Usability Study of Overbrook School for the Blind Multi-Sensory Touch Model

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ABSTRACT

The Overbrook School for the Blind Multi-Sensory Touch Model is an interactive device that helps visitors, students and staff familiarize themselves with the campus. The model is portable and can be moved easily from one location to the next. The model is composed of three distinct parts: 1) the model/map area on the left side, 2) a screen for text display on the top right hand corner, and 3) a swipe area directory on the lower right hand corner. Meant as a self-learning tool, almost any person can comfortably operate it. The model responds in a variety of ways with user interaction. Users can touch/tap on any part of the model and it will respond with audio information specific to the location that was touched. A usability test was carried out to access the effectiveness of the model. The evaluation tested 8 subjects assigned to two groups, blind and low vision. There were two dependent variables: (a) usability ratings from the Rapid Assessment of Usability and Universal Design (RAPUUD) (Lenker et al., 2011); and (b) the number of usability problems identified. This paper will summarize the evaluation of the Overbrook School for the Blind's Multi-sensory Touch Model.

Keywords

Technology, Wayfinding, Usability, Inclusive, Accessibility, Interaction

INTRODUCTION

"The best models are those which are most like the thing they represent."(Bentzen, 1983)

The process of orienting new students to a campus layout is often difficult. It is even more difficult when the student is blind or has a vision-impairment. Traditionally, schools for the blind have sought to support incoming students by providing a 'direct experience' tour of the campus with the help of an orientation and mobility specialist (Blades, Unger, Spencer, 1999). While this technique has proven effective, particularly for students attending large campuses, it does not support the goals of independence, self-sufficiency and self-fulfilment that are fundamental to this type of learning environment. Recently, some schools for the blind have sought to supplement the direct experience approach with the introduction of tactile maps. These maps are made available on a personal, portable scale and so reinforce institutional goals of autonomy. Although the potential offered by tactile maps is great, the actual product is often prepared very quickly, resulting in a crude mock-up of the campus that gives little meaningful information to the user. Over the past decade the IDeA Center and Touch Graphics, Inc. have collaborated to design interactive models to aid in orientation and wayfinding. As part of a Small Business Innovation Research grant (SBIR), Touch Graphics, Inc. created an interactive touch model for the Overbrook School using an innovative method with existing tablet/touch screen technology. This technique allow for easier and faster production as well as a significant reduction in cost. The IDeA Center evaluated the model to discover any issues that would prevent students and visitors from using the model fully and to find what could be features could be applied to future models. This, ongoing, iterative process has allowed us to streamline the touch model over the years.

OVERBROOK SCHOOL FOR THE BLIND

The Overbrook School for the Blind is located on a large campus in Philadelphia, PA. The school is committed to "develop and deliver education that enhances the options available for persons with visual impairment and other challenges so that they have the greatest opportunity to experience active and fulfilling lives." The school was established in 1832 and one of the first institutions of its kind in the United States. The campus layout includes a central building with classrooms, offices, an auditorium, a library and a touch and learn center. Two separate buildings house programs for pre-school children and elementary age students. The Nevil Field House contains a gymnasium, indoor track, physical fitness room, and a bowling alley. Behind the Nevil Field House is a track and baseball field and putting area for playing golf. Pathways and sidewalks connect buildings and parking areas on campus. Two recently renovated dormitories are provided as housing for the residential students. A playground area is situated to the right of Main Building between Kappen Aquatic Center and Nevil Center.

