

# **STCS Pre-Trip Planning and Virtualization:**

## **Project Report**

Leveraging Innovative Technology to  
Develop the Smart Travel Concierge  
System to Facilitate Pre-Trip Planning  
and Virtualization for Individuals with  
Cognitive Disabilities

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<b>16. Abstract</b>  Individuals with cognitive disabilities, such as intellectual and developmental disability, those on the autism spectrum, and people with traumatic brain injuries, can face significant obstacles in accessing America's many transportation options. Many of these individuals do not own or use personal vehicles, and can be reliant on public transportation to access employment, education, health services, social/recreational activities, and other activities of daily living. In many cases these individuals are reliant on specialized paratransit services required by various federal laws.  This project aimed at creating a series of cognitively accessible tools designed to support pre-trip assessment, training, planning and virtualization to promote greater access to fixed route transportation services for individuals who may otherwise be reliant on paratransit. This resulted in the Smart Living Concierge System, comprised of four subsystems designed to support self-assessment of current transportation skills, general training on those skills, personalized tools to support timely and accurate completion of pre-trip preparation activities, and to virtually experience trips prior to actual engagement in travel.			
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# Executive Summary

This report summarizes the activities, milestones, deliverables, and other accomplishments of a two-year effort under the Accessible Transportation Technology Research Initiative (ATTRI) conducted by AbleLink Smart Living Technologies and titled *Leveraging Innovative Technology to Develop the Smart Travel Concierge System to Facilitate Pre-Trip Planning and Virtualization for Individuals with Cognitive Disabilities*.

This project involved development and evaluation of the *Smart Travel Concierge System* (STCS), a suite of technologies for assessment of transportation readiness, training on a range of general public transportation skills, pre-trip planning and execution applications, and trip virtualization activities specifically for individuals with cognitive disabilities and other users to support increased independence in use of fixed route transportation and to reduce the need to use costlier paratransit services. Assessing transportation skills, pre-trip planning and trip execution technologies are critical components necessary for facilitating successful use of public transportation systems. The STCS provides new technology for virtualization experiences of routes and leverages existing technology to provide a comprehensive set of transportation readiness assessment and self-directed learning materials, as well as trip execution technologies that address individualized pre-trip planning, preparation and logistics that are important for engaging in independent travel. Previous research has demonstrated that the technologies that were leveraged to create the STCS (i.e., Visual Impact; the Accessible Testing, Learning and Assessment System, Endeavor) have enabled individuals with cognitive disabilities to complete self-directed assessments and perform daily living activities more independently in a wide variety of contexts (Davies, et. al., 2017; Schwartz, et. al., 2013; Shogren et. al. 2013; Tanis, et. al., 2012; O'Hara, et. al., 2008; Wehmeyer, et. al. 2006). In addition, agencies serving individuals with cognitive disabilities can reduce staff support costs through use of these types of tools (White, Liberatos, O'Hara, Davies & Stock, 2013; Schwartz, et al., 2013; Davies, Stock & Wehmeyer, 2004). This project has allowed these technologies to be extended into the transportation arena to enhance pre-trip assessment, planning and trip execution for people whose cognitive disabilities or other limitations have precluded more comprehensive use of mainstream public transit.

The initial work in this project involved development and concept validation of a STCS prototype system. This was followed by final completion of the system and conduct of field evaluation activities. The system leverages previously developed technology and provides a powerful companion system to complement the Special Media for Assisting Route Travel (SMART) wayfinding set of tools that were developed or enhanced in AbleLink's complimentary ATTRI project, titled *Leveraging Innovative Technology to Develop the SMART Wayfinding Standard to Facilitate Independent Use of Public Transit by Individuals with Cognitive Disabilities*. WayFinder is the first SMART (Special Media for Assisting Route Travel) ready application to support use of fixed route transportation systems. It has been previously validated through research and ongoing usage by travelers with disabilities (Davies, Stock, Holloway and Wehmeyer, 2010; Stock, Davies, Wehmeyer and Lachapelle, 2011; Stock, Davies, Hoelzel and Mullen, 2013; Stock, Davies, Herold and Wehmeyer, 2019). It is important to note that the STCS subsystems that were developed in this project can be used independently as stand-alone components to support pre-trip planning or in concert with WayFinder and its associated components. In other words, previous experience has shown

customer use cases where individuals with different travel support needs may engage individual subsystems or combinations thereof of the set of ATTRI technology tools.

It is well known that certain accommodations for individuals with disabilities can provide benefit for mainstream populations as well. For example, curb cuts designed for people with physical disabilities also benefit parents with strollers, and automatic door openers improve accessibility for people carrying packages. In the same way, the cognitively accessible design strategies being employed by STCS provide the potential to improve access for all people, including those who may be less comfortable with public transportation in general. Cognitively accessible design can simply make things easier for everyone. The STCS is comprised of four subsystems, each of which contains cognitive design features. These subsystems have been designed such that they can be used individually or in combination with each other depending on the unique needs of each use case. A brief description of each subsystem is provided below, followed by examples of how they may be used individually or in combination to further expand on how the subsystems may be implemented.

**Transportation Skills Assessment System**--The first subsystem is a web-based assessment system provides a format for individuals with cognitive disabilities, older adults and other users who may be less familiar with public transit to complete one or more self-assessments of public transit experience and skills. Results from completed assessments are immediately available via an on-line reporting library for viewing and to print reports. Results of individual assessments are also integrated to inform self-directed transportation skills learning in the second subsystem, described subsequently.

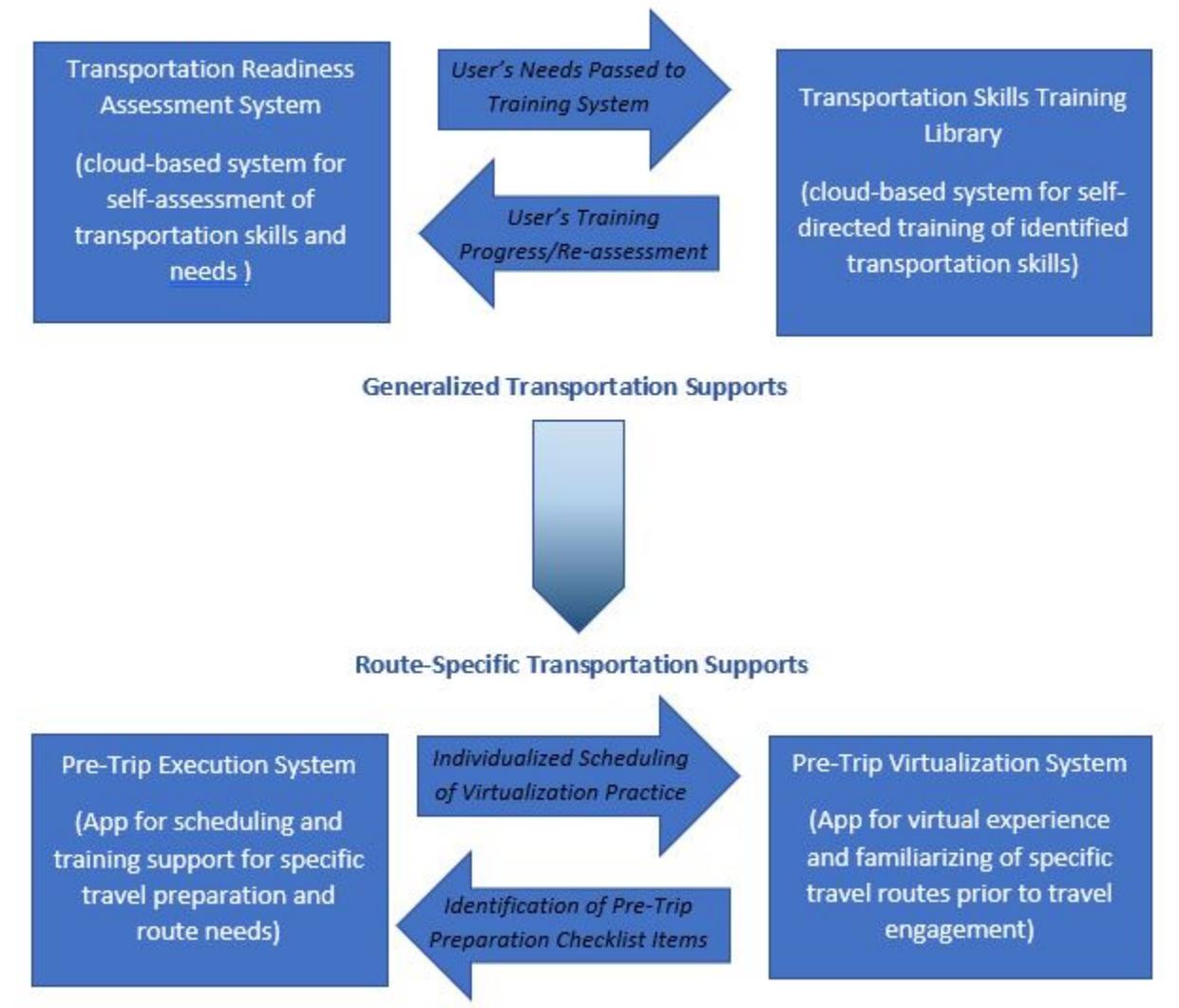
**Transportation Skills Training Library**—The second subsystem is a web-based general transportation training skills application that provides self-paced opportunities to address general transportation skills deficits, including those that may have been identified via the Transportation Skills Assessment subsystem. The content for this general skills training system was developed via research conducted during the STCS project and can also be deployed for specific transit agencies to regionalize content as needed. While these first two subsystems have a degree of integration with each other, users are also able to engage in self-assessment and general training processes independent of each other if required by individual use cases. The intent of these first two subsystems is to provide more general, high-level travel skills assessment and training, while the second two subsystems are designed to begin addressing more individualized, route-specific supports.

**Pre-Trip Execution System**—The third subsystem involves pre-trip planning, preparation, and trip execution activities that are specific to individual users and their travel needs. The components of this mobile device-based subsystem include a cognitively accessible personal scheduling system to support the ‘when’ in keeping a traveler on time with pre-trip preparation activities, and an instructional system to support the ‘how’ in completing these pre-trip activities. This instructional system uses an approach similar to the general transportation skills training subsystem described above, but instructional content is authored by individual users and/or trainers to provide personalized, route-specific supports and include an interactive pre-trip checklist format.

**Trip Virtualization System**—Finally, the fourth subsystem has been designed to allow users to experience a travel route virtually without having to leave home. Travel trainers or caregivers can capture video footage of a desired travel route from beginning to end, and then overlay the GPS-based prompts from a SMART-compliant route via a simulated on-screen WayFinder interface with the video to virtually experience the route. The virtualization system has been designed for use on a full screen computer

platform to provide a rich, immersive and realistic virtual experience and to support synchronized video/mobile app simulation playback on the larger screen format available on desktop or notebook computers.

Figure 1 provides a graphic illustration of the interaction between the STCS prototype subsystems.



Source: AbleLink Smart Living Technologies, May 15, 2018

**Figure 1. STCS Functional Block Diagram**

### ***Understanding the Subsystems of STCS***

The first two subsystems—the Transportation Readiness Assessment System and the Transportation Skills Training Library—include a degree of integration such that they can each be used by themselves or in conjunction with each other. Responses to questions in the transportation readiness assessments have been mapped to specific skill training modules to provide a degree of automation in prompting users to engage in training areas identified as deficits by the assessment process. Users are also able to

engage in the Transportation Skills Training Library independent of the assessment process in that transportation training modules are also manually selectable to allow users to engage in additional or alternative training as desired. These first two subsystems are designed to address general travel skills that are not necessarily specific to a particular route. The second two subsystems then move the focus to specific individualized traveler needs and route training. The pre-trip execution subsystem provides the capability for users to receive personalized time-based prompts to perform key pre-trip preparation activities which may include sequential or non-sequential (e.g., checklist) tasks. Finally, the virtualization subsystem provides the capability to review route-specific virtualization scenarios to support familiarization of key travel elements prior to engagement in route-specific public transportation activities. Internet connectivity is required when downloading virtualization scenarios from the SMART Route Library, but once a virtualization scenario has been downloaded, internet connectivity is not required for playback of the scenarios.

### ***Examples of Using the Subsystems Individually or in Combination***

**Example #1**—Some agencies or individuals may have already invested resources in an alternative or home-grown public transportation training program. In these cases, it is possible that only the Transportation Readiness Assessment System is used to help identify which parts of the training program may be needed by an individual, or to measure the effectiveness of engagement in a local training program.

**Example #2**—Other agencies that may have a fairly comprehensive public transit training program that includes assessment, training, and travel trainer supports may desire to integrate the virtualization subsystem to fill a gap in their program. Several members of the project Steering Committee have indicated that they already gather trip video footage that could be used in a much richer, more immersive environment such in the Trip Virtualization subsystem.

**Example #3**—A family may wish to support a member with intellectual disability to learn a bus route to another family member's home; the family may use the Assessment subsystem to help determine potential safety issues, then the Transportation Skills Training Library to provide training on identified areas, and finally the Pre-Trip Checklist to support successful travel before using the WayFinder app to help guide the rider to his or her destination.

**Example #4**—A public transit service may adopt all aspects of the STCS that could be administered by an existing team of travel managers and trainers who have themselves been trained on use of the STCS. In this case the transit service may provide additional content to the Transportation Skills Training Library, develop customizable Pre-Trip Checklist templates and build/store downloadable travel routes and/or virtualization scenarios for use with the ATTRI projects' systems.

### ***Expected Impact of the Research***

The impact of this research and development project is underscored by the significant cost differences between provision of paratransit versus fixed route transportation services provided by municipalities across the country. Paratransit services cost from seven to 10 times higher than fixed route services (CUTR, 2008; Kloehn, 2016). Given this large discrepancy in cost per trip between paratransit and fixed route services, significant cost savings could be realized by moving a segment of the paratransit ridership to mainstream fixed route services. In its 2014 guide on strategies to promote use of fixed route transit by people with disabilities, the Transit Cooperative Research Program (TCRP) estimates that even at a 25%

conversion rate, savings to municipal transit systems could exceed \$9 million annually for the country's largest transit providers (TCRP, 2014). The pre-trip planning and virtualization technologies developed in this project have been designed to meet a significant need that exists even before the trip begins. When used to teach individuals to use the fixed route system independently, these supports can be expected to result in large-cost savings for transit authorities and consumers with cognitive disabilities and other users as a result of helping to effectively transition individuals from paratransit to fixed route transportation services.



# Chapter 1. Requirements Development

## Overview

The initial task in this project involved the development of the functional, technical and user interface requirements for each component of the STCS system. The results of the Requirements Development task were used to complete the design and development effort, resulting in a functional prototype of each subsystem. These subsystem prototypes were then used to complete the various concept validation and field implementation tasks.

## System Requirements Development

The project began with a four-month period to conduct the research necessary to determine the initial system requirements for each of the four subsystems of the STCS, including assessment of transportation readiness, self-directed learning modules, pre-trip planning and execution support technologies, and travel experience virtualization tools.

**Foundational Research:** A primary focus for this research activity was on reviewing the most recent research on transportation readiness assessment, pre-trip planning and travel training, virtualization technologies, and emerging development strategies for making technology accessible to individuals with cognitive disabilities and other potential users with different needs. During the initial months of the project, we conducted several data gathering webinars with key stakeholders to discuss the issues related to transportation for individuals with cognitive disabilities, to gain the perspective of end users with cognitive disabilities themselves, their families, and the service agencies typically involved in providing transportation services. In addition to gathering relevant information using a person-centered focus, we also researched the status of smart transportation technology development, virtualization technology approaches, and connected mobile and wearable devices that can support pre-trip planning and trip execution. A significant portion of this effort was in reviewing existing tools and strategies for assessing the transportation skills and needs of both transit users in general and those with special needs related to cognitive disabilities. The results of this process were summarized in the STCS Pre-Trip Planning and Virtualization: STCS Assessment Content Summary Table (Project Deliverable, FHWA-JPO-19-770).

**Organizing Steering Committee:** A key strategy that was employed to gain meaningful involvement in the planning and implementation of this project from transportation technology developers, individuals with disabilities, parents, and disability professionals was the establishment of a Project Steering Committee (PSC) which supported both of AbleLink's ATTRI projects. This group consisted of volunteer stakeholders from each segment of the target population that were affected by the results of this project, including smart wayfinding technology developers, travel trainers from the regional transit authorities serving the agencies that participated in the project, direct support professionals (DSPs), independent living counselors, transition specialists, parents, university researchers, transit agency administrators, and service agency administrators. PSC members were provided an honorarium for participating in the PSC. This group met bi-monthly via GoToMeeting, an online web conferencing program, to provide input and

direction to project plans, to evaluate progress towards meeting project objectives and to personally evaluate emerging technologies in an iterative fashion during the course of development. The list of PSC members is provided below (name, affiliation, location):

- Nathan Anderson, DDRC, Lakewood, CO
- Carla Bailo, Center for Automotive Research, Ann Arbor, MI
- Dennis Cleary, Ohio State University, Columbus, OH
- Kevin Comstock, City of Chattanooga, Chattanooga, TN
- Laurie Dale, Ability Beyond, Bethel, CT
- Stefanie deOlloqui, Techme Community Consultants, Chattanooga, TN
- Carmen Digiovine, Nisonger Center, Columbus, OH
- Leah Drummond, Black Hills Works, Rapid City, SD
- Keely Frazier, ARCA, Albuquerque, NM
- Amy Hockman, COTA, Columbus, OH
- Yves Lachapelle, UQTR, Montreal, QC
- Michael Langford, ARCA, Albuquerque, NM
- Richard Lewis, Merakey, Lafayette, PA
- Connie Melvin, Trinity Services, Chicago, IL
- Tammy Murner, Black Hills Works, Rapid City, SD
- David O'Hara, WIHD, Valhalla, NY
- Yvette Rivera, U.S. Department of Transportation, Washington, DC
- Ben Satterfield, Center for AT Excellence, Atlanta, GA
- Shaleea Shields, Merakey, Lafayette, PA
- Katie Taliercio, DDRC, Lakewood, CO
- Shea Tanis, Coleman Institute, Boulder, CO
- Jordan Wagner, Nisonger Center, Columbus, OH
- Michael Wehmeyer, Beach Center on Disability, Lawrence, KS
- Andy Wolpert, City of Columbus, Columbus, OH

The PSC's feedback and direction were instructive in identifying aspects of public transit use and technology features from real-world practice and therefore contributed to a rich base of information and direction for the STCS project. The PSC continued throughout the two-year project to provide feedback and direction throughout the duration of the effort.

**System Requirements Development:** The system requirements for the four subsystems were documented under this subtask. This involved determining requirements for the user interface, performance requirements and technical requirements regarding the interaction between the assessment

subsystem, the self-directed training curriculum, the pre-trip planning and trip execution technologies, and the virtualization subsystem.

As these requirements were being identified, an analysis was applied to the evolving set of system requirements by the Project Team to determine which were necessary for prototype design and development and which requirements were more appropriate to address in subsequent final development efforts. The final set of requirements were recorded in the STCS Pre-Trip Planning and Virtualization: System and Subsystem Requirements (Project Deliverable, FHWA- JPO-19-768) document by the Project Director.

## Chapter 2. Subsystem Descriptions

The task of designing and developing the prototype subsystem components was a major effort of the STCS project. This section provides a brief walkthrough of each of the four subsystems that make up the STCS. These subsystems were initially developed as functional prototypes such that could be used to study their usability and efficacy before completing final design and development activities. A brief description of each subsystem is provided in the following sections.

### Subsystem Designs

**Subsystem 1: Transportation Skills Assessment System** — The first subsystem is a web-based assessment system that allows individuals with cognitive disabilities, older adults and other users to complete a self-assessment of public transit experience and skills. A series of cognitively accessible assessments were developed and incorporated into the STCS using AbleLink's Accessible Testing, Learning and Assessment System engine (ATLAS). ATLAS is a research-based, cognitively accessible survey system that enables individuals with cognitive disabilities and other users to complete tests and surveys in a more independent, self-paced and self-directed manner.

