

A Tripartite Framework for the Co-design of an Awareness-raising SG Addressing Visual Impairment: A Systematic Literature Review

Nicolas Roecklin and Nour El Mawas

Université de Lorraine, Metz, France

nicolas.roecklin@univ-lorraine.fr

nour.el-mawas@univ-lorraine.fr

Abstract: Over the past decades, social advances and the evolution of legal frameworks have strengthened the recognition of disabled people's right to equal access to employment, education, information, and full participation in society. However, navigating public spaces remains challenging for many visually impaired people (VIP), and raising awareness among public space designers is needed. Research has shown the potential of serious games (SGs) as awareness-raising tools for complex situations, fostering understanding and empathy among participants. This article is part of broader research aimed at designing an SG to raise awareness of VIP mobility challenges. It analyzes existing design methods through a systematic literature review (SLR) that identified 24 articles and 2 books within a corpus of 163 publications. The SLR compares technical criteria (SG engine, software, reality-based technology, programming language, platform, tangible object) and co-design criteria (organization, stakeholder roles, iteration frequency, gameplay considerations such as playtime, seriousness/fun balance, facilitator role, SG type, overall duration). These findings suggest that, from an Information and Communication Sciences (ICS) perspective, technology primarily acts as a mediator of social interactions, making co-design with people with visual impairments essential to developing meaningful systems. We propose a co-design method involving VIP experts, technical experts, and researchers, with attention to communication and coordination throughout the design process. This research addresses the Technology Enhanced Learning community, particularly pedagogical engineers, game designers, researchers, and public space planners concerned with VIP mobility awareness.

Keywords: Serious game, Co-design, Visual impairment, PRISMA, Information and communication sciences

1. Introduction

The World Health Organization estimated that approximately 2.2 billion people were living with visual impairment (World Health Organization, 2023). Navigating public spaces remains a challenge for many visually impaired people (VIP) (Rustemeier et al., 2021), making it crucial to raise awareness among public space designers. Research has shown that SG are effective awareness-raising tools for complex situations, fostering understanding and empathy (Hailey et al., 2016).

This article is part of broader research aimed at designing an SG to raise awareness of VIP mobility challenges. It analyzes existing design methods through a systematic literature review, comparing technical criteria (SG engine, software, reality-based technology, programming language, platform, tangible object) and co-design criteria (organization, stakeholder roles, iteration frequency, gameplay considerations such as playtime, seriousness/fun balance, facilitator role, SG type, overall duration).

This research pursues two objectives: 1) identify the technological approaches mobilized in SGs designed to raise awareness about visual impairment or support VIP; 2) characterize how co-design practices articulate the different stakeholders (VIP experts, technical experts, researchers).

It addresses the ICS and Technology Enhanced Learning community, particularly pedagogical engineers, game designers, researchers, and public-space planners concerned with VIP mobility.

First we present the theoretical context, articulating the SG as an experience, as a "*dispositif*" (Peraya, 1999), and the need for co-design. Second, we detail the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method used. Section three presents the results through two thematic syntheses (technological and co-design). Finally, we discuss these findings within ICS and outline the limitations of this work.

2. Theoretical Concept

2.1 The SG as an Experience

The SG can be defined as a digital or non-digital artefact that combines game mechanics with utilitarian functions, message dissemination, training, or data collection, thereby operating as a persuasive and pedagogical communication device (Alvarez, 2024). This definition must be complemented by the recognition that the SG exists on two inseparable planes, the artefact (SG) and the activity (serious play) and that its

perception ultimately remains subjective, leading us, to acknowledge that the question “is this a SG?” can only be answered by those who design and experience it (Alvarez, 2024).