MODEL OVERVIEW

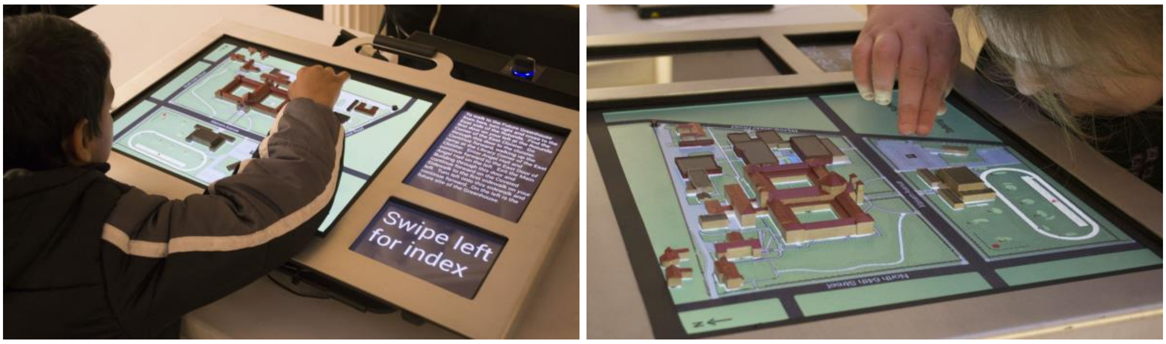


Figure 1: Students using the touch model

The Overbrook School for the Blind Multi-Sensory Touch Model is an interactive device which helps visitors, student and staff familiarize themselves with the campus. The model is portable and can be moved easily from one location to the next. The model is composed of three distinct parts: 1) the model/map area on the left side, 2) a screen for text display on the top right hand corner, and 3) as wipe area directory on the lower right hand corner. Meant as self-learning tool, almost any person can comfortably operate it. The model responds in a variety of ways with user interaction. Users can touch/tap on any part of the model and it will respond with audio information specific to the location that was touched. A slider/swipe feature provides access to a building directory. With a swipe to the right or left, each building is spoken out loud. When a building name is selected, users can then touch and drag their finger along the map area to hear a pitch. The pitch will either get louder or quieter as they continue to move their finger closer or farther from the selected building. Low vision and sighted individuals can turn off the volume and use the text display if desired. All of the identifiable buildings and complexes are touch sensitive. Landscape features including a track and field, baseball field and golf area, along with the playground are identified when touched. Roads, sidewalks, pathways, fences and parking areas are touch sensitive. The model will be located on to the right of the entry way, just after the security desk and before the rotunda of the Main Building.

TECHNOLOGY

Audio-tactile interactive systems that use changes in electrical capacitance as a way of detecting touches aren't completely opaque. To add visual effects onto the system, a projector mounted above the model need to be added or printed onto a 3D vinyl skin, vacuum formed, and then placed over a touch-responsive substrate. In these cases, dozens of coaxial cables are required to connect electrically-isolated regions of conductive paint on the tactile surface to USB sensors. Projectors, however, burn out or go out of alignment, and wire harnesses get tangled and require large housings, so a simpler solution was needed for this product to reach a wider audience.

The new system, consist of two materials: buildings will be 3D-printed in opaque ABS plastic, and attached to a thin, translucent overlay with the outlines of streets, parking lots and playgrounds shown in tactile relief. The skin is printed on flatbed UV printer which can generate optically clear, precise and durable raised lines, textures and braille on clear vinyl film, with negligible degradation of touchscreen actuation force, and permitting full, partial or no light transmissivity. The printer dispenses a thick, clear gel that hardens under UV light. With multiple passes, we can build up a hard, transparent 3D surface that captures the subtleties of our tactile graphic designs with very high repeatability, ensuring that tactile symbols, textures and line types feel precisely the same from one map to another. Once the clear gel has been laid down to create the tactile surface, we print in visual ink on top of the 3D forms, to produce high-res text and super sharp graphics. And, since the skin can be left transparent in some parts, and printed opaque in others, we can combine touch-responsive tactile graphics with high resolution visual printing, braille, video, captions, or animated sign language avatar for users who are deaf, to create truly universal displays at a low cost. This assembly is then attached to a large LCD touch screen running a small android computer (Android Stick). An app running on the Android Stick interprets touches and play appropriate audio feedback. Touches on the landscape sensed by the touchscreen directly through the sheet layer. Buildings and other 3D printed forms, however, are coated with conductive paint, followed by a finish coat of epoxy paint for durability and color. Conductive foam pads on the underside of the sheet surface will contact the touchscreen, and aluminium tubes inserted in holes bored through the models will connect these conductive pads with the painted regions. Since the conductive paint can be applied in electrically-discrete regions of any size or shape, we can create single objects that speak different things depending on where you touch. The surface of a large building, such as OSB Main Building, can be broken down into multiple wings, each with an isolated electrical pathway leading down to a finger-sized conductive pad pressing against the touch screen below. When a finger touches the painted plastic surface, the tablet computer sees a finger touching the screen at the location of the conductive pad, so that our app knows that a particular part of the building has been touched, and then speaks names and associated information about that location.

