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The potential of street-level and 3D views: Making public participation in urban planning more accessible to people with cognitive disabilities

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Abstract. Tools for public participation in urban planning processes often assume basic map literacy. People with cognitive disabilities are therefore usually excluded. This work examines whether street-level views and 3D views can make participation more inclusive, and identifies group-specific requirements for participation tools. We have developed and evaluated a demo tool in collaboration with a group of people with cognitive disabilities. The results show that many participants are able to recognize locations more easily in 3D views and street-level views than on the map. Combinations of different views have also shown to be beneficial. High resolution and broad availability of data are important, as are suitable conditions, such as assistance and support for alternative input devices. The study also highlights the need to further develop open-source map alternatives and open data.

Submission Type. analysis; case study

BoK Concepts. [CV6] Usability of maps; [GS6] Critical approach; [GS4] Geospatial citizenship

Keywords. cognitive disabilities, public participation, street-level view, 3D, usability testing

1 Introduction

Map-based online platforms for public participation have become widely used tools to involve the public in decision-making processes. Maps are also a common way to share information and opinions in local participation workshops. These practices limit or even exclude individuals who lack the required basic map-reading abilities, e.g., due to cognitive disabilities. Compared to conventional 2D maps with a bird's-eye view, photorealistic 3D models can aid the recall of spatial knowledge and contribute to efficient decision-making (Liao et al., 2017). The purpose of this work is to explore how participatory methods can be complemented by street-level views and 3D views in order to provide better access to people with cognitive disabilities. This study aimed to answer the following research questions:

1. How suitable are 3D views and street-level views to support people with cognitive disabilities in participatory processes?
2. What specific requirements do people with cognitive disabilities have for a participation tool?
3. What are the necessary non-software-related prerequisites and external conditions for successful use of the tool in terms of assistance, devices and practice?

To answer these questions, a demo tool has been developed that allows the different views to be tested separately or in combination. The tool's usability has been evaluated in user tests with individuals with cognitive disabilities.

2 Background

Different demographic groups participate in political activity and urban planning projects to varying degrees depending on their socioeconomic status (Brady et al., 1995; Panyavaranant et al., 2023; Mahjabeen et al., 2009). Terashima and Clark (2021) pointed out that there is only a very limited number of papers in planning research on topics related to people with disabilities, and many of these papers call for participation by people from this group. Public Participatory GIS (PPGIS) allow participants to dynamically interact with spatial information, analyze alternatives, and empower different groups, but they also have the potential to further sideline those without access to or understanding of the technology (Sieber, 2006). During the COVID-19 pandemic, the use of digital engagement technologies in the field of urban planning increased rapidly, perpetuating unequal practices (Estefam, 2021).

To make participation tools more accessible to people with disabilities, software accessibility guidelines should be used, such as the W3C *Web Content Accessibility Guidelines (WCAG) 2.1 2025* (W3C, 2025) and their supplement *Making Content Usable for People with Cognitive and Learning Disabilities* (W3C, 2021). These guidelines point out the importance of familiar mechanics, terms, and symbols, as well as a clear layout and simple language. They also highlight the need to support assistive technologies and to include people with cognitive disabilities in the entire development process. External conditions during software use must also be considered, as people with cognitive disabilities often have individual strategies to overcome barriers, including the use of personalized devices, handwritten notes, or asking others for help (Ågren et al., 2020). There are no specific guidelines on how to make geospatial software usable for people with cognitive disabilities. However, previous studies show that tools that rely completely on maps could be difficult to use for this group, especially because reading a map involves decoding the graphics (Hemmer et al., 2010), which requires knowledge of the symbols used or the use of a legend. Some have difficulties with mental rotation (Meneghetti et al., 2018), while others are unable to link images and paths in a configurational representation of space (Antonakos, 2004).

Building participation tools based on 3D and street-level views as map alternatives requires the corresponding data sources. Google provides its widely used *Street View* imagery and 3D views via APIs. Alternative services such as *Mapillary* and *KartaView* use crowd-sourced pictures and provide them as open data. However, they lack consistent data quality, completeness, and immersive visualization. While alternatives at the municipal or regional level do exist, they are usually not available to the public and/or use proprietary technology, thus hampering reuse.

