12-15-2022

# Webinar: Individual Wayfinding in the Context of Visual Impairment, Blindness, and Deafblindness

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# EMPOWERING INDEPENDENT NAVIGATION: APH AND PSU

Dr. Martin Swobodzinski
Dr. Amy Parker
Elizabeth Schaller
Denise Snow

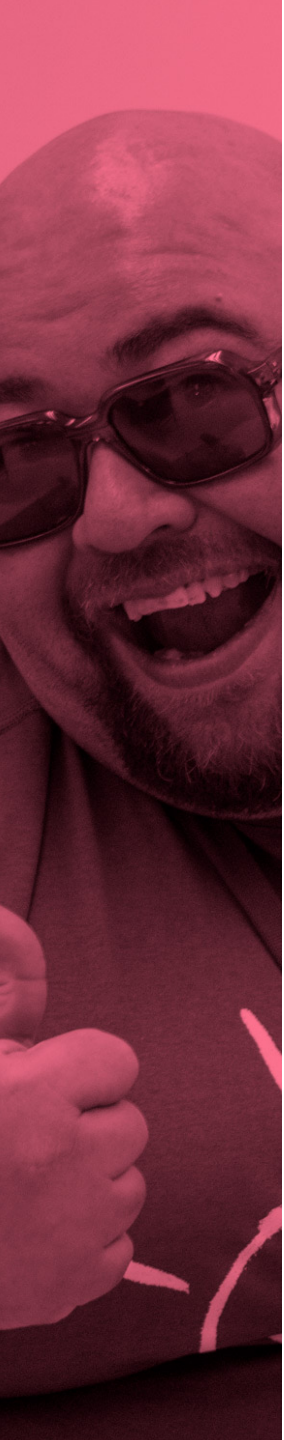# National Institute for Transportation and Communities (NITC)

This project is funded by the National Institute for Transportation and Communities, a U.S. DOT University Transportation Center.

NITC grants require "match" funds from partners in terms of time from staff. APH was a multi-year supporter of this work.

# ACCESSIBLE CITIES

APH's Leadership on Accessible Cities

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# Accessible Cities Partnership with PSU

- Research on a national and local level:

  - 449 in-person surveys – ACB, NFB, AER-O&M International, KNFB, and KCB

  - 522 online survey respondents

  - <span style="color:#E8416E">Transportation</span>, Shopping, and Workplace/Daily living

- Indoor Navigation Symposium

- NITC Grant with Portland State University

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# Learning Outcomes

Explore the University of California Santa Barbara (UCSB) Sense of Direction Scale

Understand the navigation preferences of travelers

Discuss supports for seamless navigation

Explore ways to create sustainable impacts in cities where you live.

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"Human wayfinding and navigation are key organizing activities that allow human beings to acquire knowledge about the environment and develop cognitive representations in support of such essential tasks as route planning and travel."

Swobodzinski, M. & Parker, A.T. (2019). A Comprehensive Examination of Electronic Wayfinding Technology for Visually Impaired Travelers in an Urban Environment: Final Report. NITC-RR-1177. Portland, OR: *Transportation Research and Education Center* (TREC). https://nitc.trec.pdx.edu/research/project/1177

# Multi-Year Investigation- 2018-2022

Our project was funded by two NITC grants. Across the two, the team focused on:

1) A structured literature and digital marketplace review of smartphone-based wayfinding apps and related technology

2) Focus groups with blind, deafblind, and visually-impaired participants as well as professional Orientation and Mobility instructors