EVALUATION METHODS

Following the University at Buffalo Institutional Review Board research procedure and protocol requirements, the research study was submitted for approval by the IRB before starting the evaluation. All personnel involved in the evaluation have IRB training certificates. No contact was made with potential subjects until after the full (non-expedited) IRB certification process was completed. The usability study took place on the Overbrook campus with eight subjects, ranging in age from 7 to 19 years old. Two dependent variables were used in the study: (a) usability ratings from the Rapid Assessment of Usability and Universal Design (RAPUUD) (Lenker et al., 2011); and (b) number of usability problems identified. The protocol included five tasks: 1. Initial Interview; 2. User Training; 3. Self-Interaction; 4. Specific Task Completion; and 5. Travel to Destination. Interviews in Task 1 were conducted to obtain demographic information, to better understand subjects' wayfinding and orientation skills, and to gain information about their familiarity with the campus and assistive technologies. Subjects were interviewed about their experience in orientation and wayfinding. They were asked basic demographic information (i.e. age, gender, onset of visual impairment) and familiarity with the Overbrook School campus, experience with navigating the campus and experience using assistive technologies. User Training provided each participant with a brief overview and instructions for using the talking model. Self-Interaction allowed participant to interact freely interact or "play" with the device. Subjects were encouraged to verbalize their mental process of comparing the model with what they think they know about the campus layout. System designers were on hand to observe and to answer questions during the test. Each participant were given a summary of how the model works such as single-tapping to learn a building name, double tap to learn a building function and triple-tapping to get directions. To effectively learn about the functional issues with the model subjects were then asked to carry a series of tasks which targeted all of the major features on the model. Tasks included locate a specific building on campus using the Swipe area by scrolling through an alphabetical index, find the selected place on the model using the pitch directional cue and locate the campus perimeter and pathways or sidewalks on the model. In the final stage of the evaluation, Travel to Destination, subjects had to walk to a destination on campus after hearing the directions supplied by the map. Subjects were asked to explain their internal thinking about the route as they walked to the destination with a research team member accompanying them.

DATA ANALYSIS SUMMARY

Over half of the subjects had an onset of visual impairment before the age of two, with the remaining experiencing onset of a visual impairment in their childhood (up to 17 years of age). All of the subjects used a cane to navigate, and only one participant was already familiar with the Interactive Touch Map at the school. All of the subjects had previously visited the Overbrook School at least ten times, and most stated they were familiar with the campus. A majority of the subjects were only somewhat comfortable with using interactive assistive devices such as a Braille note taker or GPS.

Quantitative and Qualitative Results

The data analysis included both quantitative and qualitative methods. The RAPUUD metrics were coded quantitatively to identify users' experiences with the various model features. Qualitative feedback was coded and themes were created for both positive and negative responses. The model is easy to use according to all, but one subject. Nearly all of the subjects could find specific buildings on the map. However, results showed more difficulty locating streets, pathways and sidewalks, parking lots, and athletic fields. Only half agreed that the textures, lines, or forms on the maps were distinct. Less than half were able to comprehend the various parts of the model, including the buildings. Over half of the subjects found the model and alphabetical index listing the locations easy to use and agreed that it required minimal effort to use. A majority of the subjects stated that using the model in a public place would not draw unwanted attention to them. However, most of the subjects stated that they preferred a faster rate of speech from the model. There was also a mix of negative and positive responses to the way in which the model was oriented and mounted. Currently, the model is sits on a flat table. Some subjects stated they would find it easier to use if it were mounted vertically on a wall. Some users also stated they would prefer buttons instead of swiping the touch screen.