This process involved review of the most recent research, tools and approaches for transportation readiness assessment, pre-trip planning, and travel training. Activities also included interviews with current WayFinder customers/partners, feedback from project stakeholder audiences during a series of presentations, and an extensive review of best-practice assessment and training tools, processes, literature, and web site information. Customer discussions and stakeholder presentations included for example Rocky Mountain Human Services, Cheyenne Village, Inc., ARCA, Black Hills Works, Ohio State University's Nisonger Center, the Westchester Institute for Human Development, the State of Tennessee's Department of Intellectual and Developmental Disabilities, and members of the AbleLink ATTRI PSC. These exchanges were beneficial in understanding the practices, tools, resources, challenges, and successes of these entities in supporting the transportation needs of individuals with intellectual and other disabilities. A major effort in this activity was in the literature and web site review, where approximately 60 best-practice resources were documented and analyzed. Extrapolations were made from these resources that were subsequently summarized in the STCS Pre-Trip Planning and Virtualization: STCS Assessment Content Summary Table (Project Deliverable, FHWA-JPO-19-770). The process for developing this document initially recorded all extrapolated information, followed by a winnowing process to identify assessment and training aspects that were prevalent across multiple research resources. Finally, the most important aspects of transportation readiness were organized into logical categories to begin the process of formulating the assessment modules included in the prototype assessment system, resulting in the following self-directed assessment modules:

1. Transportation Skills and Experience Survey (Bus and Light Rail)
2. Street Crossing Skills Survey
3. Safety/Social Skills Survey

#### 4. Vehicle Identification Survey

Survey respondents can navigate through an assessment/survey by responding to questions which are read to them via a human voice-recorded audio clip, followed by selecting an answer from available response options which can also incorporate text, pictures, video, and audio playback to enhance accessibility. During this task we used the ATLAS engine to design a battery of cognitively accessible assessments to assess transportation readiness for individuals with cognitive disabilities. These assessments each focus on several distinct sub-areas related to the overall assessment subject, although there is some natural cross-over between assessments. The self-assessment modules were then developed on AbleLink's ATLAS platform, incorporating text, graphic, and audio-based content presentation to promote access to the target audiences, including individuals with significant literacy deficits. Next, a review of the draft assessments was conducted by volunteer members of the PSC and the structured feedback received from this process was incorporated into updated versions of the assessments. The process then began to analyze the assessment module content to cull out themes that were used to develop training modules that became the Smart Travel Learning Curriculum (STLC), the operational name for the Transportation Skills Training Library subsystem. For example, training themes identified in the Vehicle Identification Survey included a training need to be able to identify vehicles by name, identify vehicles by number, and the ability to use real-time transit information displays. Each of these areas was then subsequently developed into a STLC training module such that individuals who were identified as having deficits in one or more of these areas via the assessment process could engage in targeted self-directed training to overcome these deficits. Initially, a selected subset of prototype training modules was fully developed to demonstrate the self-directed multimedia training methodology and to enable evaluation of the assessment-to-training approach in a pretest/posttest study. An important feature of the assessment system allowed results from completed assessments to automatically recommend self-directed transportation skills learning in the second subsystem, described subsequently.

**Subsystem 2: Transportation Skills Training Library** —The second subsystem is a web-based general transportation training skills application based upon AbleLink's Visual Impact technology that provides self-paced opportunities to address transportation skill deficits, including those that may have been identified via the assessment subsystem. This system component utilizes pictures, audio and text to guide individuals through the step-by-step activities of a task so that the individual can learn the material independently and in a self-paced manner. The content for this general STLC training system was developed via research conducted during requirements development and design phases of the STCS project. Ultimately, while these first two components have a degree of integration, users are also able to engage in self-assessment and general training processes independent of each other if required by individual use cases. The intent of these first two subsystems is to provide more general, high-level travel skills assessment and training, while the second two subsystems are designed to begin addressing more individualized, route-specific supports on the day of travel. Table 1 presents each of the Transportation Readiness Assessments followed by their corresponding STLC modules.

**Table 1. STLC Training Modules and Relationship with Assessment Modules**

Readiness Assessment Module	STLC MODULES
Travel Skills and Experience Assessment	
	Using a Flip Phone
	Using a Smartphone

	Purchasing a Bus Pass and Paying the Fare
	Signaling for a Stop
	Getting to Your Bus Stop
	Getting Off the Bus and To Your Destination
	Making Transfers
	Using Landmarks
	Other Bus Riding Skills
	Bus Training and Practice
	Using Escalators and Elevators
	Using Route Maps
Street Crossing Skills Assessment	
	Using Intersections and Crosswalks
	Using Transportation Signs and Signals
	Crossing Streets without a Signal
Social Skills Assessment	
	People to Ask for Help
	Getting Help in the Community
	Your Personal Information
	Tips to Remain Confident
Vehicle Identification Assessment	
	Identifying Vehicles by Name
	Identifying Vehicles by Number
	Using Real-Time Transit Displays

**Subsystem 3: Pre-Trip Execution System** —The third subsystem involves personalized pre-trip planning, preparation, and execution support that is specific to the individual user and a designated travel route. The components of this mobile device-based subsystem include a cognitively accessible personal scheduling system based upon AbleLink’s Endeavor technology to support the ‘when’ in keeping a traveler on time with pre-trip preparation activities. The scheduling system has the capability to launch personalized time-based multimedia alarms and instructional sequences (e.g. “Tasks”) which are presented within STCS’s Visual Impact technology to provide the ‘how’ in guiding the individual through the steps of a pre-trip preparation activity. Thus, for example, with this capability incorporated into STCS, the individual with cognitive disability can be alerted when it is time to leave for work (e.g., “Sue, it will be time to leave for work in half an hour, here are the things you need to do before you leave”) and then automatically present a personalized pre-trip checklist of tasks that need to be performed before Sue leaves for work. When the individual completes his or her checklist, a remote family member, caregiver, or travel trainer can optionally be sent an email notification if desired that the individual has completed his

or her pre-trip checklist and is ready to go. Then the system can again notify the individual when it is actually time to leave to get to the bus stop in time. The Visual Impact instructional system uses an approach similar to the general Transportation Skills Training Library system described above but in this local device deployment, instructional content is authored by individual users and/or caregivers to provide personalized, route-specific supports.

**Subsystem 4: Trip Virtualization System** — Finally, the newly designed fourth subsystem allows users to experience a travel route virtually without having to leave home. Travel trainers or caregivers can capture video footage of a desired travel route from beginning to end, and then overlay the GPS-based prompts from a SMART compliant route via a simulated on-screen WayFinder interface overlay displayed off to the side of the video. This system allows users with cognitive disabilities to virtually experience the route as it appears out a bus window while also interacting with the WayFinder audio and image waypoint cues. The virtualization system is designed for use on a desktop platform to provide a rich, immersive, and realistic virtual experience and to support synchronized video/ mobile app simulation playback on the larger screen format available on desktop or notebook computers.

## Content Development for Subsystems 1 and 2

In this subtask, we identified the specific survey content that was needed for assessment of transportation readiness, determined in large part by the research conducted during requirements development activities and with the direction provided by the Project Steering Committee. Survey questions and answers, including multimedia needed to support the assessment instruments, were developed to create a series of surveys that individuals use to self-assess their transportation readiness in each relevant area. This content is summarized in STCS Pre-Trip Planning and Virtualization: STCS Assessment Content Summary Table (Project Deliverable, FHWA-JPO-19-770)

Also, in this subtask we developed transportation-specific instructional content which can be used to help individuals address the general skills needed to travel independently. This included work on creation of the multimedia instructional content necessary to evaluate the approach, as well as a more complete outline of training content that followed initial testing. This content is summarized in STCS Pre-Trip Planning and Virtualization: Smart Travel Learning Curriculum (Project Deliverable, FHWA-JPO-19-769). This learning content therefore comprises a comprehensive curriculum for teaching general social, safety, transit, signage, self-rescue, etc. skills that individuals may need to support successful and independent travel in the community (and as assessed by the assessment subsystem described above). Thus, for both learning general transit system skills via the STLC or engaging in specific, pre-travel preparation tasks designed for a specific individual and route, the STCS system has been designed to create the capability of delivering cognitively accessible learning content and trip execution features to facilitate independent use of public transit systems.

## Subsystem Development

During this task, a working prototype of each of the major subsystems of the STCS was developed first to support year 1 field testing activities, followed by full system development in Year 2. They were developed to meet the design requirements to allow the concept of the STCS system to be evaluated in testing and field implantation activities. AbleLink's existing technologies were used as the foundation for prototype development. ATLAS was used to develop the surveys needed to support assessment of

general transportation readiness. Endeavor and Visual Impact were used to prototype the learning component of the STCS system and the authorable-content pre-trip execution apps so that individuals can engage in personalized self-directed skill acquisition and task execution. The following sections provide a brief walk-through of the STCS subsystems.

## Transportation Readiness Assessment Subsystem

The Transportation Readiness Assessment subsystem was based upon AbleLink's research-based ATLAS system (Davies, Stock, King, Wehmeyer and Shogren, 2017; White, O'Hara, Charrier, Liberatos, Stock and Davies, 2015; Schwartz, Bacon, O'Hara, Davies, Stock, and Brown, 2013; Tanis, Palmer, Wehmeyer, Davies, Stock, Lobb and Bishop, 2012; Stock, Davies and Wehmeyer, 2004). The assessment subsystem was deployed as a web-based application to enable wide access to users from any location, and to enable the necessary integration with the web-based Transportation Skills Training Library.

The menu of assessments, which are available at <https://ablelinksmartravel.com/pretrip.html> is shown in Figure 2.

**ATLAS Transportation Readiness Assessments**

The Smart Travel Concierge System includes five transportation skills assessments. These assessments allow individuals to complete a self-assessment of public transit experience and skills. Each of the five assessments are summarized below. To take an assessment, simply click the Start Survey button. After the survey has been completed, the results can be emailed to you if desired. No email is necessary to complete the survey.

**Transportation Skills & Experience**

This survey includes 20 questions about previous experience with riding a public transit bus and basic skills for traveling in the community independently.

[Launch Survey](#)

**Street Crossing Skills**

This survey includes 21 questions that relate to safety while navigating crosswalks and intersections.

[Launch Survey](#)

**Community Social Skills**

This survey includes 16 questions that relate to safely interacting with others while in the community.

[Launch Survey](#)

**Vehicle Identification Skills**

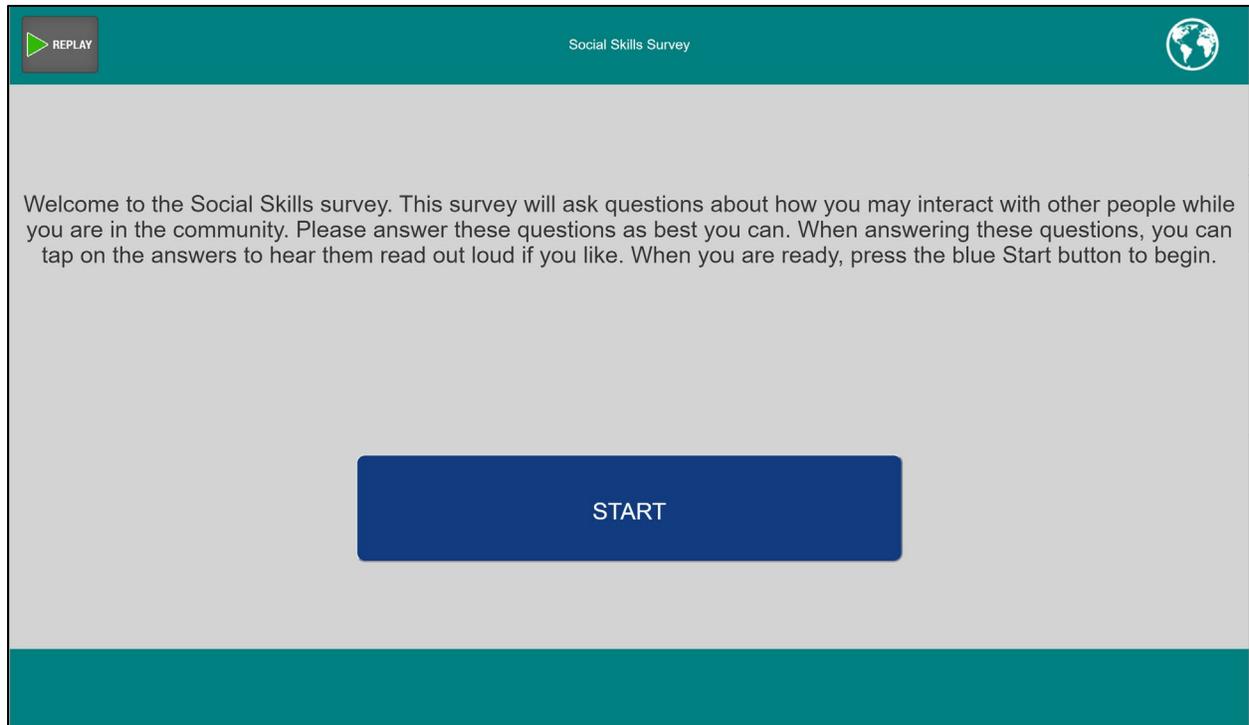
This assessment includes 12 questions designed to help understand the travelers ability level regarding identifying buses and reading transit displays.

[Launch Survey](#)

Source: AbleLink Smart Living Technologies, October 30, 2019

**Figure 2. The Main Menu in the Transportation Skills Assessment System**

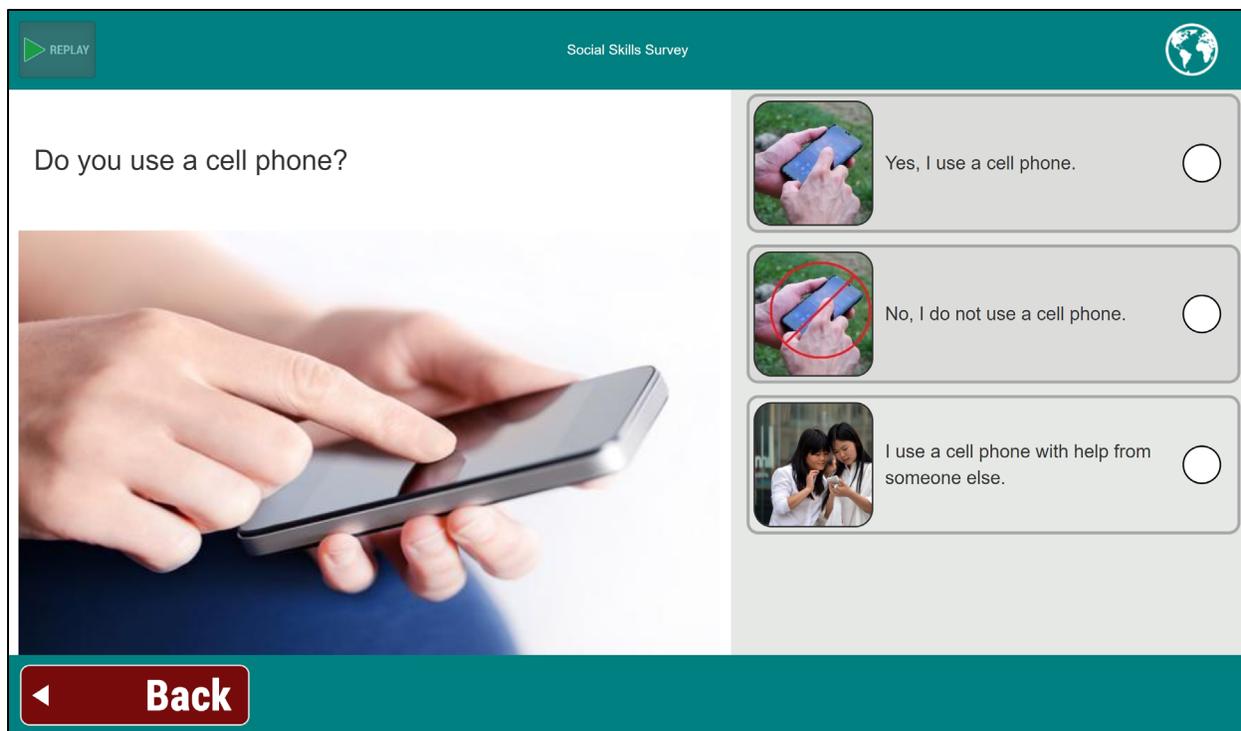
An informational screen is provided next to orient the user to the assessment after the Launch Survey link is selected. An audio version of the text in Figure 3 is played simultaneously while this screen is displayed, prompting the user to press the Start button to begin the survey when the audio rendition of the introduction finishes.



*Source: AbleLink Smart Living Technologies, May 31, 2018*

**Figure 3. The Information screen in the Social Skills Survey**

The system then proceeds with the survey question-and-answer content for each respective assessment. Figure 4 shows a sample question from the Social Skills Survey. When a question screen is first displayed, the system automatically presents the question audibly in a human-recorded voice for ease of comprehension. Additionally, pictures are provided as needed to help illustrate the question and each possible answer. A speaker button is provided in the upper left corner of each page that allows the user to replay the question if desired. Users can then either read each respective item in the answer set or click on each item to hear each answer read aloud to support low- or non-literate users.

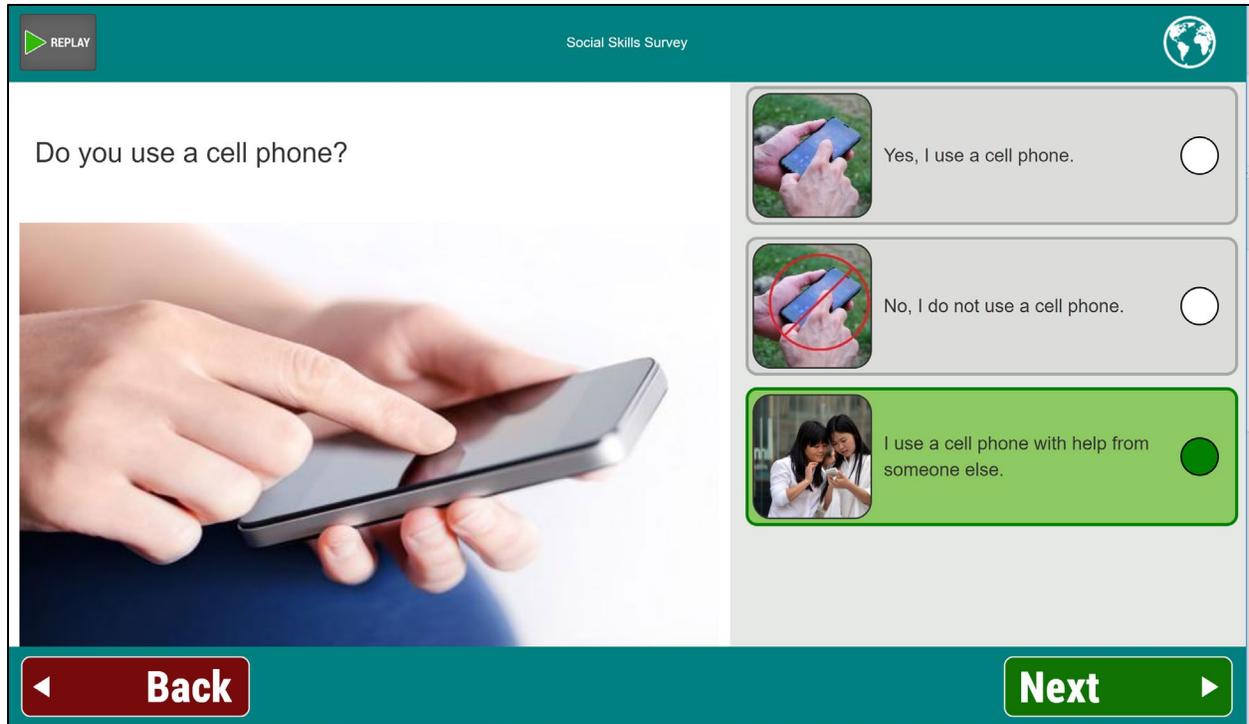


Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 4. Sample question in the Social Skills Survey without Next button showing before selection of an answer**

Users may tap on different answers to explore potential responses, and it is encouraged that trainers or support persons demonstrate this process during initial learning phases for individuals with cognitive disabilities who lack reading skills. Given the limited space on response buttons for text, the audio representation of responses can be extended if needed to provide a more comprehensive response.

As shown in Figure 5, the Next button that is used to navigate to the subsequent question is only available after an answer has been selected. This research-based error minimization technique is used to ensure that users do not skip questions and therefore provide a complete survey. Note also in Figure 5 that the answer selected (i.e., "I use a cell phone with help from someone else") is highlighted in green to provide an additional visual cue for confirmation to the user of his or her selection.

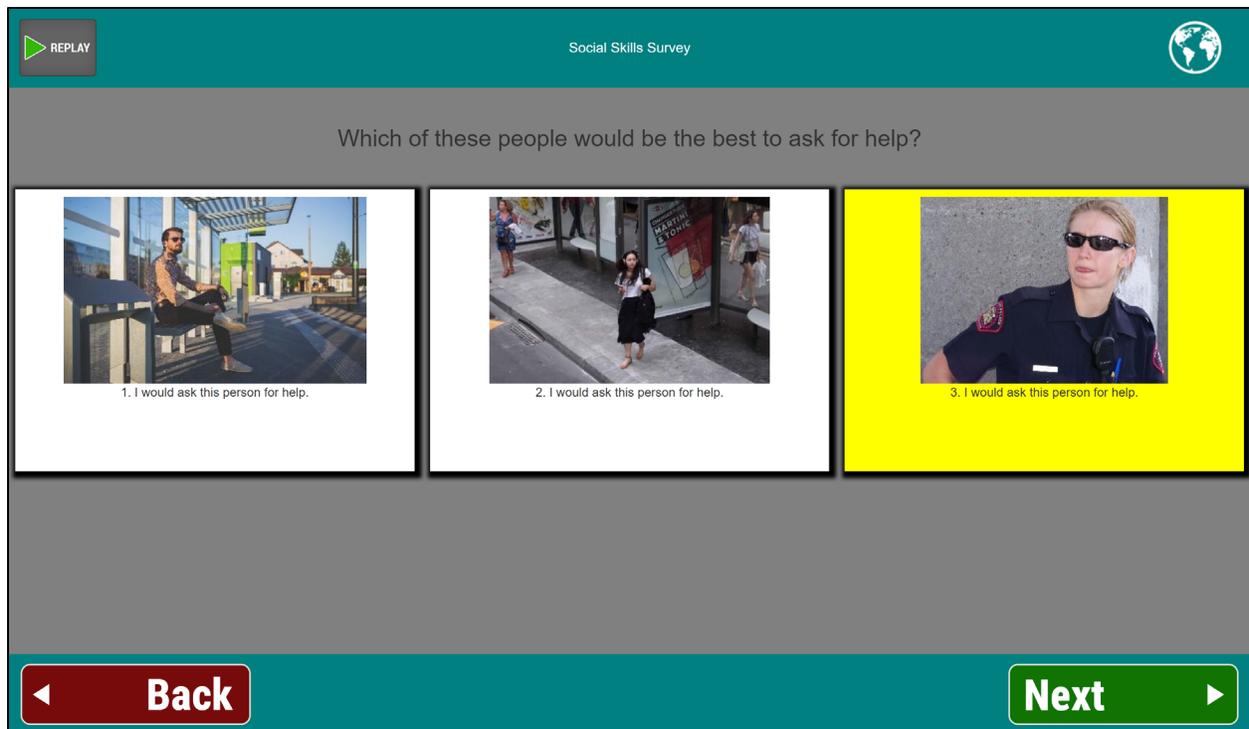


Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 5. Sample question in the Social Skills Survey with Next button showing following selection of an answer**

Upon clicking the Next button, the system proceeds to the next question in the survey. The system was also developed to support 'skips', such that if a response to a particular question made a subsequent question or questions irrelevant, those questions can be automatically skipped and the survey can resume at the next relevant question.

