AN EVALUATION OF THE EFFICACY OF A LOCATION-BASED NAVIGATION SYSTEM FOR INDIVIDUALS WITH VISUAL IMPAIRMENTS IN THE HIGHER EDUCATION SETTING

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ABSTRACT

The lack of services and accommodations that have been identified as efficacious to support orientation and mobility for students with visual impairments within the higher education setting is related to the environment failing to appropriately address the unique needs of this population. Given that institutions of higher education have historically been designed without consideration of students with disabilities, being able to navigate a college campus in a manner similar to students without disabilities provides distinct advantages. An evaluation was undertaken on BeAware, a location-based navigation smartphone app for individuals with visual impairments, to assess the efficacy of the app as well as participants' perceptions of access to and acceptance within the university as a result of its use. All aspects of the study were conducted on campus, and purposive sampling identified students to participate. Data were collected through the use of a multiple-baseline across behaviors design to test participants' independent mobility, followed by qualitative interviews. Findings suggest that BeAware is an effective method for promoting independent mobility for students with visual impairments. Participants had positive perceptions of the impact the app had on access to, and acceptance within the higher education setting. Given the nature of most of the research in this area, these findings provide valuable information to app developers and higher education leaders in supporting accessibility and access through the provision of needed accommodations.

LITERATURE REVIEW

Research suggests that the development of a sense of belonging is correlated to academic success, yet little is known about how students with visual impairments develop a sense of belonging in institutions of higher education. A critical disability theory (CDT) approach provides a lens for tackling the complexities associated with disability, equality, and equity (Rioux & Valentine, 2006).

A central theme of CDT is that disability is socially constructed and what disables is the environment. It views disability as a complex inter-relationship between impairment, the individual's perception of the impairment, and the physical, institutional, and attitudinal environment (Pothier & Devlin, 2006). CDT asserts that the social disadvantage experienced by students with disabilities is due to the environment failing to appropriately address the unique needs of persons with disabilities, and challenges the academic community to reflect on the implications of their perceptions of students with visual impairments and other disabilities.

Assistive technology plays an important role in addressing environmental factors that may negatively impact accessibility for students with visual impairments. In particular, recent studies have demonstrated the value of using location-based assistive technology devices to support orientation and mobility (O&M) for such individuals (see Hakobyan, Lumsden, O'Sullivan, & Bartlett, 2013 for a review). According to Wilson (1967), supporting O&M skills is particularly important as, "mobility represents the avenue through which a person reaches out into his social, educational, vocational, and economic environment" (p. 287). Therefore, research on the efficacy of location-based assistive technology devices that support independent O&M for people with visual impairments is warranted.

RESEARCH QUESTIONS

BeAware is a platform application compatible with iOS and Android operating systems that was developed to provide O&M support to individuals with visual impairments. Once the app is downloaded onto a mobile device, BeAware provides both audible and tactile alerts when users approach beacons that are strategically placed near or on pedestrian travel paths. This enables users to navigate to their destination safely and independently.

BeAware uses both Bluetooth sensors and a Global Positioning System (GPS) to help determine the user's location and provide corresponding navigational guidance. Sensors can be set to send messages from centimeters to 250 feet away. The beacons operate with minimal power consumption and the navigation program runs continually in the smartphone's background. The app scans for beacons and GPS points in the individual's vicinity and relays information regarding nearby construction zones, barriers, and structures, such as educational buildings or pedestrian hazards.

The research questions examined in this study included:

1. Is the BeAware app an effective method for supporting independent O&M for college students with visual impairments?

2. What impact does the BeAware app have on college students with visual impairments' perceptions of access to, and acceptance within the higher education setting?

METHODS

Research Design

An embedded mixed method design was utilized for this study (Klingner & Broadman, 2011). Participants were current college students with visual impairments referred by the Services for Students with Disabilities (SSD) office at their university. Quantitative data was collected by means of a multiple-baseline across behaviors design (Maul, Findley, & Nicholson Adams, 2015). Within this single subject design, a minimum of three stable data points were obtained across each behavior, and intervention was introduced in a staggered manner to demonstrate internal validity. Intervention effects were then determined through visual inspection of graphed data. A single participant took part in this phase of the study.

The researchers collected data on the participant's independent mobility while navigating through three 6-ft wide outdoor paths that were 150 ft in length with 6 total turns each. Each of these paths was outlined using water-solvent marking paint on a 100-yard grass field. During the baseline trials, the participant utilized a dog guide to attempt to navigate the outlined path. During intervention trials, the evaluators placed Bluetooth beacons at each of the outlined turns. The beacons were programmed to alert the participant when they were less than 5 ft from the turn. In addition to an iPhone 7 with the BeAware app downloaded to receive alerts, the participant also utilized the dog guide during the intervention phase. Data regarding the participant's ability to independently stay on the outlined path and navigate turns was collected via 5- second whole-interval recording and analyzed based on level changes, variability, and trends in the data paths.

Semi-structured, face-to-face qualitative interviews were conducted with two participants. Interviews were video recorded and transcribed for analysis. Collected data were analyzed using qualitative content analysis to make inferences to the CDT framework in order to determine results.

Reliability

Inter-observer agreement (IOA) data was collected for 25% of the baseline trials and 33% of the treatment trials within the multiple-baseline across behaviors design in order to support inter-rater reliability. IOA data for independent mobility ranged from 86%-100%, with a mean agreement rate of 94%. These results suggest the data was reliable across the two raters.