2.2 The SG as a "Dispositif"

The design of a SG can be framed by the science of the artificial concept, in which the artefact emerges as an interface between an internal structure and an external environment that it both shapes and depends upon (Simon, 1987; Herbert, 1991). This artefact, however, does not operate in isolation: it is embedded within a social, informational, and communicational environment where it functions as a mediating device (Peraya, 1999). Such a device, identified as a “*dispositif*”, must be understood as an articulation of heterogeneous elements, material and symbolic, operating as an “in-between” that distributes agency between the technical object and its users (Peeters and Charlier, 1999).

It is precisely because this double mediation traverses the “*dispositif*”, and because its lived dimension cannot be anticipated without the active involvement of those who experience it, that co-design emerges not as a methodological option but as a communicational necessity.

2.3 The SG Needs Co-design

The SG as “*dispositif*” can be analyzed through three states: ideal, functional, and lived, which reveal the gap between design intentions and actual user experience (Albero, 2010). This gap reflects a double mediation: any technology-mediated practice is structured both by the tool itself and by the social relationships, identities, and contexts of its appropriation (Jouët, 2000).

The user cannot therefore be reduced to a passive recipient of a pre-written technical script but must be recognized as a potential actor of innovation, capable of adapting or co-writing the scenario inscribed in the artefact (Akrich, 1998).

Co-creation, co-design, and co-production represent distinct levels of stakeholder engagement: co-creation covers the entire process from problem framing to evaluation, co-design refers to the collaborative phase where stakeholders develop solutions, and co-production focuses on downstream implementation (Vargas et al., 2022). Grounded in participatory action research, these approaches rely on power-sharing, reciprocity, and mutual learning, and follow an iterative six-stage cycle (identify, analyze, define, design, realize, evaluate) that positions co-design as a continuous communicational process among heterogeneous actors (Vargas et al., 2022).

Having established the SG as a communicational “*dispositif*” and co-design as a structured process of mediated collaboration, the next section presents the PRISMA-based systematic review of existing research at the intersection of these two fields, in relation to visual impairment and public space accessibility.

3. Method

The PRISMA method allows the identification of the most pertinent research work within a large corpus (Moher et al., 2009). We follow the protocol proposed by Gajewski et al. (2022): preparation, execution, and reporting (Kitchenham et al., 2007). We focused on articles published between 2015 and 2025 to capture current knowledge in a rapidly evolving technological domain. We searched four databases: (1) Open Alex for its openness, (2) Web of Science for its multidisciplinary scientific coverage, (3) Science Direct for applied sciences and health, and (4) Google Scholar for broad coverage and open access. Only English-language articles were selected for wider international coverage.

Our keywords were defined around the central theme of SG, combined with “visual impairments”, “co-design” and “accessibility”. We obtained 14 articles from Open Alex, 6 from Web of Science, 69 from Science Direct, and 74 from Google Scholar, totaling 163 articles integrated into the Rayyan tool for systematic review management. After removing 11 duplicates, 152 articles were screened by title and abstract, yielding 33 validated articles. After full-text assessment, 14 articles were excluded (wrong domain: 4; wrong population: 5; duplicate content: 2; non-English full texts: 3), resulting in 19 retained studies.

To address gaps identified in the areas of co-design method, game design frameworks, and educational game modeling, seven complementary articles were identified through expert consultation and included in the corpus to mitigate potential linguistic and database selection biases (Moher et al., 2009). These additions include works on formal game design models (Vermeulen et al., 2016; Guigon et al., 2018; Marne et al., 2021), co-design methods (Gajewski et al., 2021; El Mawas, 2014), participatory frameworks (Vargas et al., 2022), and computational thinking scenarios (Brunet et al., 2020). The final corpus comprises 26 studies (24 articles, and 2 books).