3) A case study with a Deafblind participant

4) A scholarly literature review on wayfinding technologies

5) A mixed-method study with teenage and adult participants that compared wayfinding tasks using maps or wayfinding technologies
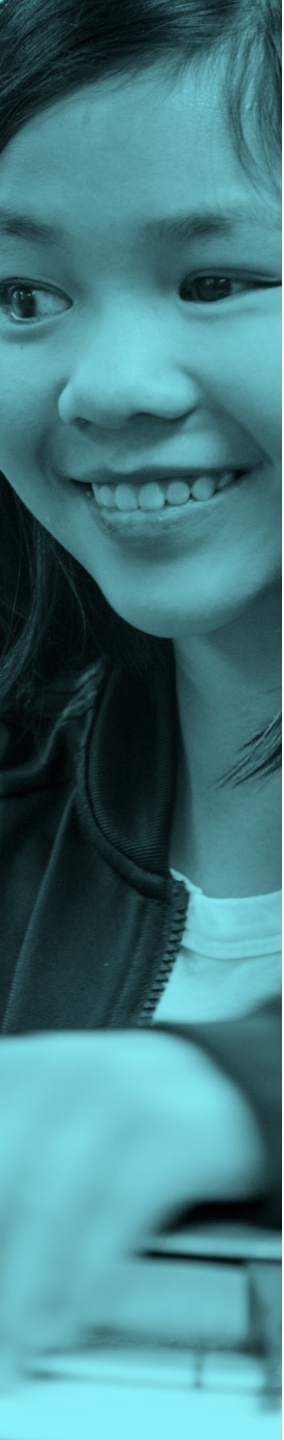
# UNIVERSITY OF CALIFORNIA SANTA BARBARA (UCSB) SENSE OF DIRECTION SCALE

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# UCSB – used in case study and mixed-method group study

It's not important to me to know where I am.

I can usually remember a new route after I have traveled it only once.

I don't have a very good "mental map" of my environment.



Survey:

https://forms.office.com/r/t8vGUEiCMq
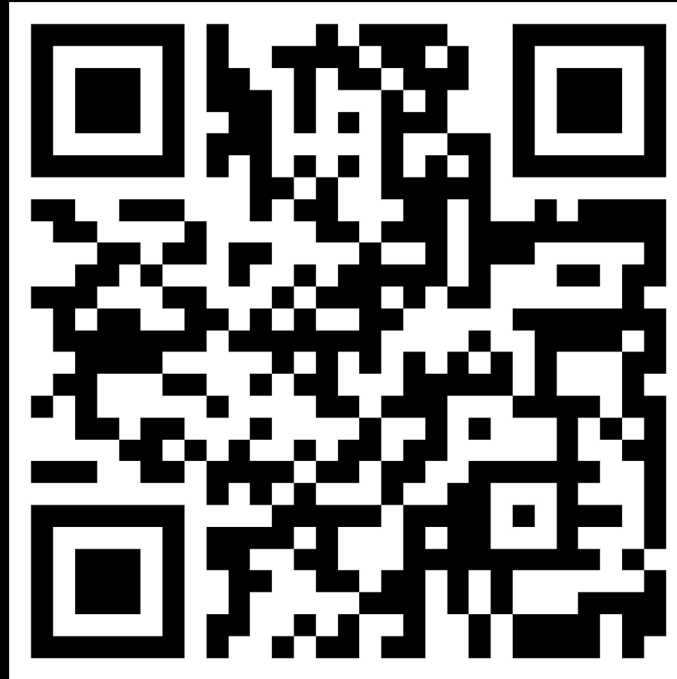
I am very good at giving directions.

I tend to think of my environment in terms of cardinal directions (N, S, E, W).

Reference: Hegarty, M. Richardson, A. E., Montello, D. R., Lovelace, K & Subbiah, I. (2002). Development of a Self-Report Measure of Environmental Spatial Ability. Intelligence, 30, 425-447.

# Discussion: Implications for Educators – UCSB Scale

The journey to adulthood, college and career readiness, is complex.

Environmental literacy, comfort with technological tools, orientation and mobility, self-determination, self-advocacy are vital skills that require direct instruction and practice for students with visual impairments and deafblindness.

Facilitating opportunities and experiences requires thoughtful collaboration and partnership. Youth are a part of this partnership!

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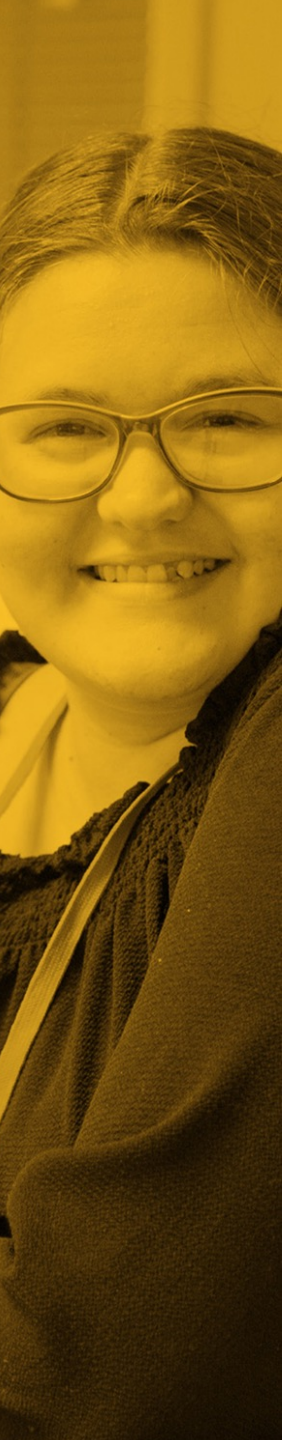
# SYSTEMATIC REVIEW AND FOCUS GROUPS

