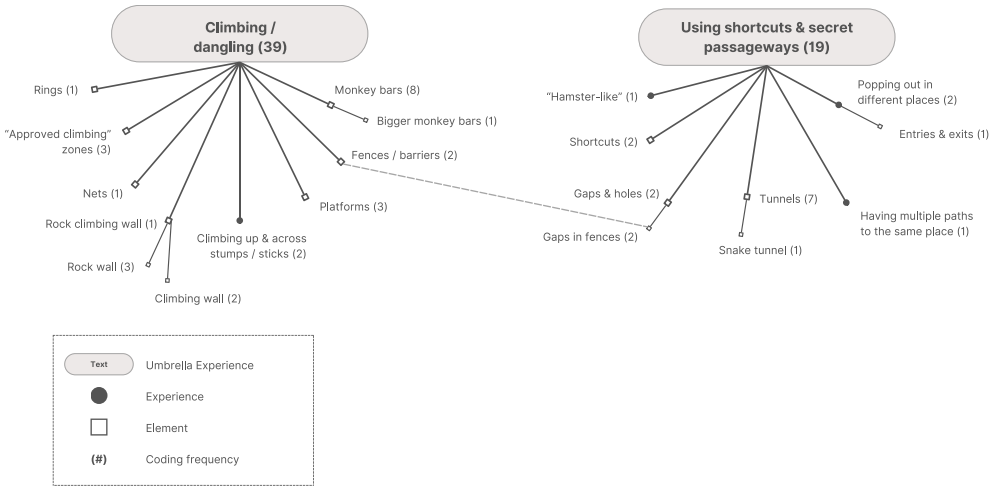

Figure 5 Examples of two umbrella experiences and their associated priority experiences and elements, demonstrating connections within and between umbrella experience categories

were recognized as affording the umbrella experience of 'climbing/dangling'- because they all supported the experience of vertical movement and upper-body challenge.

As with code names, the naming of umbrella experiences drew upon the language of participants and the shared meaning that was developed iteratively over the course of in-person sessions. In this case study, the coding of play elements and experiences emerging from activities into condensed umbrella experiences was completed using MAXQDA Analytics Pro 2022 (Version 22.8.0).

As part of the iterative process of analysis and in line with established practices for trustworthiness in qualitative research (Lincoln & Guba, 1985), we included member checks, a technique where preliminary findings, data, or interpretations are returned to participants (i.e., members) for their review and feedback to ensure accuracy and confirm trustworthiness. Child participants were invited at multiple points during the co-design program to engage critically with our emerging analysis of the umbrella experiences, which were presented to them visually as in Figure 5. This iterative feedback cycle helped support the validation and refinement of the final set of umbrella experiences. Refinements based on these member checks included updates to umbrella experience names, the addition of priority elements or experiences that the children felt had been missed during synthesis exercises, and in a few cases the reorganization of priority elements and experiences within umbrella experience categories. The research team made a point to ask clarifying questions during the member checks, for example, when they were uncertain about the

Table 2 Ranking of umbrella experiences based on frequency

Code Frequency	*Rank*	*Umbrella Experience*
41	1	Being high up
39	2	Climbing/dangling
35	3	Playing organized games
31	4	Sliding
27	5	Being in nature
27	5	Being thrilled/challenged
25	6	Swinging
25	6	Jumping on, off and into things
22	7	Embracing unique identity/history
21	8	Being covered/hidden
19	9	Having sensory variety
19	9	Using shortcuts and secret passageways
19	9	Being in quiet spaces
13	10	Limiting injuries
13	10	Being weather protected

umbrella experience a given priority might be supporting. Upon completion of content analysis, 23 umbrella play experiences were identified from the larger set of elements and experience priorities identified throughout co-design activities. The top three umbrella experiences based on code frequency (i.e., with the highest number of mentions during the synthesis exercises held at the end of co-design activities) were i) being high up, ii) climbing/dangling and ii) playing organized games (see Table 2).

Stage 3: Prioritization and Triangulation of Top Umbrella Experiences

The third stage of the PrEP framework aims to develop an understanding of relative priority order via ranked ordering of umbrella experiences. Three prioritization techniques were utilized to rank order umbrella experiences: (1) calculation of the code frequency of umbrella experiences derived from activities, (2) mean scores from a Q-Sort analysis of individual children's ranked experience preferences, and (3) frequency with which umbrella experiences were listed as 'Top 5 Experiences' in the final designs by child design teams. These measures were triangulated with each other and with qualitative data to strengthen our understanding of children's priorities. These three techniques were intentionally selected because they capture priorities through fundamentally different approaches: code frequency reflects the collective emphasis across all activities, Q-Sort reveals the trade-offs made by individuals when forced to choose between competing priorities, and team rankings represent collaborative negotiation of shared values. This methodological diversity helps surface not only majority consensus but also minority perspectives that might only emerge through specific prioritization approaches.

(1) *Code Frequencies:*

The first prioritization technique of calculating code frequencies involves counting up the number of times each umbrella experience (or those lower-level experiences and elements associated with each) is coded across all co-design activities. For example, code frequency of the umbrella experience 'swinging' included summing the number of mentions of all elements and experiences coded under swinging (e.g., tire swing) as well as direct mention of swinging itself. Table 2 highlights the top ten ranked umbrella experience categories based on code frequency, which provided the first measure of relative importance.

(2) *Q-Sort Mean Score*

Q-Sort is a technique aimed at understanding subjective social perspectives by combining qualitative understanding of a topic area with quantitative statistical analysis (Amin, 2000). The Q-Sort process traditionally comprises four phases: development of the Q-sort pack (i.e., a list of statements related to the topic under study); administration of the Q-sort whereby participants sort statements into a custom grid to indicate relative importance; factor analysis to determine statistically distinct viewpoints; and interpretation of factors to explain variance in participant viewpoints (Corr, 2001).

Utilizing content analysis from Stage 1, we developed a set of 28 play experience statements that reflected the most common desired play experiences that had emerged from the co-design activities. All statements began with gerunds (e.g., being high up or having lookouts), and each child participant sorted the 28 statements into a Q-Sort grid from "most important" to "least important" based on each statement's relative importance to them personally (See Appendix A for statements used). This forced ranking required participants to make trade-offs, that is, making decisions to prioritize certain experiences over others. This process provides a quasi-normal distribution that is conducive to statistical analysis.

Participants began by identifying the 11 statements from the larger set of 28 statements that they felt were most important to them, adding these to the "most important" columns (+1 through +3) in their Q-Sort grid (see Appendix A). They then sorted the remaining 17 statements into either the neutral (0) or least important columns (−1 through −3), arranging the statements from left to right in order of perceived importance for that individual child.

We interpreted the Q-Sort data through two lenses: mean score analysis and factor analysis. Mean scores were calculated for each experience statement, highlighting the highest and lowest priorities on average for all participating

children. Factor analysis was then used to identify distinct player personas to understand the nuances between different child viewpoints and the needs of different player types. Mean scores are reported for purposes of illustration here, while the factor analysis to identify distinct player personas is reported elsewhere.

