

Making Voting Accessible: Designing Digital Ballot Marking for People with Low Literacy and Mild Cognitive Disabilities¹

KATHRYN SUMMERS, University of Baltimore

DANA CHISNELL, Center for Civic Design

DREW DAVIES, Oxide Design Co.

NOEL ALTON, University of Baltimore

MEGAN MCKEEVER, University of Baltimore

This research began with a question about addressing a broader range of accessibility issues in voting than the standards in the Voluntary Voting System Guidelines (VVSG) require. The VVSG standards cover accessibility for low vision, blindness, and cognitive disabilities. But what if anyone could mark their ballot anywhere, any time, on any device? While the likelihood of voters voting on their own devices may be remote in the current elections environment, it is likely that election jurisdictions will begin to use consumer off the shelf devices as the voter-facing part of voting systems soon. Thus, we narrowed the scope of our research to prototyping an accessible, responsive, Web standards-compliant front end for ballot marking that would be accessible to voters with low literacy (a previously ignored voter audience) or who had mild cognitive disabilities. The final ballot interface is based on principles of “plain language” and “plain interaction.” The ballot interface is available under a Creative Commons license at anywhereballot.com. This paper reports on the rapid iterative testing and evaluation (RITE; Medlock et al., 2002) we conducted and the lessons we learned about designing a digital ballot interface for people with low literacy or mild cognitive disabilities.

Keywords

Ballot design, universal usability, accessibility, mobile design, low literacy, cognitive impairment, older adults, digital voting

1. INTRODUCTION

1.1 Why Usability Matters in Election Technology and Ballot Design

Much of the discussion of improved election technology has centered around issues of voting security and efficiency (Dill, Schneier, & Simons, 2003; Gallo, Kawakami, Dahab, Azevedo, Lima, & Araujo, 2010). However, another important priority is usability (Herrnson et al., 2006). According to the Voting Accessibility for the Elderly and Handicapped Act of 1984 and the Help America Vote Act of 2002, voting systems that result in voter error or that are easy to misunderstand can be subject to legal challenge. This is particularly true of voting systems that place an unequal burden on specific members of the population—such as low literacy readers, the elderly, and those with disabilities (United State Election Assistance Commission, 2009; Schur et al., 2002; Ward et al., 2009).

While an increasing number of jurisdictions have moved toward electronic voting systems, relatively little research has been done on ways to make the voter interface broadly usable by groups such as those listed above who may have particular difficulty filling out ballots. Additionally, while voting on mobile devices has promise to increase both efficiency and accessibility for many voters, there has been little research on the usability of electronic interfaces on such devices².

¹ Funded by the Accessible Voting Technology Initiative of the Information Technology & Innovation Foundation, with funds originally provided by the Elections Assistance Commission.

² Campbell et al. (2011) designed a mobile voting system for the iPhone and tested its usability compared to traditional voting platforms. They found that smartphone owners committed fewer errors on the mobile voting system than on

This research represents a step toward establishing principles of usable electronic ballot interface design—starting with the best current thinking about electronic ballot design, and then improving it. As such, it provides both specific research-based guidelines about how to make ballot interfaces more usable, and an illustration of the kind of research and design efforts that are needed to achieve the goal of ballot usability.

1.2 Principles of Ballot Design

General principles of ballot design are well understood. The baseline was set in work commissioned by the Election Assistance Commission (EAC) and researched by AIGA's Design For Democracy, which became Effective Designs for the Administration of Federal Elections (EAC, 2009; http://www.eac.gov/assets/1/workflow_staging/Page/70.PDF). This set of best practices for ballot design includes design specifications for many types of printed materials used on Election Day, from signs to ballots. It also proposes a basic framework for a digital user interface. The National Institute of Standards and Technology (NIST) and the EAC have worked since the Help America Vote Act (HAVA) became law in 2002 to establish standards for voting systems. The current version, *Voluntary Voting System Guidelines (VVSG) 2.5*, includes standards on usability and plain language and accessibility practices for people with low vision, who are blind, or who have cognitive disabilities (see vote.nist.gov/publications). These standards have come from NIST-sponsored studies on plain language in instructions and on use of color in user interfaces, reviews of the literature on system accessibility, expert review and opinion, and other basic and applied research (Chisnell et al., 2009; Redish et al, 2009, 2010). These standards do not have force of law, but as recommendations of the commission that is responsible for developing guidance for meeting requirements of the Help America Voting Act of 2002 (HAVA), they represent important ballot design parameters.