## First NITC Grant

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# Method for the Systematic Review: 2007 to Present

- IEEE Xplore, Google Scholar, Web of Science, and Engineering Village to cull studies for analysis

- Google Play and the iTunes store

- The search terms "wayfinding", "visually impaired", "smartphone", and "mobile apps"were used in exhaustive combinations using the Boolean operators "AND" and "OR" to search several databases.

# Snippet from Categorization of Mobile Wayfinding Apps for Visually Impaired Pedestrian Travelers

| Application Name | Cost | Wayfinding Support | Operating System | Additional Hardware Needed? |
|---|---|---|---|---|
| Aira | High | Indoor and Outdoor | iOS and Android | Yes |
| Apple Maps | Free | Outdoor | iOS | No |
| Ariadne | Low | Outdoor | iOS | No |
| Arianna | Free | Indoor | Both | Yes |

Swobodzinski, M. & Parker, A.T. (2019). A Comprehensive Examination of Electronic Wayfinding Technology for Visually Impaired Travelers in an Urban Environment: Final Report. NITC-RR-1177. Portland, OR: *Transportation Research and Education Center* (TREC).

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# Synthesis from Structured Review of Apps

Our technology review revealed that many apps have one or two areas of wayfinding that they focus on and few if any address the information needs of blind, visually impaired, and deaf-blind travelers across the *complete trip.*

That is, 1) plan and book a trip, 2) travel to transit station, 3) ride bus/transit, 4) cross streets/intersections, 5) arrive at destination.

In addition, it is apparent that the artificial separation between indoor and outdoor travel prevails, even as it comes to conceptualizations of the complete trip.

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# Qualitative Method

Focus groups:

    Blind and visually-impaired consumers (8)

    Deaf-blind consumers (9)

    O&M specialists (7)

Audio recordings and video recordings of focus groups

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# Method

We used a naturalistic inquiry approach within a qualitative descriptive design (Kim, Sefcik, & Bradway, 2017).

Purposive sampling allowed us to include the perspectives of adults with visual impairments and deafblindness across two distinct but similar urban settings.

# Results from the Focus Groups

As many navigation apps have limitations, it appears that blind travelers use multiple sources as a means of navigation. Many apps were identified as being used simultaneously for different aspects of the journey (i.e., BlindSquare used for intersection navigation in combination with Apple or Google maps for wayfinding).

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# Qualitative Content Analysis

Open coding

Creating categories

Abstraction

Meaningful patterns for exploring a model (ongoing)

Focus groups--descriptions of experiences in everyday language without high-level interpretation (Southall and Wittich, 2012)

# Analysis of Apps Mentioned in Focus Groups

## O&M Specialists

### Apps

BlindSquare, PDX Bus, Nearby Explorer, Apple Maps, Google Maps, Aira, Seeing AI, Soundscape, Be My Eyes, Siri, Lazarillo

### Devices

Bluetooth, RFID, iPad, iPhone, Android, BrailleNote (Touch), Trekker Breeze, iBeacons, Miniguide

### Assistive Software

Navigon

## Blind/Visually Impaired Consumers

### Apps

PDX Bus, BlindSquare, Trip Planner, Be My Eyes, Moovit, Apple Maps, Google Maps, Siri, Lyft/Uber, Soundscape

### Devices

iPad, headphones, iPhone/phone

### Assistive Software

Zoomtext, JAWS

## Deaf-Blind Consumers

### Apps

iMove, SenseNav, Transit App, Google Maps, One Bus Away, Seattle Metro Trip Planner, Google Earth, AT&T, Uber, Apple Maps, Waze. Moovit, Seeing AI

### Devices

iPad, Iphone, Iphone 6, Apple watch, Braille interface, guiding robots

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# Positive Themes from App Use

Three main themes emerged around the positive aspects of using wayfinding apps:

- increased access to environmental knowledge and literacy

- support for travelers during dynamic travel tasks (in the moment support)

- increased support in planning routes ahead of time

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# Challenges in App Use

Negatives overwhelmingly had to do with accessing a small screen, manipulating features on the phone, dropped signals, unreliability, inability to customize features for better access, and lack of adaptability.