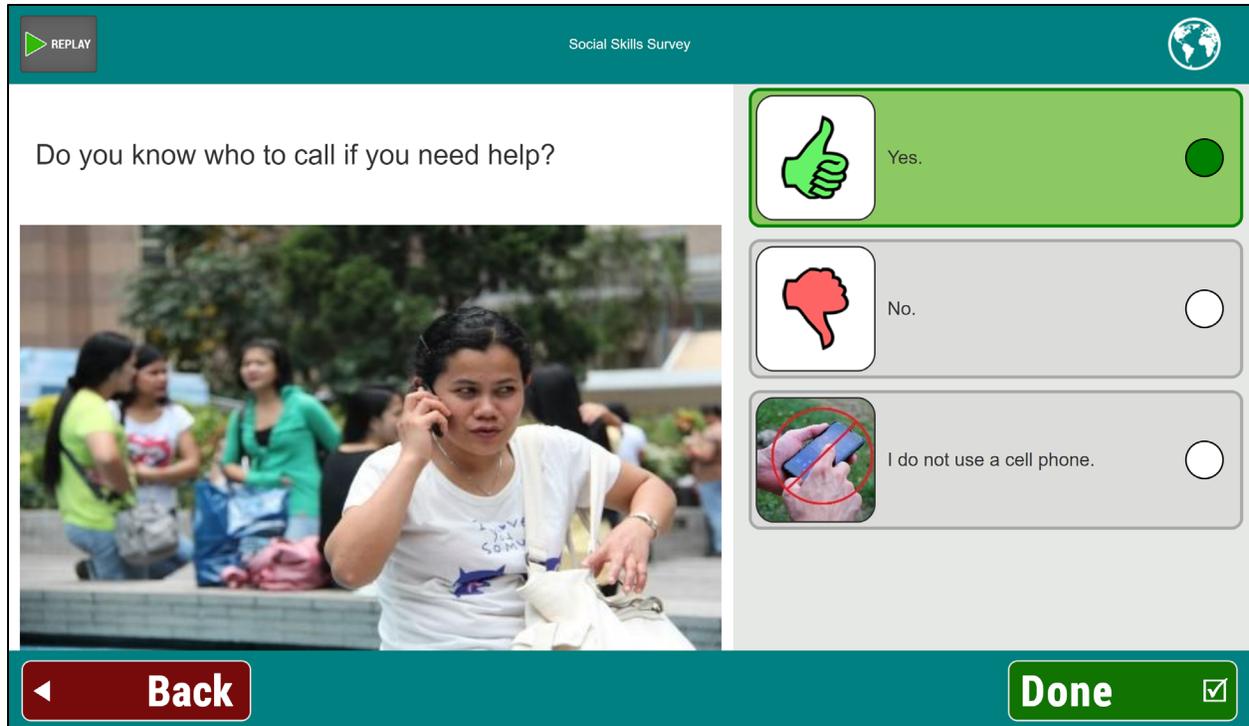
Another feature of the system includes an alternative question-and-answer display for questions where the content of images in the answer set needed to be emphasized due to their increased relevancy. Figure 6 shows an example of a picture question where there is no image associated with the question, but enlarged images are provided for the answer set. Picture questions incorporate the same user interaction as other questions, where answers can be selected to hear the audio description of the answer and the Next button does not show until the user has selected a response.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 6. Sample of Picture Question with enlarged answer set images**

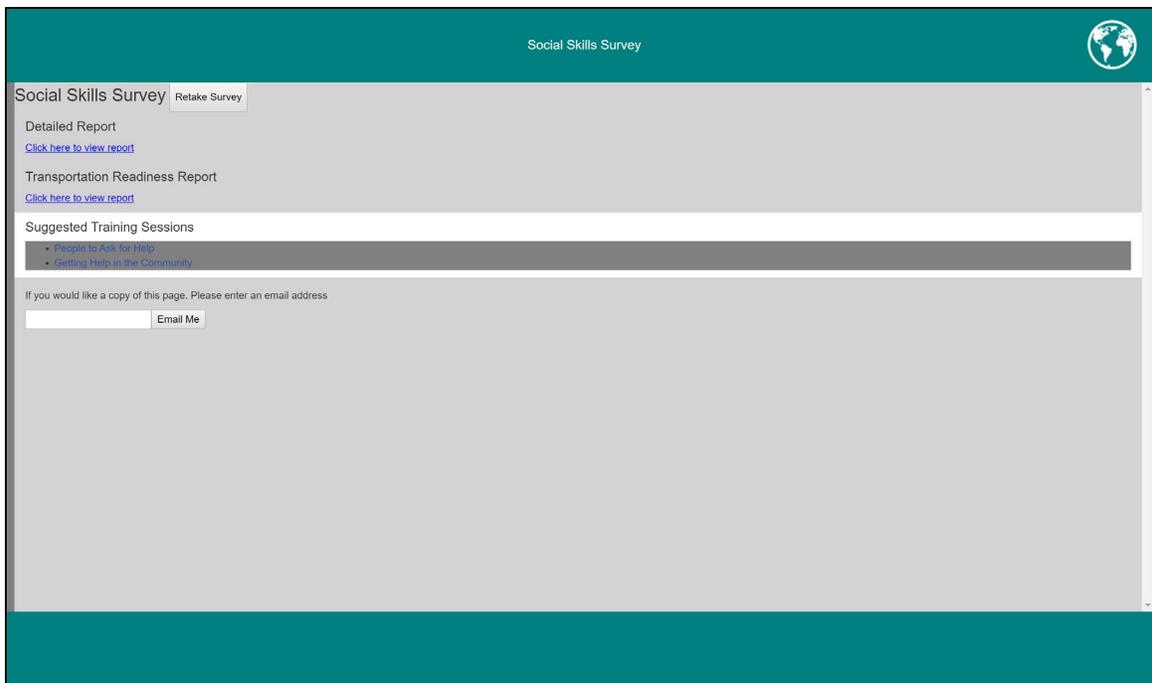
The system proceeds through the series of questions and answers as described until reaching the last question of a survey. When the last question is reached, the display is like previous screens except that when an answer is selected a Done button appears instead of the Next button, as shown in Figure 7. Upon selection of the Done button, a closing screen is provided indicating in text and audio that the survey is over and thanking the user.



Source: AbleLink Smart Living Technologies, May 31, 2018

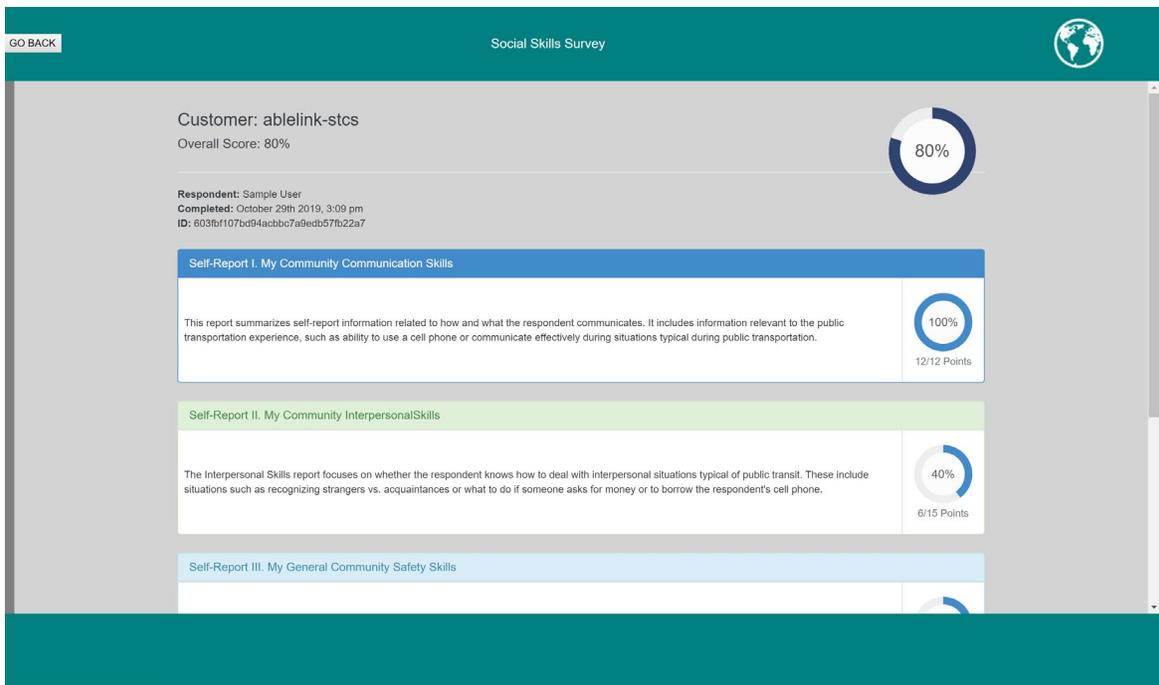
**Figure 7. Sample of last question in an assessment with Done button showing**

After the survey is complete, a summary page is displayed that allows the user to view the results immediately via two reports, as shown in Figure 8. The first report is a Detailed Report which lists each of the individual's selections for each item in the survey. The second report is the Transportation Readiness Report, which summarized the individual's results across a number of dimensions based on which survey he or she has completed (Figure 9). In addition, the individual's responses are used to suggest training sessions from the Transportation Skills Training Library, based on the connections shown in Table 1 previously. This allows areas where the individual selected an incorrect response to be reviewed following completion of the survey to allow the individual to strengthen his or her knowledge in the respective area. For example, Figure 8 shows two training sessions that the survey taker may wish to review to improve their transportation readiness: "People to Ask for Help," and Getting Help in the Community." Each of these training sessions are clickable links that allow the specific training sessions to be reviewed immediately if desired using the STCS Transportation Skills Training Library system (Subsystem 2 described in the next section).



Source: AbleLink Smart Living Technologies, October 30, 2019

**Figure 8. Assessment Report Summary Page with Suggested Tasks**



Source: AbleLink Smart Living Technologies, October 30, 2019

Figure 9. Social Skills Transportation Readiness Report

## Transportation Skills Training Library Subsystem

AbleLink's Visual Impact multimedia step-by-step training and instructional system was used as a base for both the Transportation Skills Training Library and for aspects of the Pre-Trip Execution subsystem. This technology uses text, audio, and video on a tablet or smartphone to support usability and understanding by a range of users with different needs and abilities. The Transportation Skills Training Library is a web-application deployed to support wide ranging access to users from across the country to general travel skills training. The menu for the STCS Transportation Skills Training Library (available at <https://ablelinksmartravel.com/learning.html>) is shown in Figure 10.

## STCS Transportation Skills Training Library

The Smart Travel Concierge System includes a transportation skills training library which provides 22 self-directed learning sessions designed to be used by individuals to learn about important topics related to public transportation and community access. Each training sessions allows individuals to follow a simple step-by-step approach to review safety and other skills needs for traveling independently in the community. The training sessions can be used to improve travel readiness and learn about staying safe while in the community, ways to find help when needed, important things to remember when traveling on the bus or light rail commuter train, and many other topics. The training modules are presented using AbleLink's cognitively accessible Visual Impact Learning Library system which using pictures and audio within a simplified interface for working through the training sessions in a self-directed manner. The training sessions are organized into the following four modules:

### Travel Skills



This module includes six self-directed training sessions focused on general travel skills for traveling in the community independently.

[View This Category](#)

### Safety Training



This module includes five training sessions that relate to safety while navigating crosswalks and intersection, as well as understanding traffic signs and signals.

[View This Category](#)

### Community Social Skills



This module includes four training sessions that relate to important social skills for safely interacting with others while in the community.

[View This Category](#)

### Vehicle Identification Skills



This module includes three training sessions designed to help practice skills needed to identify the correct bus or train, as well as an introduction to understanding the information contained in transit displays.

[View This Category](#)

Source: AbleLink Smart Living Technologies, October 30, 2019

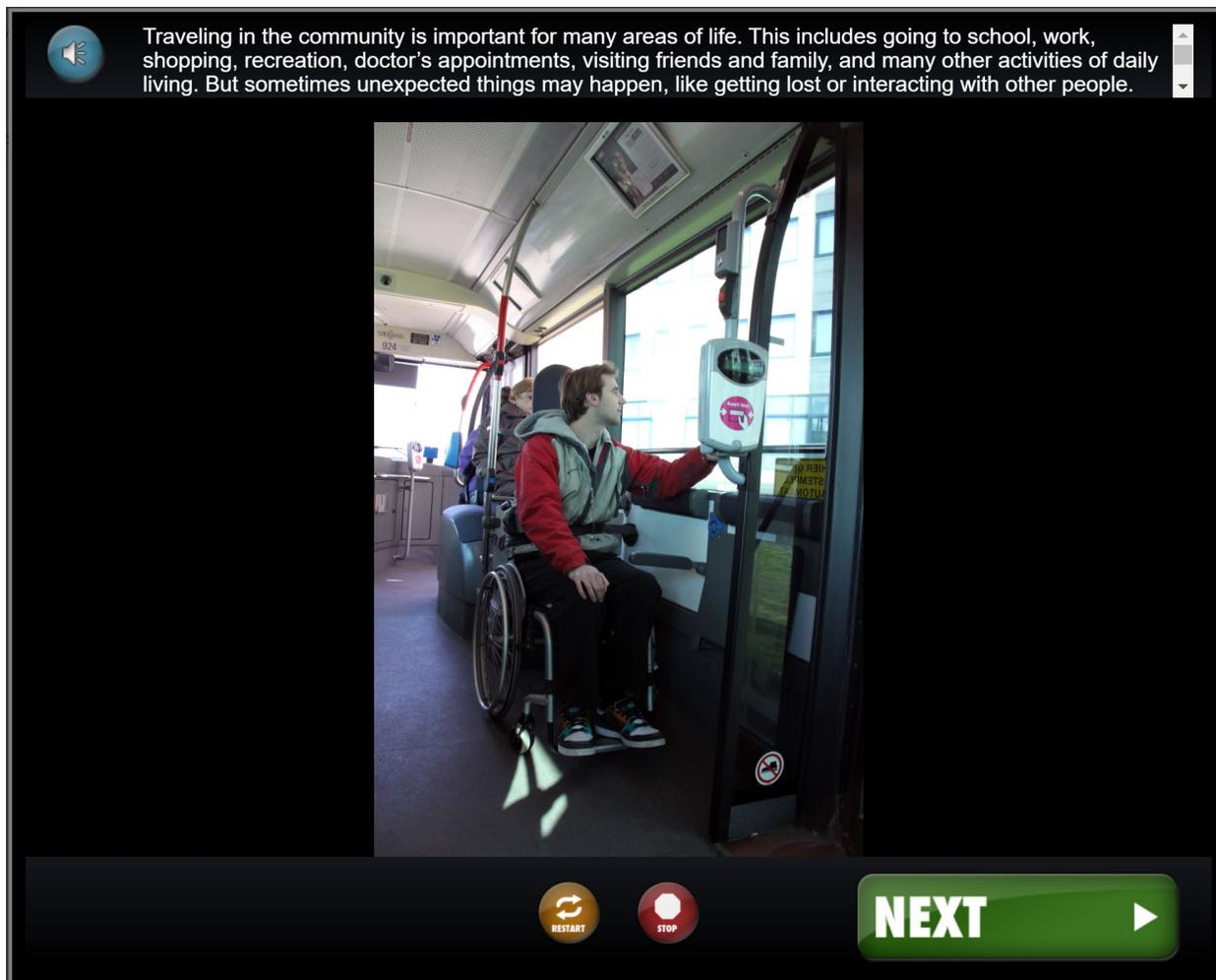
Figure 10. The Main Menu of the Transportation Skills Training Library System



Source: AbleLink Smart Living Technologies, October 30, 2019

**Figure 11. Start page of “Getting Help in the Community” Training Session**

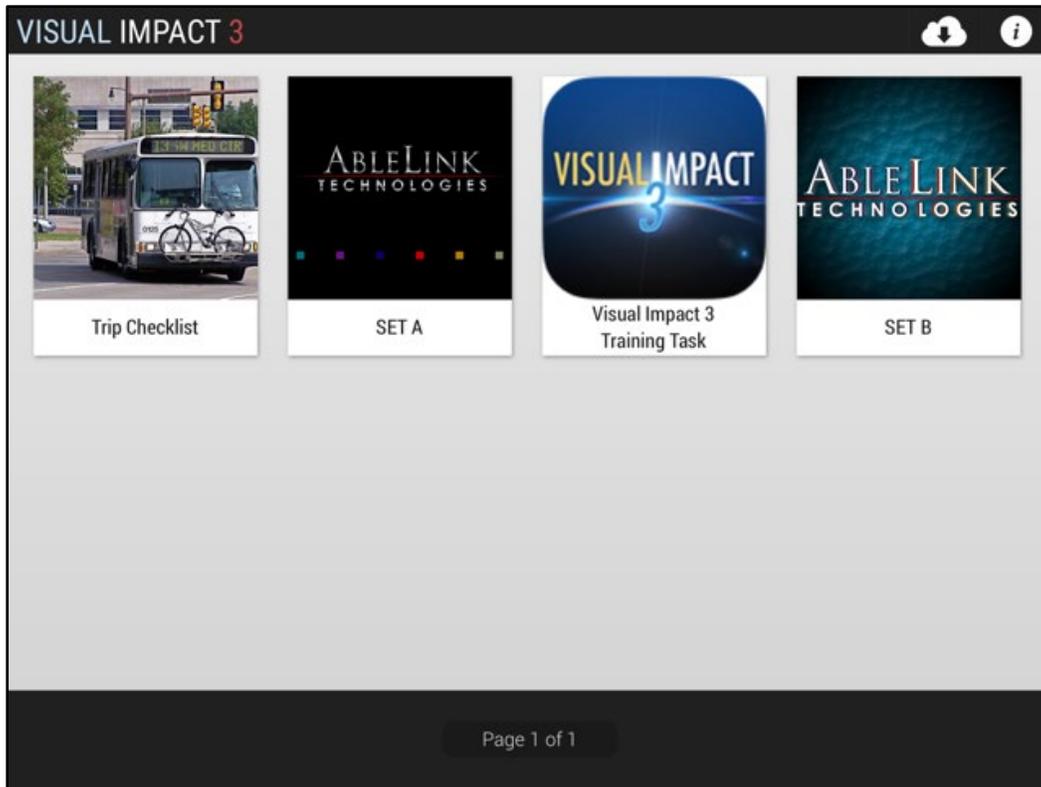
The links titled “View this Category” can be selected to access the various training sessions, which then lists each of the training modules in the selected category. For example, the Community Social Skills category contains several sessions including “Getting Help in the Community.” When the session is selected, an audio plays introducing the session and a green Start button is displayed (Figure 11). After the Start button is pressed, the session proceeds by presenting the training content using pictures, text, and audio to explain important topics as part of the session. For example, Figure 12 shows the first page of the “Getting Help in the Community” training session which, when displayed, automatically plays an audio description (which corresponds to the text on the screen) saying “Traveling in the community is important for many areas of life. This includes going to school, work, shopping, recreation, doctor’s appointments, visiting friends and family, and many other activities of daily living. But sometimes unexpected things may happen, like getting lost or interacting with other people. This session reviews basic things you can do to get help when you are out in the community. It also includes things you should not do to get help. Press the Next button to continue.”