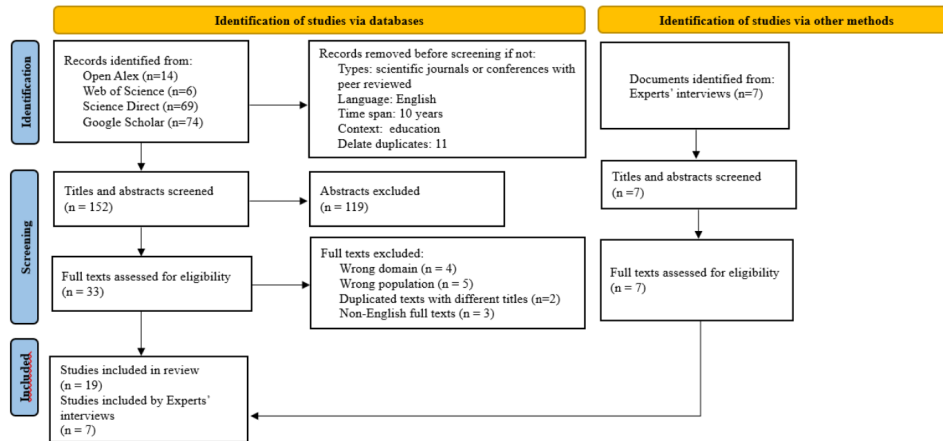


Figure 1: Flowchart completed following the steps of the PRISMA method

4. Results

Building on this PRISMA method, the following results present a structured analysis of the selected corpus, highlighting key trends in technological choices and co-design processes.

4.1 Technological Thematic Synthesis

The analysis of the 26 selected studies reveals a high heterogeneity of technological approaches, with no dominant standard. Five paradigms emerge.

Immersive and XR-based environments. Representing 3 out of 26 studies (Gatto et al., 2025; Chenais and Görgen, 2024; Palmquist et al., 2024) mobilize Virtual Reality (VR), Augmented Reality (AR), and Extended Reality (XR) as key drivers for interaction. These technologies rely on sophisticated ecosystems (Unity, XR toolkits, tracking systems), enabling high levels of immersion. However, they remain resource-intensive and less focused on accessibility. Conversely, 23 out of 26 studies do not engage with immersive technologies.

Multimodal accessibility-oriented technologies. 5 out of 26 studies (Agrimi et al., 2024; Coronado et al., 2023 ; Chai et al., 2019; Gamage et al., 2024; Pissaloux and Velazquez, 2018) illustrate systems based on sonification, binaural audio, haptic feedback, and assistive navigation. These systems prioritize usability and perceptual adaptation over graphical complexity, often deployed on mobile or lightweight platforms.

Low-tech and pedagogical environments. Representing 6 out of 26 studies (Hainey et al., 2016; Campisi et al., 2021; Ran et al., 2025; Sari et al., 2019; Guigon et al., 2018; Gajewski et al., 2021) highlight simple design tools or non-digital prototyping approaches. These works support learning-by-design processes and enable non-expert users to engage in content creation.

Socio-technical and design-oriented platforms. 4 articles out of 26 studies (Rustemeier et al., 2021; Marne et al., 2021; El Mawas, 2014; Mattheiss et al., 2017) focus on web-based platforms, authoring tools, and collaborative infrastructures. These approaches emphasize interaction between actors, traceability, and adaptability, positioning technology as a support for design processes.

Tangible and embodied interaction. 3 out of 26 studies (Chibaudel et al., 2020; Metatla et al., 2020; Pissaloux and Velazquez, 2018) explore robots, tactile maps, and physical artefacts, representing. These approaches support spatial cognition through embodied interaction and multisensory engagement.

A cross-cutting finding is that over half of the studies (16 out of 26) does not explicitly specify game engines, programming languages, or detailed software architectures. This suggests that the technological dimension is often secondary to usage, design processes, and accessibility concerns. From an ICS perspective, technologies are therefore primarily considered as mediating devices embedded within socio-technical systems rather than as ends in themselves.

4.2 Co-design Synthesis

The analysis reveals a progressive but uneven transition from top-down design toward participatory co-design. Three types of design organization are identified.

