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THE POTENTIAL OF DIGITAL TECHNOLOGY TO ENGAGE CHILDREN WITH HOSPITAL EXPERIENCE AND DESIGN

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Abstract

This study examines how virtual reality (VR) supported co-design methods can help recover children's perspectives in shaping hospital environments. Building on NHS priorities for child-centred healthcare design, the project developed immersive digital replicas of key hospital spaces through 360° video, 3D models, and VR simulations. These were tested with children from local schools to explore their perceptions, reduce hospital related anxiety, and gather design preferences. Findings show that VR supported children engagement, familiarity with clinical spaces, and insights into sound, colour, layout, and wayfinding. The study shows the potential of VR as a participatory tool for inclusive paediatric healthcare design.

Introduction

Creating strategies to educate and prepare children for hospital visits as patients and designing hospital services for children from the child's point of view has been for some time part of the NHS framework (Department of Health, 2003; NHS England, 2014). Recently, increased recognition has been given to the requirement to include the views of child patients in the planning of health care services so that hospitals can be designed to enhance future experience. However, the voices of children remain often under-represented or represented through adult proxies in projects to design, develop and improve healthcare service delivery. Co-design methodologies (Bratteteig and Wagner, 2016; Luck 2018) and digital technology such as VR bring the potential to support user empowerment and participation in the design of buildings and services (Sateei et al., 2025; Roupé et al 2020; Maftei et al. 2018).

This study draws on a co-design approach to explore the use of digital technology such as VR (virtual reality) for engaging children with hospital spaces and experiences, and recovering children's perspectives of what constitutes ideal hospital design. The study is based on a community engagement project drawn on collaboration between the author's University, the local NHS hospital and local schools. The project aimed to: 1) develop a friendly but realistic immersive experience of hospital through digital simulations (including 3D photographic visualisation and surround sound); 2) examine the use of these virtual simulations to familiarise children with hospital spaces they might encounter, and to reduce the apprehension experienced by children as reported anecdotally by the hospital; and 3) use these virtual simulations to understand children's perceptions and preferences to inform the co-design of children hospital spaces.

In collaboration with the local hospital including the Children Strategy, Health Inequalities, and Patients Experience teams, we identified that the project would be particularly useful in understanding the experience of children with special educational needs and disabilities. We ran a demonstration session with the hospital Youth Forum, a group of 16-24 year old young adults who work with the hospital to improve services for young patients.

We co-developed digital replicas of three children's hospital spaces based on advice from the hospital team. This included a journey from the car park to main reception, the children's clinic waiting area, and the X-Ray room. Using a 360° video camera different types of digital replicas were created such as immersive VR films, 2D films, and interactive 3D models developed with laser scanning techniques.

The digital replicas were shown to children in three local schools, including the Junior Carers (an initiative to engage primary school children with the hospital and healthcare services). They were able to experience the spaces virtually in a classroom environment on VR headsets, iPads and laptops. The schools were chosen to represent a diverse range of children from different backgrounds, some with special educational needs and disabilities. The project team asked children for their thoughts and ideas, while showing them what happens in hospital. Through a series of fun story-telling classes developed with teachers and the hospital, the children could ask questions and tell what they think, 'before-they-go' and 'after-they've-been' to hospital (in the virtual simulations), then what they would like to see in the future.

In workshops conducted at the schools, children were able to see parts of the hospital they had not seen before, and reported that they would not be scared if they needed to visit them. They provided useful insights into the design and experience of children's hospital spaces talking about sounds, colours, lighting, seating areas, waiting, and wayfinding. They also enjoyed the experience of using digital technologies, especially the VR headsets and often said it helped them to feel immersed in the space in a 'very real' way.

This paper reports on this project and takes a focus on the participating children's perspectives on the technology and of the hospital virtual simulations for engaging children with hospital experience and co-design.

Background and related literature

Hospitalisation is frequently accompanied by elevated anxiety in children, arising from disruption to routine, exposure to unfamiliar sensory cues, and shaped by the experience of the hospital environment (Signorelli et al., 2023). The design literature similarly recognises that paediatric environments can either amplify or reduce stress, with supportive design elements (e.g., positive distraction, sense of control, and social support) linked to improved affective outcomes for young patients (Sathyanarayanan & Caldas, 2025). Yet, despite the centrality of child experience in paediatric care, children's perspectives remain under represented in both healthcare research and design decision making. Methodological and structural barriers often lead to reliance on adult proxies, resulting in partial accounts of children's priorities.