# Comparison of Topic Items Discussed during Focus Group Sessions: Desires

| Visually Impaired/Blind | Deaf-Blind |
|---|---|
| The killer navigation app | Integration instead of proliferation of technologies |
| Alternative interfaces (spatial, non-audio) | Easy interface with braille; vibratory features |
| Matched, exact information (transit, rerouting, names of stops, alarms) | Apps to translate sound information for safety (sirens/alarms) |
| Seamless, real-time navigation (landmarks, POIs, distance, time) | Easy to enlarge, customize colors, and scale; control glare |
| Learn routes, reduce stress | |
| Coverage in rural areas | |
| Empathy, compassion, shared experiences | |

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# Social Aspects of Travel with Friends & Family

Some of the aspects of travel are social. Tasks can relate to providing support to travel companions or making social arrangements with companions.

I can give my friends directions, recommend restaurants near us

It makes me seem more independent with friends or family

I often compare apps with my brother

I recommend apps to my friends

When I am with my hard-of-hearing partner, I turn up the volume and let her use that feature

My friend was driving the wrong way, I could advise her

I take the lead and navigate with friends using my GPS

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# CASE STUDY–TRAVELER WITH USHER SYNDROME TYPE II

## Second NITC Grant

*In response to the pandemic, our recruitment was cut short, and we were only able to gather data initially on one person.

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# Purpose of This Study

- **Identify useful strategies and secondary support tools for people who are blind, deafblind, or low vision**

- **Investigate three specific secondary support tools:**

  - **Written directions**

  - **Tactile map**

  - **Smartphone navigation app**

# Case Study: Participant

- **32 years old male**

- **Combined visual impairment and hearing loss**

- **Some formal O&M training**

- **Primary Mobility Supports**

- **Secondary Supports**

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# Route Descriptions and Support Tools

| Route Name | Length in Steps | Number of Turns | Support Tool |
| --- | --- | --- | --- |
| 1. Smith to FMH Student Accounts | 177 | 5 | Technology |
| 2. Park Block to Library Café | 184 | 11 | Braille/Written/Audio Directions |
| 3. Lamp Post to FMH Room 100 | 192 | 10 | Tactile Map |

*Note.* Technology refers to the smartphone app, Nearby Explorer Online. Audio directions refer to written text accessed through a screen reader.