Top-down design. Eleven out of 26 studies do not explicitly address participatory processes (Hailey et al., 2016; Campisi et al., 2021; Agrimi et al., 2024; Ran et al., 2025; Chai et al., 2019; Sari et al., 2019; Guigon et al., 2018; Gamage et al., 2024; Vargas et al., 2022; Chenais and Görgen, 2024; Pissaloux and Velazquez, 2018). The user remains a represented user (Akrich, 1998): a figure inscribed by designers into the technical script but absent from the design process. This approach privileges technical mediation while neglecting social mediation (Jouët, 1993).

User-Centered Design (UCD). Six out of 26 studies adopt an intermediate approach (Coronado et al., 2023; Rustemeier et al., 2021; Othman et al., 2023; Itzhak et al., 2022; Palmquist et al., 2024; Marne et al., 2021). Users are involved through testing and evaluation, acting as informants who adjust the technical script after it has been written but do not participate in its initial elaboration. The "*dispositif*" is evaluated at the functional level (Albero, 2010), but the gap between prescribed and lived experience remains partially unaddressed.

Participatory co-design. Eight out of 26 studies explicitly integrate co-design as a central approach (Gatto et al., 2025; Chibaudel et al., 2020; Metatla et al., 2020; Mattheiss et al., 2017; El Mawas, 2014; Gajewski et al., 2021; Brunet et al., 2020; Marne et al., 2021). Users co-write the technical script rather than merely responding to it. The "*dispositif*" is engaged at the level of lived experience (Albero, 2010), articulating both technical and social mediation (Jouët, 1993). In one case (Marne et al., 2021), the analysis suggests an evolution toward meta-design, where users gain the capacity to appropriate and reconfigure the design environment itself.

The results highlight a fragmented design landscape, in which approaches are driven by usage contexts, accessibility objectives, and disciplinary traditions rather than by standardized co-design methods. From an ICS perspective, this shift moves from the design of technical artefacts toward the construction of socio-technical "*dispositifs*", where users emerge as active contributors to the production, circulation, and transformation of knowledge.

5. Discussion

The following discussion examines co-design as a communication process, focusing on the double mediation at play and on how experiential knowledge circulates and is transformed within these socio-technical configurations.

5.1 Co-design as a Communication Process: The Double Mediation

The transition from top-down to co-design can be analyzed through the theory of double mediation (Jouët, 1993). Any technology-mediated practice is simultaneously shaped by technical mediation, in which the tool structures the practice, and a social mediation, in which usages are shaped by social relationships, identities, and contexts.

In top-down approaches, technical mediation dominates. SG is conceived as a tool whose properties determine its effects. Accessibility features and game mechanics are selected primarily on technical criteria, with limited consideration for social context or user participation (Hailey et al., 2016; Campisi et al., 2021; Agrimi et al., 2024; Ran et al., 2025; Chai et al., 2019; Sari et al., 2019; Guigon et al., 2018; Gamage et al., 2024). Users are mainly considered through predefined needs or abstracted profiles, reinforcing a design logic centered on the artefact rather than on situated practices.

In UCD approaches, social mediation begins to be acknowledged through user testing that challenges embedded assumptions, although its integration remains partial and asymmetrical, filtered through the researchers' approach (Coronado et al., 2023; Rustemeier et al., 2021; Othman et al., 2023; Itzhak et al., 2022; Palmquist et al., 2024; Marne et al., 2021), where users provide feedback that contributes to refining usability and accessibility features, while not being directly involved in the initial design process. Here, the "*dispositif*" (Peraya, 1999) is evaluated at the functional level, yet the gap between prescribed and lived experience remains only partially addressed.

In co-design (Gatto et al., 2025; Chibaudel et al., 2020 ; Metatla et al., 2020 ; Mattheiss et al., 2017; El Mawas, 2014; Gajewski et al., 2021; Brunet et al., 2020) approaches the design process becomes a space of communication where actors negotiate meaning, exchange experiential knowledge, and co-construct the "*dispositif*" (Peraya, 1999) where users actively contribute to the definition of interactions, scenarios, or game structures. In these cases, experiential knowledge such as spatial perception, mobility strategies, and accessibility constraints is progressively translated into design choices through iterative collaboration. Some contributions, such as Marne et al. (2021), even suggest a shift toward meta-design, where users gain the ability to appropriate and reconfigure the design environment itself.