Overall, the study suggests that the talking model system helps with orientation, wayfinding, and mobility. Only one subject was unable to complete the set of tasks in Task 4, and all of the subjects were able to successfully complete the walking exercise in Task 5. All of the participants were able to use the system, regardless of disability, including visual, motor and cognitive impairments, and learning delays. This reaffirms our view that, by adding touch-responsive audio to a 3D representation of the campus, we could achieve user friendly system for a broad range of individuals. This is the primary goal of Universal Design as first set out by Ron Mace in 1991, and then reconsidered and improved in work done at IDeA Center (Steinfeld & Maisel, 2012)The evaluation study was particularly helpful in identifying issues and recommendations for future updates to the model. Phase 2 will address and incorporate some of these suggestions. It will also include creating a model that can tolerate rigorous use testing to ensure the materials hold up over time. The detailed results from the questionnaire is located at the end of this paper.

CONCLUSION

The Overbrook School for the Blind Touch Multi-Sensory Model Usability Study demonstrates that the talking model system helps with orientation and mobility. Although many of the subjects were already familiar with the campus, their interaction with the model showed additional learning of unknown campus information. Subjects learned new information about the overall physical layout of the campus, how many buildings are on the campus and locations of pathways and sidewalks that connect these buildings. The tap and touch technique was easy for students to comprehend, however, they will need additional time to learn its many functions. Visitors, staff and students at the Overbrook School for the Blind will benefit tremendously once the interactive touch model is improved through some of the recommendations outlined and then installed.

ACKNOWLEDGEMENTS

This study is funded by Small Business Innovation Research grant 90BI0025 and a grant from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR grant number 90RE5022-01-00).

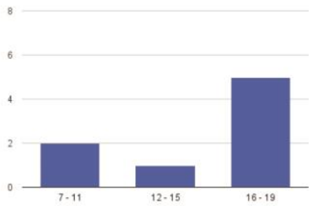
REFERENCES

Bentzen, B.L. (1983). “Orientation Aids.” Foundations of Orientation and Mobility, American Foundation for the Blind, 291-354.

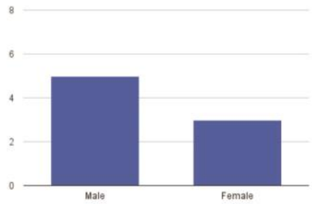
Blades, M., Ungar, S. and Spencer, C. (1999), Map Use by Adults with Visual Impairments. The Professional Geographer, Vol. 51: 539–553.

Detailed Results: Demographics

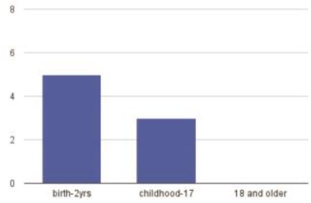
What is your age group?



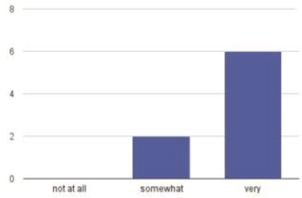
What is your sex?



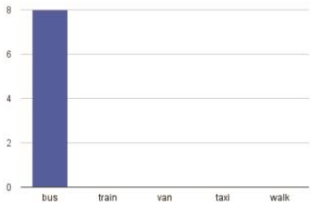
What was your age at the onset of your visual impairment



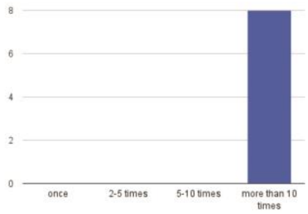
How familiar are you with the Overbrook School for the Blind?