A total of 18 child Q-Sort charts (95 % of the class) were able to be included in the analysis (two charts were incomplete). Mean scores for all 28 priority statements ranged from +3 to −3 (See Table 3). Ranking of Q-Sort mean scores indicated that using shortcuts or secret passageways (+1.72) was the highest priority on average, and being able to play safely and limit possible injuries (−1.76) was the lowest priority experience for the child participants.

(3) *Design Team Top 5 Experiences Frequency*

By the end of the co-design activities, each of the five child design teams had prepared a final proposed design for the school playspace redesign. Each team was asked to document the five most important play experiences their final designs offered to children. We took these Top 5 Experiences as an additional data set for ranking children's relative play priorities. Relative ranking was measured using the frequency with which each umbrella experience was mentioned across all design teams. Table 4 details the number of design teams that included each umbrella play experience as a Top 5 Experience in their final design plan worksheets. More than half of the five design teams embedded the experiences of being thrilled/challenged, being covered/hidden, and being high up or having lookouts as top experiences.

Table 3 Rank order of Q-Sort mean scores (n = 18). Note: only the top five and bottom five statements are shown

Statement	*Rank*	*Mean Score*	*SD*
Using shortcuts or secret passageways	1	1.72	1.56
Being high up or having lookouts	2	1.39	1.67
Having opportunities to climb or hang (examples − monkey bars, climbing wall)*	3	1.00	1.57
Having opportunities to hide or hang out in small, enclosed spaces	4	0.94	1.39
Having opportunities to jump on, off, or into things*	5	0.88	1.18
Having a quiet space to read or draw	24	−0.61	1.64
Having opportunities to perform or pretend using imagination (example − playing "house")*	25	−0.71	1.45
Having opportunities to sit alone	26	−0.78	1.13
Having opportunities to interact with digital elements* embedded in the playspace	27	−1.22	1.62
Being able to play safely and limit possible injuries*	28	−1.76	1.66

Note: Statements with asterisks were not ranked by one child; sample size for these items was 17.

Table 4 Umbrella experiences emphasized by team final design plans

No. teams	*Rank*	*Umbrella experience*
4	1	Being thrilled/challenged
4	1	Being covered/hidden
3	2	Being high up or having lookouts
2	3	Being in nature
2	3	Having sensory variety
2	3	Being in quiet spaces
1	4	Climbing/dangling
1	4	Playing organized games
1	4	Sliding
1	4	Swinging
1	4	Using shortcuts and secret passageways
1	4	Jumping on, off, and into things

2.3.1 *Triangulation of priority experiences*

The triangulation process revealed both convergent and divergent priorities across the three techniques (see Table 5). Strong alignment across methods, such as being high up or having lookouts ranking highly in all three techniques, indicated high-consensus priorities that consistently emerged regardless of how priorities were elicited. Conversely, discrepancies proved equally informative: *using shortcuts and secret passageways* ranked highest in Q-Sort, but lower in code frequency, suggesting this was a deeply held individual priority that emerged when children were forced to make trade-offs, but was less frequently vocalized in group activities. Rather than resolving these discrepancies, we interpreted them as indicators of different types of priorities: aligned results suggested broad consensus experiences, while method-specific high rankings revealed minority or context-dependent preferences that might be overlooked without methodological triangulation. Table 5 summarizes the umbrella experiences ranked highest across each prioritization technique. Experiences are ordered by code frequency.

Six umbrella experiences received top ranks across multiple prioritization techniques: i) being high up or having lookouts, ii) climbing/dangling, iii) being in nature, iv) being thrilled/challenged, v) jumping on, off and into things, and vi) being covered/hidden. Relative ranking was fairly aligned across techniques, with a few notable exceptions. Using shortcuts or secret passageways emerged as the highest average priority from the individual Q-Sort data but received only a modest rank based on code frequency and design team's Top 5 Experiences. Code frequency ranking also highlighted playing organized games, sliding, and swinging more than the other two prioritization techniques. And design team ranking highlighted *having sensory variety* and *being in quiet spaces* to a higher degree than other techniques.

Table 5 Umbrella experience rankings triangulated across prioritization techniques

Umbrella Experience	*Rank*		
	Code Frequency	*Q-Sort*	*Team Designs*
Being high up or having lookouts	**1**	**2**	**2**
Climbing/dangling	**2**	**3**	4
Playing organized games	**3**	9	4
Sliding	**4**	7	4
Being in nature	**5**	15	**3**
Being thrilled/challenged	**5**	6	**1**
Swinging	**6**	12	4
Jumping on, off and into things	**6**	**5**	4
Embracing unique identity/history	7	11	
Being covered/hidden	8	**4**	**1**
Having sensory variety	9	16	**3**
Using shortcuts and secret passageways	9	**1**	4
Being in quiet spaces	9	13	**3**
Limiting injuries	10	20	
Being weather protected	10	10	
Having a clean/maintained playspace	11	17	
Performing/pretending	11	19	
Having a variety of things to do	12	14	
Sitting	13	8	
Ground surface variety	13		
Being in loud places	13		
Interacting with digital devices	14	18	
Biking	15		

Note: Bolding indicates top-ranked umbrella experiences by prioritization technique; code frequency – top six of 23; Q-Sort – top five of 20; Team Designs – top three of 12.

Stage 4: Integration of Qualitative Data

This fourth stage aimed to integrate rich, contextual details that can help researchers and designers understand not only what umbrella play experiences were most important to child participants, but how these experiences were envisioned and embodied by participants. To do so, we integrated additional sources of qualitative information, which added depth to our analysis from: 1) design artifacts – drawings and photos created by participants, and 2) thick descriptions from our interactions with participants during activities.

Design artifacts emerging from the co-design activities contributed depth to our understanding of the umbrella experiences detailed in Stages 2 and 3. Analyzing design drawings began with the identification of tangible examples of how the children envisioned various umbrella experiences being supported. For example, a child's drawing of an interconnected tunnel network was used to illustrate how the experience of using shortcuts and secret passageways was conceptualized by participants (see Figure 6).

Analysis of the final design plans involved identification of play element patterns across plans. Elements that were integrated visually within teams' design

Figure 6 Sketch created by child design team to illustrate the desired experience of using tunnels

plan drawings were compared against those identified by design teams as Top 5 Elements (See Appendix C for a breakdown of elements incorporated visually in team drawings compared with those captured verbally in team worksheets). Three elements appeared as Top 5 Elements for at least three of the five design teams: towers, lookouts, or high places; tunnels or shortcuts; and hiding spots or caves. The drawings themselves revealed clear preferences for additional play elements that were not evident from the worksheets alone, including bridges, areas for sitting or hanging out, and trampolines (see Figure 7 for an example). Gardens and other forms of trees, vegetation, or wildlife were also featured heavily in the drawings. These natural elements were emphasized to a lesser degree in written and verbal contributions, highlighting the children's tacit value of these features.