This articulation of mediations is also supported by studies focusing on accessibility and spatial cognition (Pissaloux and Velazquez, 2018; Gamage et al., 2024; Agrimi et al., 2024), which highlight how user experience and environmental constraints must inform design decisions. These works reinforce the idea that effective design cannot rely solely on technical optimization but requires the integration of situated knowledge.

The concept of mediation thus allows overcoming the binary opposition between subject and object, individual and organization, and technology and society, by conceptualizing a triadic relationship between individual, technology, and organisation (Bernard, 2000). From this perspective, SG design for accessibility can be understood as a socio-technical process in which meaning, use, and function emerge from the interaction between these three dimensions.

5.2 The Circulation and Transformation of Experiential Knowledge

The co-design of a SG intended to raise awareness about VIP involves a communicational challenge: the experiential knowledge of VIP must circulate from one group of actors to another, from VIP experts to game designers and then to urban planners. These dimensions are documented in the literature regarding mobility practices and environmental constraints (Campisi et al., 2021; Pissaloux and Velazquez, 2018; Gamage et al., 2024), as well as spatial cognition and multi-sensory interaction (Chibaudel et al., 2020; Metatla et al., 2020). Other studies highlight how user experience and accessibility constraints emerge through interaction with technological systems and environments (Agrimi et al., 2024; Coronado et al., 2023; Chai et al., 2019).

This process can be understood as a form of triviality (Jeanneret, 2008): the circulation of cultural beings through society, which necessarily involves their transformation. No transmission occurs without alteration. As experiential knowledge is translated into game mechanics, transposed into a digital environment, and received by a new public, it is rewritten, recontextualised, and reinterpreted at each stage. This dynamic is observable in studies where user experience is progressively integrated into design processes (Gatto et al., 2025; Mattheiss et al., 2017; and Gajewski et al., 2021), as well as in platforms supporting iterative design and knowledge transformation (Rustemeier et al., 2021; Marne et al., 2021; El Mawas, 2014).

This has two implications. First, it explains why top-down approaches, which assume direct and stable transmission of knowledge, fail to account for the transformations occurring during design and usage. Indeed, several studies adopting such approaches rely on predefined representations of users without integrating their situated experience (Hainey et al., 2016; Sari et al., 2019; Ran et al., 2025; Guigon et al., 2018). These approaches overlook the variability and contextual nature of experiential knowledge, particularly in relation to accessibility and spatial practices.

Second, it provides a theoretical justification for co-design as a methodological necessity: the knowledge involved is experiential and situated, it cannot be extracted or formalized without the active participation of those who hold it. This necessity is reflected in studies explicitly involving users in the design process, where knowledge emerges through interaction, negotiation, and iteration (Chibaudel et al., 2020; Metatla et al., 2020; Mattheiss et al., 2017; Gajewski et al., 2021). In these contexts, users do not simply provide feedback but actively contribute to shaping the design, allowing experiential knowledge to be translated into meaningful and usable artefacts.

Studies focusing on collaborative design environments and iterative development processes (Rustemeier et al., 2021; Marne et al., 2021), where knowledge is continuously reconfigured through interaction between actors.

In this sense, the SG becomes a socio-technical space of mediation, in which the SG functions not as a vehicle for pre-existing knowledge, but as a mediating “*dispositif*” (Peraya, 1999) through which new meanings are collectively produced and in which experiential knowledge is not transmitted but transformed through collective activity.