Source: AbleLink Smart Living Technologies, October 30, 2019

**Figure 12. Example page from “Getting Help in the Community” Training Session**

In addition to the web-based training system described here, a local device-based deployment was used for the Pre-Trip Execution prototype to enable end-user authoring of content to support individual and trip-specific personalized travel needs, such as in the Pre-Trip Checklist. The following paragraphs provide an overview example of how this technology was enhanced and deployed in the Pre-Trip Execution System for use in evaluation activities. Figure 13 provides an example of the opening screen, or Main Menu, used for the STCS Pre-Trip Execution field evaluation conducted using a tablet device. The Main Menu is where users access desired training or support modules. Up to eight modules can be displayed on a screen at one time; if more than eight modules are available, a blue arrow button appears in the lower right corner of the screen. Tapping this button moves the Main Menu to subsequent sets of up to eight training modules, thus supporting essentially an infinite number of modules on a single device.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 13. The opening screen, or Main Menu, of the STCS study prototype**

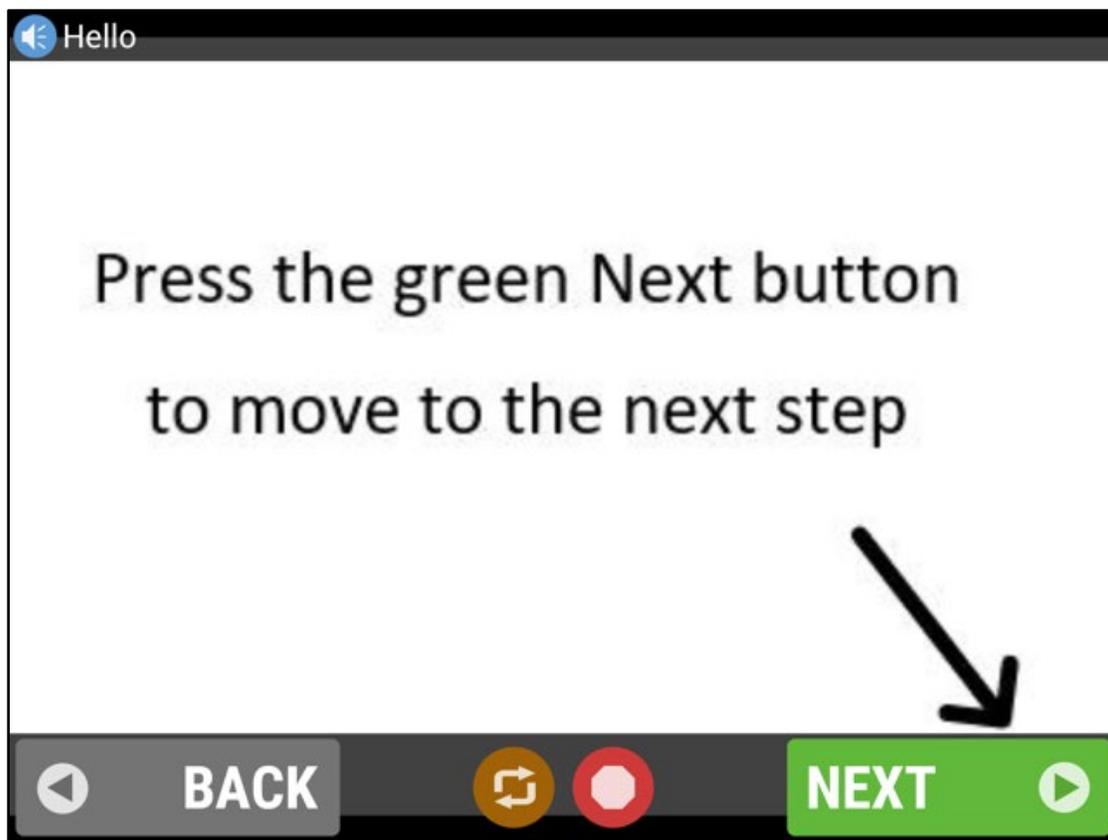
To operate the system, users tap on a desired module button to hear an audio recording such as (for the Visual Impact 3 Training Task): “For instructions on how to use this app, tap here again.” Upon a second consecutive tap, the system opens the selected module (or ‘task’) to a Start screen such as is shown in Figure 14. This audible button identification feature allows low literacy users to tap around on the various Main Menu buttons to help understand what subject matter they contain (that is, without consecutively tapping on the same module).



Source: AbleLink Smart Living Technologies, May 31, 2018

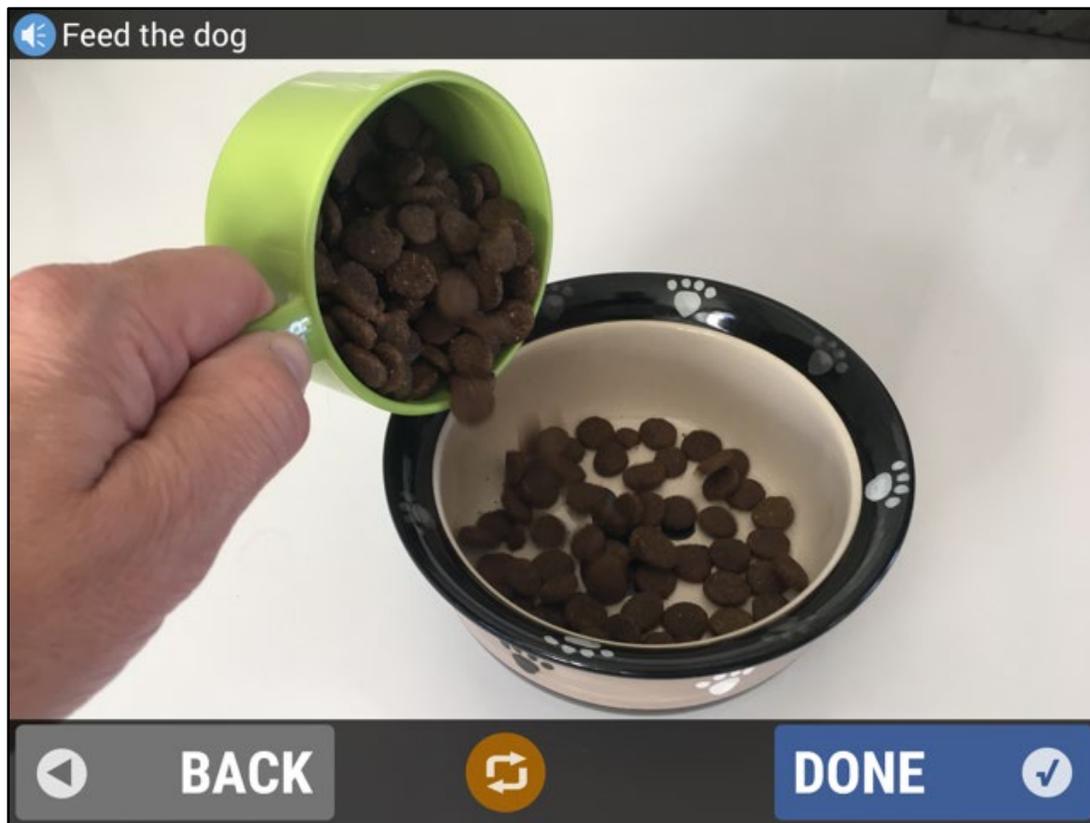
**Figure 14. The Start screen of the Set B module in the STCS evaluation prototype**

Once a task module has been selected, the system audibly confirms the selected module and prompts the user to proceed, as in “You have selected the Training Task; press the Start button to begin.” The system proceeds through the steps of the module via the interface shown in Figure 15, optionally supporting both forward and backward navigation and the ability to repeat audio/video instructions within each step. When a training module is completed, an option is available to automatically send an email message to a designated recipient as a form of remote notification (Figure 17) that the specific task module is finished. The remote notification information that is automatically sent includes the name of the individual for whom the notification is being sent, the time/date the message was sent, and the nature of the event notification (e.g., module was started, completed, or aborted), the number of steps completed, and the total time to complete the module. Task completion notifications are triggered when a user reaches the last step in a training module sequence and selects the Done button (Figure 16, which shows a pre-trip preparation task of feeding the dog), or when a task module has been aborted mid-task by using the stop sign button.



*Source: AbleLink Smart Living Technologies, May 31, 2018*

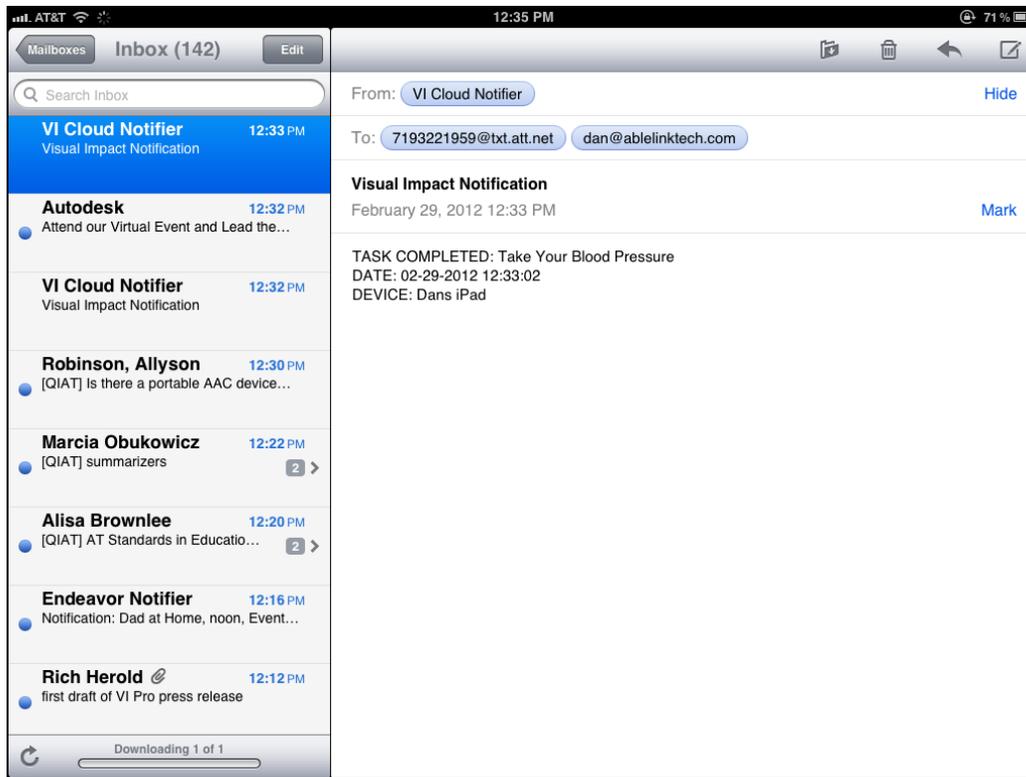
**Figure 15. Sample screen of the Training Task module in the STCS evaluation application**



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 16. Tapping the Done button, which only appears at the end of each task module sequence, triggers the automated notification message as shown in Figure 17.**

While Figure 17 provides an example of a remote notification in email format, also note that the feature can alternatively send text message notifications as well. When an instructional module has been completed, the system returns to the Main Menu as shown previously in Figure 13.



Source: AbleLink Smart Living Technologies, May 31, 2018

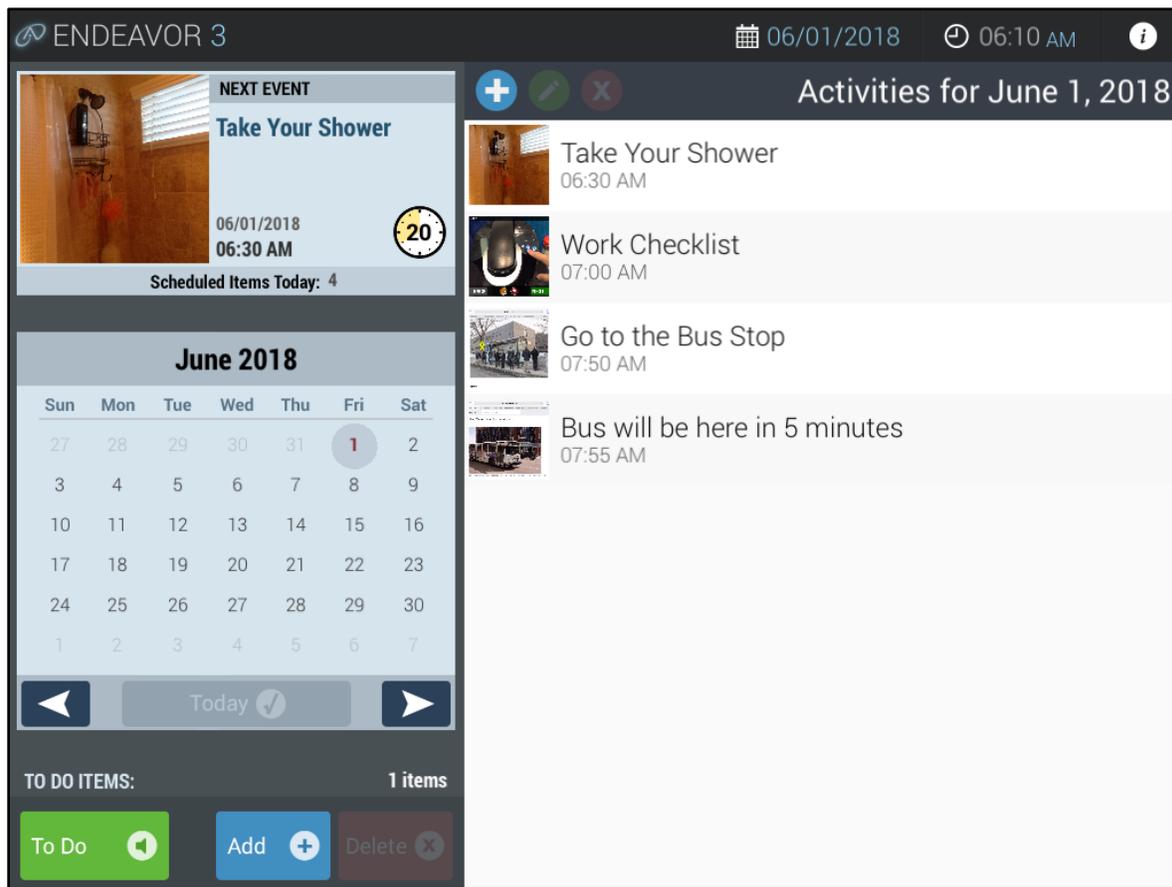
Figure 17. Sample of automated remote notification email indicating module completion

## Pre-Trip Execution Subsystem

Individual users, including travel training instructors, teachers, agency staff, or families, can create original and highly individualized travel preparation prompts and content via the Pre-Trip Execution subsystem of the STCS project. To support this end-user authoring of content, this subsystem has been deployed as two local, integrated tablet or smartphone-based apps for personal use unlike the publicly available, web-based deployment of the Transportation Skills Training Library. The Pre-Trip Execution system includes a schedule-based multimedia reminder system based upon AbleLink's Endeavor technology, and step-by-step instructional supports that use the previously described Visual Impact cueing approach for completion of important pre-trip tasks. A new feature developed during this project involves presentation of prompts for task completion of activities that do not need to be completed sequentially, i.e. in a checklist format. The following section provides a walk-through of the scheduling component of this subsystem.

Figure 18 shows an example of the schedule display, the first component of the Pre-Trip Execution system. The Activities list on the right side of the screen shows the scheduled events for the currently selected day depicted with an image and text along with the time for the event to launch. Items on the list can be selected (tapped) if desired to hear the audio cue associated with the event. At the top left of the Activities list display are a series of buttons for adding an event to the list, editing a selected event on the list, or deleting a selected event from the list. Above the Activities list are a series of widgets showing the

date, time, and a Settings button (white circle with small letter 'i' on it). An option is available that allows users to hear the date and time to be read aloud by tapping the respective widget. The next scheduled event in the cue on the Activities list is highlighted in the upper left of the display to provide emphasis to users as to the next item on their schedule. This highlighted event includes a graphical countdown timer to assist users in understanding the relative time remaining until the event launches. Below that is an optionally displayed calendar that allows users to navigate to and tap on different days to view previous or upcoming schedules.

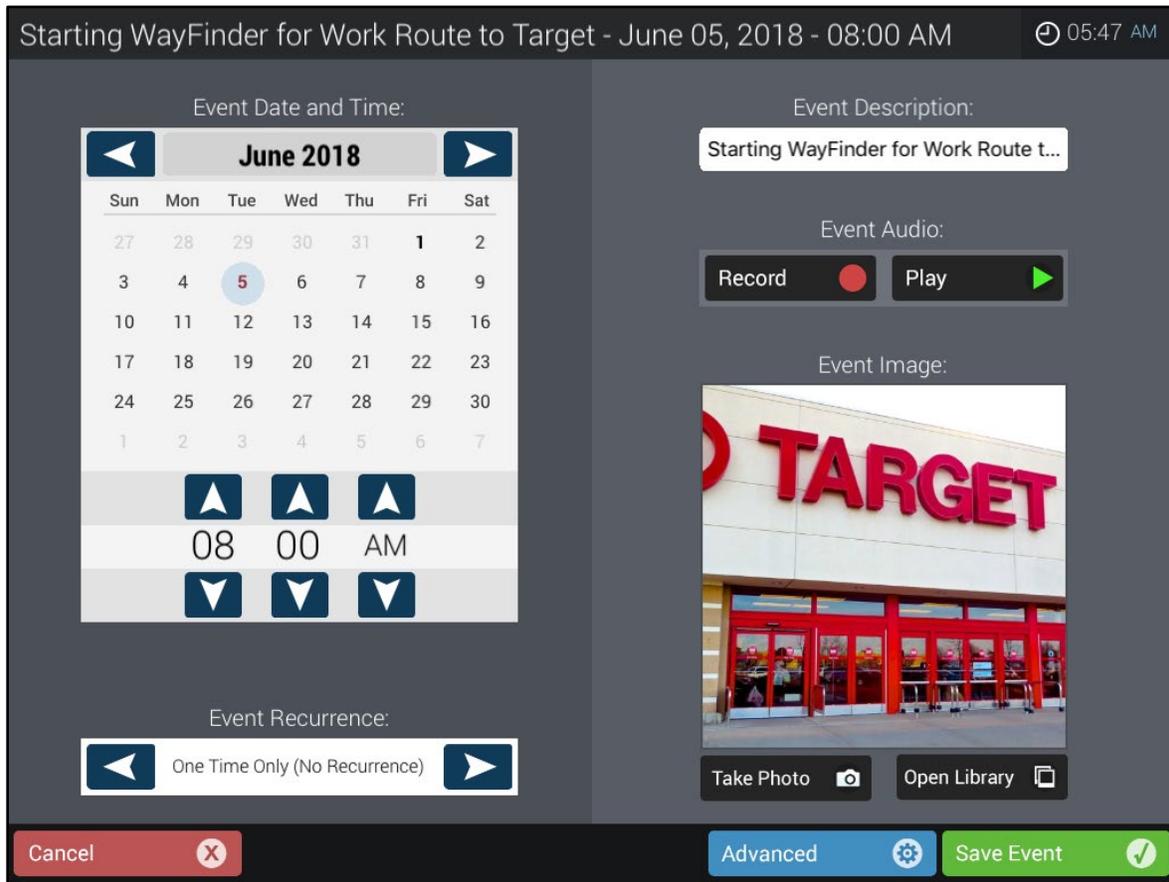


Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 18. Sample of Pre-Trip Execution system's schedule display**

Finally, an optional To Do widget can be provided in the lower left corner of the display. This widget allows users to keep an ongoing list of reminders that are *not time based*. Tapping the blue Add button activates a voice recorder to record the reminder. During recording a Stop button is displayed to allow the user to end the recording. Users can tap the To Do button consecutively to listen to the reminders on the list; tapping the Delete button immediately after hearing a reminder removes the reminder from the list. This To-Do-List feature was originally developed and evaluated in a Small Business Innovation Research project in which soldiers with traumatic brain injuries participated in a study that successfully demonstrated the usability and significant benefits of the approach as compared to traditional written reminders.

