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OneView: Enabling Collaboration Between Blind and Sighted Students

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Abstract
Collaborative activities, especially those that require sharing or referencing visual artifacts, can present a significant barrier to blind and visually impaired students in the classroom. We present our ongoing work on OneView, an application for tablet PCs that enables blind and sighted students to work collaboratively by integrating visual sketching tools with an accessible talking touch screen interface. In this paper, we describe a formative survey we conducted to understand accessibility challenges related to classroom collaboration, provide an overview of the OneView prototype, and describe a preliminary user study in which pairs of blind and sighted participants used OneView to collaboratively create diagrams.

Keywords
Accessibility, blind, collaboration, tablet PC, touch screens, education.

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation: User Interfaces – input devices and strategies, voice I/O. K.4.2. Computers and Society: Social issues – assistive technologies for persons with disabilities.

Introduction

Over the past several decades, students with disabilities have increasingly moved from specialized schools and individual tutors to mainstream classrooms. This integration has been driven largely by research that has shown that students with disabilities benefit from integrated educational settings (*e.g.,* [1,4,6]). As a result, students with disabilities have increasingly found themselves integrated into mainstream classrooms, working alongside non-disabled students with non-specialized teaching staff. No longer separated from their peers, these students regularly engage in class lectures, assignments, and projects.

For students with visual impairments, integration into the classroom can present significant challenges. Two notable challenges include the reliance on visual materials and the difficulty in engaging in collaborative work. First, mainstream classrooms may rely heavily upon visual media such as maps, charts, chalkboards and whiteboards, and presentation slides. In their default form, these media are partially or completely inaccessible to some blind or visually impaired students. The traditional solution to this problem is to provide the student with an alternative version of the course content, such as a printed Braille diagram or an audiobook. But these workarounds require advance planning, and limit the student's ability to explore unexpected topics. Second, a blind or visually impaired student may have difficulty sharing information with her sighted peers while working collaboratively with them. Even if the student has access to the material in an alternative format, such as Braille, this information is not easily shareable with her sighted peers. Likewise, the blind or visually impaired student may have trouble keeping up with her group's discussion of visual artifacts, as well as their written notes and diagrams.

The goal of the *OneView* project is to create classroom tools that enable blind and visually impaired students to easily share information, including visual information, with their sighted peers. In this paper, we describe our work to date on this project, including a formative survey of blind students, the development of the prototype, and feedback from early user testing.

Related work

Our work is motivated by several studies that demonstrate the advantages of integrating students with disabilities into the classroom. Prior research has shown that integrated education improves academics [1], social interactions [6], and self-esteem [4] among students with disabilities.

Of course, problems with the accessibility of visual media are not unique to integrated classrooms, and have been addressed over many years by analog technologies such as Braille and tactile graphics, as well as by interactive technologies. OneView was initially envisioned as an accessible diagramming tool, and builds upon previous accessible diagramming tools such as PLUMB [2] and TeDUB [5], These tools enable blind and visually impaired people to navigate various types of diagrams, but primarily target the blind user, and do not explicitly support collaboration between blind and sighted users.

Researchers have also previously explored the creation of multi-modal user interfaces for collaboration between blind and sighted users, including HOMER [7], AVANTI [8], and the Collaborative Towers of Hanoi game [9].

Statement	Agree
I enjoy participating in group activities.	52%
I am excluded from some aspects of group activities.	59%
I am an equal partner during group activities.	49%
I have difficulty keeping up with my partners during group activities.	39%
My partners need to change their behaviors to accommodate me during group activities.	52%
I need to remind my partners to include me in group activities.	40%
I experience accessibility challenges during group activities.	68%
Decisions are made without my input during group activities.	32%

Table 1. Responses from our formative survey of accessibility issues in classroom collaboration.

OneView presents an alternative approach to enabling collaboration between blind and sighted users that focuses explicitly on enabling lightweight collaboration in the classroom, and which leverages recent research in accessible interaction for touch screens.

Accessibility in classroom collaboration

The OneView project developed from our prior work on developing accessible touch screen interaction techniques for blind and visually impaired people [3]. While this prior work demonstrated that touch screen-based mobile devices could be effectively used by blind people, making touch screens accessible required substantial changes in how the user interacted with the touch screen. This raised questions about how touch screens can be used to connect blind and sighted people, even if the underlying mode of interaction differed for the two users. Based on informal conversations with several students with disabilities, we became convinced that a touch screen, if accessible to users with different abilities, could improve the quality of collaboration between two students, and could potentially address barriers to participation faced by some students with disabilities.