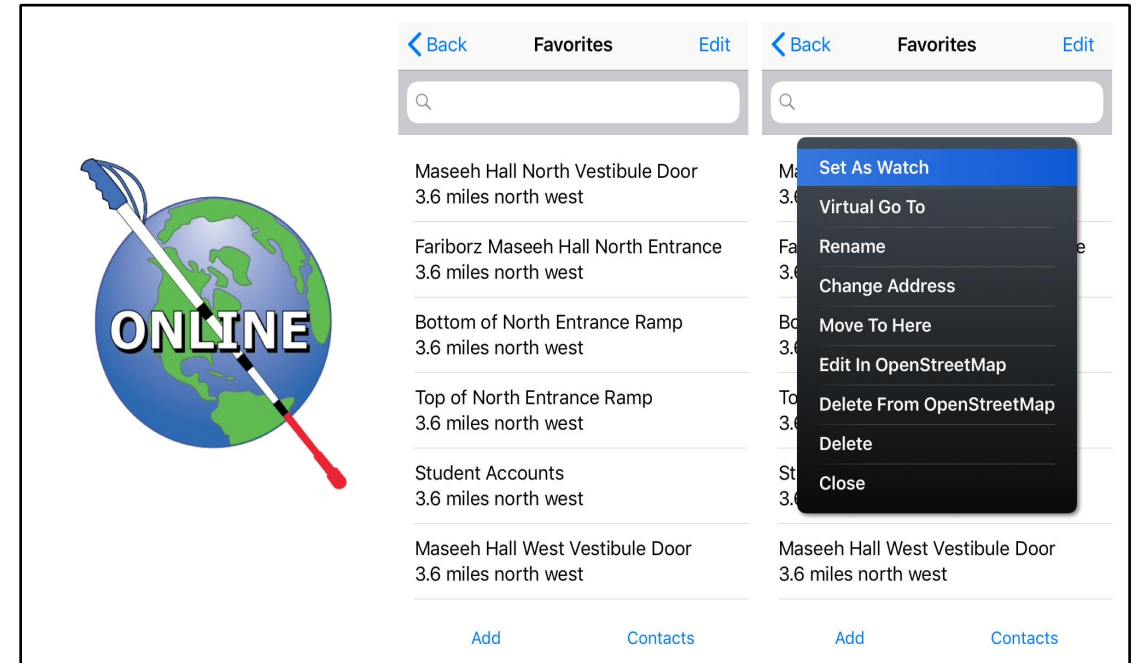empowered

# Route 1: Smith to FMH Student Accounts



Origin – East Door of Smith Memorial

Route – Outdoor, turns to FMH North Door

Route – Indoor, Entrance Ramp to 1st Floor

Destination at Red Dot – FMH Student Accounts

# Technology (Route 1 support tool)

- **APH's Nearby Explorer Online App**

- **Utilizes GPS when outdoors**

- **Utilizes beacons when indoors**
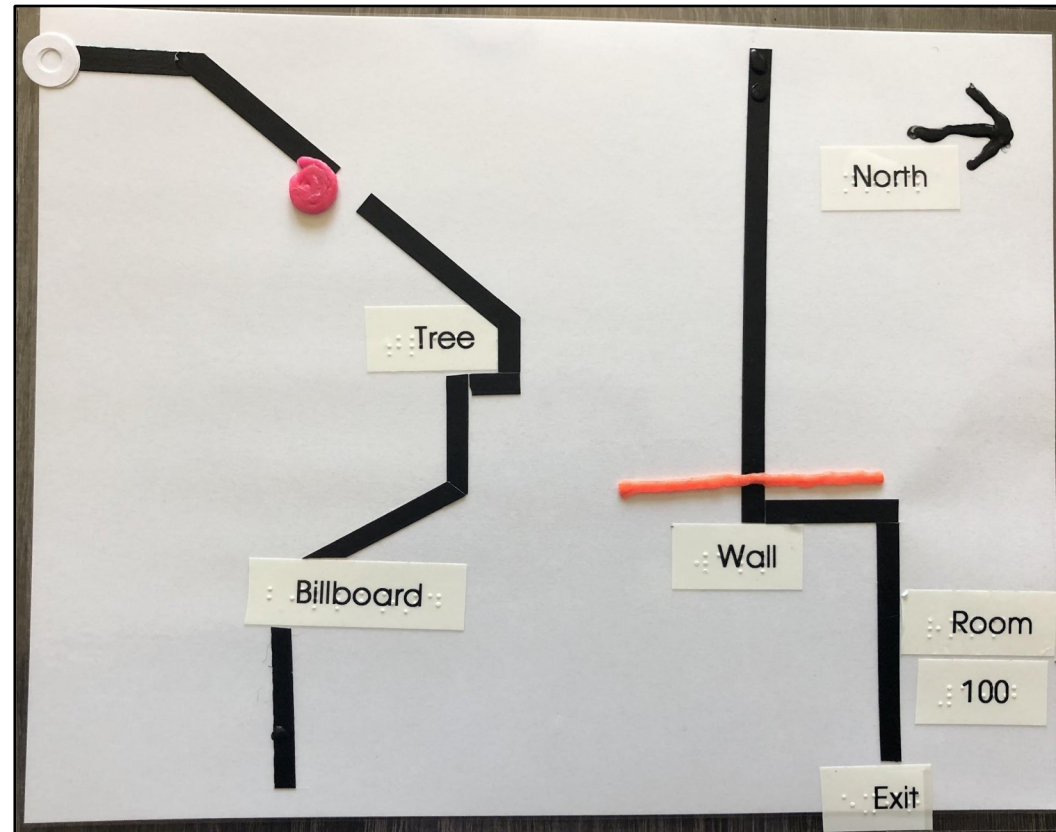
- **Users set Watch Points**

# Print/Braille/Audio (Route 2 support tool)

- **Presented in user's preferred format**

- **PDF document emailed to participant**

- **Used iPhone 6s Plus with VoiceOver to listen to the instructions while on route**

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# Tactile Map (Route 3 support tool)