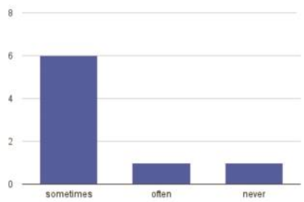
What mode of transportation do you use to get to the Overbrook School for the Blind?



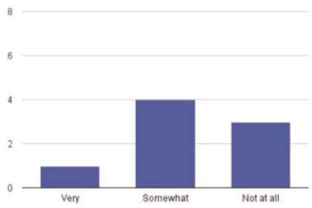
How many times have you been to the Overbrook School for the Blind?



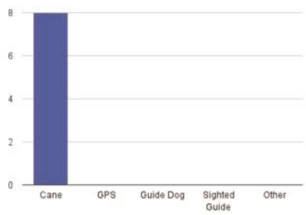
How often do you ask for assistance when trying to find a location around the Overbrook School for the Blind?



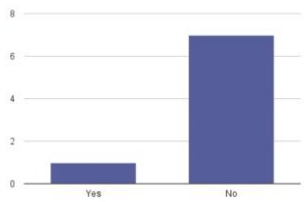
How comfortable are you with using interactive assistive devices such as a Braille note taker, GPS, etc.?

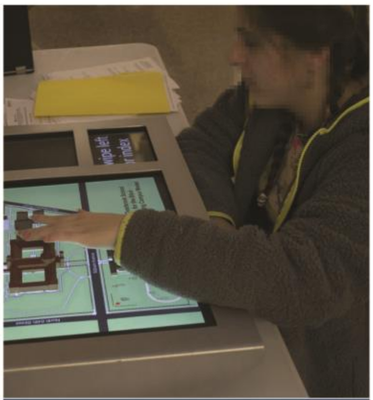


What assistive technology do you use to navigate around the Overbrook School for the Blind?



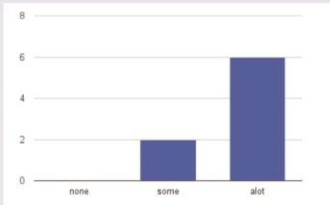
Are you familiar with the Interactive Touch Map at the Overbrook School for the Blind?



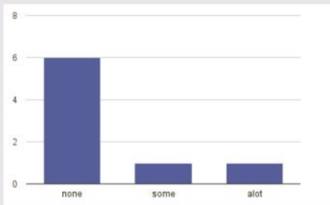


Level of experience using various types of maps

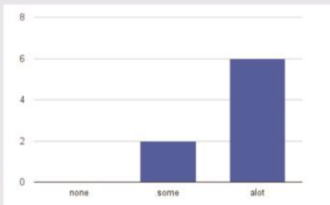
Tactile Maps



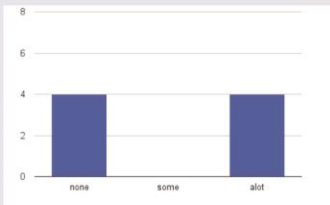
Talking Tactile Maps



Visual Maps

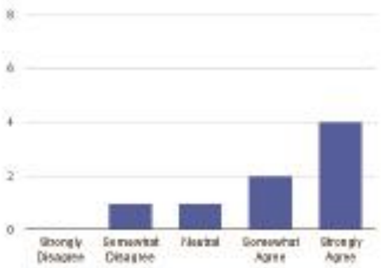


Braille Maps

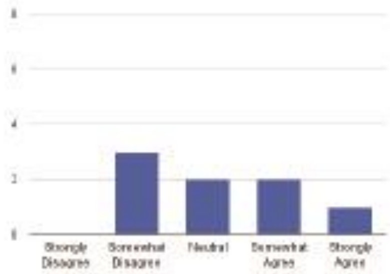


Detailed Quantitative Results from RAPUUD

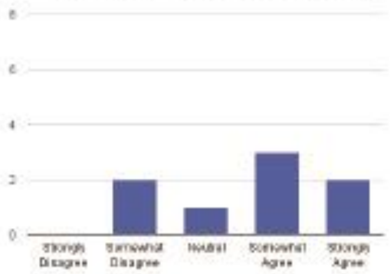
The talking campus model is easy to use.