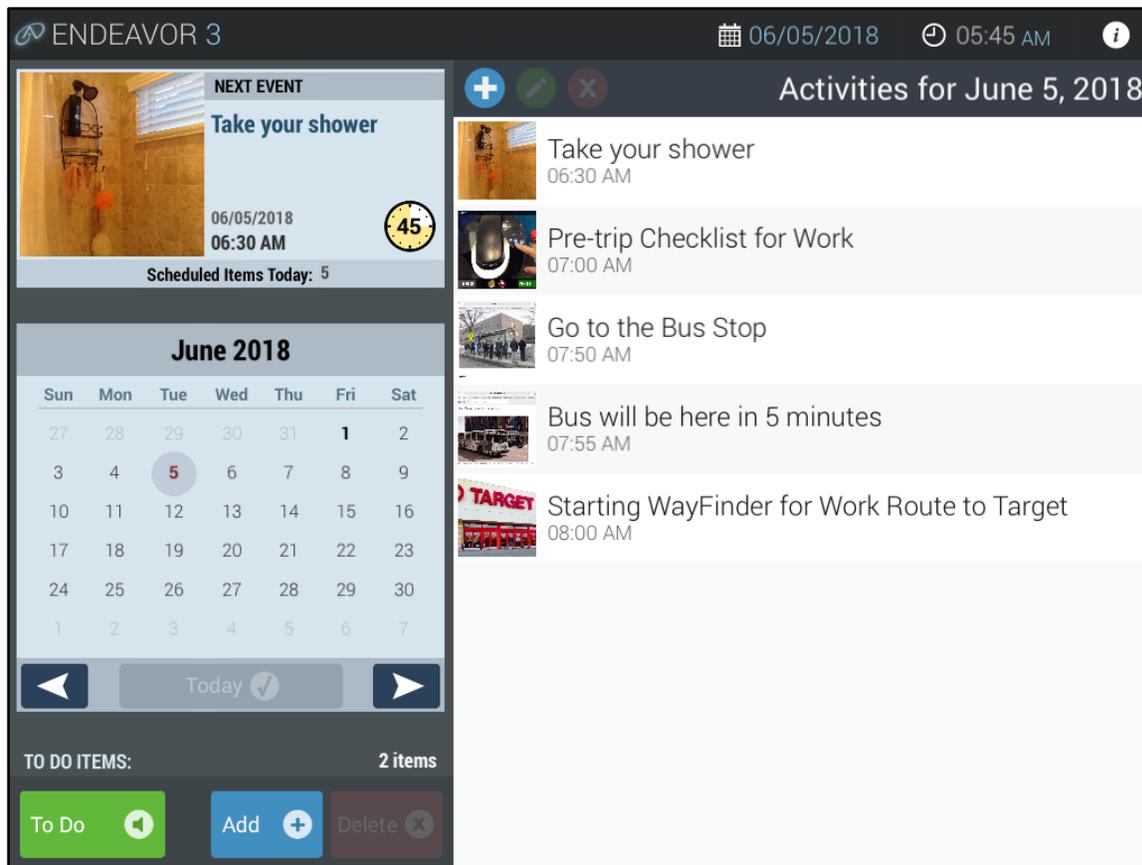
To create a new scheduled event, users tap the blue Add Event button (with the white plus sign on it as shown in Figure 18) just above the Activities list. Figure 19 shows an example of the Create New Event display with each field already populated with content for a new scheduled event.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 19. Sample of Pre-Trip Execution system's schedule display**

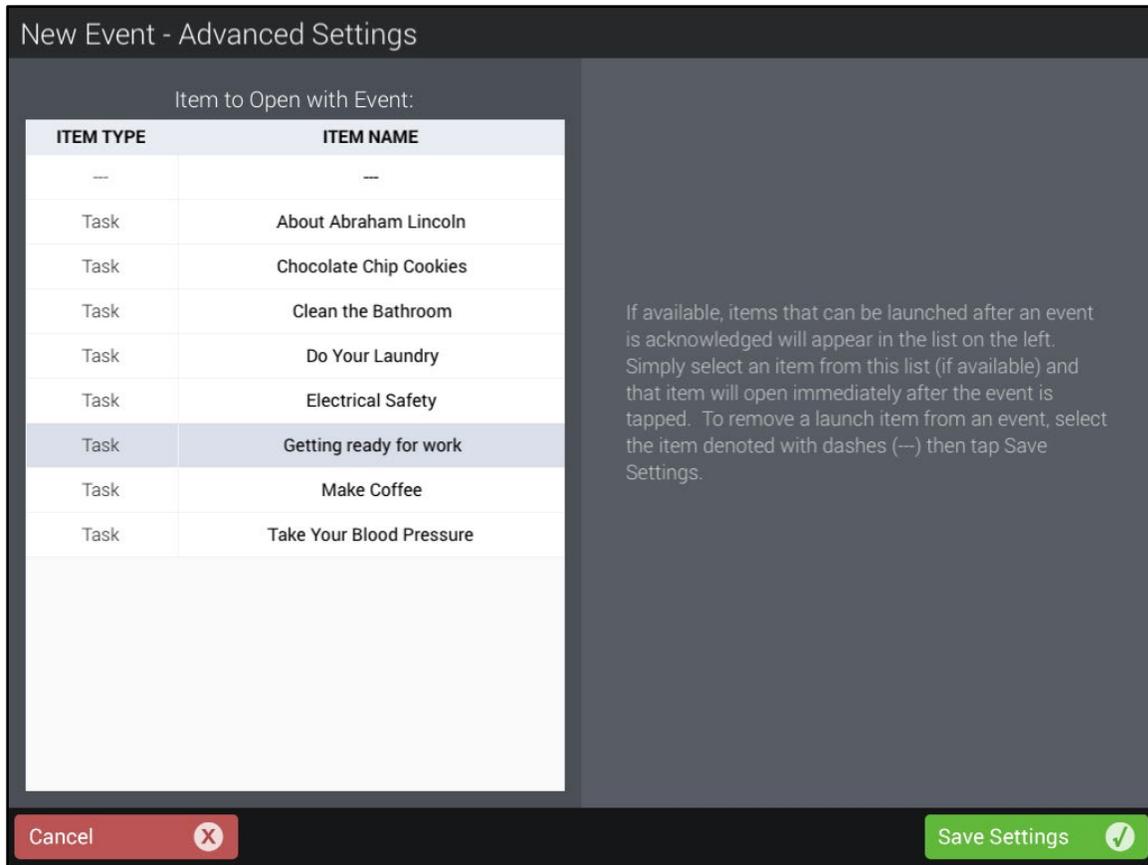
The Event Description field is where the text is entered that is displayed on the Activities list in Figure 18, and the Event Audio allows in-line recording of the audio cue that plays when the event launches. The Event Image that is also displayed on the Activities list and when the event launches can be obtained in-line using the device's built-in camera (i.e., the Take Photo button), or by navigating to an existing image already on the device (i.e., the Open Library button). The Calendar control on the left side of the screen allows the person setting up the event to select the day and time at which the event will launch. The Event Recurrence control provides the option of setting the event to launch only at the date and time selected, or at a variety of recurring instances for user convenience. Figure 20 shows the Activities list with the newly created event for 'Starting WayFinder for Work Route to Target' now showing on the screen.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 20. Activities List with new event for Starting WayFinder for Work Route to Target showing**

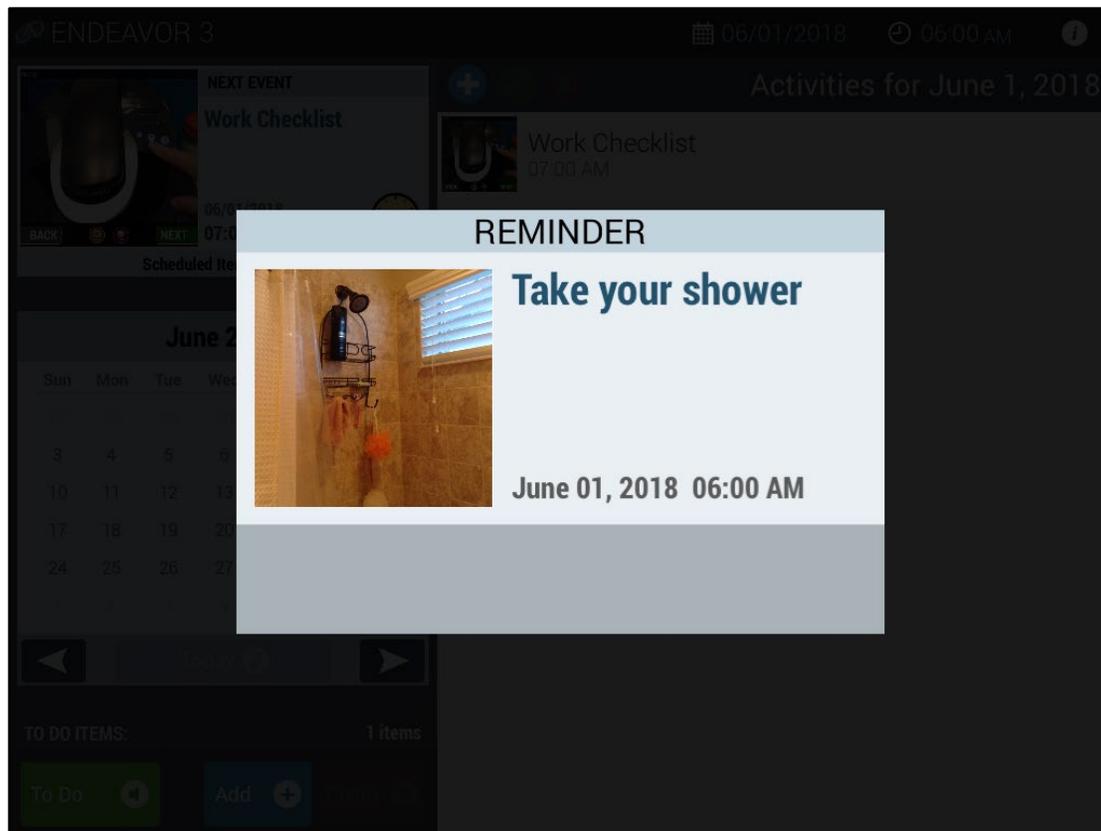
The Advanced button at the bottom of the display in Figure 19 provides the functionality to automatically launch other technology supports when an event comes due. These include launching a step-by-step or pre-trip checklist task feature (Figure 21) or automatically launching the WayFinder application to a specified SMART Route. The scheduling system has been integrated with both the Visual Impact and WayFinder applications to enable it to poll these applications and display the currently available list of instructional tasks (Visual Impact) or SMART Routes (WayFinder) to enable time-based automated launching via scheduled events.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 21. Schedule system Advanced Settings display for automatically launching the Getting Ready for Work pre-trip checklist**

Figure 22 shows an example of the Alert display when a scheduled event activates. At the same time, an audio alert plays stating “You have a message. Tap the screen to hear it.” This message plays at diminishing intervals for up to one hour until it is acknowledged. When the user taps the screen, the event audio message plays (e.g., “It’s time to go to the bus stop for work”) and then returns to the Activities list. Optionally, a setting is available to display an OK button that allows the event audio message to be replayed repeatedly, and manually acknowledging the event by tapping the OK button returns the display to the Activities list.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 22. Schedule system Alert screen that activates when a scheduled event is launched**

Finally, tapping the Settings button (i.e., the white circle with the *i* on it in the upper right corner of Figure 18), opens the Settings display shown in Figure 23. The Settings display shows options and features that are available to be turned on or off. The Settings options allow the interface to be optimized to better meet the unique needs of different users and different situations. For example, users with greater cognitive challenges may benefit from advanced features being turned off so as not to clutter the display or promote unnecessary confusion. Numerous previous research and development projects conducted by the STCS project team have demonstrated the benefits of providing this capability to turn features and screen elements on or off on a user-by-user basis. The following section provides an overview of the Settings display options.

**Endeavor 3 - Settings**

**Notification and Alert Options**

- Enable Email Notifications
- Notification Address: staff@gmail.com
- Show the OK Button on the Event Alert

**Interface Options**

- Allow Playback of the Calendar Audio
- Allow Playback of the Clock Audio
- Show the Settings Button
- Show the Calendar Navigation
- Show the Audio To Do Tools

**Application Settings**

Reset All Endeavor Settings

**Schedule List Options**

- Show the New Event Button
- Show the Delete Event Button
- Show the Edit Event Button
- Show the Splash Screen

**Endeavor Compatible Applications**

- Retrieve Surveys from ATLAS
- Retrieve Tasks from Visual Impact
- Retrieve Routes from WayFinder

Endeavor 3 ©2018 AbleLink Technologies, Inc.

Cancel

Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 23. Schedule system Settings display for personalizing the interface and operation**

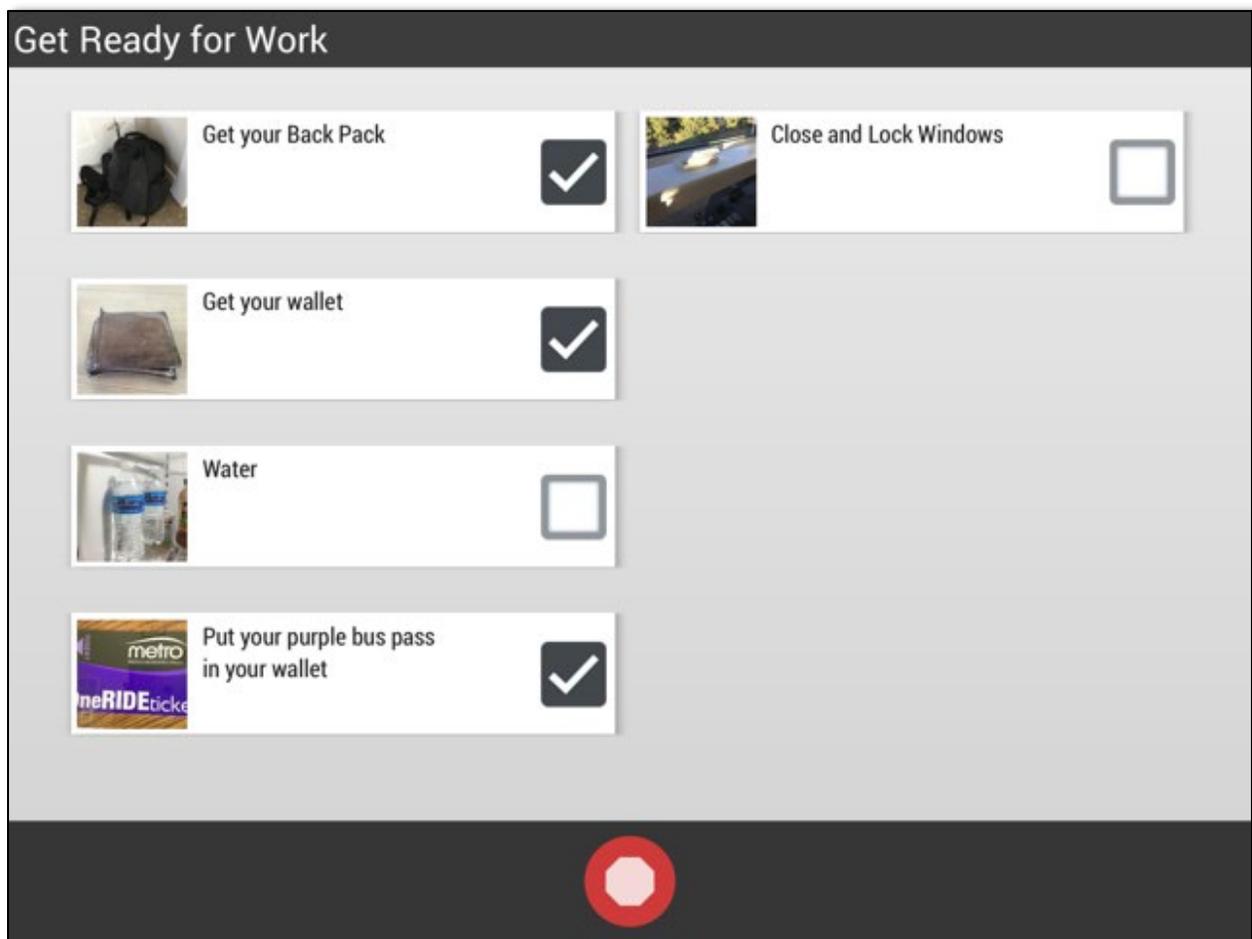
- **Enable Email Notifications**—This option turns on the Email Notifications feature. This feature will send an automated email to the address indicated in the Notification Address field whenever a scheduled event (such as starting a WayFinder route) is acknowledged in the scheduling system.
- **Notification Address**—When the Enable Email Notifications feature is turned on, automated email messages are sent to the address indicated in this field whenever a scheduled event is acknowledged.
- **Show the OK Button on the Event Alert**—When a scheduled event activates, an Alert message plays stating “You have a reminder. Tap the screen to hear it.” At the same time the image selected for the scheduled event is displayed. If this OK Button feature is turned on, when the user taps the screen to hear the reminder an OK button is displayed. Further taps on the image or screen will replay the reminder; tapping the OK button confirms the event has been acknowledged and the user is returned to the Activities list display. If this feature is turned off and a scheduled event activates, the screen can be tapped one time to hear the reminder and acknowledge it before it disappears from the screen and returns to the Activities list display. When the OK Button feature is turned off, there is no option to replay a reminder.
- **Allow Playback of the Calendar Audio**—When this option is on, the Calendar icon near the top of the display can be tapped to hear the date read aloud in a computer voice. This is designed to assist users with reading limitations or who otherwise have difficulty with calendar concepts. If turned off, the Calendar will still be displayed but no audio will play if it is tapped.

- Allow Playback of the Clock Audio—When this option is on, the Clock icon near the top of the display can be tapped to hear the time read aloud in a computer voice. This is designed to assist users with reading limitations or who otherwise have difficulty with time concepts. If turned off, the Clock will still be displayed but no audio will play if it is tapped.
- Show Settings Button—Turning this feature on displays the Settings button above the Activities list. To access the system’s interface configuration Settings, users must tap and hold this button for about five seconds. An initial sound will play when the button is first touched, and a second sound will play after five seconds to indicate success. Note that if this feature is turned off, the Settings page can still be accessed by tapping and holding the blank space where this button was previously displayed; turning it off removes the button but not the functionality to access Settings. The tap-and-hold interface is designed to prevent accidental access to the Settings page by unintended users.
- Show the Calendar Navigation—Turning this option on displays the Calendar that can be used to review past day’s schedules and preview future day’s schedules. Turning this feature off removes the Calendar from the display for those who may not be able to benefit from it; instead, a blank space is displayed instead of the Calendar to provide a more clutter-free screen.
- Show the Audio To Do Tools—Turning this option on displays the To Do List feature which allows users to create an audio list of reminders that are not time specific. Turning this feature off removes the To Do List from the screen for those who may not be able to benefit from it; instead, a blank space is displayed instead of the To Do List to provide a more clutter-free screen.
- Reset All Endeavor Settings—Tapping this button will reset all options in Settings to the original factory defaults.
- Show the New Event Button—Turning this option on will display the New Event button on the Activities list. While generally left on, this button can be turned off for users who may unintentionally or otherwise add inaccurate events to their schedule.
- Show the Edit Button—Checking this option will display the Edit button on the Activities list and allow scheduled Activities on the list to be edited. It may be hidden for users who may not have the skills to edit scheduled Activities.
- Show the Delete Button—Turning this option on will display the Delete Event button whenever an event is highlighted (tapped) on the Activities list. This button can be turned off if desired so that the end user cannot accidentally or intentionally delete scheduled events from the Activities list.
- Show the Splash Screen—Checking this box will display the Splash Screen with a short music clip when the schedule system is launched; unchecking the box skips the Splash Screen and allows the app to load faster.
- Retrieve Surveys from ATLAS—Tapping this button will refresh the list of surveys that are available via the companion ATLAS survey application which must be running on the same hardware device. When a scheduled event is acknowledged, an ATLAS Survey can be automatically launched to prompt the user to take the survey. For example, a scheduled event may state “It’s time to give some feedback on how your last bus trip went,” which can then automatically launch a trip satisfaction survey in ATLAS and then return to the scheduling system when completed.
- Retrieve Tasks from Visual Impact—Tapping this button will refresh the list of step-by-step or checklist task instructions (or ‘tasks’) that are available via the companion Visual Impact prompting application which must be running on the same hardware device. When a scheduled event is acknowledged in the scheduling system, a checklist can be automatically launched to prompt the user through the steps of completing important pre-trip tasks. For example, a scheduled event may state “It’s time to get ready to go to work, tap the OK button to see your list of things to do before you leave”, and can then automatically launch the checklist to guide the user through the activities that need to be

completed prior to travel. The system will automatically return to the scheduler when the checklist is completed.

- Retrieve Routes from WayFinder—Tapping this button will refresh the list of routes that are available via the companion WayFinder application which must be running on the same hardware device. When a scheduled event is acknowledged, a SMART Route can be launched within WayFinder automatically when it is time for the individual to begin his or her trip.

To complement the Pre-Trip Execution scheduling system described above, the step-by-step multimedia prompting system described previously via Figures 13 - 17 was enhanced and deployed as a local device app. The step-by-step prompting functionality in this component is similar to that previously described and therefore will not be re-presented here. A pre-trip checklist feature was designed to support pre-trip preparation, as shown in Figure 24 below. This capability is designed to make it easier for the user to complete the tasks necessary for getting ready for a trip to help with pre-trip planning and execution activities.