RESULTS

Multiple-Baseline Across Behaviors Design

Stable baseline measures were collected prior to the intervention phase. The BeAware app was introduced in a stepwise fashion while the other courses remained in the baseline phase. When analyzing the data for

percentages of independent mobility (Figure 1), results indicate increases in performance across all three courses only when the app was used. Each graph indicates significant level increases over the course of intervention, with fairly steadily increasing trends. All baseline trials indicated accuracy of 5% or less. By the end of intervention, the participant was at least 70% accurate in their ability to independently navigate each course. These results suggest that BeAware was effective in supporting the participant's independent mobility.
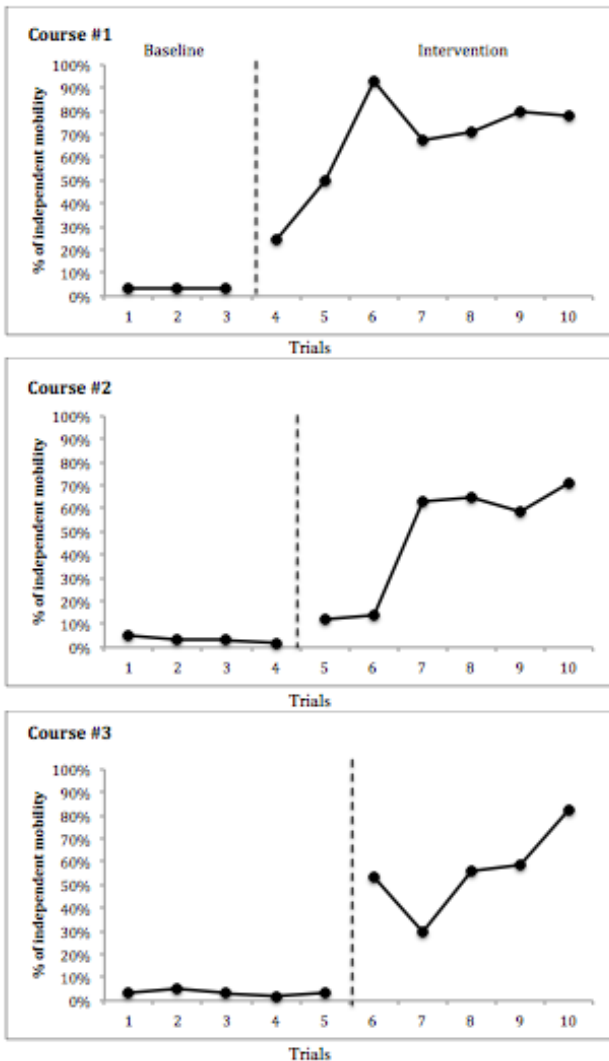

Figure 1: The percentage of intervals with independent mobility during the baseline and intervention trials for each of the courses.

Qualitative Data

The following themes were gleaned from the qualitative interviews:

Theme 1: Equality. Respondents described how the opportunity to participate in campus life equal to those without a disability shaped their perception of inclusion on campus. The students explained how equality was rooted in a self-awareness of their disability and corresponding needs. It also comprised of the ability to compensate in a way that fulfilled their needs when accommodations from the university were not available. When participants were asked what they do in situations where beacons are not available so they can navigate areas on campus on a level equal to their peers without disabilities, a participant responded:

"I don't really know what to do. Um, I guess I just rely on others, you know, if I hear anybody around me and just ask them, like where I am or if I'm close to, you know, so and so building."

As such, students with disabilities continue to encounter barriers in their search for equality on campus when effective assistive technology supports are not available.

Theme 2: Equity. Equity is characterized by providing equal opportunities for access to educational and social experiences.

When asked to describe their overall thoughts about BeAware and its use on campus, the participants stated:

"I enjoy having it. When I feel like I'm lost or even when I'm just walking trying to get to class, getting the notification…it'll confidently tell me where I am. It's nice to have that because I know I'm on track."

"My vision is constantly blurry, so I'm having, I'm always falling, running into things, and that's why I use the app. I like the app. I've been really impressed with it."

In describing their perceptions of accessibility at their university, participants stated:

"With the app, it's accessible. But if you don't have the app, I don't see how you can get around campus."

"With the app, I feel better walking. I feel a little bit safer that, if I don't see it, the app will. It's made me feel a little more independent."

The component of equity, or lack thereof, in each response demonstrated the importance of being able to confidently and safely navigate the campus environment.

Theme 3: Inclusion. By addressing equality and equity, a sense of inclusion was reported by the participants when asked about their perceptions of acceptance, access, and sense of belonging after implementation of BeAware in their daily routine. A snapshot of the responses is as follows:

"Just knowing that something is being implemented like this on campus. It's nice knowing that people are trying to, you know, increase and expand the independence of those who maybe have vision loss."

"I cancelled [the campus provided transportation system] and I just walked to campus cause I felt like a million bucks, I felt like a kid in a candy store."

Based on the responses, concepts of inclusion as they relate to the needs of students with disabilities can be reframed by exploring how disability is currently represented on campus.

DISCUSSION

In order to advance the conversation on equity, it is important to acknowledge that disparities in access exist in all facets of society, including institutions of higher education. Unfortunately, disability is not always adequately addressed in equity discussions. Therefore, recognizing disability, specifically visual impairments in the case of this study, as a central equity issue, and providing a location-based navigation system for students with visual impairments, may lead to a greater sense of independence by being able to navigate the campus autonomously, thus fostering an environment of success.

Attaining a level of inclusion can help support the long-term success of students with disabilities. The results of this study indicate the efficacy of the BeAware app and suggest that it can promote campus accessibility for college students with visual impairments. As universities upgrade their infrastructure, educational leaders must continue to consider the assistive technology needs of students with disabilities in order to support equality, equity, and inclusion for all students of all ability levels.

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