However, the VVSG standards assume current technology—mainly a choice between optical scan paper ballots and electronic touch screen interfaces—none of which optimally serves people with disabilities. In contrast, use of smaller mobile devices to mark ballots would allow voters with disabilities to use familiar assistive technology, thus dramatically increasing accessibility and ease of use across a range of audiences.

1.3 Designing for Voters with Lower Literacy Skills and Cognitive Disabilities

Research has shown that voters with disabilities are less likely to participate in elections—even those that use traditional voting technology (Schur et al., 2002; Ward et al., 2009)³. Moving to a digital format has the potential to increase usability, and thus participation, for such voters—but can also present additional barriers.

Our task was to design a ballot marking interface for people with low literacy and mild cognitive impairments, while incorporating what was already known about accessibility for people with low vision and who are blind. To reach this goal, we incorporated in our initial design research-established principles of what works in Web design for at-risk readers. We conducted formative evaluation sessions with individual adults with low literacy skills and age-related mild cognitive impairments. Research shows that improvements aimed at a particular special population, such as older adults and low-literacy readers, often help other groups as well (Chadwick-Dias, McNulty, & Tullis, 2003; Summers & Summers, 2005). Even expert readers (not surprisingly) tend to prefer information that looks easy to read, gets to the point quickly, and

traditional voting systems—a potentially promising outcome for voters using their own familiar assistive devices in digital voting.

³ Research has not been conducted on voting participation rates of low literacy voters. However, research on other dimensions of the behavior of low literacy users, and anecdotal evidence from those who work with voter participation efforts, suggest that such voters are less likely to participate when they find voting confusing or difficult.

provides plain language explanations of unfamiliar terms and concepts (Nielsen, 1997). Expert readers also sometimes skip over long blocks of text because they feel overloaded with information. So adaptations that increase accessibility for at-risk groups help expert readers as well.

The value of plain language in designing for audiences who do not read well, who are older, who are English language learners, or who are busy or stressed, is well established (Jarrett, et al. 2012; Redish et al, 2009, 2010; Chisnell et al, 2009). From a cognitive perspective, reading involves both decoding and comprehension (Tunmer & Gough, 1986). First the reader “decodes” the text on the page by associating the code—the words—with the concepts they represent. After decoding the individual words, the reader moves on to comprehension: figuring out what the writer was trying to communicate by putting those particular words together. Adults with low literacy skills can struggle with both word recognition and understanding what the words put together actually mean. These reading difficulties can affect voter education, and unavoidably affect the process of marking a ballot and casting the vote.

Additional major challenges in designing digital interactions for lower-literacy audiences, readers with cognitive disabilities, and other at-risk audiences such as the elderly include accommodating their need for sequential processing, guiding interaction effectively, providing clear feedback cues (without text when possible), and helping users avoid, discover, and recover from errors (Summers et al., 2006).

One of the challenges faced by readers with lower literacy skills, some readers who are older, and readers under stress is that their effective field of view is especially narrow. Processing the text itself takes so much cognitive attention that they become less able to pay attention to cues about what might be coming up or remember where they came from. As they move through page content, they are not looking ahead or behind. They are not likely to notice any content above, below, or to the sides of their focus of attention (Summers et al., 2006).