3 Methods

3.1 Participants

The participants are co-researchers in a larger project, working alongside university researchers to make digital participation - including the use of maps - more inclusive. The participants are 5 young male adults with various disabilities and neurodiversities associated with physical and cognitive symptoms. Diagnoses include Prader-Willi syndrome, ADHD, and autism. One person has spasticity. They have different levels of independence. Some of them live in residential facilities, while others have supported living arrangements or participate in other programmes for people with cognitive disabilities. Most of them can read and write simple words, but prefer to use voice (messages) for communication rather than texting. Two preparatory workshops were carried out with the co-researchers to find out about their previous experience and problems with digital devices and discuss the topic of digital maps, 3D views and street views. The results of the workshops showed that the participants have used smartphones, laptops, and Google Maps before. They don't use voice control for applications. One participant has used a screen reader before, but does not use it regularly. The workshops also included a short introduction to Google Street View and Google Maps 3D. Most participants were able to use the tools effectively after a brief introduction. However, switching between them was difficult. This led to the idea of a tool that combines the views in a simple way.

3.2 Ethical Considerations

Ethical approval was not required for this study. However, ethical reflection was done to consider the impact on participants and how to respond appropriately to challenging situations. The criteria for the ethical reflection in this work are based on the Research Ethics Code by the German Association of Social Work (DGSA, 2020). The code sets out how the rights of research participants are to be protected, with regard to minimal burden and risk, participation, and informed consent. As presented by Oswal (2025), to develop accessible software, it is not enough to simply meet legal and industry standards. Manual testing is necessary. The test is limited to one hour to reduce fatigue. Facing barriers and the resulting sense of being overwhelmed could lead to psychological stress. Therefore, the interviewer made clear that the test is not about assessing individuals' abilities and that every discovered difficulty is helpful. At signs of frustration, it was necessary to consider whether to take a break, or skip a point. Participants may have forgotten that they had the option to say no and interrupt. Within the scope of this study, it was not entirely possible to involve all groups relevant to the research and avoid reproduction of social exclusion. All participants already possessed the physical, cognitive and linguistic abilities required to take part in the research group in the first place. Other groups without these abilities, who did not live in a facility and who had only limited access to media or advice centres were therefore not included. Informed consent was obtained through a presentation of the proposed research project accompanied by a handout containing images and simple language. The consent form and a privacy policy are also provided in simple language.

Figure 1. Example of a parklet

3.3 Demo Tool

A demo tool was developed using HTML, JavaScript, and the Google Maps API. For the user test, the participants are asked to find a suitable location for a parklet (a mobile city furniture that can be placed, e. g., on former parking lot areas, see Fig. 1). In the demo tool, three stages are prepared. In the first stage, three different views are tested separately: map (Fig. 2), 3D (Fig. 3), and street-level (Fig. 4).

Figure 2. User test stage 1 - map view
heading: "Pick a nice spot for a parklet."
button label: "Draw marker here!"

Figure 3. User test stage 1 - 3D view

Figure 4. User test stage 1 - street view

In the second stage, the participants can switch between the three views, while the indicated position on the map stays the same across views (Fig. 5).

Figure 5. User test stage 2 - changeable view
upper button labels: "map - street - 3D"

In the third stage, the screen is divided into two areas, with a map on the left and a street-level view on the right (Fig. 6). The sides sync automatically, with an emoji icon on the map showing the exact position of the street-level view.

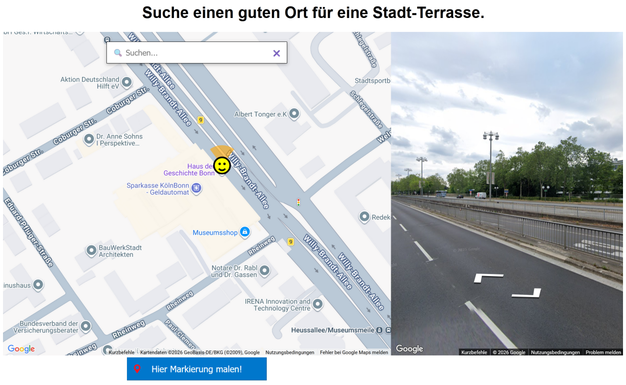

Figure 6. User test stage 3 - split view

At each stage, a marker can be placed to indicate a desired location for a parklet.