Thick description, as detailed by Lincoln and Guba (1985), was also leveraged and included integration of quotes from participants and facilitator observations to provide rich contextual understanding of how the children conceptualized and valued their priority experiences. These observations, which were captured via ongoing facilitator field notes, focused on classroom dynamics and non-verbal expressions by participants that emerged during co-design activities. This approach captured not only what children said, but how they expressed themselves through gestures, interactions with peers, and emotional reactions during activities, revealing the deeper values underlying their experiential preferences. For example, when discussing their current playspace, one child expressed with frustration, "they closed up the holes in the fence." Other children responded enthusiastically with one punching their fist in the air pronouncing, "gaps are fun!" and another saying, "we would rather have it open." This thick description deepened our understanding of the umbrella experience of using shortcuts and secret passageways and highlighted embedded values of non-rigidity, novelty, escape, and connectedness. Such thickly described

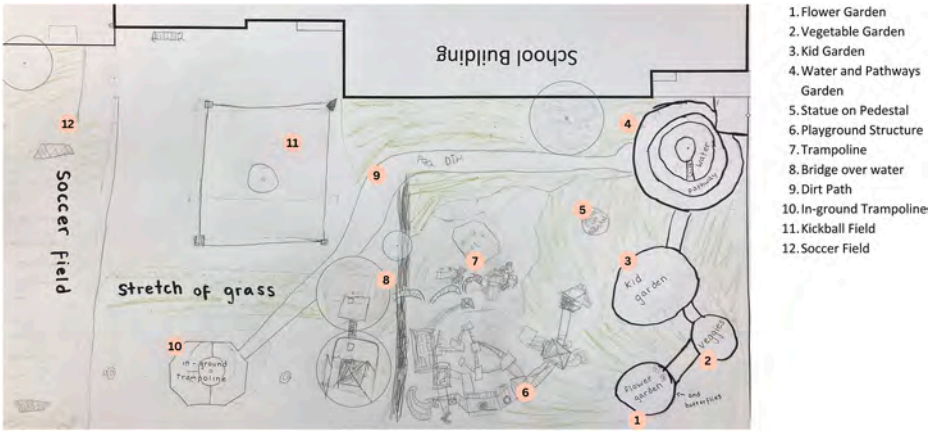

Figure 7 Example final design plan with diverse play elements labeled

interactions provide further context to project architects, supporting their ability to determine creative solutions to achieve the desired connections in the future playspace, whether through formal elements like tunnels and bridges, or more subtle interventions like path placement and permeable barriers.

The qualitative integration of design artifacts with participant quotes also provided deeper insight into how umbrella experiences functioned together in meaningful ways for participants; that is, it revealed how children envisioned umbrella experiences being combined to create a diverse playspace that could support many types of play and players. For example, the team whose final design plan is displayed in Figure 7 articulated how their design balanced active and quiet umbrella experiences that had emerged as priorities in previous stages; they describe their vision as, "We want our playground to have a lot of calm spaces and active spaces. We would love to have a sensory garden that is active. We want our playground to have a lot of balance and different things." Their design plan showed climbing structures and sports fields for active challenge alongside a quiet garden labyrinth space for restoration. The integration of this team's design drawing with their verbal explanation demonstrated how umbrella experiences such as having sensory variety, having a variety of things to do, being in nature, and being thrilled/challenged could be woven together. Such illustrative examples were critical in supporting the fifth stage of the framework, which was focused on the effective translation of the analyzed data into design guidance.

Stage 5: Translation to Design Guidance

The fifth and final stage of the PrEP framework focuses on translating the analyzed umbrella experiences into actionable design recommendations. This stage synthesizes priority rankings, design artifacts, and qualitative

insights from Stages 1–4 to create concrete guidance that designers can implement while honoring children's authentic preferences.

The consistently high-ranking umbrella experiences of being high up, climbing/dangling, and being thrilled/challenged were integrated into recommendations for complex, multi-level play structures (see Figure 8). Children's design artifacts consistently showed interconnected systems rather than isolated elements, such as towers connected by net bridges, multiple climbing routes, and varied descent options, including ziplines and twisty slides. The design brief recommended "encouraging risk and supporting thrills through a unique, complex and challenging structure." Exemplars from other playspaces were then provided to the designers to demonstrate how this could be accomplished, such as through climbable multi-level towers with lookouts, parkour-style wood structures with varied climbing routes, and net bridges providing challenging pathways. These recommendations directly reflected children's drawings of connected elevated systems and their verbal emphasis on "getting high up" and "getting down fast."

The umbrella experiences of using shortcuts and secret passageways, being covered/hidden and being in quiet spaces translated into recommendations for the provision of "spaces of adventure, novelty, and escape." Exemplars illustrated playspaces featuring tunnels, obscured nooks, corners and pathways, and retreat or 'away' spaces. The recommendations were supplemented with some of the narratives from Stage 4 analysis, such as the appeal by the

Figure 8 Design recommendation excerpt for umbrella experiences of being high up, climbing/dangling, and being thrilled/challenged

children for gaps in fences as novel shortcuts, and directed designers to consider ambiguous spaces and circulation options that "stimulate creativity and exploration." These recommendations also honored the embedded values of non-rigidity, novelty, and connectedness identified through qualitative analysis.

A third example of translating umbrella experiences into design guidance can be seen in the connected umbrella experiences of being in nature, being in quiet spaces, and having sensory variety. The design brief recommended "multi-purpose garden areas" providing "opportunities for restoration, social interaction and sensory stimulation." Example strategies included seating woven into garden spaces for individual or group use, diverse seating options throughout the playspace, and garden plantings embedded around play pathways and perimeters to provide sensory interest and natural sound-absorbing barriers between spaces (see Figure 9).

The translation process culminated in a comprehensive design brief organized around high-priority umbrella experiences while ensuring lower-ranking umbrella experiences were still acknowledged alongside their supporting elements. Design recommendations provided overarching experiential goals, integrated illustrative design artifacts and context generated during the program, and highlighted design strategies and exemplars, enabling designers to understand both what children wanted to experience at a high level and how these experiences might be physically realized. Design guidance also

Figure 9 Design recommendation excerpt for umbrella experiences of being in nature, being in quiet spaces, and having sensory variety

Co-designing outdoor playspaces with children

highlighted how multiple umbrella experiences could be supported by the same design solution. The translation stage is a critical final step in bridging the gap between complex co-design outputs and practical design implementation. The Co-Design Playbook provided in the Supplementary Materials provides visual examples of design recommendations as well as additional resources for implementing co-design programs and analysis in line with the PrEP framework.