Readers who are using a screen magnifier literally have a narrow field of view. They can only see what the magnifier focuses on. Much of what is around the magnified text is obscured. Readers who must rely on screen readers have an even more narrow field of view. They can only “see” what the screen reader is currently reading aloud. They have no access to information above, below, or to the side.

This narrow field of view has implications for the design and content of a digital ballot. Materials must support sequential processing. Pages must make sense independently. Headings must make sense out of context. Even adjacent paragraphs should be as independent as possible. If readers must remember one paragraph to make sense of the next paragraph, some people who do not read well are likely to come away with misinformation.

Other research has confirmed the value of designs that encourage people to focus on one thing at a time. Allowing for more linear cognitive processing increases the success rate of people experiencing any form of cognitive impairment (Detterman et al., 2000; Salthouse, 1985). Making task demands sequential rather than concurrent also increases the success rate of people under stress (Dutke & Stober, 2001). At the same time, understanding and performance also improve when users can see the structure of the information or task they are performing. The challenge is to provide an overview, or show the structure of the ballot, without losing the specificity and clarity of a “single race at a time” interaction. Even for larger screens, this can create difficulties. With smaller devices, the challenge becomes significantly greater.

2. RESEARCH AND DESIGN METHODOLOGY

Our initial design adapted an existing NIST ballot for use with mobile devices, incorporating principles of usability with at-risk readers. We then conducted two rounds of qualitative, formative, iterative one-on-one test sessions using the RITE method (Medlock et al., 2002). The

first round consisted of 18 sessions over four days with a paper prototype; the second round consisted of 15 sessions over four days with a digital prototype, for a total of 26 participants and 33 sessions⁴. Changes to the prototypes were made between sessions as needed. Tests were conducted in the University of Baltimore's User Research Lab.

One hallmark of the RITE method is its qualitative, real-time diagnosis of design issues. To accomplish this diagnosis, the moderator interacts with the participant during the session, responding to questions and comments, and giving programmed hints when participants get frustrated and stuck. In the meantime, others from the design team listen and watch to identify the particular design elements that may be causing participants to become frustrated.

We used what we learned in each session to make changes to the ballot interface design for the next session, continuously iterating until no more problems were observed during the final sessions. Team members observing the sessions watched for voter hesitations, discomfort, mistakes, or other indications that the interface was not supporting the voter's intended actions or mental model. When necessary, the moderator asked questions to understand the voter's reactions. We then made changes based on our observations, which we tested in the next session. Analysis between sessions allowed us to come to consensus on observed issues and to generate inferences about why the issues were happening and how we could respond in future design iterations.

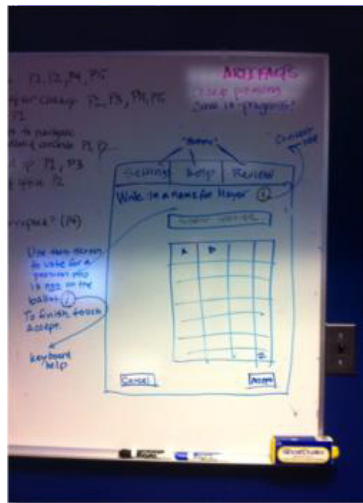


Figure 1. Observed issues were captured between sessions, and the team worked together to develop possible design responses to test in the next session.

While any observation has some impact on user behavior, direct observation has several advantages over the “think aloud” protocol that is often used in traditional usability testing, in which participants give a running commentary describing what they are doing and why (Dumas & Loring, 2008). While having participants “think aloud” can be an effective method to gain insights about an interface's design, it places an additional burden on participants: not only do they have to attempt to complete the assigned tasks, they also have to verbalize their thoughts. Having participants think aloud about what they are doing can also change what they do, thus potentially changing the very behavior that is being studied (Brinkman, 1992; Nagle & Zietlow, 2012). The

⁴ Several participants from the paper prototyping sessions were invited back three months later to use the digital prototype. We needed to make sure that specific comprehension and interaction problems faced by these participants had been successfully addressed.

method becomes even more of a problem with participants who have cognitive impairments, such as those that often affect reading (Johnstone, 2006). Additionally, while users with adequate reading skills might be able to explain what parts they had trouble reading and why, those who lack such skills might not even admit they had trouble reading (Parikh, Parker, & Nurss, 1996).