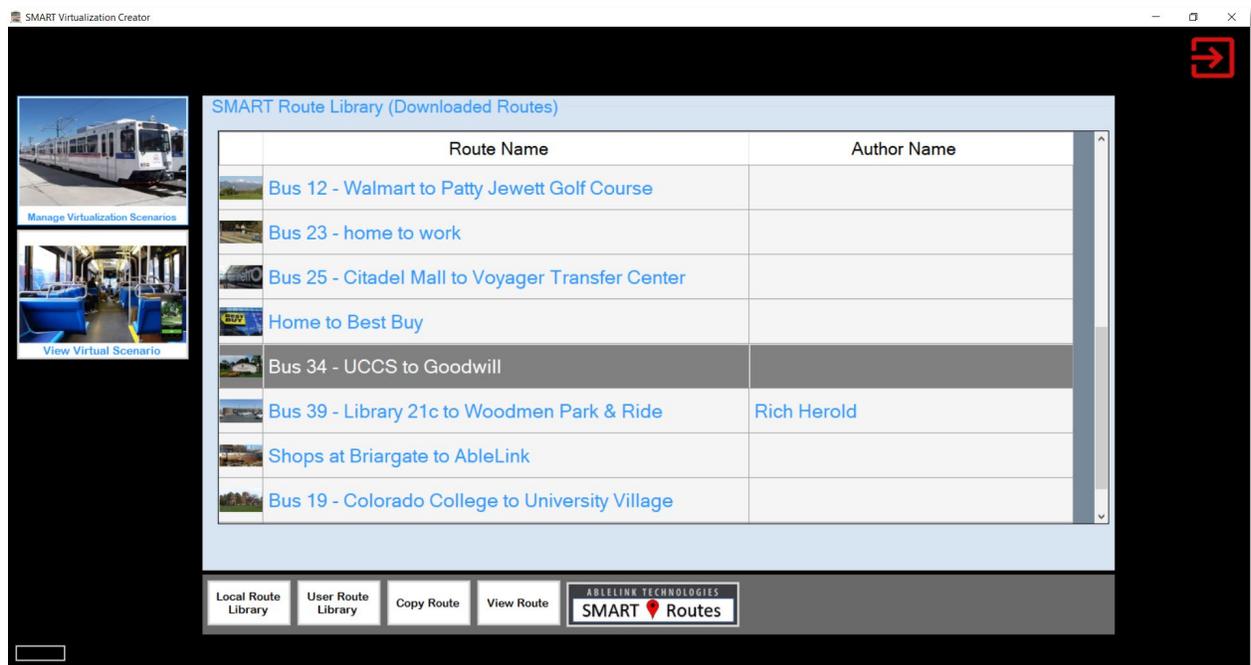


Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 24. Pre-Trip Checklist Interface**

## Trip Virtualization Subsystem

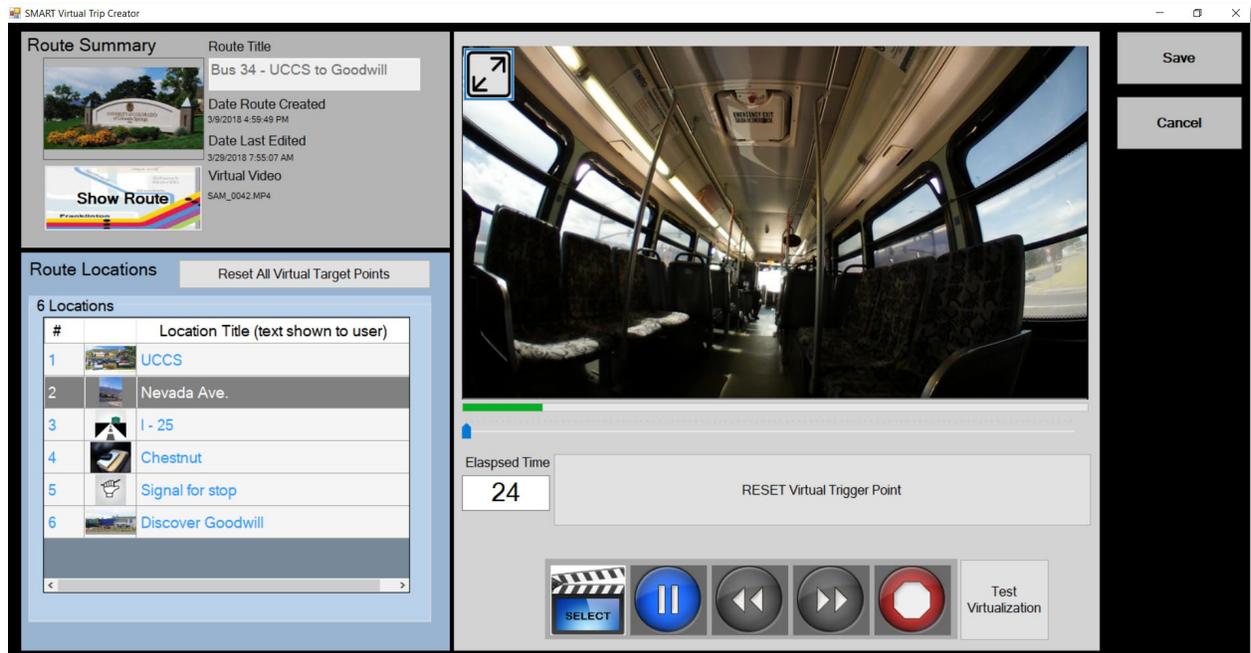
The final STCS subsystem that was developed was the Trip Virtualization System. This subsystem is designed for use on a desktop or notebook computer and allows users to experience a “virtual” trip through use of a video of the trip and a simulated travel support prompting system to provide travel instructions during the virtualization scenario. The scenario may include just a bus route, for example, or may include an entire door-to-door route to include first mile/last mile foot travel sandwiched around a bus route. Ideally the video will be shown from the traveler’s perspective, such as out a side or front window of a vehicle depending on where the user usually sits or is trained to sit while traveling. The subsystem is composed of an application used to create the virtualization scenarios (Trip Virtualization Creator) and an application used for playback of the virtualization scenarios by the traveler in need of travel training (Trip Virtualization Viewer). Figure 25 shows the main menu of the Trip Virtualization Creator application with several routes that have been downloaded from a SMART Route Library (developed in AbleLink’s companion ATTRI project). A virtual trip experience can be created for any of these routes by selecting the Manage Virtualization Scenarios button after highlighting the desired route.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 25. SMART Virtualization Creator – Main Menu with SMART Routes Downloaded from a SMART Route Library**

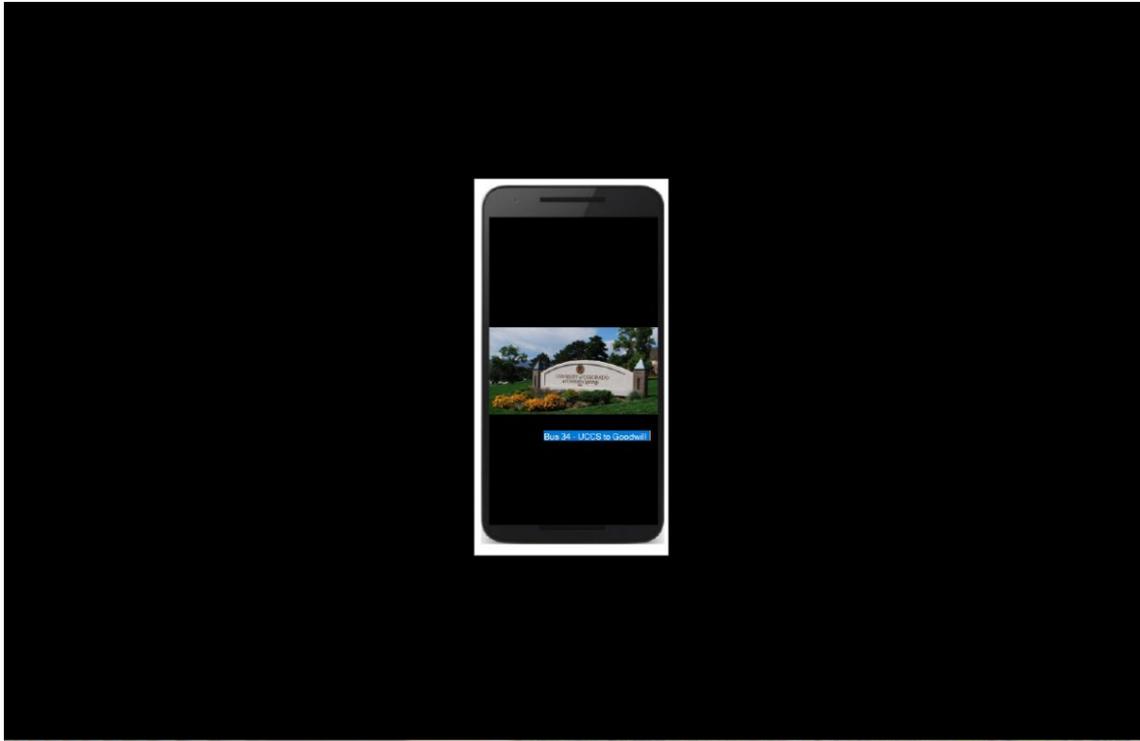
After a video has been captured for a specific route, the travel trainer or caregiver will select the route and begin to build the virtualization scenario using the interface shown in Figure 26.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 26. SMART Virtualization Creator – Display showing a Virtualization Scenario being built for “Bus 34 – UCCS to Goodwill” SMART Route**

The basic process for creating a virtualization scenario begins with selecting the video that was recorded for the route by pressing the Select video button (that is, the first button in the button bar at the bottom of the display). When the virtualization scenario is saved, the filename of the video is added to the SMART Route. Then as the video is played within the creator interface by using the multimedia control bar beneath the video window, the user marks the scenario video playback location by pressing the Virtual Trigger Point button under the playback window for each of the locations in the route (shown in the table in the blue shaded section on the lower left side of the screen). Once a trigger point is set, the button is labelled RESET Virtual Trigger Point to allow the user to change the trigger point for a location (as shown in Figure 26). Thus, as the video progresses, the elapsed time and place where each route location (and the associated multimedia instructions) is to be presented to the individual playing back the virtualization scenario is marked using the Virtual Trigger Point button as described. This process continues until all the locations have been marked. The scenario developer can then test the virtualization scenario by pressing the Test Virtualization button on the lower right of the screen. This will launch the virtualization in full screen mode similar to how the user will view the scenario in the Trip Virtualization Viewer app and the simulated SMART travel app (e.g. WayFinder) will be shown in the center of the display, as shown in Figure 27.



*Source: AbleLink Smart Living Technologies, May 31, 2018*

**Figure 27. Simulated WayFinder app is used to launch Virtualization Scenario**



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 28. Virtualization Scenario with Simulated Wayfinding App**

As the user taps the image for the route, the route audio is played identifying the route to the user and requesting him or her to tap the route image again to select the route. Once the route is selected a second time, the virtualization video begins playing full screen and the fully operable WayFinder simulation is shown in the bottom right of the display, as shown in Figure 28.

As the video progresses, each of the appropriate prompts (pictures and audio instructions) associated with different locations along the route is presented on the simulated app for the user to respond to. The virtualization scenarios provide the dual opportunity for individuals 1) to virtually experience the upcoming trip and learn more of what to expect during the trip and 2) to learn how to interact with the WayFinder SMART travel app designed to provide instructions throughout the route, such as when it will be time to notify the driver that you are ready to get off the bus. For example, Figure 29 shows the prompt that is shown to the user when it is time to notify the driver to stop at the next bus stop and in the scenario the audio will play saying “Now pull the cord to let the driver know it is time to stop the bus so you can get off.”

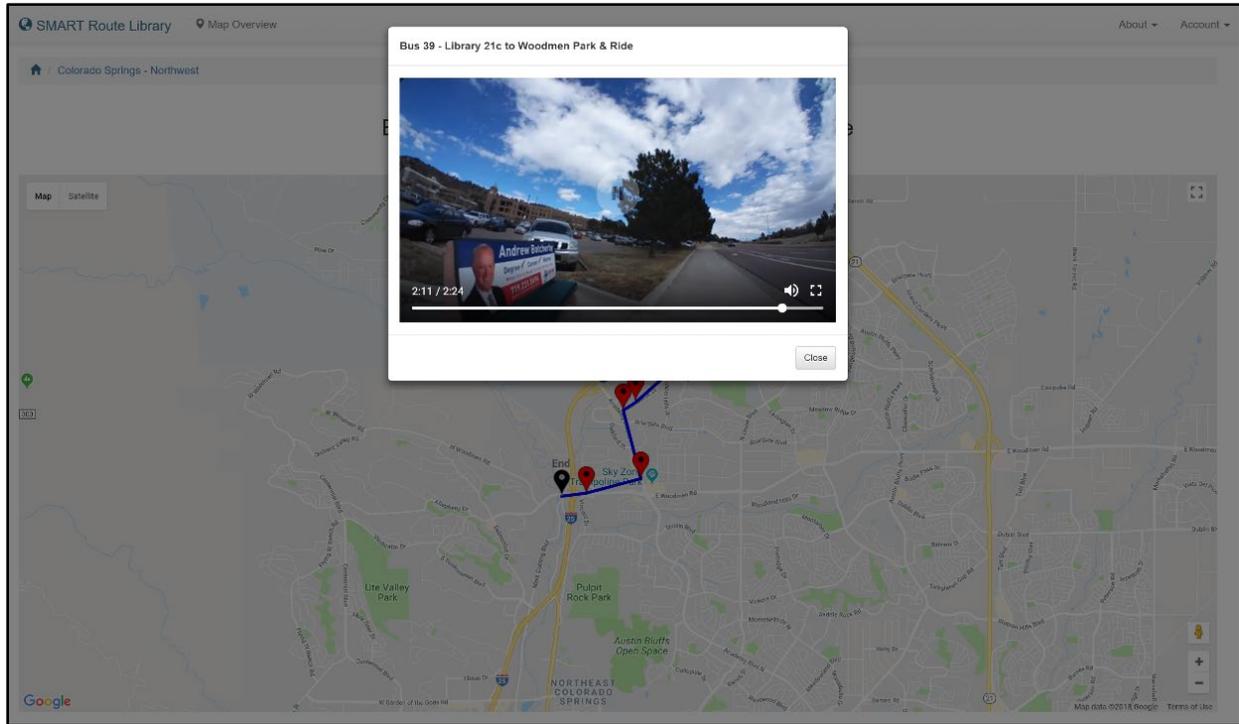


Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 29. Virtualization Scenario illustrating it is time to notify the driver to stop at the next bus stop with the simulated Wayfinding app**

The Trip Virtualization Viewer app uses this same playback interface to allow individuals to select a trip to practice prior to leaving home for the trip. The pre-trip execution app described previously can also be used to provide scheduled reminders for individuals to go through a particular virtualization scenario relevant to an upcoming trip.

During the requirements development activity of the STCS project, select members of the Project Steering Committee indicated that incorporating this virtual component to the travel training process would provide an important tool for helping travel trainees familiarize themselves with embarkment and debarkment points, landmarks, in-route stops, length of trip, etc. Virtualization scenarios for more generalized travel routes, such as taking a local bus from the mall to downtown can be uploaded to a SMART Route Library to allow others to download and utilize a previously created virtualization scenario. This capability was developed as part of AbleLink's companion ATTRI project. A SMART Route Library with a virtualization video shown is depicted in Figure 30.

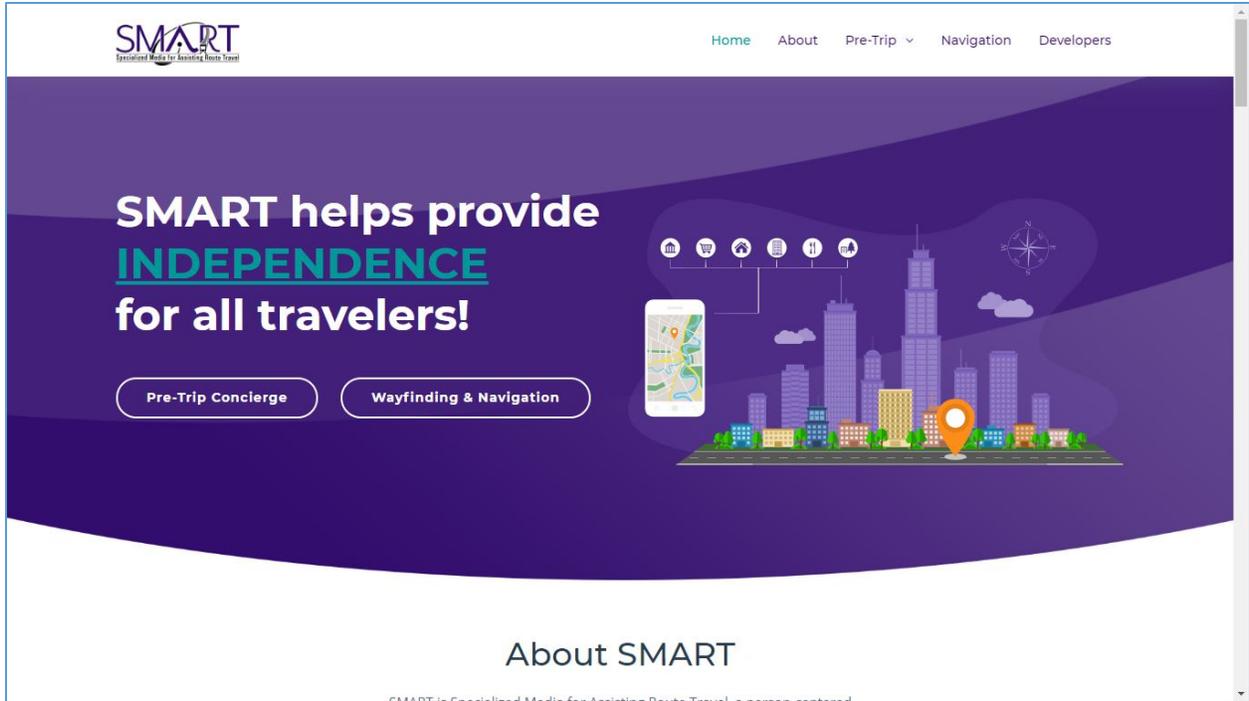


Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 30. Virtualization Scenario Video Shown in SMART Route Library**

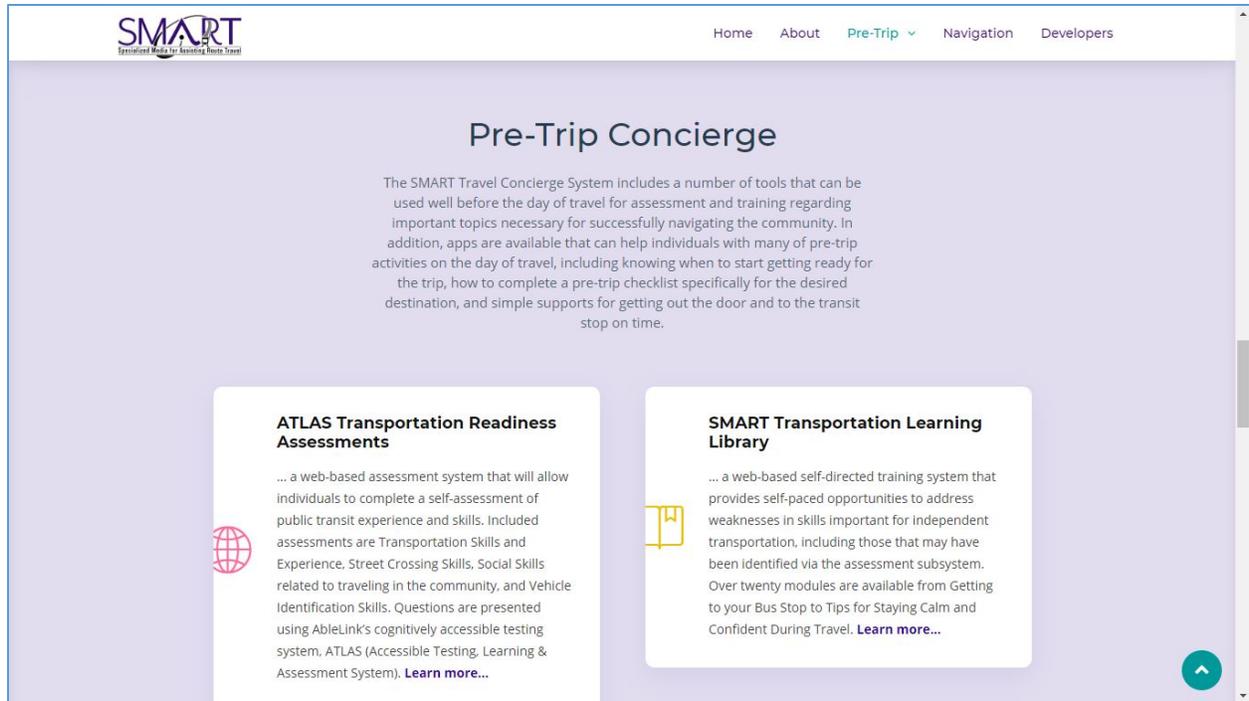
## Accessing the STCS Subsystems

A web portal is under development to provide access to information and tools developed in this project. Figures 30 and 31 show sample displays from this web site. This site also includes links and information for AbleLink's companion ATTRI project, *Leveraging Innovative Technology to Develop the SMART Wayfinding Standard to Facilitate Independent Use of Public Transit by Individuals with Cognitive Disabilities*. This web portal can be found at <https://ablelinksmartravel.com/index.html#>.



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 31. AbleLink’s ATTRI web portal site**



Source: AbleLink Smart Living Technologies, May 31, 2018

**Figure 32. Beginning of STCS section of ATTRI project web portal site**

# Chapter 3. Testing, Evaluation, and Field Implementation Activities

Throughout the project various testing, evaluation, and field implementation activities were performed to provide a variety of approaches and contexts to assess the efficacy of the STCS design approaches for meeting the transit skills assessment, training, and pre-trip execution needs for individuals with cognitive disabilities. A summary of each of these evaluation activities is presented in this chapter.

## Finalize Plans and Procedures

This involved completion of necessary details and logistics in planning for the controlled and field evaluations of various subsystem components. Throughout the project, informal usability testing was conducted with local volunteers with cognitive disabilities to observe their interactions with interfaces, navigation strategies, feature options, and other components of project subsystems. It is common for multiple interface approaches to be prototyped in the early design phases so that this hands-on testing could help discern which ones were more usable and preferable by the end user populations. This allowed the project team to involve end-users at very early stages of the project and get first-hand feedback prior to investing significant time and cost in software development activities.

In more controlled testing situations, data collection forms and protocols were prepared and reviewed to assure a variety of possible data collection scenarios were addressed. Project staff documented specific guidelines and training for partner agencies and project data collectors regarding different components of the system as part of this effort. Statistical analysis was conducted by the Project Advisor with support from Dr. Michael Wehmeyer of the University of Kansas's Beach Center on Disability, who was also a member of the Project Steering Committee. Additionally, implications of the results for future development activities were analyzed. The following section provides a brief outline of the controlled testing performed for the assessment, training, and pre-trip execution subsystems of the STCS.

## Overview of Field Testing

### Objectives

- 1) To evaluate change in travel readiness after engaging in self-directed assessment and travel training modules
- 2) To evaluate impact of pre-trip execution apps to support the task of getting ready for travel on the day of travel
- 3) To capture feedback from field testing organizations following real world implementation of STCS technologies

## Study 1: Evaluation of STCS Assessment Subsystem Approach

Under a controlled testing environment, this study used a pretest/posttest format (a. initial baseline STCS Assessment; b. self-directed Transportation Skills Training Library Engagement; c. post-training reassessment) to measure changes in travel readiness knowledge. Participating agencies in this study were local adult intellectual disability service agencies Cheyenne Village, Discover Goodwill of Southern and Western Colorado, Dungarvin, and Mosaic. Volunteer participants with cognitive disabilities involved in local controlled evaluation received a cash stipend for their efforts in participating in the project.