2.4 Establishing trustworthiness during application of the PrEP framework

Although this study employed quantitative methods, it primarily relied on qualitative approaches. Following Frauenberger et al. (2015), we adopted Lincoln and Guba's (1985) framework for trustworthiness to ensure rigor in qualitative work. This framework outlines four concepts: confirmability, credibility, dependability, and transferability. To achieve confirmability, we conducted four peer-checks among research team members to verify coding consistency and interpretability. Credibility, which requires results to be believable from participants' perspective, was established through two member checks with participants, prolonged engagement, and data triangulation across three levels of analysis (class, team, and individual child). The triangulation approach involved examining and comparing children's priorities through three different methods: analyzing patterns across all class activities, reviewing individual children's personal rankings through Q-Sort, and examining collaborative team decisions about their Top 5 Experiences. Rather than resolving discrepancies between triangulation methods, we interpreted them as revealing different types of priorities: experiences with strong alignment across methods indicated broad consensus, while method-specific high rankings revealed minority or more tacitly held individual preferences that might be overlooked without methodological triangulation. Our goal was not to reach a single consensus of priorities but to use triangulation to establish dominant patterns while surfacing less vocal or context-dependent preferences that enriched our understanding of children's diverse needs. Throughout data collection and analysis, decisions and questions of the researchers were logged, resulting in an audit trail, which, along with triangulation, served to reinforce the dependability of our findings. Finally, transferability was achieved through thick descriptions and cross-method triangulation. These validation strategies worked together to establish confidence in our findings; when multiple methods point to the same priorities, we can be more certain of those results, while differences between methods help reveal diverse perspectives that might otherwise be missed. In combination, these techniques strengthened the rigor of our approach and enabled continuous refinement of our findings.

Addressing our positionality as both facilitators and researchers, we maintained awareness that our facilitation and interpretation choices could influence both data generation and analysis. A shared field notes document was

maintained by the research team throughout the program, where each member of the research team reflected on the session and potential biases they introduced or observed. The member checking process also served as a critical bias check by validating our umbrella experience categories with participants, ensuring our analysis remained grounded in children's intended meanings rather than researcher assumptions.

2.5 Outputs of the PrEP framework analysis

The systematic application of the PrEP framework to the Fall Creek Elementary case study yielded rich insights into children's design priorities through the five-stage analytical process. This analysis moved from capturing numerous desired play elements and experiences during co-design activities into a synthesized categorization into 23 umbrella experiences; these experiences were then rank ordered through triangulated methods. Finally, rich contextual understanding was generated through consideration of design artifacts and interactions with participants to enrich understanding and help to flesh out specific design recommendations. It is important to note that the specific priority experiences identified through this case study are unique to this group of children and should not be interpreted as generalizable design guidance for all playground or co-design projects. Rather, this case study demonstrates how the PrEP framework can be systematically applied to uncover the specific priorities of any given group of child participants, with different contexts and populations expected to yield different priority experiences. See Supplementary Materials for a Co-Design Playbook, which provides additional guidance and visual examples to support application of the PrEP framework across various project types.

3 Discussion

Although the use of participatory design methods such as co-design are becoming more common in environmental design and planning practice, there remains a need for systematic approaches to analyze and synthesize outputs from these highly qualitative and context-rich design processes. This is particularly necessary for work with young people who typically have fewer opportunities and tools to express their design priorities and influence design decision-making. This paper outlined a new, systematic framework for organizing and translating children's design priorities arising from co-design activities in a way that can effectively inform designers and decision makers. Building on Gibson's theory of affordances, the PrEP framework de-emphasizes specific features suggested by participants and focuses instead on the key embodied experiences, or umbrella experiences, that the built environment should afford to align with user values and needs. This approach then provides designers with clear guidance for experiences to support while still giving them significant license and flexibility in how the design will specifically honor the priorities of the child users. Experience-focused recommendations

limit restrictions on designers to provide these experiences through specific play elements.

3.1 Utility and value of the PrEP framework

The aim of the PrEP framework is to support facilitators and researchers in the rigorous and authentic synthesis of participants' priorities and to address the dearth of analytical tools available to support co-design practice. The framework defines a systematic, five-stage process for identifying participants' highest priority umbrella experiences as a mechanism for translating co-design outputs into appropriate and practical design solutions. At the highest level, the framework produces a list of umbrella experiences ordered in terms of relative importance to participants. While Stages 1−3 systematically identify and prioritize umbrella experiences through data collection, content analysis, and triangulated ranking, Stage 4 of the framework ties these broad experiential descriptions to more specific examples, descriptions, and context, which encourages a deeper understanding and transferability of the priority findings to design and planning strategies. Stage 5 then completes the framework by translating these analyzed insights into actionable design recommendations that bridge the gap between user priorities and implementable design solutions.

A key strength of the framework is the use of mixed methods of validation and integration across different types of co-design outputs, ranging from interview narratives to annotated photos and design visualizations. This approach accommodates different modes of expression and also ensures that design solutions do not only reflect the wishes of only a subset of participants − generally those who are most vocal − and that the priorities of minority voices are not lost.

The framework's integration of multiple triangulation techniques to confirm key umbrella experiences also ensures that co-design insights are not overly reliant on outputs of a single activity. For example, in the Fall Creek co-design process, tunnels and gaps and holes in fences emerged early as priority elements. Through iterative content analysis and member checks with the children, we subsumed these priority elements under the larger umbrella experience using shortcuts or secret passageways. However, had we relied solely on code frequency (that is, the number of times this priority was highlighted during synthesis exercises at the end of co-design activities) to dictate its level of priority, this umbrella experience would not have been viewed as particularly important (see Table 2). In the Q-Sort analysis, however, this experience was the highest ranked statement on average (see Table 3), indicating that when individual children were forced to choose between priorities, they were least willing to sacrifice this experience. Using shortcuts or secret passageways was also a Top 5 Experience for one of the five teams, and four of the five

teams integrated shortcuts or secret passageway elements prominently in their final design plan drawings. Both the Q-Sort and design drawing analyses raised our awareness of the significance of this umbrella experience. This, in turn, encouraged further investigation of the meaning behind the experience, revealing participant values of non-rigidity, novelty, and escape. This example reveals how one method of prioritization alone may be misleading, and how the process of triangulation embedded in the PrEP framework supports a deeper understanding of children's priorities.

The concept of umbrella experiences integrated in the framework also serves as an effective tool for co-design facilitators to highlight and discuss the collaboratively constructed values that emerge during co-design. The PrEP framework is thus aligned with calls for more value-sensitive PD processes (Iversen et al., 2010) in which activities are designed to surface deeper values that participants may not be immediately aware of. Umbrella experiences function as a common language between non-designers and designers, bridging user values and design implications while remaining grounded in affordance theory's core principle that environments are perceived in terms of possibilities for action. By emphasizing ease of translation to design professionals, we can increase the likelihood that child participant priorities will be honored and reflected in final designs. An accessible common language also allows designers to return to participants and confirm whether their priorities have been honored. Thus, the language of umbrella experiences within the PrEP framework provides a structure to help uphold the democratic mission of co-design and other PD approaches, better empowering participants to be equal partners in design outcomes.