The first round, using a paper prototype of an iPad interface, took place in October 2012. Using paper in the first round of testing rather than programming a digital interface provided a high level of flexibility for trying new designs and responding quickly to observations (Snyder, 2003), allowing us to create and test 16 prototype versions in 18 sessions. The second round, using a digital prototype delivered on an iPad, took place in January 2013, and involved four prototype versions. Most of the pages went through at least three iterations; some pages or sections required as many as four or five iterations before voters were able to proceed without problems.

2.1 Participants

Participants included 18 women and 8 men, representing a variety of literacy levels and age levels, and including some participants with mild cognitive impairment. While this may seem like a relatively small number of participants, this number of participants can still lead to reliable conclusions about user behavior related to usability (Virzi 1992; Spool & Schroeder 2001). Key participant characteristics are summarized in Tables 1 and 2.

Table 1. Participant Data

Total Number of participants		26
Gender	Male	8
	Female	18
Age	18-35	7
	36-70	15
	70+	4
Ethnicity	Black	19
	Caucasian	5
	Hispanic	1
	Asian	1
Voting method in 2012 elections	Abstained	4
	Touchscreen	8
	Paper	14
REALM Score ^a	0-44 or 6 th grade or below reading level	3
	45-60 or 7 th -8 th grade reading level	6
	61-66 or 9 th grade or higher	17
Tablet familiarity	Familiar with tablets	5
	Unfamiliar with tablets	21

^aThe REALM (Rapid Assessment of Adult Literacy in Medicine) is a word recognition test that physicians use to determine whether their patients have low literacy skills and therefore may need additional help with instructions. It is a list of 66 medical words that the moderator asks the participant to read aloud. The number of words the participant pronounces correctly accurately reflects that person's literacy level (Davis, et al., 1991). It is a well-validated measure that is easy to administer, and is often used in non-medical user experience research to recruit participants with low literacy skills (Frascara, 2003; Carstens, 2004; Harper, et al., 2013).

Table II. Participant Self-Reported Disabilities

	Paper Prototype Session	Digital Prototype Session
Difficulty Learning	1	2
Seizures	-	1
Physical Limitations	-	2
Serious Vision Issues	-	1 ^a
Difficulty Working	-	3

^aThe participant with serious vision issues also reported difficulty learning and physical limitations.

We scheduled the majority of participants who were 70 years old or more or who self-reported physical or cognitive limitations, using classifications from the U.S. Census Bureau, for Round Two. We wanted to find and resolve as many potential issues as possible during the paper prototyping in Round One, but we were sensitive to the fact that moving to a digital prototype on a potentially new device could possibly introduce new interaction issues for our most “at-risk” participants. So we made sure that our most vulnerable participants interacted with the most mature version of the ballot that we could manage, and in the most realistic format. We also made sure that we included participants who were unfamiliar with tablets, as well as participants who were familiar with tablets. We wanted to make sure that we did not create barriers to voting for those who were not already familiar with tablets—particularly for elderly voters who might be uncomfortable with new technology.

2.2 Materials

Participants used a version of the NIST medium complexity ballot, which uses realistic but fictional names and contests, with colors for party names. The ballot had 18 pages, with 11 contests, three judge retention contests, one constitutional amendment, and two ballot measures.

We started with the visual designs and interaction designs developed by the work of Design for Democracy in *Effective Designs for the Administration of Federal Elections*, a project involving hundreds of different types of voters working with dozens of design iterations and variations. That project delivered the most widely used template for paper optical scan ballots, but it also generated a hypothetical design for an electronic ballot interface that was remarkably compatible with the iOS interface (which it had pre-dated by two years) and which provided many of the visual elements that worked well in our interface.