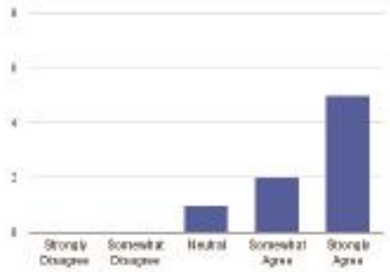
Using the talking campus model device takes more time than it should.



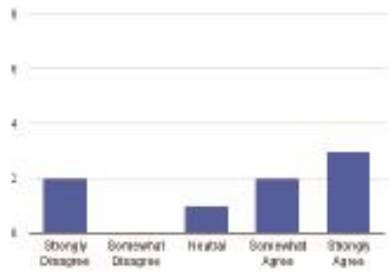
Using the talking campus model requires little physical effort.



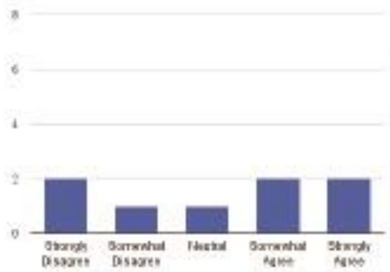
Using the talking campus model requires minimal mental effort.



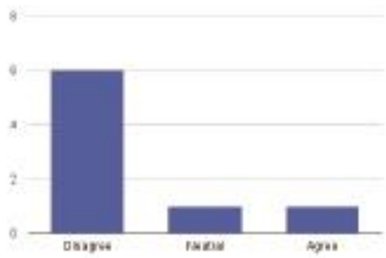
When using the talking campus model I make mistakes that require me to "do over" some steps.



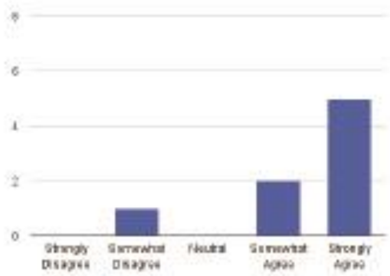
I need assistance to use the talking campus model.



Using the talking campus model in a public place would draw unwanted attention to me.

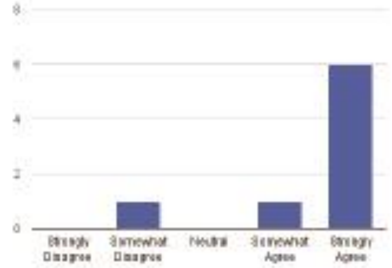


I could find buildings, roads, and other parts of Overbrook School on the talking campus model.

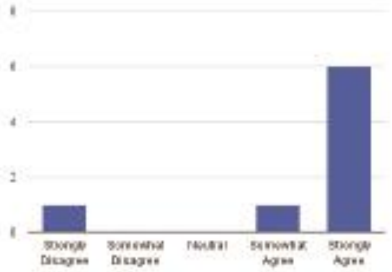


Additional Quantitative Results

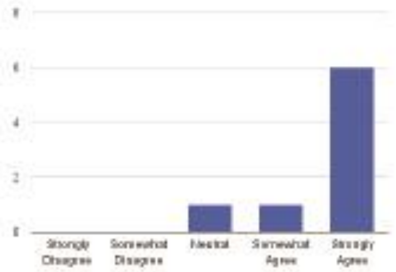
The alphabetical index was easy to use.