### Study Design

In the first activity, a pretest/posttest design was used to evaluate the combined self-assessment and independent skill acquisition approach of the STCS. This involved use of the Transportation Skills Assessment System to establish a baseline of transportation knowledge. Participants with disabilities then engaged in corresponding aspects of the self-directed Transportation Skills Training Library before repeating the self-assessment process to provide a measure of efficacy for the approach. The *Vehicle Identification* assessment was used in the study along with the corresponding Training Library modules of *Identifying Buses by Name* and *Identifying Buses by Number*. The dependent variable was change in the number of correct responses between the pre- and post-test sessions following the intervention of engagement in the Training Library modules. The hypothesis for this activity was that implementation of the Training Library modules would increase posttest Assessment scores over pretest results.

A total of 23 individuals with intellectual disabilities participated in the study. Intellectual disability status of participants was determined by eligibility for developmental disability Medicaid waiver funded community-based day programs designed to promote community integration and community skill acquisition. Participating adult service agencies included Dungarvin, Cheyenne Village, Mosaic, and Discover Goodwill of Southern and Western Colorado. There were 10 males and 13 females in the study group. The average age of the 23 participants was 40.3 years old (sd = 18.34), with a range of 18 to 60. Self-report data from participants and accompanying agency Direct Support Professional staff indicated that 56.5% of participants were non-readers (n = 13), and that 86.9% (n = 20) were not current users of public transportation for various reasons to include perceived gaps in transportation knowledge, community safety skills, and interpersonal skills.

### Results

As described above, each participant began by engaging in the *Vehicle Identification* assessment of the Transportation Skills Assessment System. Table 2 shows that the average number of correct responses in this pretest activity was 7.87 (sd = 1.687). Participants then engaged in self-directed training via the two corresponding Training Library modules, *Identifying Buses by Name* and *Identifying Buses by Number*. Following the training, participants increased the average number of correct responses in the post-test session with the Vehicle Identification assessment to 8.57 (sd=1.121). As shown in Table 3, a Sandler's A-test (a derivative of Student's t-test designed for comparing means between paired samples) was used for analysis and yielded significant improvement in vehicle identification knowledge among the study group (p = .029, one-tailed). These results provide initial evidence of the efficacy of the combined approach of self-assessment of transportation skills and engagement in self-directed training and education of corresponding multimedia training modules to effectively improve knowledge in the use of public transportation.

**Table 2. Assessment and Training Evaluation Paired Samples Descriptive Statistics**

Skill	N	Mean	SD	SE
Pre-Test Vehicle Identification Skills	23	7.870	1.687	0.352
Post-Test Vehicle Identification Skills	23	8.565	1.121	0.234

**Table 3. Assessment and Training Evaluation Paired Samples t-test**

Street Crossing Skills Survey	t	df	p
Pre-test vs Post-test	-2.336	22	0.029**

\*\* statistically significant ( $P < .05$ )

During test sessions, unsolicited comments made by study participants were also recorded. To provide the reader with further understanding of the study group, several of these comments are provided below:

*“That’s awesome!”*

*“They talk about buses.”*

*“That was easy, that was good.”*

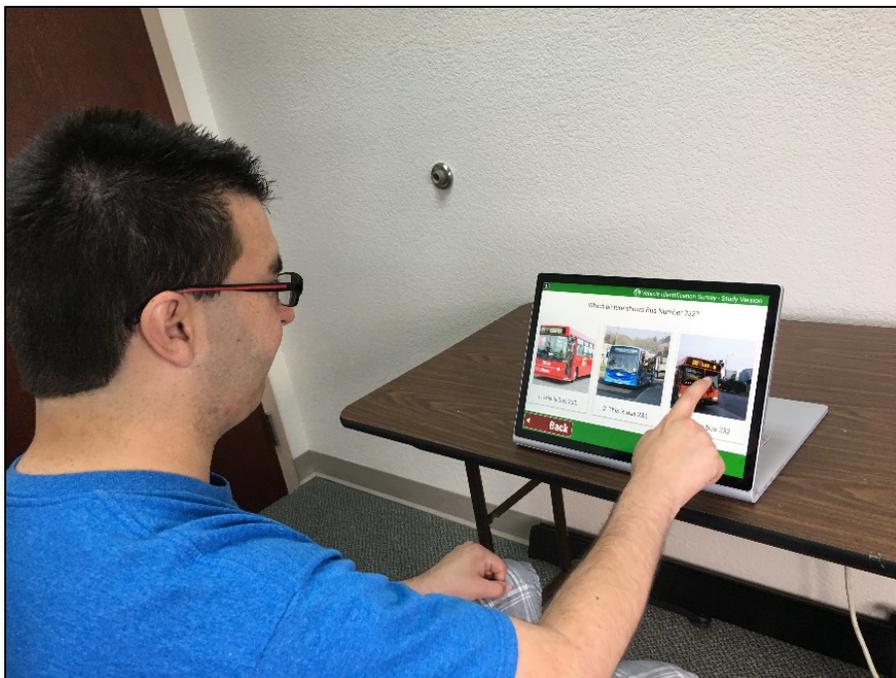
*“It helps you know where to go.”*

*“I like about it because it tells me about names of buses.”*

*“They were easy for me because it’s reading out loud, because I can’t read too well.”*

### **Discussion**

This study provides preliminary evidence of the efficacy of the approach of combining self-assessment tools with self-directed, interactive multimedia training to improve public transportation knowledge. Despite the somewhat extended length of study sessions during the evaluation of the assessment/training/reassessment study, participants remained engaged and it appeared that the interactive multimedia approach was supportive in avoiding study participation fatigue. Despite a lack of real-world experience on using public transportation reported by the test group, subjects demonstrated a higher level of knowledge on the pretest than may have been expected by researchers. Further testing may investigate the potential of repeat exposure to the self-directed transportation training content on assessment results, as well as evaluation of other assessment and training modules developed for the system.



Source: AbleLink Smart Living Technologies, October 21, 2018

**Figure 33. Study participant engaging in the Identifying Vehicles by Number ATTRI Assessment**

## Study 2: Evaluation of Pre-Trip Checklist and Schedule System Components

A second study activity involved evaluation of the pre-trip preparation technology components of the STCS. Technical components evaluated in this activity included the pre-trip checklist tool and the multimedia scheduling system designed to promote independence in completing pre-trip preparation activities accurately and on time.

Under a controlled testing environment, this study used a within-subjects design to have individuals complete two simulated “day of travel” scenarios a) with the technologies and b) without the technologies (using traditional supports, e.g. paper-based supports, digital clock). The technologies included the Pre-Trip Checklist system and the time-based scheduling system. The study measured and compare the ability of participants with cognitive disabilities to complete pre-trip tasks successfully and on time under the two conditions. Participating agencies again included Colorado Springs-based Cheyenne Village, Discover Goodwill of Southern and Western Colorado, Dungarvin, and Mosaic. Volunteer participants with cognitive disabilities involved in local controlled evaluation received a cash stipend for their efforts in participating in the project.

### Study Design

To support this study, two sets of pre-trip preparation activities were designed that were different but equivalent. Each set consisted of an equal number of similar pre-trip preparation tasks, such as getting a backpack, putting a bus pass in it, getting keys, etc. Both electronic and paper versions of each of the

two checklists were created for use in the study. A study room was set up with the necessary props and activities to complete the tasks for both checklist A and B. A moderate level of preoccupation on the part of test subjects was desirable to simulate the distractions that would likely be present in a real-world setting, so a nature video was set up to play on a large screen computer monitor prior to and during study sessions. An independent variable for this study was presentation of Set A and Set B checklists via both the pre-trip checklist app operating on a mobile electronic device and via a written checklist using the same images and text prompts. The order of presentation for Set A or Set B and for the app or checklist condition was randomized to control for effects given the within-subjects study design.

In addition, a second independent variable included a timing component for completion of the pre-trip preparation tasks under two conditions. Under the electronic condition, the STCS scheduling system was used to prompt the study participant to initiate the checklist activities at the prescribed time. Correspondingly, a traditional scheduling condition was created using a large display digital clock along with a designated start time written on the paper checklist to prompt the study participant when to begin pre-trip preparation activities. The same time period for completion of pre-trip preparation tasks was allotted to each condition. Prompts for task completion were identical between the two conditions, except that the scheduling app provided them via a recorded audio in a human voice and the checklist provided them via written text. Dependent variables for this study were therefore 1) the number of pre-trip preparation tasks successfully completed and 2) whether pre-trip preparation tasks were completed on time. The study hypothesis was that the automated multimedia schedule and task prompting technologies would result in more tasks being successfully completed, and increased compliance with time constraints than when using the traditional paper-based prompting approach.

A total of 12 individuals with intellectual disabilities participated in this study. Intellectual disability status of participants was determined by eligibility for developmental disability Medicaid waiver funded community-based day programs. There were eight males and four females. Average age of all study participants with intellectual disabilities was 38.8 years (sd = 14.98) old with a range from 22 to 66.

## Results

Under the traditional paper condition, participants successfully completed 51 of the possible 60 pre-trip preparation tasks (85%). When using the prototype STCS apps, participants were able to complete 58 of the 60 pre-trip tasks (96.7%). Using Sandler's A-test (e.g., paired samples t-test), these results indicate a significant difference between the two conditions ( $p = .046$ , one tailed).

For the start and completion time, 5 of the 12 participants started on time and 8 completed the tasks on time when prompted using the written paper support, while 11 of 12 participants both started and finished on time when using the STCS supports. A paired samples t-test indicated significant improvement in timeliness of starting and completing pre-trip task preparations between the two conditions ( $p = .005$ , one tailed).

**Table 4. Pre-trip Checklist and Schedule System Evaluation Paired Samples t-test**

Paired Samples t-tests	t	df	p
Task Performance	2.244	11	0.046**
Time Performance	3.458	11	0.005***

\*\* statistically significant ( $P < .05$ )

\*\*\* statistically significant ( $P < .01$ )

During test sessions, unsolicited comments made by study participants were also recorded. To provide the reader with further understanding of the study group, several of these comments are provided below:

*“That’s so easy!”*

*“That’s easy.”*

*“I’m getting good at this!”*

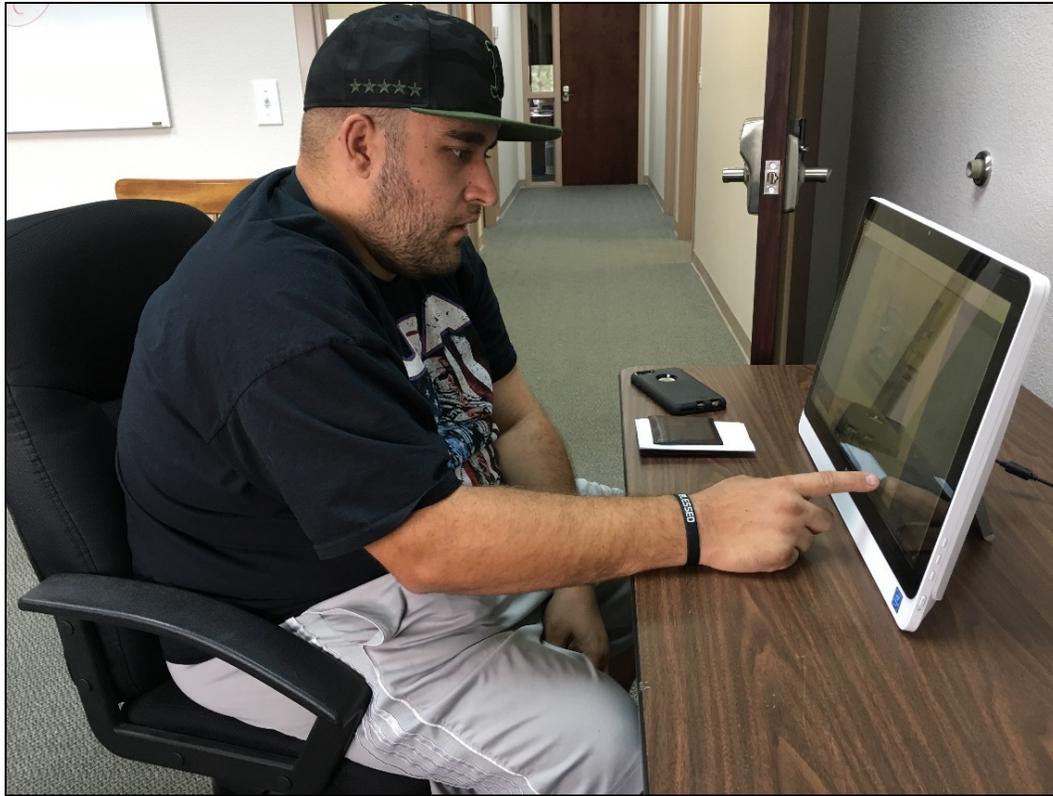
*“Really awesome!”*

### **Discussion**

These results provide initial evidence of the efficacy of the ATTRI STCS prototype technologies for improving public transportation knowledge and for increasing on time, accurate performance of pre-trip preparation tasks. Further, participants indicated a clear preference of the technology supports in the pre-trip execution study over traditional paper-based prompting approaches.

Regarding pre-trip task performance, the same graphical images were used for both the traditional written cueing system and the computerized prompting app. This may indicate that the significant difference in task performance between the two conditions may have primarily been due to the audible prompting support provided by the technology as opposed to the associated text-based support of the paper-based prompts. Additionally, several subjects appeared to lose track of what step they were on during the task completion process when using the written list condition, as opposed to the ordered structure provided by the step-by-step electronic checklist system.

Results for the scheduling/timing aspect of starting and completing pre-trip execution tasks represented the strongest evidence of the improved efficacy of computerized vs. traditional support systems. This appeared to result from two distinct phenomenon. One was in the distractibility and perhaps lower attention spans of the test group of individuals with cognitive disabilities. While the written start/end times and digital clock provided passive visual cues to participants regarding timing of pre-trip preparation activities, the prototype scheduling app provided a more proactive cue via the addition of an automated audible cue to get the user’s attention in addition to the image prompt. Additionally, the paper-based cueing system provided a static prompt, as it required the user to repeatedly check the written time and clock to see when it was time to start and finish. Conversely, the electronic system was more complimentary to the potentially increased distractibility of this population by requiring attention only at the time the cue was provided instead of the intermittent attention required to effectively use the traditional written cues.



Source: AbleLink Smart Living Technologies, October 24, 2018

**Figure 34. Study participant engaging in pre-trip execution prototype systems**

## Field Implementation Activities

Currently SMART Wayfinding and various STCS components are undergoing ongoing evaluation in several cities and service agencies around the United States. The following provides a brief summary of these field implementation activities at the time this report was prepared.

### ***Merakey – Coraopolis, Pennsylvania***

Merakey participated as a field-testing organization in the Western Pennsylvania area for our companion project, *Leveraging Innovative Technology to Develop the SMART Wayfinding Standard to Facilitate Independent Use of Public Transit by Individuals with Cognitive Disabilities*. As part of their field-testing effort, Merakey was provided several components of the SMART Wayfinding system to support bus travel for the study participants, as well as the Transportation Skills Assessment System. Travel training staff at Merakey utilized two of the assessments in the system as part of their preparation activities and to help determine the readiness of individuals for learning how to ride the bus independently. None of the participants in the study were able to use public transit and thus, all were dependent on others for meeting their transportation needs. Access to the Transportation Skills Assessment System was provided to Merakey, as shown in Figure 33. Two of the surveys (Street Crossing Skills and Social Skills) were chosen for participants to complete as time permitted. As a baseline, each member of the travel project completed either one or both of the targeted surveys. A total of 17 individuals completed the Street

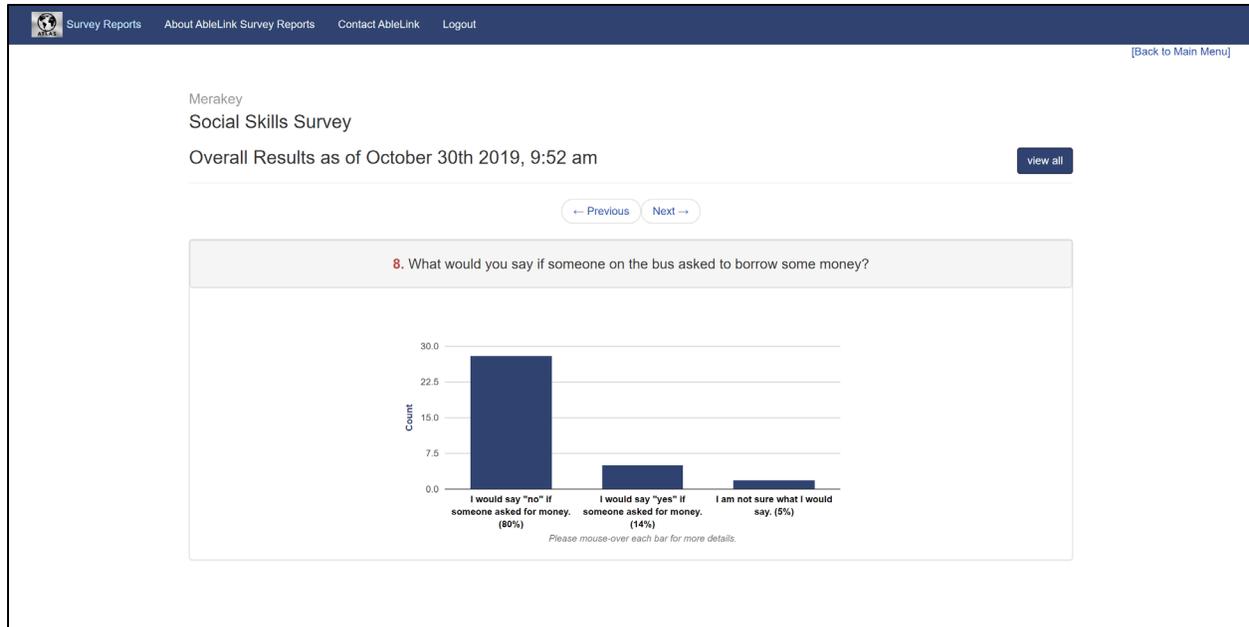
Crossing Skills Survey at least once, with 10 of them also completing the survey a second time at the completion of their field-testing period of participation. Several individuals are still involved in the ongoing field-testing activities at the writing of this report and will complete the survey a second time at the completion of their participation. For the Social Skills survey, a total of 15 individuals have completed the baseline survey, and 14 of them have completed the survey a second time following completion of their field-testing activities. The totals shown on the summary table in Figure 35 include several test surveys taken by staff to familiarize themselves with the process, as well as the surveys completed by study participants.

Survey Name	Last Survey Taken	Total Surveys	Aggregate Reports
Transportation Skills and Experience Survey	June 11th 2019, 8:20 am	4 (Download Data)	Overall Results Readiness Report
Street Crossing Skills Survey	October 16th 2019, 11:48 am	40 (Download Data)	Overall Results Readiness Report
Social Skills Survey - Readiness Report	October 16th 2019, 11:52 am	35 (Download Data)	Overall Results Readiness Report
Vehicle Identification Survey - Readiness Report	May 20th 2019, 12:47 pm	2 (Download Data)	Overall Results Readiness Report

Source: AbleLink Smart Living Technologies, October 30, 2019

**Figure 35. Survey Reports Home Page showing Merakey's Completed Surveys**

In addition to providing a quick summary of how many surveys have been completed and the date the last survey was taken, the reports page shown in Figure 33 also provides access to both the individual survey reports and aggregate reports. For example, clicking the Overall Results button provides a summary of each item in bar chart form for a quick overview of responses for a particular item. These summaries can be helpful for identifying training needs at an organization. For example, the charts in Figure 36 show that 20% of the respondents either would give money to a stranger or would not know what to do if a stranger asked them for money while out in the community. Thus, the Merakey was able to view the aggregate results of the Travel Readiness Reports and address important topics in their travel training programs.



Source: AbleLink Smart Living Technologies, October 30, 2019

**Figure 36. Bar charts show overall responses for each item in a survey**

An analysis was conducted on the Street Crossing Skills survey data and the Social Skills Survey data to provide a general measure of changes in those skill areas as a result of participating in the ATTRI field testing project. Previously the experimental evaluation that was conducted in Year 1 was described where the impact of the self-directed training system provided in the Transportation Skills Training Library was evaluated. The primary difference in this analysis was that there were many travel training and bus riding activities that were part of the intervening period between the pre-test (baseline) survey and the post-test survey. The post-test survey was completed after the individual completed the agency's travel training and bus riding activities using the SMART Wayfinding technologies. Merakey staff provided each of these assessments to study participants at the onset of the project and then again after the individuals completed their participation in the study. The following paragraphs provide a summary of the results of comparison of the pre-test/post-test surveys for each of the two assessments.

### ***Merakey Field Implementation – Street Crossing Skills Pre-Test/ Post-Test Comparison***

As indicated previously, a total of 17 individuals completed the Street Crossing Skills Survey at least once, with 10 of them also completing the survey a second time at the completion of their field-testing period of participation. Transportation Readiness scores in the Street Crossing Skills survey represent percentage values, thus 100 indicates the maximum value. A Sandler's A-test was used for analysis of potential differences between the pre-test and post-test means. The results showed there was significant improvement in Street Crossing Skills following participation in the SMART Wayfinding travel project. The mean Transportation Readiness baseline score was 70.1 and following participation in the study activities, the mean Transportation Readiness score increased to 79.7, which was a statistically significant increase ( $p < .039$ , one-tailed). Table 5 provides the paired data sets for the Street Crossing Skills surveys; Table 6 provides the specific t-test results, and Table 7 provides descriptive statistics for the pre-test/ post-test conditions.