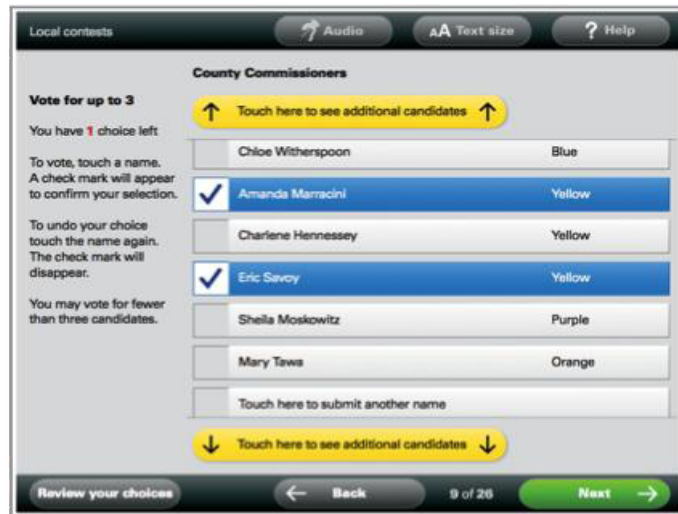


Figure 2. A contest from Design for Democracy’s hypothetical electronic ballot interface

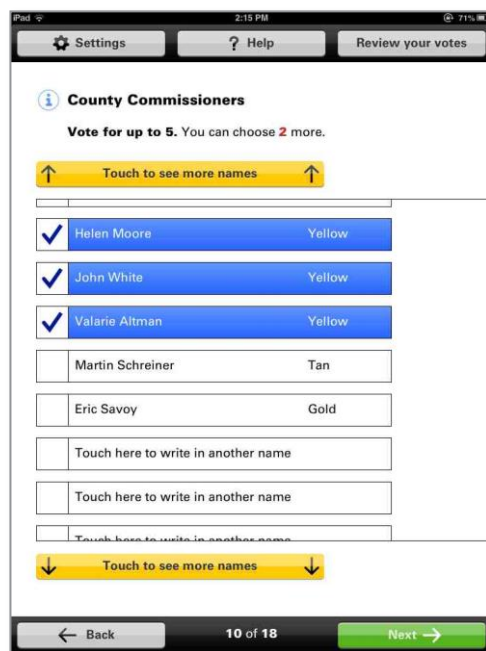


Figure 3. The same contest in the final version of our ballot. Instruction text is minimized and integrated into the path of voter action and attention, rather than being placed in a separate column.

2.3 Test Tasks

Participant tasks included simple selection of candidates, straight party voting, writing in candidates, reviewing votes, and changing some votes before casting the ballot. For some of the contests, participants made selections without explicit direction. Other selection tasks were party-based or candidate-based. The tasks and the ballot were drawn from NIST research on the language of instructions on ballots (Chisnell et al., 2009; Redish et al, 2009, 2010).

The tasks were originally designed for a performance test in which the researchers investigated whether plain language instructions helped voters make fewer mistakes than conventional instructions. We were conducting a formative study rather than a performance test, but the maturity of the test protocol ensured that we tested a wide range of voting behavior, and using the same tasks and slate anchored our rapid iterations. We did not measure performance because we changed aspects of the design between many of the sessions.

2.4 Procedure

Sessions were held one-on-one, in a physical arrangement meant to loosely mimic voting at home. Participants sat in a comfortable chair, using the “tablet” on their lap. For the paper prototype session, two video cameras recorded the session: one camera suspended over the back of the chair to show the prototype (main frame), and one camera across from the participant to capture face and body language (picture-in-picture). For the digital prototype session, the contents of the iPad screen were echoed on the recording computer using the Reflector application (main frame), and a camera was placed across from the participant to capture face and body language (picture-in-picture).