The framework demonstrates how affordance theory can be operationalized in practice through systematic co-design analysis. While Gibson's theory provides the conceptual foundation for understanding environment-user relationships, this case study shows how affordances can be identified, categorized, and prioritized through children's multimodal contributions. The framework's integration of design artifacts and thick description in Stage 4 was critical in aiding effective translation of umbrella experiences from abstract concepts to actionable design guidance in a way that captured their deeper meaning and context. Without this integration, the umbrella experiences would remain too abstract for practical application; with it, designers receive both experiential priorities and tangible examples of how children envision these experiences being supported, effectively bridging affordance theory's explanatory power and its practical application in environmental design.

3.2 Challenges, limitations, and future research

While the Priority Experiences of Participants framework offers many benefits for participatory processes with children, we acknowledge the challenges

associated with understanding participant perspectives and translating the highly contextual and intersubjective outputs of co-design activities to designers or other stakeholders who may not be intimately involved in the process. The PrEP Framework does not claim to fully capture the complexity of participant perspectives but rather aims to systematically identify key priorities of child user groups in a way that honors children's preferences while being practical for informing design solutions. To better capture a degree of complexity and nuance, the framework recommends allowing ample time for iterative analysis of participant narratives, artifacts, and other contributions, which can be an effective means of eliciting tacit knowledge and gaining insight into user perspectives (Luck, 2003). Additionally, as is recommended by Derboven et al., 2015, the framework ties verbal and written contributions to visual and graphical artifacts to avoid overreliance on linguistic modes of communication. A limitation of note regarding the code frequency analysis is that participants were unaware of how their contributions would be coded and may assume mentioning an idea once sufficiently conveys its importance. The PrEP framework responds to this limitation by incorporating triangulation across multiple methods.

While co-design encourages designers to adopt user-centric perspectives, truly understanding and designing from children's viewpoints remains challenging. The PrEP framework helps bridge this gap by systematically capturing and analyzing children's priorities. However, the framework's effectiveness ultimately depends on how its insights are integrated into final designs. Given children's limited power to advocate for themselves in adult-dominated design processes, co-design facilitators must champion these documented priorities throughout the design process. This aligns with children's rights to not only participate in decisions affecting them, but to have their views given due weight in the final outcomes.

While the PrEP framework proved effective in the co-design work with Fall Creek Elementary, it has only been tested to date within the context of this single case study. The framework's resource requirements also warrant consideration. The 11-session program described here, along with the subsequent multi-stage analysis, required significant facilitator time and expertise: six facilitators working with students once a week over almost three months. While the framework was designed to be accessible to practitioners without specialized research training, implementing it in real-world projects requires adequate budgeting for workshop materials, facilitator compensation, analysis time, and ongoing engagement. Future research could explore streamlined versions of the framework that maintain analytical rigor while reducing time and cost barriers to adoption, particularly for projects with limited budgets or shorter timelines. Proposed structures for abbreviated programs (i.e., 3-session and 5-session programs) have been outlined in the Co-Design Playbook provided in the Supplementary Materials.

Examination of the framework in different contexts and with diverse child populations would provide a deeper understanding of its strengths and remaining challenges. This paper only provides a partial view of overall framework effectiveness as it has not yet been able to examine how effectively the co-design outputs and subsequent design recommendations were integrated by project architects into the final redesign, and whether the child participants agreed that the proposed design was an accurate reflection of their play priorities. As the project moves into final design development and implementation, we hope to be able to further confirm the framework's utility and efficacy.

Future research could directly interrogate how the perceived affordances and priorities of children differ from adults – particularly educators and design professionals. For example, while children in this study prioritized experiences of thrill, discovery, and autonomy, "being able to play safely and limit possible injuries" ranked lowest in their Q-Sort preferences. In comparison, adult designers, who completed the same Q-Sort activity in a parallel study, prioritized safety above all other experiences. This divergence underscores why systematic frameworks like PrEP are essential: without them, adult designers or school administrators may emphasize maintenance, supervision, and risk mitigation at the expense of the exploratory, challenging, and semi-autonomous experiences children value most. However, future research is still needed to understand these differences in greater depth, and to develop targeted approaches to navigating tensions between children's priorities and adult concerns about such factors as safety, cost, and oversight.

Future studies could also explore aesthetic and material preferences of co-design participants, as these were not evaluated within the current study and may provide additional insight into children's needs and values. Additionally, while this pilot study focused on co-design of a playspace environment with children, the experience-centered approach could be translated to co-designing with other populations, such as adults or intergenerational groups, as well as to other contexts, such as technology and industrial design. Further research beyond this single case study is needed to validate the use of the framework within such contexts.

4 Conclusion

Leveraging co-design techniques can create more inclusive design solutions that elevate the marginalized viewpoints of children. Child engagement in environmental design projects can also position young people as civic leaders and environmental problem solvers, teaching them to imagine various scenarios for future land use. Although the environmental design and planning fields acknowledge the benefits of participatory approaches, there's a significant lack of frameworks for systematically analyzing participant contributions, particularly across diverse types of data that can be produced during

co-design. This paper outlines the PrEP framework (Prioritizing the Experiences of Participants), grounded in affordance theory, to capture and identify child participants' most desired experiences.

The PrEP framework emphasizes strategies such as triangulation, peer examination, member checking, researcher reflection, and prolonged engagement to help co-design facilitators reach a high level of rigor and confidence with co-design analysis. While emphasizing rigor, the framework is also designed to be accessible for designers and other practitioners outside of research, utilizing techniques of analysis that do not require specialized skills. The focus on understanding users' priority experiences, rather than focusing on specific design forms or features, still allows designers agency and creativity in their design response.

While our illustrative case study focused on environmental co-design of playspaces with children, we believe this approach can support co-design processes across diverse design domains and populations. The framework's components can be adapted by tailoring activities and the element/experience taxonomy by domain (e.g., user journey maps and features/functions focus for technology design) and adjusting synthesis methods by population (e.g., incorporating more complex reflection activities for older participants). This adaptability maintains the framework's analytical rigor while accommodating the unique characteristics of different co-design contexts.

The PrEP framework offers flexibility for designers in how they honor participants' highest priority experiences, while maintaining fidelity to participant intent through salient and illustrative examples surfaced during co-design activities. We anticipate that use of the framework will not only help to increase transparency, rigor and efficacy within participatory design processes with children and other populations but can provide the processes and language to ease the translation from user desires into innovative design solutions.

CRediT authorship contribution statement

Karen Joyce: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Janet Loebach:** Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Claude 3 (2024) and Claude 3.5 (2024) to improve readability, conciseness, and language. This technology was also used to summarize existing written content by the

authors, confirming whether key points were clear and informing the structure of future sections. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix D. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.destud.2025.101377.

Appendix A.

Q-Sort activity materials.