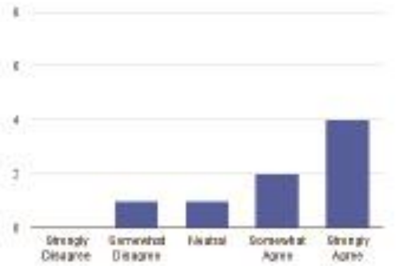
The speech was clear and the volume was OK.



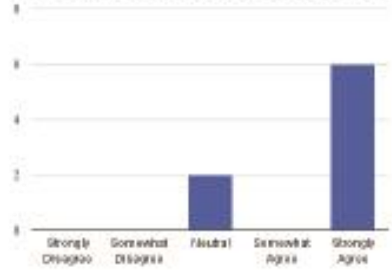
It would have been better if the speech was faster.



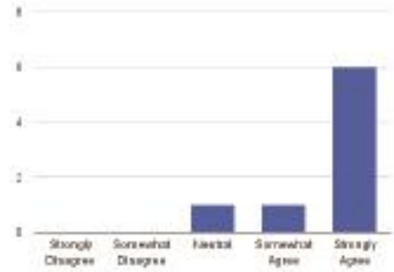
Each texture, line or form on the map was distinct.



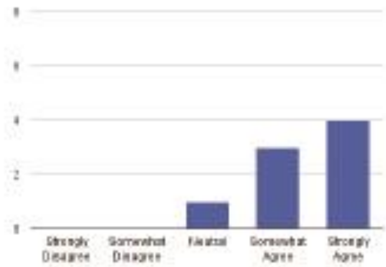
I understood that it was necessary to tap again for more detailed information about a place I found on the model.



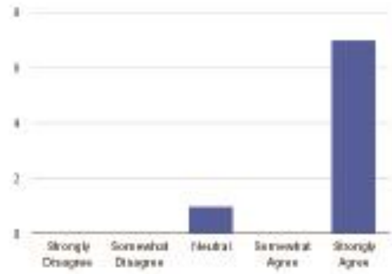
I could understand the spoken information.



I was able to comprehend the various parts of the model, including buildings.

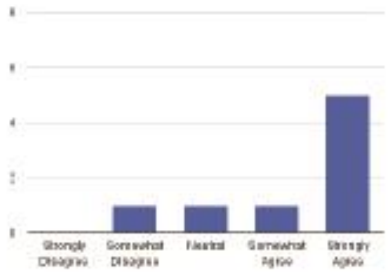


I was able to find specific buildings on the map.

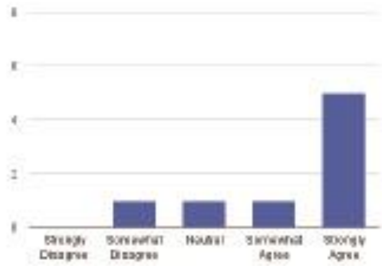


Additional Quantitative Results

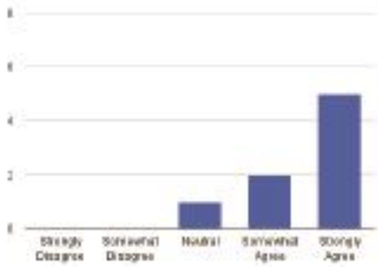
I was able to find streets.



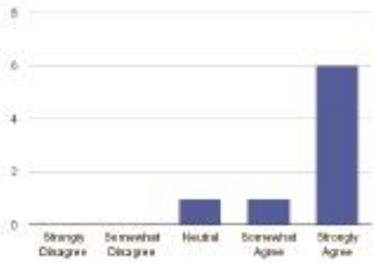
I was able to find pathways and sidewalks.



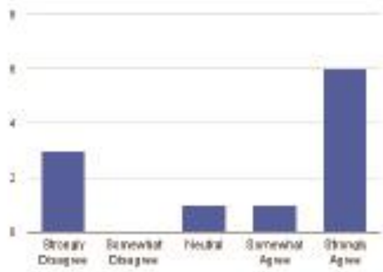
I was able to find parking lots.