# Convergent Parallel Approach
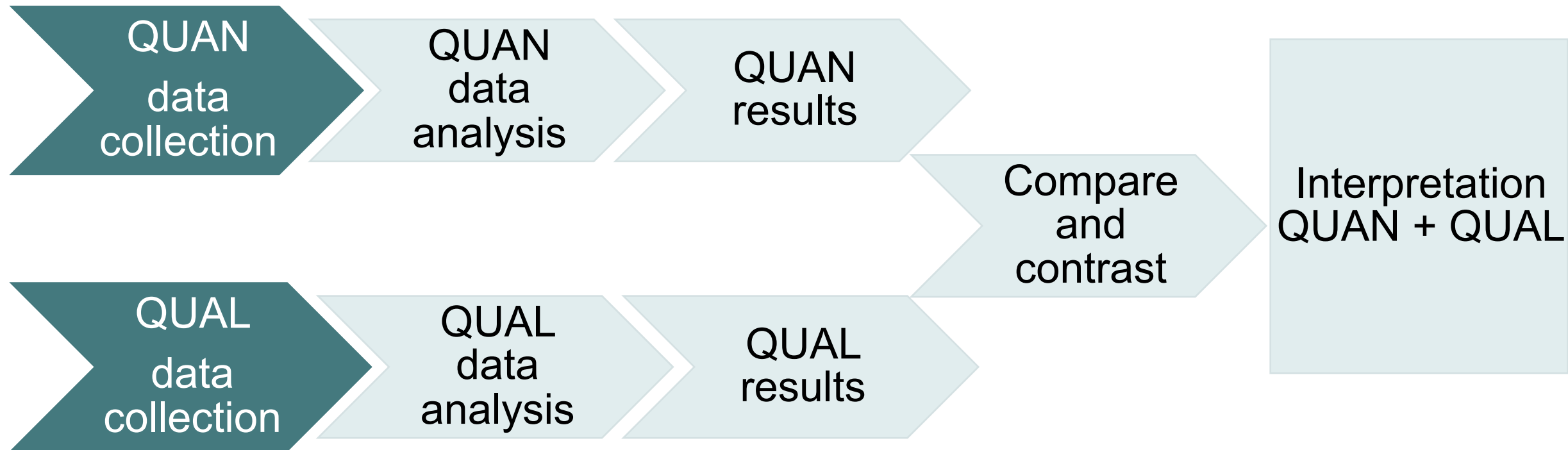
# Data Analysis Procedure

- **Quantitative and qualitative data from routes**
  - ○ **Coded using Google Forms**
  - ○ **Compared for validity**
- **Qualitative data from interview**
  - ○ **Coded for themes**
  - ○ **Compared for validity**
- **Compared and contrasted the two sources of data**

# Quantitative Results from Travel Experiences

| Type of Data | Technology | Written directions | Tactile Map |
|---|---|---|---|
| Preview time with tool | 4:24 | 5:34 | 8:37 |
| Duration of route | 17:07 | 15:57 | 9:14 |
| Errors (no.) | 3 | 7 | 3 |
| Duration of errors | 7:04 | 7:05 | 3:31 |
| Research interventions (no.) | 9 | 3 | 3 |
| Participant questions | 4 | 2 | 4 |

*Note.* "Participant questions" refer to questions directed at the researcher, and does not include self-directed questions.

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# Pre-Route Survey

| Question | Technology | Written directions | Tactile Map |
|---|---|---|---|
| Have you ever used this type of tool before? | Yes | No | Yes |
| How often do you use this type of preview tool for wayfinding already? | 2 | 1 | 1 |

*Note.* Surveys used a 5-point Likert scale. For the pre-route survey, "1" meant "has little to no experience," and "5" meant "has used very often."

# Post-Route Survey

| Question | Technology | Written directions | Tactile Map |
|----------|------------|--------------------|-------------|
| How useful do you feel the preview was for navigating the route? | 1 | 2 | 4 |
| How comfortable/confident did you feel navigating the route? | 1 | 4 | 3 |
| How useful do you feel the in-route information was while navigating the route? | 1 | 5 | 5 |
| How comfortable/confident were you in navigating the indoor/outdoor transition section/s of the route? | 1 | 4 | 5 |

*Note.* Surveys used a 5-point Likert scale. For the post-route survey, "1" meant "not at all comfortable/confident/useful," and "5" meant "very comfortable/confident/useful."

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# Qualitative Data from Interview

1. Expectations

2. Comprehension & Interfering Information

3. Wayfinding Strategies

# Comprehension & Interfering Information

1)  Simplicity is paramount to minimize cognitive load

2)  Information presented by a support tool can be distracting or contradicting to the information perceived from the environment.