Table A1 Experience statements utilized in Q-Sort activity

Q-Sort statement
1. Being high up or having lookouts
2. Having LOTS of different things to do
3. Having opportunities to use digital devices
4. Having opportunities to swing
5. Seeing or interacting with water
6. Having space to play games on a hard surface (examples − basketball, dodgeball)
7. Having space to play games on a soft surface (examples − soccer, football)
8. Having opportunities to hide or hang out in small, enclosed spaces
9. Seeing or interacting with animals (examples − birds, dogs)
10. Having shade from the sun
11. Having lots of sensory variety (examples − color, things to smell, touch, or taste)
12. Being in a unique or iconic playspace (examples − clocktower, artwork)
13. Having wind/rain protection
14. Having a quiet space to rest or hang-out
15. Being thrilled or challenged
16. Having opportunities to perform or pretend using imagination (example − playing "house")
17. Being able to play safely and limit possible injuries
18. Having opportunities to sit alone
19. Having opportunities to slide (examples − slides, sledding hill)
20. Having opportunities to interact with digital elements embedded in the playspace
21. Having opportunities to jump on, off, or into things
22. Having opportunities to sit with friends
23. Having opportunities to climb or hang (examples − monkey bars, climbing wall)
24. Seeing or interacting with plants (examples − trees, grass)
25. Having a clean, well-maintained playspace
26. Being in a garden
27. Having shortcuts or secret passageways
28. Having a quiet space to read or draw

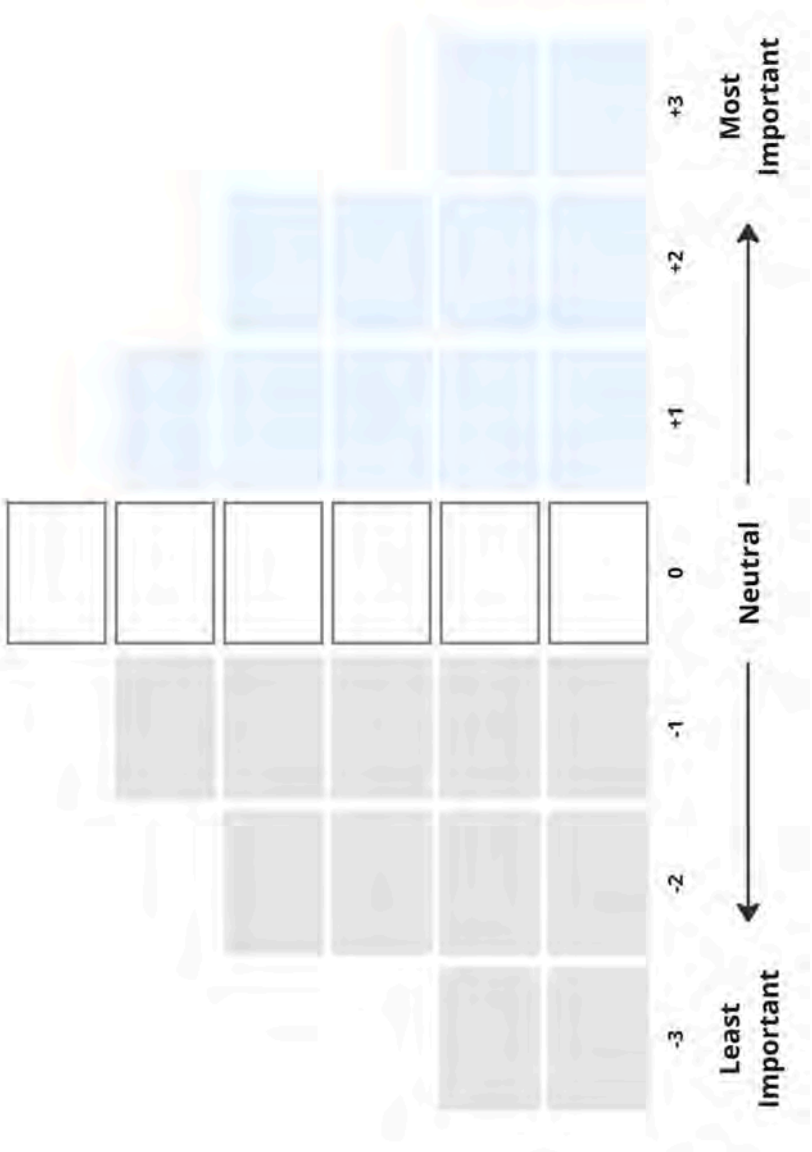

Fig. A1 Q-Sort Grid

Appendix B.

Code system − All priority elements and experiences.

Umbrella experience	*Level 1 Sub-code*	*Level 2 Sub-code*	*Level 3 Sub-code*	*Code frequency*
Being high up				3
	Ladder			1
	Tall/high elements			11
		Bridges		11
			Bouncy bridge	1
			Net bridge	1
		Lookouts		7
		Towers		6
Climbing/ dangling				12
	Monkey bars			8
		Bigger monkey bars		1
	Platforms/places to climb to			3
	Climbing up and across stumps/ sticks			2
	Nets			1
	"Approved climbing" zones			3
	Fences/barriers			2
	Rings			1
	Rock/climbing wall			1
		Rock wall		3
		Climbing wall		2
Playing organized games				1
	Timer			1
	Playground games			0
		Hay wars		1
		Tic-Tac-Toe		1
	Blacktop sports			0
		Basketball		6
			Lower basketball hoops	1
		5th grade vs. teachers games		1
		Four square		1
		Blacktop		5
		Wallball		1
		Dodgeball		2
	Field sports			0
		Kickball		2
			Kickball markings	1

(*continued on next page*)

(*continued*)

Umbrella experience	*Level 1 Sub-code*	*Level 2 Sub-code*	*Level 3 Sub-code*	*Code frequency*
		Football		3
		Non-soccer field sports		1
		Bigger field		1
		Soccer		6
Sliding				1
	Sliding down from destination (e.g., tower)			1
	Slides			19
		Using snow on slide		1
		Twisty slide		5
		Big/steep slide		2
	Sledding hill			2
Being thrilled/ challenged				0
	"Child cage"			1
	Doing back flips			1
	Spinning			1
		Spinning elements		1
	Gymnastics area			2
	Obstacle course			1
		Big, swinging hammer		1
	Running			1
		Track		1
		Chasing		1
	Going fast			3
		Zipline		7
	Ramp			2
	Dangerous			2
	Scary			2
Being in nature				2
	Going into wooded area behind school			1
	Green area by swings			1
	Interacting with animals			2
		Wildife/animals		4
	Trees			3
	Grass area			7
		Bigger grass area		3
	Garden			3
		Garden beds		1
Jumping on, off and into things				3
	Soft landing surfaces			0
		Mattress below		1
		Hay pile		1
		Rubber ground surface		1
		Ball pits		1
		Foam/mulch pit		1
		Soft landing mats		1

(*continued on next page*)

(*continued*)