To better understand the challenges faced by blind and visually impaired students, we deployed a web-based survey that focused on accessibility challenges in the classroom. We received responses from 47 current or recent students from several countries. Participants were asked to briefly describe past instances in which they had collaborated with other students, and to describe whether these collaborations were successful. Participants also answered general statements about their overall experiences collaborating with other students. Participants indicated their agreement with the statements on a 7-point Likert scale (1=Disagree strongly, 7=Agree strongly). Table 1 lists the statements presented on the survey, and the percentage of respondents who agreed with each statement (by responding with a score of 5 or higher).

We may draw several conclusions from this formative study. First, blind students do participate in group activities on a regular basis. Fifty-four percent of survey participants reported participating in a group activity at least once per week. Participants described their participation in several types of group activity, including small group discussion, project planning, and in-class research. More than half of the participants reported experiencing accessibility challenges during group activities (68%) and being excluded from some aspects of group activities (59%). A large number of participants also reported difficulties keeping up with their partners during group activities (39%). These results provide evidence that blind and visually impaired students face additional accessibility challenges when working within groups, and that sharing information within the group often presents a major obstacle to collaboration.

Designing OneView

Based on this formative research, we began to design several prototypes of OneView, our classroom tool intended to improve collaboration between blind and sighted students. Our prototypes have consisted of several touch screen-based applications. We have targeted touch screens for several reasons:

1. Touch screens are ubiquitous, and can be found on many technologies that may be used in the classroom, including mobile phones and tablet PCs;

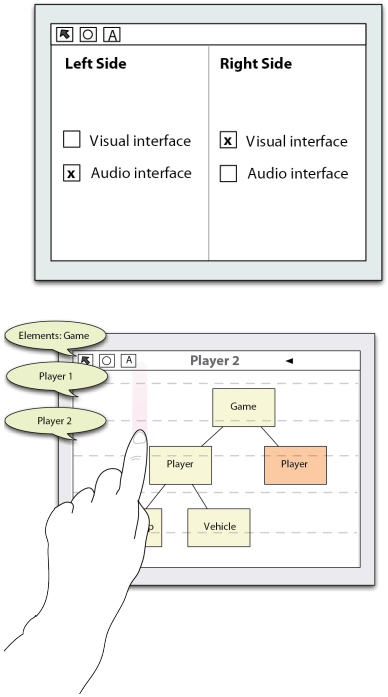

Figure 1. Initial design sketches of the OneView tablet PC application.

2. Touch screens are ideal for exploring spatial data;
3. Touch screens enable flexible interfaces that can change depending on whether they are being used a blind or sighted person;

Likewise, our prototypes to date have focused largely on supporting face-to-face collaboration, as our research has uncovered significant accessibility problems in this area. Figure 1 shows early design sketches of the OneView prototype for a tablet PC.

Design goals

Drawing on our formative research and on extended conversations and iterative prototyping with a blind computer science student, we developed a set of design goals for our prototypes. These goals are intended to ensure that our work empowers blind users, respects the autonomy of students, and promotes successful collaboration between students.

Ensure equal use. If a program feature is usable by a sighted person, it must also usable by a blind person, and vice versa. Whenever possible, each feature should perform identically for both blind and sighted users.

Maintain group awareness. OneView should provide each user with awareness of what his or her partners are working on at any moment, so that the user does not need to ask their partner what they are doing.

Flexible use. Because group activities in a classroom can vary greatly depending on the subject, activity, class size, and available resources, OneView should support collaboration for a range of group sizes, and should be able to support various working arrangements, (*e.g.*, each student has their own computer, or students are sharing computers).

Easy configuration. Students should be able to configure the program, including any accessibility settings, without assistance. To support ad-hoc collaboration, students should be able to start working together quickly, and with minimal setup.

Universal usability. Although we have primarily focused on supporting blind students, OneView should provide accessibility features for users of all abilities whenever possible, including users with low vision and users with hearing impairments, who may also be excluded from some aspects of group collaboration.

Prototype

Our prototype of OneView is a C# application designed to run on Microsoft's Tablet PC platform. OneView enables users to create, browse, and edit diagrams. Users can add boxes, labels, and clip art to a diagram, and can connect diagram elements with arrows.