3)  Functional vision may distract from information provided by a support tool.

4)  Personal perception influences wayfinding decisions. (Continued…)

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# Comprehension & Interfering Information (cont.)

5) Information provided by technology can be irrelevant and should be adjustable by the user.

6) User preference in how directions are given may be situational.

7) Interfering information can be more of an issue when an individual has a dual sensory disability.

# Wayfinding Strategies

1) Environmental information is useful for following a physical line of travel (trailing) using a mobility cane.

2) The ability and willingness to adapt can be very helpful when wayfinding. (continued…)

# <u>Wayfinding Strategies</u> (cont.)

3) **A mobility cane or dog guide should be used as a primary mobility tool. Relying solely on a secondary support tool, such as technology, is not practical.**

4) **Reducing sensory input may be helpful and reduce stress during wayfinding.**

# SCALING THE CASE STUDY

n= 30

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# Refinement of Method for Scaling Study

When we were able to resume in-person research, the wayfinding technology tool had significantly evolved into Goodmaps, which is based on high resolution LiDAR scanning.

When we were able to resume in-person research, we sought input from an expert traveler with vision loss who was also an O&M Specialist. They participated with the team in doing the routes and sharing insight on our approach.

The counsel that they offered was to eliminate the written directions because of how many ways they could be interpreted and because of cognitive load and fatigue.

We replicated the indoor and outdoor routes using two support tools- the tactile map or the wayfinding app.

We reached out to school personnel to recruit as well as adult service agencies.

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# Inclusion of Youth and Adults

21 participants were adolescents between the age of 14 and 18 and seven were adults between the ages of 19 and 50.

Qualitative and Quantitative Focus

Describe Experiences on Routes-making meaningful connections

High social validity for the **experience** was noted in the comments from participants and from educators who attended with the youth participants.

# Environmental Factors

Weather

Built Environment

Natural Environment

Social Environment

Affordances in Environment

**Naturalistic inquiry with participants to examine the impact of tools in complex travel conditions.**

# Global Supports and Findings

Assembling mental maps through experiences and questioning.

Cognitive load remains a factor across conditions.

While speed is a performance measure in the study, it is not necessarily the most important aspect in the wayfinding experience. Participants' confidence and confirmation where they were along the route was incredibly important.

Our preliminary analysis of the spatial abilities of the participants based on individual-level responses to the Santa Barbara Sense of Direction scale (Hagarty et al., 2002) revealed significantly lower aggregate spatial ability scores of the adolescent participants compared to the adult participants.

*more analysis is needed to control for when someone experienced visual impairment

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# Questions and Opportunities

Does O&M training support greater spatial cognition for travelers?

Will O&M become obsolete?

It can help make better use of tools. Confirmatory sense during travel experiences.

Opportunities to integrate more formal measures of spatial cognition into our O&M curricula and training efforts.

Role that confidence and confirmation plays in wayfinding.

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# Reflections on the Multi-Year Journey

Our study gave <span style="color:#e91e63">voice</span> to the experience of diverse travelers who use wayfinding technologies to accomplish important life tasks. Despite the proliferation of wayfinding apps that are meant to benefit travelers, the goodness of fit of such tools remains constrained.

At the same time, there is a great desire for technologies to be better integrated, more intuitive, and more responsive to individual traveler characteristics and needs.

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# Mobility Matters Community Outreach and Interdisciplinary Engagement

Transportation and Wayfinding Summit

https://mobilitymatters2020.sched.com/

Portland State
UNIVERSITY

# Participatory Design

Participatory designs sound simple, but this type of design involves engagement with diverse members of a community.

Engagement can be expensive in terms of the time that it takes to listen to each other.

Lack of engagement is also expensive.

**DBCA**
**DeafBlind Citizens in Action**

**Transportation Leadership and Learning**

DeafBlind Citizens in Action has been engaged with Portland State University in a participatory approach with transportation providers.

https://dbcitizens.org/transportation-leadership-workshop/

DeafBlind Citizens in Action Transportation & Leadership

# Collaborations to Create Systemic Improvements

- Schools for the Blind and Adult Service Agencies (students and adult consumers)

- University Researchers and Students

- Public Spaces

- Building Managers- support digital mapping

- Technology Partners

- Interdisciplinary Conferences & Planning Time

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# References

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