**Table 5. Paired Data Set – Street Crossing Skills Survey**

Pair	Pre-Test	Post-Test
1	76	93
2	59	81
3	56	56
4	74	96
5	41	41
6	85	63
7	85	89
8	69	100
9	69	85
10	87	93

**Table 6. Social Skills Survey Paired Samples t-test**

Street Crossing Skills Survey	t	Df	p
Pre-test vs Post-test	1.99	9	0.039**

\*\* statistically significant (P<.05)

**Table 7. Street Crossing Skills Descriptive Statistics**

Skill	N	Mean	SD	SE
Pre-Test Street Crossing Skills	10	70.1	14.72	4.66
Post-Test Street Crossing Skills	10	79.7	19.68	6.22

### ***Merakey Field Implementation – Social Skills Pre-Test/ Post-Test Comparison***

As indicated previously, a total of 15 individuals completed the Social Skills survey at least once, with 14 of them also completing the survey a second time at the completion of their field-testing period of participation. Transportation Readiness scores in the Social Skills survey also were represented by percentage values. A Sandler's A-test was used for analysis of potential differences between the pre-test and post-test means for the Social Skills surveys. The results did not show a significant difference between the mean pre-test and post-test survey scores, although the results approached significance. The mean Transportation Readiness baseline score was 87.64 and following participation in the study activities, the mean Transportation Readiness score increased to 92.07, which was not a statistically significant increase. Table 8 provides the paired data sets for the Street Crossing Skills surveys; Table 9

provides the specific t-test results, and Table 10 provides descriptive statistics for the pre-test/ post-test conditions.

**Table 8. Paired Data Set – Social Skills Survey**

Pair	Pre-Test	Post-Test
1	95	99
2	100	88
3	89	71
4	71	100
5	86	75
6	93	100
7	83	95
8	95	99
9	95	90
10	90	93
11	89	87
12	58	83
13	90	93
14	93	100

**Table 9. Social Skills Survey Paired Samples t-test**

Social Skills Survey	t	df	p
Pre-test vs Post-test	1.42	13	0.09*

\* Not statistically significant

**Table 10. Social Skills Survey Paired Samples Descriptive Statistics**

Survey	N	Mean	SD	SE
Pre-Test Social Skills Survey	14	87.64	10.98	02.93
Post-Test Social Skills Survey	14	92.07	7.55	2.02

### **Discussion**

The pre-test/ post-test results for the two surveys completed by Merakey study participants were mixed. For street crossing skills, the results indicated that participation in the various travel training activities as well as the real-life experiences of using the WayFinder app to ride the bus appeared to have a significant impact on improving these skills. While these results are encouraging, it must be noted that in an in vivo implementation such as this, it is not possible to draw specific conclusions as to which aspects of the travel training and bus riding activities contributed most to the observed increase in street crossing skills. In addition, the sample size was limited. Therefore, further research is needed to explore the role each of the transportation support activities may have played in improving street crossing skills.

With respect to the social skills surveys, there was no significant difference found when comparing the baseline data to the post-test surveys. However, it should be noted that the baseline Transportation Readiness scores in the social skill area were quite high at baseline (87.64%) for the selected study participants. This may account in part for the data that shows four individuals actually produced lower scores in the post test. This finding could be further investigating by using a repeat-assessment approach to average several pre-test and post-test scores across time to investigate potential day-to-day environmental or performance variations within a participant. After the study, the average Social Skills score was 92.07%. This difference in scores is not necessarily unexpected. It is typical that for safety reasons human service agencies initially consider offering travel training to individuals with cognitive disabilities served by their agency that already have good community social skills and self-rescue skills. Thus, community social skills are a key factor in determining who is ready for inclusion in travel training activities. The fact that the study group demonstrated reasonably high social skills at the start of the project represents a best practice in the field when it comes to knowing who is ready to learn how to use public transportation and transition to more independent community access.

### **Black Hills Works - Rapid City, South Dakota**

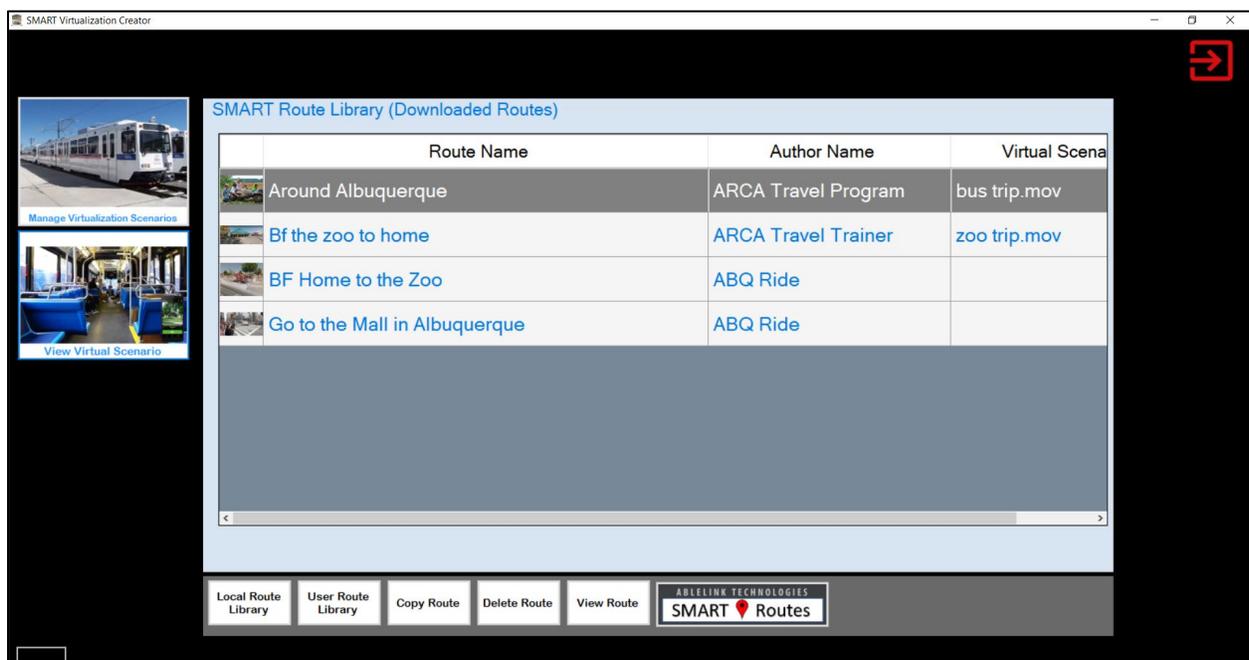
Another agency participating in the project as a field implementation site included Black Hills Works, an adult services agency providing residential, vocational and community access support to several hundred individuals with intellectual and developmental disabilities in the Rapid City area. Staff at Black Hills Works have incorporated the STCS Transportation Readiness Assessments into their day-to-day procedures for evaluating the travel readiness of individuals served by their program. Each individual that is a candidate for travel training takes the assessments as a first step identifying the individual's current level of transportation skills and experience, which then allows them to develop a customized travel training program for each individual. Tammy Murner, Black Hills Works Director of Innovation and Assistive Technology, summarized their overall experience with STCS and the SMART Wayfinding technologies, by saying:

“I can definitely say the WayFinder has been a game changer for the individuals that we have trained to use it. They have been able to keep and obtain jobs in our community, shop, get to medical appointments, and visit their friends and family when they want and not have to wait for staff to give them rides. This also frees up more staff time because they are not spending all of their time running people back and forth and they are able to do more direct supports. It has increased their confidence and independence greatly. Most of the people that have used the WayFinder

device have used it for only a couple of months to learn to ride the bus, and then give it back so others have the opportunity to use it and learn the bus system.”

### ***The ARC of Albuquerque (ARCA) - Albuquerque, New Mexico***

ARCA, another partner throughout this two-year project, has also begun implementing various SMART Wayfinding and STCS technologies into their day-to-day services, a key goal for AbleLink’s two ATTRI projects. Most recently, ARCA is trialing the SMART Virtualization Creator and SMART Virtualization Viewer apps to help individuals they serve prepare for new bus routes. Field implementation of these systems is ongoing at the time of the writing of this report. Feedback from ARCA on their use of the virtualization system will be posted to the <https://www.ablelinksmartravel.com> website as it becomes available. This website will serve as a central resource for cities, transit agencies and human services agencies interested in learning more about the SMART Wayfinding and STCS technologies and the different ways these tools can be implemented in their local area. Figure 37 shows the SMART Virtualization Creator app being used by ARCA, with a few of the SMART Routes they have created for participants in their program.



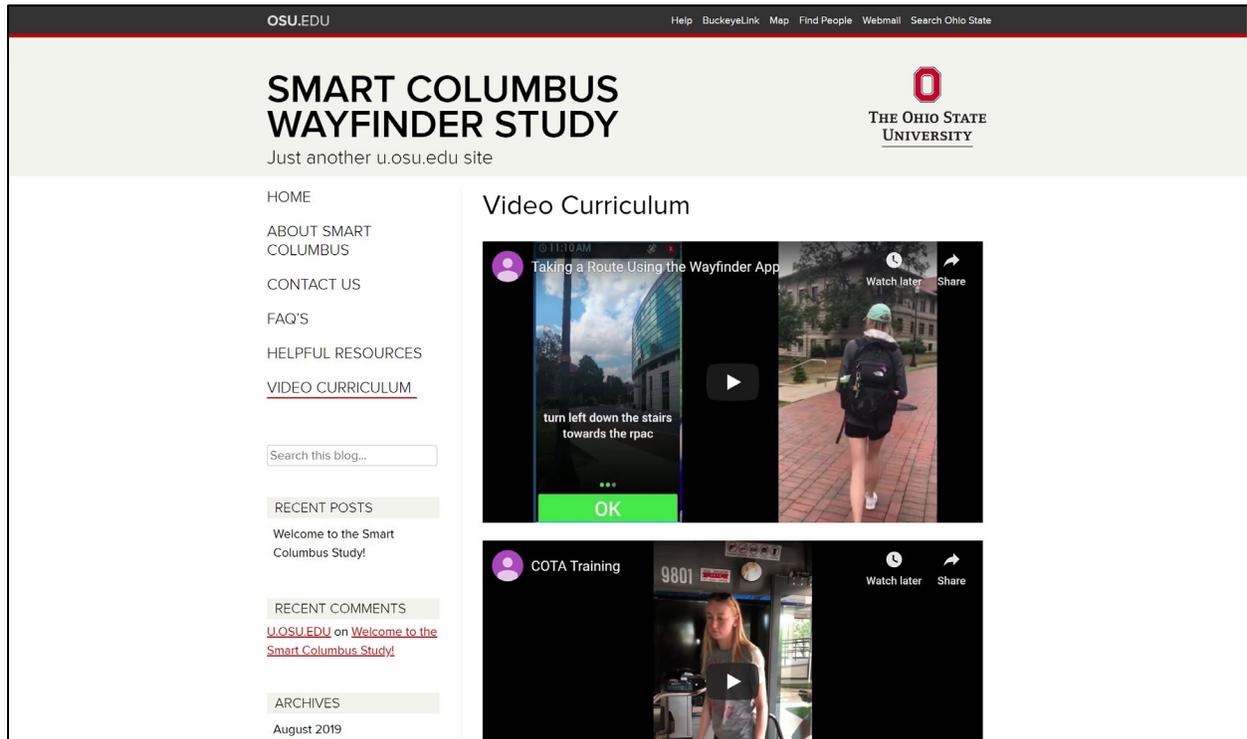
Source: AbleLink Smart Living Technologies, October 30, 2019

**Figure 37. SMART Virtualization Creator App with SMART Routes Created by ARCA**

### ***SMART Columbus – Utilization of the STCS Transportation Skills Training Library***

The SMART Columbus project has adopted the WayFinder app for their project, Mobility Assistance for People with Cognitive Disabilities (MAPCD). The project goal is to enable people with cognitive disabilities (e.g., individuals with autism, Down syndrome, Traumatic Brain Injury (TBI), etc.) to travel more independently on fixed-route bus service. The project team includes the City of Columbus and COTA, Ohio State University (OSU), AbleLink Smart Living Technologies, and individuals with cognitive

disabilities. The OSU team has developed a rigorous multi-stage training curriculum, including videos, for the travel partners (agency staff and family members) and travelers with disabilities (see Figure 38). The OSU team was provided access to the STCS Transportation Skills Training Library early on in the development of their training system and as a result, they have incorporated several of the self-directed training sessions developed as part of this project into their training curriculum. Thus, individuals in the Columbus metro area participating in the SMART Columbus project are already benefiting from the availability of the STCS Transportation Skills Training Library.



Source: The Ohio State University (<http://u.osu.edu/smartcbus/>) October 10, 2019

**Figure 38. Smart Columbus Website**

## WayFinder Case Study Sample from Field Implementation Activities

We conclude this Project Report with a case study from Black Hills Works, which provides an excellent example of the impact the SMART Wayfinding and STCS technologies are already having for individuals previously unable to use public transportation independently and the agencies that provide services to them.

James is a young man of 26 living in Rapid City, South Dakota. He lives independently with four other roommates. He holds a job as an assistant in a local grocery store. James has a great work ethic and getting to work on time every day is very important to him. His schedule varied a lot throughout the week and work was too far to walk. This posed a significant problem. James did not have a driver's license and he did not know how to use the bus system. As a result, James was fully dependent on staff for getting rides to work. After getting a ride to work, he would then have to wait after work for staff to pick him up and take him back home. Staff from Black Hills

Works, the local adult services agency supporting James (and also the agency responsible for providing him rides when needed), approached James and asked him about learning to ride the bus on his own to get to work. Although somewhat hesitant, he agreed to try learning how to ride the bus. Unfortunately, the first day he was scheduled to learn to ride, the travel trainer was inadvertently delayed and in addition, there was some confusion as to the route and the destination. Both of these events resulting in James feeling significant stress. Thus, the bus training was not successful. From that time forward, the plan went back to James receiving rides from staff to get to and from work. In addition, due to James's concerns about staff arriving on time to pick him up, starting at about two hours before staff were expected to show up to take him to work, he would start calling the office to see when his ride was going to arrive. Black Hills Work staff would field between 10 – 15 of these calls every shift that James worked, which was very stressful for James and difficult for staff as well.

This is when Black Hills Works began to work with WayFinder, AbleLink's cognitively accessible transportation app. James was once again asked if he would like to try to learn to ride the bus and he agreed to try again, but this time using WayFinder as a support tool. Black Hills Works staff created two new WayFinder routes containing step-by-step multimedia instructions for James, one to get from home to work and one to get back home after work. Staff then set up a schedule to ride the bus with James to show him how to use WayFinder to travel on the bus. After staff rode with James just **two** times he announced "OK, I don't need you anymore!" From that day forward, James began successfully travelling to work completely on his own using WayFinder to guide him along the way. Immediately his self-confidence sky-rocketed and the multiple calls to the office each day also ended immediately, providing a welcome change for staff that had been taking those calls each day. After experiencing the new-found freedom of unrestricted travel, James then asked staff how he could learn new bus routes around town. Staff provided James with the bus route schedules for RTS, the Rapid Transit System for Rapid City and he got to work learning new routes on his own. Not long after this, James announced to staff he no longer needed WayFinder. Staff were then able to provide the device to another individual needing help riding the bus, with new routes created for that individual. James's use of WayFinder and the experience gained traveling the bus to and from work resulted in such an increase in confidence, he began exploring the city on his own. Instead of just travelling for work, James began taking the bus to go to stores and see friends. Also, his ability to travel on his own allowed him to go to work early to meet up with co-workers for lunch at the café. His social network grew as a result of him being in control of where and when he wanted to go. Tammy Murner, Director of Innovation and Assistive Technology at Black Hills Works summarized the life changes experienced by James, stating "James had never expressed to staff that he had a desire for any of these social outings or additional travel destinations. But after experiencing freedom of travel, his personality has blossomed, and he has become far more outgoing with all kinds of confidence! And not having to answer repeated calls from James wondering about his ride has been a great benefit to staff as well."

## Summary

In summary, accessible transportation technologies made possible by the SMART Wayfinding and STCS ATTRI projects are changing lives by enabling the complete trip for many individuals like James, offering newfound freedom and opportunities through independent transportation, thus increasing overall quality of life. The development activities of this project provided important tools that allow individuals to properly

prepare for successfully engaging in public transit. The following sections provide some observations resulting from the work completed in this project.

The human service systems that exist to support individuals with cognitive disabilities promote a common goal of maintaining and increasing independence in various life activities. Historically their focus has been on a wide range of everyday activities such as dressing, grocery and personal shopping, nutrition and meal preparation, housekeeping, dental and personal hygiene, medication administration, overall health care, employment, financial management, and social and safety skills. While great strides have been made in these areas through the use of tools and techniques such as task analysis, behavior modification, backward chaining, partial participation, consistency, repetition, and others, the area of independent transportation has been and continues to be an under addressed area. In nearly a decade of work in the area of independent transportation by members of the project team, it has been observed that the primary reasons for continued dependency in this area are concerns about safety. These safety concerns appear to break down into two basic areas; getting lost, and being taken advantage of while in the community by oneself. The pervasive nature of these concerns has historically led these human service systems to one primary intervention—human assistance. The widespread availability of portable cell phones has emerged as a tool to address some of these safety concerns for some people, but opportunities for exploring independent transportation continue to be limited as human service agencies and families remain motivated to “err on the side of safety.” Much of the feedback from this project, and resulting focus of development, has been in attempting to address these safety concerns through technology interventions. For example, the various remote notification features of elements of the STCS—such as in an automated email that is sent upon completion of pre-trip preparation activities—have been designed specifically to address the safety concerns of caregivers and service agencies. Technology interventions developed in this project and designed to address community safety appear to have a threefold effect. First, they do indeed provide concrete supports to increase the likelihood of successful and safe community travel. Secondly, as can be seen in James’s case study, technology interventions can improve confidence and break down mental barriers for individuals with cognitive disabilities such that they may have a newfound willingness to engage in independent public transportation. And finally, and perhaps most crucially, they can break down the barriers in the minds of human service agencies, families, and other caregivers toward being more open to providing opportunities for their clients and loved ones to engage in independent community travel, with the potential to open a virtually unlimited array of new experiences, environments, and improved quality of life.

Use of several aspects of the STCS technologies involves the authoring of content that is used by the systems to support pre-trip preparation activities. This may include development of personalized pre-trip checklists, schedules, or video to support the virtualization tool. A finding of this project is that users of these systems continue to need support in the development of personalized content. This need was the driving force in this project for development of the base content for the Transportation Skills Assessment System and Transportation Skills Training Library. Although opportunities exist for municipal and agency transit providers to customize the content of these subsystems, the ability for these tools to be used immediately as-is without content development provides an important starting point to help agencies and families to get started in thinking about independent transportation for individuals with cognitive disabilities. Interestingly, field implementation feedback seemed to have an effect of opening the eyes of human service staff, as they observed the people they serve—often for the very first time—use computer technology independently and successfully. This provided a new opportunity for staff to view individuals with cognitive disabilities as capable. Therefore, the very process of completing a travel readiness assessment independently had positive effects toward reducing the stigma of dependent transportation.

The results of using these tools also served to get agency staff and families to begin actively thinking of what it would take to support independent use of mainstream public transportation, thus also helping to overcome the perceived attitudinal barriers that had previously prevented the provision of opportunities to test the waters of public transit use.

The opportunity to create custom content such as personalized pre-trip checklists and schedules has been shown to be critical to some individuals. Personalized content moves instruction from the general to the specific arena. For example, the web-based Transportation Skills Training Library includes a module titled Crossing Streets Without a Signal. The pretest/posttest research conducted in this project demonstrated the potential value of these general skills training modules, but the ability to create custom content via the Pre-Trip Execution System allows travel trainers to record audio instructions and obtain pictures and video of the actual streets and intersections that an individual may need to cross during first mile or last mile travel. This removes a need to generalize learning and provides the opportunity for consistent, repetitive, real-world, and self-paced instruction that serves as a natural bridge to beginning to engage in active independent community travel. An observation during field implantation activities is that agency staff, travel trainers and family supports may be reluctant to creating this personalized training content. Therefore it will be important going forward to support customers of the STCS system in providing training and sample instruction modules (such as sample pre-trip checklists) to encourage use of these tools as an important bridge to successful community travel

The provision of various user options and settings in the various subsystems also proved to be important for optimizing success in use of the STCS tools. For example, the ability to display or remove the Calendar navigation or To Do List tools in the Pre-Trip Execution System's scheduling module extends its usability to a wider range of cognitive ability. Users whose special needs enable them to manage their own audio To Do List are able to benefit greatly by recording ongoing reminder messages throughout the day, while other users can still benefit from the modules multimedia scheduling prompts without the potentially confusing and distracting availability of the To Do List tool being visible and active on the screen. Similarly, having step-by-step instructions read aloud in a human voice can be critical to low literacy users, but the ability to turn off audio playback removes the distraction for those who prefer to use their visual literacy skills to read on-screen text. This again points out the need to provide training to teachers, travel trainers, agency staff and families so they are aware of these features and options and know how to use them to best support the unique needs of different users with cognitive disabilities.

The notion of "getting out of your comfort zone" is often discussed as a means for learning more about one's self and how we might act and react to new experiences. As individuals with cognitive disabilities increasingly implement the STCS tools to help in getting out the of the comfort zone of specialized, segregated travel, we will undoubtedly learn more and more about their needs in supporting the use of more independent and integrated transportation options. It will be this real-world experience that will continue to mold best practices and system enhancements to not only improve use of mainstream transportation options, but to open doors to new environments and experiences that can contribute to improved quality of life for individuals with cognitive disabilities.

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