OneView provides separate visual and non-visual interaction modes. Visual mode uses a sketch-based interface: users can manipulate elements of a diagram using ink. For example, a user can add an element by drawing its bounding box, and can remove an element by drawing an X gesture over the element. Non-visual mode utilizes an accessible talking touch screen interface, similar to our prior project Slide Rule [3], which has been previously validated as an effective touch screen interface for blind users. Non-visual mode presents the user with a hierarchical menu that fills the entire height of the screen. The user drags their finger across the screen to hear menu options, and double

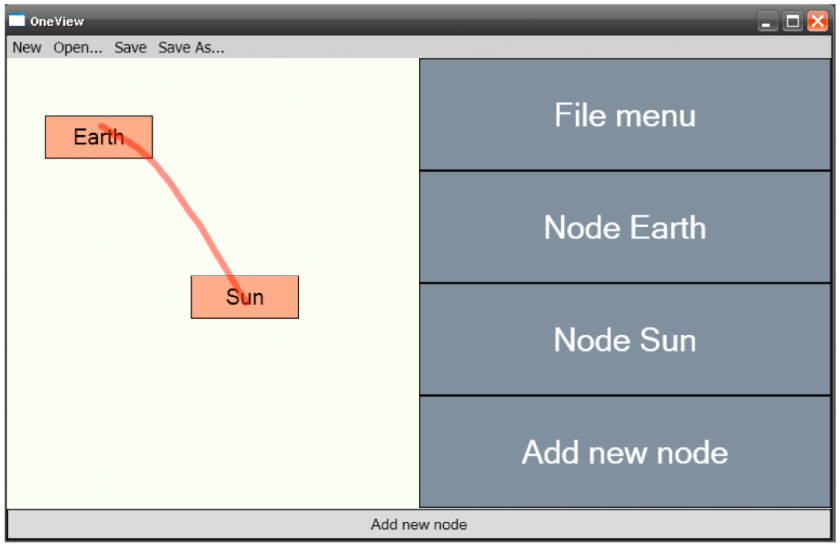

Figure 2. OneView's split screen interface presents both a visual, sketch-based interface and a hierarchical talking menu.

taps the screen to select a menu item. All commands that are available in visual mode are available in non-visual mode also, although they may be activated differently. The non-visual mode menu is also high contrast and features large type to make it usable by people with low vision. In both modes, OneView supports several options for editing text. Users may enter text using an on-screen QWERTY keyboard, handwriting, or speech recognition.

OneView offers several features to support collaboration. OneView's split-screen view enables 2 users to share a single tablet PC (Figure 2). Split-screen can be used by a blind user and sighted user together, with one side of the screen controlling visual mode and the other side controlling non-visual mode. If students have access to more than one tablet PC, OneView's network mode allows each student to use their own device to edit a shared diagram. Finally, OneView provides a comprehensive change tracking feature: each change made to the shared diagram is highlighted visually on the document, announced using speech, and displayed as an on-screen caption.

User study

To better understand OneView's potential and to guide future development, we conducted a formative user study with 6 pairs of blind and sighted participants. Five women and 7 men participated in the study, ranging in age from 20 to 62 (average age = 36.3). Participants in the study did not know each other previously.

Because the blind participants were less familiar with touch screens, they received a 1-hour tutorial from the experimenter, while sighted participants completed a 10 minute tutorial based on a written guide. Once both participants were trained in using OneView, they were introduced to one another. Participant pairs completed 2 tasks in which they read some text describing a topic (either the solar system or the water cycle), and then worked together to create a diagram that represented that topic. Finally, participants provided informal feedback about their experiences.

Participants were generally positive about their experiences with OneView, and blind participants were especially excited to be able to collaborate with their partners. Overall, sighted participants were more familiar with the visual interface than blind participants were with the non-visual interface, and were typically faster at performing tasks. Several blind participants stated that they found the interface somewhat difficult

to use, and 2 participants mentioned after the session that they felt somewhat self-conscious because they were slower than their sighted partner.

Much to our surprise, several blind participants stated that they would prefer an interface that was similar or identical to the interface used by their sighted partners. OneView's non-visual mode is based on prior research on accessible touch screen user interfaces, and thus we expected that it would be best for blind users. However, some blind participants stated that they felt it was important for them to use the same user interface as their sighted partners. Blind participants also stated that they would like to see a spatial view of the diagram, instead of, or in addition to, the non-visual hierarchical view.

Future work

We continue to refine the OneView prototype. In particular, based on feedback from the user study regarding users feeling self-conscious, we intend to both improve performance of the non-visual interface and provide feedback that more clearly highlights the contributions of each participant. We also intend to explore how to improve the spatial information provided by the non-visual interface. Beyond these changes, we are also interested in extending OneView to other devices, and to other applications such as map exploration. The ultimate goal of OneView is to create a usable and accessible tool to support a variety of collaborative tasks between blind and sighted students.

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