Co-design and participatory design (PD) with children have gained traction within healthcare facilities planning, but adoption remains uneven and methods are often limited to short, one off sessions that do not translate into buildable specifications (Sathyanarayanan & Caldas, 2023; Schepers et al., 2020).

Architectural engineering and construction management research indicates that conventional tools (plans, renders, physical mock-ups) can fail to capture embodied, affective, and developmental nuances of paediatric users, thereby constraining the fidelity of user requirements that propagate through briefing, design development, and delivery (Sfandyarifard & Tzortzopoulos, 2011; Jurk, 2023).

Against this backdrop, immersive digital technologies—particularly virtual reality (VR)—present the potential to both alleviate anxiety and support co-design processes. On the clinical side, VR can reduce pre procedural anxiety and improve the hospital experience for children and families (Oh et al., 2023; Hu et al., 2024). On the design/construction side, studies in the architecture/engineering domains indicate that immersive HMD VR may enhance stakeholders' spatial understanding, sightline appraisal, logistical flow testing, and identification of latent design conflicts. When VR supports interaction and multi user collaboration, end users can iteratively adjust layouts in real time, accelerating decision cycles from weeks to hours (Sateei et al., 2025). In combination with other digital technologies, VR can support participatory design, user empowerment and better management of user requirements (Maftei et al., 2018). Other healthcare focused AEC work further explores the role of VR for simulating "in between" spaces (waiting rooms, corridors) and diverse user conditions to inform design decisions that address stress and inclusivity, thereby improving experiential quality where anxiety often accumulates (Harkness et al., 2018). For paediatrics specifically, emerging research demonstrates how immersive tools can enable child centred engagement beyond verbal self-reports. For example, architectural experiments pairing VR with eye tracking and physiological measures capture moment to moment emotional responses to spatial variables in paediatric rooms, offering developmentally appropriate pathways to elicit preferences about privacy, control, and positive distraction (Sathyanarayanan & Caldas, 2024). These methods address known shortcomings of traditional PD with children—notably, the difficulty of translating tacit or affective responses into design parameters—by supporting evidence based design (Jurk, 2023; Sateei et al., 2025).

In construction management terms, the capacity of immersive technology such as VR to host multi disciplinary, multi user reviews directly within a navigable, to scale prototype is salient for briefing, options appraisal, and stakeholder sign off—especially when paediatric participants may struggle to read drawings or comprehend scale (Sateei et al., 2025; Sfandyarifard & Tzortzopoulos, 2011). Finally, children's co-design literature highlights the need for deeper participation models—moving beyond episodic ideation toward ongoing roles in defining processes and decisions—suggesting that immersive platforms can enable such "deep participation" by making options experientially comparable and discussions evidence rich (Kheirollahi et al., 2021; Schepers et al., 2020).

Overall, this literature indicates that integrating digital technology such as VR within participatory design frameworks can both mitigate hospital related anxiety and amplify children's voices in the planning and delivery of paediatric facilities. This study builds on this literature by taking a qualitative interpretivist approach to explore how digital technology such as VR can support engaging children with hospital experience and design.

Methods

The study followed a qualitative interpretivist research design consistent with established participatory and co-design protocols used in child-centred healthcare design research (Bratteteig & Wagner, 2016; Schepers et al., 2020). This approach emphasises eliciting children's lived experiences through multimodal, developmentally appropriate formats, aligning with guidance on participatory methods for child participants in both design research and architecture/engineering contexts (Sfandyarifard & Tzortzopoulos, 2011; Sathyanarayanan & Caldas, 2023).

In line with this approach, we adopted a co-design approach to explore children's perspectives on the technology and the hospital virtual simulations for engaging children with hospital experience and co-design. The study aimed to develop a friendly but realistic immersive experience of hospital through digital simulations (including surround image and sound), to familiarise children with hospital spaces they might encounter, and to understand children's perceptions and preferences to inform the co-design of children hospital spaces.