Umbrella experience	*Level 1 Sub-code*	*Level 2 Sub-code*	*Level 3 Sub-code*	*Code frequency*
	Platforms/places to jump off of			2
	Parkour			1
	Bouncing			5
		Bouncy house		1
		Trampoline		6
			Less dangerous trampolines	1
Swinging				4
	Swings			14
		Vine swing		1
		Chair swing		1
		Tire swing		2
		Baby swing (adjustable)		2
		Bench swing		1
Embracing unique identity/ history				1
	Clocktower			4
	Colorful mural			1
	Art			3
	Unique design			1
		Hexagon shapes		1
		Creative		1
		Animal-themed designs		0
			"Snake tunnel"	1
			Origami snake	1
			Dragon-themed slide	1
			Dolphins	2
			Rocking animal	1
	Inclusiveness			1
	Historical structure			1
	Carved wooden boards			1
	Memory tree			1
Being covered/ hidden				2
	Hiding			4
		Being unsupervised		1
		Hiding spots		4
		Spying		1
		Hide and seek		1
	"Basements," caves, and dark areas			2
		Caves		2
		Basements		3
			Calming basement	1

(*continued on next page*)

(*continued*)

Umbrella experience	*Level 1 Sub-code*	*Level 2 Sub-code*	*Level 3 Sub-code*	*Code frequency*
Having sensory variety				2
	Having color variety			1
		Colorful parts on structure		1
	Glass/see-through elements			1
		Fake glass place for playing games		1
		Glass dome		1
	Food			3
	Viewing/interacting with water			2
		Fountain		4
		Water cascade		1
	Sensory garden			1
	Sensory space			1
Being in quiet spaces				0
	Quiet space			1
	Secret garden			2
	Talking with friends			4
		Telling secrets		1
	Feeling tired			1
	Privacy			3
		Secret places		3
	Drawing			1
	Reading			1
		Book nook		1
	Quiet garden			1
Using shortcuts and secret passageways				0
	Tunnels			7
		Snake to go inside (tunnel)		1
	Having multiple paths to same place			1
	"Hamster-like"			1
	Shortcuts			2
	Gaps and holes			2
		Gaps in fences		2
	Popping out in different places			2
		Entries and exits		1
Limiting injuries				3
	Limiting falling off			2
	Age 5+ only areas			1
	Materials that limit injury (e.g., burns, splinters)			5
		Non-scratchy materials		1
		Non-metal materials (heat/slipping issue)		1

(*continued on next page*)

(*continued*)

Umbrella experience	*Level 1 Sub-code*	*Level 2 Sub-code*	*Level 3 Sub-code*	*Code frequency*
Being weather protected				0
	Shady and dry areas			8
		Gymnasium		1
		Roof and tarps		1
		Giant umbrella		2
	Eating in shade			1
Performing/ pretending				0
	Fake cars			1
	Ampitheater			1
	Stage			1
	Role playing			1
	Playing "house"			1
Having a clean/ maintained playspace				1
	Minimizing litter			1
	Minimizing repairs/broken things			2
	Trash can			1
Having a variety of things to do				2
	Having different/distinct areas			2
Being in loud places				1
	Energizing			2
Sitting				2
	Tables and benches			1
Ground surface variety				1
	Less concrete			1
	More than wood chips			1
Interacting with digital devices				0
	Robotic parts			1
	Wifi			1
Biking				0
	Bike trail			1
		Roof and tarps		1
		Giant umbrella		2
	Eating in shade			1
Performing/ pretending				0
	Fake cars			1
	Ampitheater			1
	Stage			1
	Role playing			1
	Playing "house"			1

(*continued on next page*)

(*continued*)

Umbrella experience	*Level 1 Sub-code*	*Level 2 Sub-code*	*Level 3 Sub-code*	*Code frequency*
Having a clean/ maintained playspace				1
	Minimizing litter			1
	Minimizing repairs/broken things			2
	Trash can			1
Having a variety of things to do				2
	Having different/distinct areas			2
Being in loud places				1
	Energizing			2
Sitting				2
	Tables and benches			1
Ground surface variety				1
	Less concrete			1
	More than wood chips			1
Interacting with digital devices				0
	Robotic parts			1
	Wifi			1
Biking				0
	Bike trail			1

Appendix C.

Play elements prioritized in team final design plans.

Priority elements	*No. Integrated in all design plan drawings*	*No. in "Top 5 elements"*
Bridge (inc. rope and net bridges)	14	
Towers, lookouts, or high places	13	3
Slides (inc. Water slides)	12	2
Area for sitting or hanging out	8	
Garden	7	2
Ziplines	6	2
Trampoline	6	
Tunnels or shortcuts	5	3
Soccer or grass field	5	1
Shelter	5	
Swings	5	
Kickball, dodgeball, or other hard surface	5	
Trees, vegetation, or wildlife (other than garden)	4	1
Water feature	4	
Structure for climbing or dangling	3	1
Identity elements or art	3	
Little kids area	3	
Hiding spots or caves	2	3
Maze	2	
Sledding hill	2	1
Gaga ball pit		1

Data availability

The data that has been used is confidential.

References

Amin, Z. (2000). Q methodology - A Journey into the subjectivity of human mind. *Singapore Medical Journal, 41*(8), 410–414.

Bødker, S., Dindler, C., Iversen, O. S., & Smith, R. C. (2022). What is participatory design? In S. Bødker, C. Dindler, O. S. Iversen, & R. C. Smith (Eds.), *Participatory design* (pp. 5–13) Springer. https://doi.org/10.1007/978-3-031-02235-7_2.

Bossen, C., Dindler, C., & Iversen, O. S. (2016). Evaluation in participatory design: A literature survey. In *Proceedings of the 14th participatory design conference: Full papers* (pp. 151–160). https://doi.org/10.1145/2940299.2940303.

Brown, C., de Lannoy, A., McCracken, D., Gill, T., Grant, M., Wright, H., & Williams, S. (2019). Special issue: Child-friendly cities. *Cities & Health, 3*(1/2), 1–7. https://doi.org/10.1080/23748834.2019.1682836.

Burke, C. (2005). "Play in focus": Children researching their own spaces and places for play. *Children, Youth, and Environments, 15*(1), 27–53. https://doi.org/10.1353/cye.2005.0066.

Can, E., & İnalhan, G. (2017). Having a voice, having a choice: Children's participation in educational space design. *The Design Journal, 20*(sup1), S3238–S3251. https://doi.org/10.1080/14606925.2017.1352829.

Clark, A., & Moss, P. (2011). *Listening to young children: The mosaic approach.* Jessica Kingsley Publishers.

Cooper, A. (1999). The inmates are running the asylum. In U. Arend, E. Eberleh, & K. Pitschke (Eds.), *Software-ergonomie '99: Design von informationswelten*. Vieweg+Teubner Verlag. https://doi.org/10.1007/978-3-322-99786-9_1. (pp. 17–17).

Corr, S. (2001). An introduction to Q methodology, a research technique. *British Journal of Occupational Therapy, 64*(6), 293–297. https://doi.org/10.1177/030802260106400605.

Derboven, J., Van Mechelen, M., & Slegers, K. (2015). Multimodal analysis of participatory design with children: A primary school case study. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (pp. 2825-2828). ACM*. https://doi.org/10.1145/2702123.2702475.

Druin, A. (2002). The role of children in the design of new technology. *Behaviour & Information Technology, 21*(1), 1–25. https://doi.org/10.1080/01449290110108659.