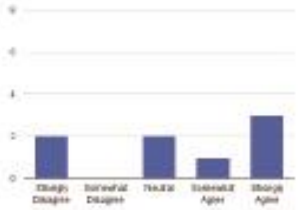
I was able to find athletic fields, like baseball, track or golf.



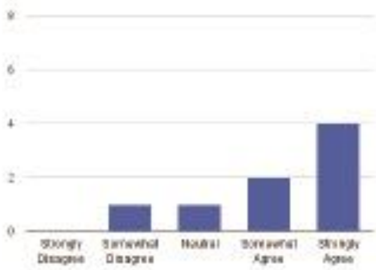
The map is too low.



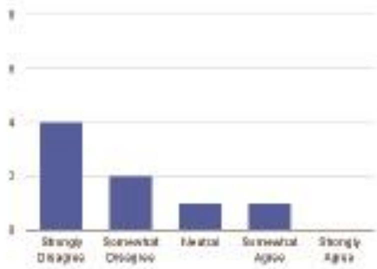
The map should have been displayed mounted vertically to a wall instead of on a flat table.



The map is oriented properly for comfortable use.

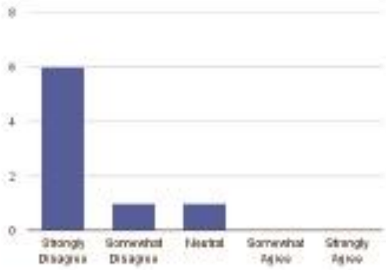


I had trouble reaching all parts of the map.

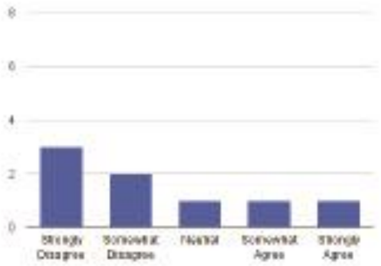


Additional Quantitative Results

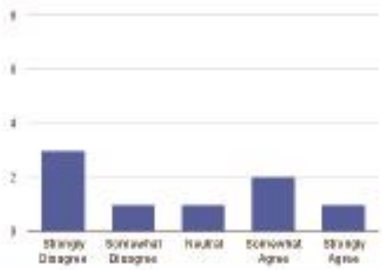
The map is too small.



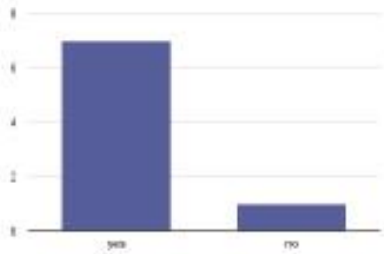
There is too much background noise where the map is located.



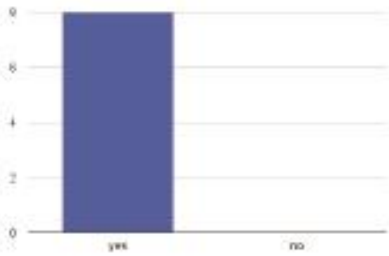
I could read the displayed text information.



Completion of tasks.



Completion of walking exercise.



Qualitative Results

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- *Well rounded map. Anyone could use it. Has everything on it.*
- *The map is perfect for students and visitors.*
- *There is little or nothing wrong with this map.*
- *Map is useful for new people visiting the campus and not for people who are already familiar with the campus.*
- *I like that i can see where the dormotories are.*

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- *I would like a more detailed list in the directory.*
- *I would like a wall mounted version.*
- *I prefer buttons instead of swiping.*
- *Head phone jacks would be better for me to hear the audio information*
- *It would be useful to include audio descriptions of interior features of the building.*
- *Faster speech setting. More precise directions.*