Technology used and content creation

The equipment used comprised an Insta360° surround image and sound camera, Oculus/Meta Quest VR headsets, a 2D camera, a laser scanner, iPads, and laptops. In the first phase, the 360° camera and headsets were tested by filming the author's department building. Based on these tests and demo sessions with hospital collaborators and the Youth Forum (YF), we decided to augment 360° recordings with 2D films and laser scanned interactive models for creating journeys and higher interactivity with the virtual models. The final hospital simulations recreated a child patient's visit from the car park to main reception, through the children's clinic waiting area, and into the X ray room. These virtual simulations were co-created with volunteer actors (child patients, parents, hospital staff).

Participating groups

A purposive sampling strategy was adopted to involve groups for whom the intervention would be most relevant. In collaboration with the local NHS hospital (Community Engagement, Health Inequalities, Patient Experience and Children Strategy teams), we prioritised groups for whom the intervention might be particularly useful, notably children with Special Educational Needs and Disabilities (SEND). This sampling approach aligns with participatory design guidance encouraging recruitment of participants with lived or contextual experience relevant to the design domain (Bratteteig & Wagner, 2016; Schepers et al., 2020).

Following this sampling strategy, we worked with three schools: two mainstream primary schools in the Junior Carers programme (about 30 children total, ~10 years old, split into two workshops, W1 and W2) and one highly special educational needs school (12 children, 13–16 years, mixed disabilities and neurodivergence; W3). The Junior Carers children had ongoing, non-patient engagement with the hospital. The SEND group included children with frequent or extended hospital visits. This sampling strategy mirrors participatory approaches in healthcare design that emphasise working with children who are either direct stakeholders or frequent service users (Sfandyarifard & Tzortzopoulos, 2011).

Workshop design and flow

Each workshop followed a structured sequence. First, children developed short written stories about hospital "before" the virtual experience. Next, they experienced the simulations across three display modalities—VR headset, iPad, and laptop—rotating through sub areas of the room arranged to follow the hospital journey. This was followed by mini focus groups (≈30 minutes per subgroup) and a whole group debrief (≈15 minutes). In W1 and W2 (≈1.5 hours each), groups of ~15 were divided into subgroups of five to balance group dynamics and avoid unification and standardisation of opinions, while remaining practical for facilitation time. In W3 (~2.5 hours), 12 children worked in pairs, with ~1h40m hands-on time across devices, followed by a ~30 minute whole group debrief.

Figure 1: Image from the school-based workshops

This workshop design followed established child-centred co-design procedures. Warm up activities (in our case written "before" stories) bring the potential to activate prior knowledge and reduce cognitive load, a method routinely employed in PD with children (Schepers et al., 2020). Multimodal interaction -in our case with three display types (VR headset, iPad, laptop)- has been recognized to be useful for inclusive technology mediated engagement (Sathyanarayanan & Caldas, 2023; Roupé et al., 2020). Organizing small-group mini focus groups using interactive prompts reflects PD protocols that minimise peer influence and support diverse participation (Bratteteig & Wagner, 2016). Whole-group debriefs as employed in our study are consistent with iterative reflection cycles common in co-design and evidence-based design (Sateei et al., 2025; Jurk, 2023). Subgroup sizes (in our case, 5 in W1/W2 and pairs in W3) were selected to align with guidance on balancing conversational richness with facilitation manageability (Schepers et al., 2020).

Data collection and analysis

In line with qualitative and PD research methods of data collection, we collected: (i) written "before" stories; (ii) audio recorded mini focus groups on "after" perceptions, including what children would like to change; and (iii) whole group debriefs. Interview prompts focussed on likes/dislikes of hospital experience and space/design before and after the simulations, and explicitly invited reflections on the technology and films (in terms of usefulness for potentially helping other children familiarise with the hospital).The written stories provided pre-experience framing, aligned with narrative elicitation protocols used in paediatric design studies (Sathyanarayanan & Caldas, 2023). The audio recorded

mini focus groups drew on semi structured thematic protocols common in architectural PD research (Sfandyarifard & Tzortzopoulos, 2011; Jurk, 2023). The whole group debriefs enabled collective reflection, frequently recommended in co-design workflows (Schepers et al., 2020). Prompts were designed to capture perceptual, emotional, and spatial responses—an approach supported by VR assisted evidence-based design methods (Sateei et al., 2025).