Dubois, L.-E., Le Masson, P., & Weil, B. (2024). That was fun, now what?: Modelizing knowledge dynamics to explain co-design's shortcomings. *Design Studies, 95*, 101274. https://doi.org/10.1016/j.destud.2024.101274.

Ferguson, K. T., Cassells, R. C., MacAllister, J. W., & Evans, G. W. (2013). The physical environment and child development: An international review. *International Journal of Psychology, 48*(4), 437–468. https://doi.org/10.1080/00207594.2013.804190.

Frauenberger, C., Good, J., Fitzpatrick, G., & Iversen, O. S. (2015). In pursuit of rigour and accountability in participatory design. *International Journal of Human-Computer Studies, 74*, 93–106. https://doi.org/10.1016/j.ijhcs.2014.09.004.

Gibson, J. (2014). The theory of affordances. In J. J. Gieseking, W. Mangold, C. Katz, S. Low, & S. Saegert (Eds.), *The people, place, and space reader*. Routledge.

Hassenzahl, M. (2010). *Experience design: Technology for all the right reasons*. Morgan & Claypool Publishers.

Heft, H. (1988). Affordances of children's environments: A functional approach to environmental description. *Children's Environments Quarterly, 5*(3), 29–37.

Iversen, O. S., Halskov, K., & Leong, T. W. (2010). Rekindling values in participatory design. In *Proceedings of the 11th biennial participatory design conference* (pp. 91–100). https://doi.org/10.1145/1900441.1900455.

Jewitt, C. (2013). *Multimodal methods for researching digital technologies—Record details—EBSCO Discovery Servibsco*. https://research-ebsco-com.proxy.library.cornell.edu/c/u2yil2/details/3lffz3pvgv.

Kress, G. R. (2010). *Multimodality: A social semiotic approach to contemporary communication*. Taylor & Francis.

Kyttä, M. (2004). The extent of children's independent mobility and the number of actualized affordances as criteria for child-friendly environments. *Journal of Environmental Psychology, 24*(2), 179–198. https://doi.org/10.1016/S0272-4944(03)00073-2.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.

Loebach, J., Little, S., Cox, A., & Owens, P. E. (2020). *The Routledge handbook of designing public spaces for young people: Processes, practices and policies for youth inclusion*. Routledge.

Lucero, A. (2015). Using affinity diagrams to evaluate interactive prototypes. In J. Abascal, S. Barbosa, M. Fetter, T. Gross, P. Palanque, & M. Winckler (Eds.), *Human-computer interaction – INTERACT 2015* (pp. 231–248). Springer. https://doi.org/10.1007/978-3-319-22668-2_19.

Luck, R. (2003). Dialogue in participatory design. *Design Studies, 24*(6), 523–535. https://doi.org/10.1016/S0142-694X(03)00040-1.
Luck, R. (2018). What is it that makes participation in design participatory design? *Design Studies, 59*, 1–8. https://doi.org/10.1016/j.destud.2018.10.002.
Malinverni, L., Mora-Guiard, J., & Pares, N. (2016). Towards methods for evaluating and communicating participatory design: A multimodal approach. *International Journal of Human-Computer Studies, 94*, 53–63. https://doi.org/10.1016/j.ijhcs.2016.03.004.
McCarthy, J., & Wright, P. (2004). Technology as experience. *Interactions, 11*(5), 42–43. https://doi.org/10.1145/1015530.1015549.
Montreuil, M., Bogossian, A., Laberge-Perrault, E., & Racine, E. (2021). A review of approaches, strategies and ethical considerations in participatory research with children. *International Journal of Qualitative Methods, 20*. https://doi.org/10.1177/1609406920987962.
Paracha, S., Hall, L., Clawson, K., Mitsche, N., & Jamil, F. (2019). Co-design with children: Using participatory design for design thinking and social and emotional learning. *Open Education Studies, 1*(1), 267–280. https://doi.org/10.1515/edu-2019-0021.
Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*(10), 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014.
Saiger, M. J., Deterding, S., & Gega, L. (2023). Children and young people's involvement in designing applied games: Scoping review. *JMIR Serious Games, 11*, e42680. https://doi.org/10.2196/42680.
Sanders, E., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign, 4*(1), 5–18. https://doi.org/10.1080/15710880701875068.
Sanoff, H. (1999). *Community participation methods in design and planning*. Wiley.
Sanoff, H. (2006). Multiple views of participatory design. *Journal of the Faculty of Architecture, 23*(2). https://doi.org/10.15368/focus.2011v8n1.1.
Sevón, E., Mustola, M., Siippainen, A., & Vlasov, J. (2025). Participatory research methods with young children: A systematic literature review. *Educational Review, 77*(3), 1000–1018. https://doi.org/10.1080/00131911.2023.2215465.
Smith, R. C., & Iversen, O. S. (2018). Participatory design for sustainable social change. *Design Studies, 59*, 9–36. https://doi.org/10.1016/j.destud.2018.05.005.
Spinuzzi, C. (2005). The methodology of participatory design—EBSCO. *Applied Research, 52*(2), 163–174. https://research-ebsco-com.proxy.library.cornell.edu/c/u2yil2/viewer/pdf/s3tylzisxj.
Sullivan, E., Egli, V., Donnellan, N., & Smith, M. (2021). Policies to enable children's voice for healthy neighbourhoods and communities: A systematic mapping review and case study. *Kōtuitui: New Zealand Journal of Social Sciences Online, 16*(1), 18–44. https://doi.org/10.1080/1177083X.2020.1772325.
Tippett, J., Handley, J. F., & Ravetz, J. (2007). Meeting the challenges of sustainable development—A conceptual appraisal of a new methodology for participatory ecological planning. *Progress in Planning, 67*(1), 9–98. https://doi.org/10.1016/j.progress.2006.12.004.
United Nations. (1989). Convention on the Rights of the Child, November 20, 1989, https://www.ohchr.org/en/professionalinterest/pages/crc.aspx.
Van Mechelen, M., Derboven, J., Laenen, A., Willems, B., Geerts, D., & Vanden Abeele, V. (2017). The GLID method: Moving from design features to underlying values in co-design. *International Journal of Human-Computer Studies, 97*, 116–128. https://doi.org/10.1016/j.ijhcs.2016.09.005.

Van Mechelen, M., Willems, B., Zaman, B., Vanden Abeele, V., & Laenen, A. (2016). *Designing technologies for and with children: Theoretical reflections and a practical inquiry towards a co-design toolkit*. https://lirias.kuleuven.be/1674366.

Williams, T., Ward, K., & Smith, M. (2023). Conceptualization of Co-creation, co-design and co-production with children for health-promoting physical environments: A systematic search and scoping review. *Children, Youth, and Environments, 33*(2), 1–38. https://doi.org/10.1353/cye.2023.a903096.

Yip, J. C., Sobel, K., Pitt, C., Lee, K. J., Chen, S., Nasu, K., & Pina, L. R. (2017). Examining adult-child interactions in intergenerational participatory design. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 5742–5754). https://doi.org/10.1145/3025453.3025787.