Because this was iterative, formative testing, the moderator interacted extensively with the participants, restating tasks and asking follow-up questions when needed. The rest of the research team observed through a one-way mirror, and saw a close-up video feed of participant actions. Between each session, team members captured issues, generated inferences, and agreed upon design changes, which were generally implemented between sessions. Larger design changes were sometimes implemented prior to the next day of sessions. Successful design changes were retained; other design changes were refined or replaced until the issue was resolved.

For the paper prototype, participants interacted with paper pages of the prototype held in a simple foam-core frame; a human “computer” added or removed pages in response to the participant’s actions. The digital prototype was coded in HTML5 and was hosted on a private server, but behaved like an iPad application rather than being delivered in a browser.

3. RESULTS

The formative testing and iterative design resulted in a final ballot interface that addressed the specific problems that had been observed in earlier participant sessions. While the sample sizes were too small (and revisions too frequent) to make for meaningful quantitative comparison, nonetheless there was a noticeable increase in ease and accuracy of use, particularly among the most at-risk participants, in later iterations of the design.

While all screens went through multiple iterations, some changes had a bigger effect on the overall accessibility of the ballot for participants. The result was an interface that was noticeably easier to use, and in which all of the major observed points of difficulty from earlier versions had been successfully eliminated.

Elements of the ballot interface design that underwent significant testing and revision included the following:

<p>Instructions to voters— general</p>	<p>Changes to the voter instructions based on participant behavior during testing consisted primarily of the following:</p> <ul style="list-style-type: none"> • Fewer words • Simpler language, with key phrases bolded to support skimming • Changing the order of the instruction on recovering from a mistake to refocus on changing with less focus on “fault.” <p><u>Original version:</u> “If you make a mistake or you want to change a vote, first touch the blue choice you no longer want. It turns white again. Then touch the choice you do want.”</p> <p><u>Final version:</u> “If you want to change your vote or if you make a mistake, first... [same as original]”</p>
<p>Straight party voting (for states where this is relevant)</p>	<ul style="list-style-type: none"> • Instructions were revised to have minimal words and simple language. • Icons leading to supplemental voter education content were first moved and made less visually prominent, and then ultimately removed. Voters kept tapping these information icons when they wanted to mark their vote, and voters with mild cognitive impairment then got confused and stuck in the supplemental content.
<p>“Vote for one” contests (national, state, and local)</p>	<p>Instructions were reduced from nine lines to a single line, integrated into the vertical layout.</p> <p><u>Final version:</u> “Vote for 1.”</p>
<p>Multi-candidate contests</p>	<ul style="list-style-type: none"> • Instructions were reduced from 12 lines to a single line. • Wording was changed to sound less directive and to avoid the word “choices” (see later discussion). <p><u>Earlier version:</u> “Vote for up to 5. You have 2 choices left.”</p> <p><u>Final version:</u> “Vote for up to 5. You can choose 2 more.”</p> <ul style="list-style-type: none"> • Researchers carefully observed scrolling behaviors in order to support all methods that participants tried to use. <ul style="list-style-type: none"> – For screenreaders, the full list of candidate names was read without requiring any scrolling. – For visual display, voters could scroll by touching buttons at the top and bottom of the visible candidate names that say “Touch to see more names.” – Voters could also scroll using the visible scroll bar, or on the iPad by flicking with a finger.
<p>Judge retention contests</p>	<p>We reduced the instructions to one line, and phrased the contest as a question with simple language.</p> <p><u>Final version:</u> “Keep Esther York as Supreme Court Chief Judge? “Choose Yes or No”</p>