Audio recordings were transcribed and thematically analysed. In this paper, particular attention is given to the analytical themes around the technology perception and use (device preference; immersion vs distraction; usability; comfort and accessibility) and perceived usefulness (familiarisation, anxiety reduction, wayfinding confidence).

The study complied with University ethics and hospital Information Governance approvals.

Analysis and findings

Engagement, preference, and perceived usefulness

Across the Junior Carers workshops, many children identified VR headsets as the preferred display, often highlighting the 360° look around affordance: "I liked it when we could look around through the X ray room" (Participating Child in W2). The interactivity of the laser scanned model was also appreciated—"I liked the one where you can move around… so you can, yeah, feel like you're there, instead of watching someone else do something" (Participating Child in W1)—suggesting agency and navigation mattered at least as much as immersion. Children repeatedly proposed the simulations as tools to prepare and reassure peers: the films "can help the children about knowing… what's going to happen and calm, cool them down… if they did know what was going to happen they're like, 'all right, it's going to be fine…' I think it's good to let them know what's going to happen" (Participating Child in W1). Some noted the simulations resembled real visits: "I have been to X ray before… It was the same as in the films" (Participating Child, W2).

SEND participating children and school staff framed the simulations as a useful alternative/complement to existing preparation practices (e.g., social stories, photos), emphasising choice of device: "Some people need the VR headset, but some people don't need it… it could be on a phone… an iPad… or a VR [headset]" (Participating Child, W3). For this group, the value of multiple modalities (2D, 3D, interactive, non-interactive) was explicit, reinforcing that iPads and laptops were "as useful as the VR headset" (Participating Child, W3), and sometimes more comfortable or accessible.

Immersion, novelty, and distraction

The same features that made VR compelling could disrupt focus. In W2, the headset became the attraction of the workshop, with competition for turns—"How did she have the long go? She had longer. I'd like to have another go too" (Participating Child in W2)—shifting attention away from hospital design reflections. Some children focussed on production technicalities (e.g., people disappearing and reappearing in Matterport style models) rather than spatial qualities. Others encountered navigation issues: "I didn't really get to see much of the hospital, I just went straight into this other world, and I didn't get any time in the actual hospital" (Participating Child in W2). These moments illustrate how medium driven attention capture can overshadow the message without allowing the potential to support the focus of the workshop.

Perceived usefulness: familiarity with clinical processes and spaces

Children engaged closely with clinical procedures—notably X ray—and reported recalibrated expectations from "scary" to "not scary." Seeing "what they're doing" and "what the facilities are about each room" was valued, with previewing activities in medical rooms recommended to build understanding (Participating Child in W1). This aligns with comments that simulations may reduce anxiety by clarifying who does what, where parents wait, and how the process unfolds. In Junior Carers groups, prior visits (e.g., cardiology) blended with the virtual encounter (X ray) to form an overall familiarity that children found useful.

Comfort, accessibility, and session design (SEND insights)

For SEND participants, personalisation was key. Some found VR engaging "partly because of its novelty," while others were uninterested—"I'll never get used to it… you have to want to do it" (Participating Child in W3). Practical recommendations included shorter VR experiences to avoid dizziness and pre familiarisation: "with VR you have to actually get used to it" (Participating Child in W3). Children also articulated desired technical refinements—"I wish the lens didn't have to be circular, wish I could fully immerse myself"—and affirmed that iPads/phones were equally useful, reinforcing the need for optional pathways through the content.

Children's design insights through digitally mediated participation

Across workshops, children indicated design perceptions (e.g., sounds, light, wayfinding, waiting), often proposing adjustments —quieter/ambient soundscapes; more colour; the provision of more engaging activities in the waiting area ("add iPads and books for 8–10 years old"). These place-based concerns often interacted with technology use: when audio in films included a child crying, some found it disturbing; conversely, appropriate sound design enhanced presence. For SEND participants, discussions expanded to outdoor/open air spaces, polysensory seating (softer, "hugging" seats alongside standard chairs), handrails along long routes, and strategies to mitigate waiting time challenges for autistic children who cannot physically wait. Technology was thus perceived not just as a medium, but as part of a broader toolkit and methodology for inclusive preparation and design feedback.