3.4 User Tests

The user tests were conducted with individual participants as semi-structured interviews and Thinking-Aloud-Tests. They were structured as follows: The introduction was kept as relaxed and casual as possible to make sure the participants were not stressed or nervous. They were reminded once again that they can stop any time and that the aim is to test the tool, not the person. To take into account the participants' different skills and experience with technical devices, they could decide whether to work on a laptop or a tablet. Before the test began, there was a short introduction to the topic of parklets using photos of real-life examples, to ensure that the participant knew the topic under discussion.

The participants were invited to start with the view that they considered the simplest, so the beginning of the test was as easy and encouraging as possible. The views were initially zoomed to a location which they are all familiar with and which is in the same city in which they live. The participants were allowed to move freely in the different views and were guided through the three stages by the interviewer. They were asked to share their thoughts as they operated the tool. If not much feedback was communicated, further questions were asked as necessary. These included questions about orientation, e. g., whether the person already has a location in mind, whether they know the location in the view, or whether they find it difficult to navigate and set the marker.

3.5 Collection and processing of data

During the test, speech and screen were recorded. Afterwards, the audio was transcribed, and the transcript was supplemented with observations from the screen captures and coded using a deductive-inductive approach. Per single view (map, 3D, and street-level), there are the categories *orientation*, *control*, and *general evaluation*. Per combined view (changeable view and split view), there are the categories *practicality*, *operability*, and *suggestions for enhancement*. In addition, the categories *expected simplest view*, *search function*, *bugs*, *assistance*, *input device*, and *general suggestions* were defined.

3.6 Data and Software Availability

The coded interview data cannot be made available due to sensitive personal data on vulnerable groups (e. g. place of residence / frequently visited places). However, the demo tool code is available at https://github.com/DiKomAll/street_view-3d-map-demo. A Google Maps API key is required to use the application in full.

4 Results

4.1 Applicability of the different views

In the map, when the participants were asked what they recognize or what they use to orient themselves towards, they mentioned street names, specific supermarkets, bus lines, or the name of a certain takeaway. The texts, the recognizability of water through blue color, and the recognizability of pathways and streets were mentioned as positive aspects. One also stated that the map is "a good overview, without somehow having too much". The aspect that most negatively affected the applicability of the map was the inability to clearly see what it looked like at a given location. For that reason, one of the participants was unable to choose a location for the parklet using only the map. Another participant said they would be unable to find the same location on the map again that they selected in another view. One participant placed a marker directly on the caption of a place, without trying to find the more precise position considering the street geometry.

For orientation in the 3D view, streets or street names were again important, as well as certain companies or stores. Sometimes participants could determine positions more precisely, but one found the 3D view difficult because they could not see all the names of the shops. Another obstacle to orientation were trees. They often covered the streets, so they were not completely modeled at some places. Two participants said they liked about the 3D view that one can easily imagine the places. Compared to the street-level view, it can show places that are not accessible via the road. One participant described the colors as pale and suggested to improve them. For that reason, they had difficulties finding a certain place precisely.

Orientation seemed easy for the participants in the street-level view, since three of them directly "walked" from the starting position to find their locations. The other two used the search function and recognized the place, although one of them was only successful at the second attempt. However, problems occurred when the boundaries of the area available in StreetView were reached, and the participants could not go any further. Like in 3D, the possibility to see what the places really looked like, was well received. The participants asked for a better area coverage of the imagery beyond the street network, which could be collected by cameras mounted on bicycles or backpacks. They also suggested ways to make the moving around more intuitive: the image should be clearer and less distorted when moving from one place to another and the camera angle should match the direction of movement.