5.3 Transversal Dimensions

Several transversal dimensions’ structure co-design practices across the 26 studies included in the review. The diversity of actors increases significantly in participatory approaches, bringing together VIP users, educators, therapists, and caregivers (Pissaloux and Velazquez, 2018; El Mawas, 2014; and Gajewski et al., 2021). Iterative methods are widely adopted, though their depth varies: in UCD, iteration adjusts the technical script; in co-design, it redefines objectives, rules, and scenarios. Co-design activities are predominantly situated and in-person, particularly significant given that VIP rely on embodied, multisensory interaction. Remote collaboration remains exceptional (El Mawas, 2014). The temporal dimension varies from short workshops to long-term

processes, with longer processes producing deeper participation though this requires further longitudinal validation (Hassan, 2024).

Finally, the social link emerges as a transversal finding across all 26 selected studies. Whether the focus is urban displacement (Campisi et al., 2021), museum accessibility (Gatto et al., 2025), game-mediated interaction (Agrimi et al., 2024; Chibaudel et al., 2020), or learning (Othman et al., 2023; Itzhak et al., 2022), the digital object consistently functions as a mediator of social relationships. This reinforces the ICS reading of the SG as a communicational “*dispositif*” whose primary function is not content transmission but the production and transformation of social bonds.

5.4 Deduction

The co-design analysis reveals a conceptual evolution from UCD (evaluation-oriented) to co-design (participation-oriented) and meta-design (appropriation-oriented). Framed within ICS, this gradient corresponds to a shift from technical mediation alone to the articulation of both mediations (Jouët, 1993, 2000); a transition from the represented user to the user as actor of innovation (Akrich, 1998); a progression from the ideal to the lived dimension of the “*dispositif*” (Peeters and Charlier, 1999; Alberio, 2010); and a recognition that knowledge is not transmitted but transformed through successive mediations (Jeanneret, 2008, 2014).

6. Conclusion and Limitations

6.1 Limitations

This review presents several methodological limitations. First, the selection of databases may introduce a structural bias, as it likely excludes relevant contributions indexed in other disciplinary or regional repositories. Second, the corpus was exclusively English language, we added francophone contributions where ICS theoretical resources on “*dispositifs*” and mediation are substantial, but it is only a selection. A complementary english and francophone review is planned. Third, the classification of design approaches along the proposed gradient involves a degree of subjectivity. Finally, the ICS theoretical framework has not yet been empirically tested. The present article offers a conceptual mapping that will be confronted with fieldwork in subsequent phases.

6.2 Conclusion

This paper presented an enhanced systematic literature review based on the PRISMA method, examining 26 studies on the use of SGs in relation to visual impairment, co-design practices, and public space accessibility. It addressed two main questions. First, which technological approaches are mobilized in the design of SGs aimed at raising awareness of visual impairment or supporting VIP? It appears that immersive XR/VR environments, multimodal audio-haptic systems, mobile and web-based accessible platforms, tangible and robotic interfaces, adaptive assistive technologies, and collaborative design tools are mobilized, reflecting a strong emphasis on accessibility, sensory substitution, and user-centered interaction in SGs aimed at supporting or raising awareness about visual impairment. From an ICS perspective, the critical variable is not the level of technology itself, but the way technology mediates interaction, perception, and meaning within specific contexts of use.

Second, how are co-design practices articulated around the different stakeholders (VIP experts, technical experts, researchers) in the design of these SGs? The co-design analysis, grounded in ICS theoretical structure, demonstrated that co-design operates not merely as a methodological choice but as a communicational necessity: the experiential knowledge of VIP cannot be transmitted without transformation, and the active participation of knowledge holders is required to ensure meaningful circulation of that knowledge through the “*dispositif*”.

A transversal finding is the centrality of social bonds: the digital object consistently functions as a mediator of social relationships.

These results open several perspectives. The most immediate one is the proposition of a structured co-design method, derived from the gaps and convergences identified in this state of the art. It would operationalize the collaboration between VIP experts, researchers, and developers articulated from lived experience to game, and from game to new public.

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