Discussion

Using digital technology to improve the design and children's experience of hospitals?

The technology was widely perceived as useful for engaging children with hospital environments, increasing familiarity, and "calming worries" before visits. Interestingly, the same features that make VR compelling—immersion and novelty—could also be disruptive, pulling focus away from the workshop's purpose of discussing hospital experience and design. Instances of children competing for VR time, becoming preoccupied with production technicalities, or getting "lost" in navigation illustrate how the medium may overshadow the message/purpose if not carefully used. These observations point to the importance of facilitation strategies (e.g., clear turn-taking, guided tasks, and wayfinding prompts within the VR interface) to keep attention on the spatial and experiential content rather than the device itself. At the same time, the SEND group's emphasis on choice demonstrates that, although VR was preferred by some, other children found iPads and laptops equally useful, and in some cases preferable for comfort, accessibility, or sustained focus. Designing technology-mediated participation should therefore provide multiple display options, flexible session lengths, and staged familiarisation.

Overall, the findings show that VR-supported digital simulations can meaningfully engage children in exploring hospital environments, yet the immersive qualities of VR can both support and hinder design-focused dialogue. While many participants valued the 360° affordance and sense of presence, others became preoccupied with the novelty of the device or encountered navigation challenges. These dual effects highlight the importance of structured facilitation—guided tours, turn taking protocols, and clear task prompts—to ensure that immersion enhances rather than distracts from design discussion.

Across all workshops, children articulated design-relevant preferences relating to colour, sound, lighting, waiting experiences, and wayfinding. SEND participants emphasised sensory comfort, predictable routes, and the usefulness of multiple device modalities. These observations demonstrate how multimodal, digitally enabled simulations can reveal tacit experiential knowledge difficult to express using traditional PD tools.

Implications for hospital design

The study contributes evidence that VR-supported co-design can uncover child centred insights into hospital environments. Children's suggestions—ranging from quieter soundscapes and clearer wayfinding to softer seating and reduced visual clutter—align with recognised paediatric design principles and offer specific, actionable recommendations for design teams. As shown in our study, interactive models and VR combined with 2D animated options, also support accessibility and differentiated sensory needs. Overall, the findings demonstrate how VR-supported sessions can reveal design aspects that traditional participatory tools may not capture.

Relation to Prior Literature

The findings support AEC research indicating that immersive VR enhances spatial understanding and supports stakeholder dialogue (Roupé et al., 2020; Sateei et al., 2025). At the same time, the need to manage distraction aligns with literature emphasising careful facilitation in participatory sessions with children (Sfandyarifard & Tzortzopoulos, 2011). The multimodal digital simulations preference of SEND children extends emerging work calling for flexible, accessible co-design tools in paediatric environments.

Limitations

Many participating children—particularly those in the Junior Carers programme and the SEND school—had prior or frequent hospital experience. In combination with the digital hospital simulations, this familiarity enabled children's rich insights of hospital experience and design, and it supported useful background for the participating children assessment of the realism of the hospital virtual simulations. However, this familiarity may have influenced the participating children's perceptions of the simulations, their reported levels of anxiety, and the specificity of their design suggestions. Future work could include children with little or no prior hospital exposure to explore whether the technology supports first-time preparation differently.

Conclusions and Future Work

This study shows that multimodal digital simulations—360° VR films, 2D videos, and interactive laser-scanned models—can meaningfully engage children, including SEND participants, in understanding hospital environments and expressing design-relevant preferences. VR supported participation and familiarisation, yet immersion also introduced distractions, highlighting the need for clear facilitation, guided navigation, and multimodal display options.

As in all research, there are limitations to this study. Many child participants had prior hospital experience, which may have shaped perceptions and reduced anxiety. Future work could include children with little or no prior hospital experience to examine whether the technology supports first-time preparation differently. Group-based school workshops may have also limited the depth of individual feedback. Relatedly, future work might focus on individual sessions to capture more fully personal feedback from child participants. Further avenues for future work may also explore iterative co-design with children, and may include longitudinal studies examining anxiety reduction ahead of real hospital visits.

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