4.2 Other hints to group-specific requirements for participation tools

The changeable view was only helpful for a few participants. In some cases, the different views were not linked to each other, or the view was not changed at all. Only one participant clearly benefited from the changeable view. The split view was both praised and met with a lot of critical feedback and suggestions for improvement: All the participants found it useful or rated it positively, but the movement of the emoji could be improved, and it should be possible to place the marker on the street-level view instead of the map. It was also observed that some participants only used the street-level view on the right side, and the map view on the left side seemed to receive little attention.

While using the search function, spelling mistakes were a problem. Although the search function supports fuzzy searches, too many spelling errors led to zero results. Another problem was multiple results with the same name: A search for a certain supermarket with several stores in the city led to a different store of the supermarket chain. Also, the search function only allows clicking on one result, and does not support free search with multiple results. To click on the right suggestion, knowing further information, such as the street name, was required.

Some of the participants made other suggestions for improvement: Usability should be improved for people with visual impairments. A poll could be integrated to rate different parklet locations, using emojis or colors. Instead of only two views in the split view, there could be all three.

4.3 Prerequisites and external conditions

Most of the participants received slight assistance, mostly to remind them of certain control options, the possibility to change the view, or to remind them that they can start from wherever they want. One participant did not need any assistance. Another participant was unable to use a standard computer mouse due to spasticity, so a joystick mouse was used instead. They still had many difficulties, including moving the mouse in an undesired direction, confusing the mouse buttons, and being unable to turn the street-level view around via drag-and-drop, which required substantial assistance. However, they said that with a little more practice, they would become better. They also agreed that the tool could be better adapted to this kind of input device.

5 Discussion

Results show that using only maps in a participation tool disadvantages some people because they cannot imagine what the places are like in real-life. The captions on the map were very important to most of the participants. One reason could be that some were not able to make significant use of the geometries, which aligns with the studies about mental rotation ability and linking images and paths (Meneghetti et al. (2018), Antonakos (2004)). In some cases, 3D views can enhance the ability to imagine a certain place. However, current technical limitations restrict usability in certain cases, so that the graphics were too blurry or covered by trees for some people to recognize things. The street-level view worked well and was very intuitive for the available areas, but there are still too many areas missing, so that not every desired location can be found. Combining the views with the split view was received very positively. The real use of it still remains unclear, because some participants only seemed to look at one of the sides. This can only be proven using advanced methods, such as eye-tracking.

Some participants found the search function confusing because they sometimes got zero or too many results. The search function could be improved by adding pictures or an (AI-based) assistant that asks further questions about the desired place. In combination with voice input or voice assistance, spelling errors could be avoided.

The user test with the joystick mouse showed that tools have to be adapted to alternative input devices. This does not just mean supporting the hardware on a technical level, but also offering alternative control options. One possible option would be that the street-level view can be moved directly with a joystick, like in a video game, without first pressing a button. Rather than using the drag-and-drop mechanism designed for a standard mouse, this could be more intuitive.

The test results are not analyzed separately by diagnosis, because doing so could lead to false conclusions due to the small number of participants. The aim of this study is to demonstrate the wide range of user requirements.

6 Conclusions and future work

This work shows that 3D and street-level views can be used to make participation tools more accessible to people with cognitive disabilities (research question 1). To make tools suitable for this target group, the quality of 3D views and the data availability in street-level views are important. Combining different views, or changing the view on demand, can support some people. However, the best ways to combine views still remain to be explored. Furthermore, easy and fail-safe search functions that do not depend on correct spelling and knowledge of exact addresses have to be developed (research question 2). The necessary external conditions include a comprehensive introduction to the system, assistance being provided when needed, and the option to use alternative input devices (research question 3). In future research, similar improved tools should be tested in a practical setting, e. g. in internet participation processes or in moderated group workshops. In order not to rely on Google products, there is a high demand for investigating alternatives. Regarding 3D views, there are many current developments, also from public institutions. For street-level views, real alternatives for Street View are still needed.

Declaration of Generative AI in writing

The authors declare that they have used Generative AI tools for interview transcription, language checking and improvement in the preparation of this manuscript. All intellectual and creative work, including the analysis and interpretation of data, is original and has been conducted by the authors without AI assistance.

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