Referenda and ballot measures	<p>Moving to a vertical layout (to prepare for responsive design on mobile phones as well as tablets) made the biggest difference here, allowing more of the text to appear on screen. We also reduced the instructions to one line.</p> <p><u>Final version for referenda:</u> “Choose For or Against”</p> <p><u>Final version for ballot questions:</u> “Choose Yes or No”</p>
Write-in candidate interactions	<p>Instructions were reduced from 19 lines to two, focusing on the essential message that voters not write in the name of someone already on the ballot. Additional instructions were available if voters wanted them. The size of the letters in the on-screen keyboard was also increased.</p> <p><u>Final version:</u> “Use this screen to vote for a person who is not on the ballot.</p> <p>“To finish, touch Accept. If you change your mind, touch Cancel.”</p>
Changing a vote interactions	<p>A key feature of the interaction on the ballot forces voters to deselect their original choices before they can change their vote. With an interaction as important as voting, we wanted to make sure that changes were intentional rather than accidental. But we wanted voters to be able to recover quickly from this somewhat non-standard requirement.</p> <p>In the final version:</p> <ul style="list-style-type: none">• The “Close” button was made the same color as the action buttons in the rest of the ballot.• The wording was simplified, and the most important information was bolded to make it easy to find for voters with low literacy skills.• Voters could also dismiss the error message by touching the screen anywhere outside the error message.

Review votes screen	<p>This screen caused the most problems. Voters were confused, made mistakes, and consistently got lost and confused by having to re-navigate the ballot.</p> <ul style="list-style-type: none">• Adjusting spacing and leading between titles and names in the contests solved some issues.• Language was refined. In particular, the word “choices” was eliminated, since this made some voters think they had choices still to make (see additional discussion below).• We refined the message about undervoting to be more clear but less directive.• We changed the interaction pattern. In the first version, voters who decided to change a vote from the Review screen were taken back to the ballot, starting at the contest they had wanted to change. They could either continue through the ballot a second time, one contest at a time, or use a button at the top to return to the Review screen. We changed this to an “out and back” interaction that took voters to the contest to be changed, then back to the Review screen. <p>Letting the Review screen ground their ballot changes was more successful, and voters were able to make the changes they wanted then proceed to casting.</p>
Casting the vote	<p>Our early rounds of testing showed participants becoming somewhat anxious and backing away from casting their votes, even though they did not have actual changes they wished to make to their ballots. Revising the text on the confirmation screen ameliorated this anxiety and helped participants feel more confident.</p> <p><u>Original version:</u> “Are you sure you have finished voting?”</p> <p>“Note: Once you press the Vote button, you will not be able to make any more changes.</p> <p>“If you want to make changes, touch the Return to ballot button.</p> <p>“If you are ready to cast your ballot, touch the Vote button.”</p> <p><u>Final version:</u> “Are you finished?”</p> <p>“If you want to make changes, touch the Return to ballot button.</p> <p>“If you are ready to cast your ballot, touch the Vote button.”</p>

<p>Supplemental content (Help screen for using the interface, supplemental information about contests and candidates)</p>	<p>Our early versions included three types of supplemental content: help information for using the interface, basic civics information about offices and contests, and simple voter education materials about candidates.</p> <p>However, in the testing we found that the voter education materials caused voters to lose track of their voting activity, sometimes to the point of needing help to restart the voting process. Voters also persistently tried to use the information icons next to candidate names to mark their votes. We tried to eliminate these problems through moving the icons, changing their visual treatment, and simplifying the voter information to make it easier to process.</p> <p>In the final version:</p> <ul style="list-style-type: none"> • Help information for the interface can be accessed through a button at the top, and through an information icon next to the voting instructions on each page. • Information about offices and contests can be accessed through an information icon next to the contest name. The information icons went through multiple iterations to make them less visually intrusive but still findable. • Eventually we reluctantly eliminated the voter education materials. The process of marking and casting the ballot is essential for democracy, and the benefit for “at risk” voters of eliminating disruptions that might prevent voting outweighed the benefits of supporting additional research about candidates.
---	---

Most of these design revisions reflected changes towards plainer, simpler language, and plainer, simpler interaction: a style we have summed up as plain language and plain interaction⁵. More information about these findings and the design principles they suggest is provided below. Additionally, the finalized ballot interface is available for use under a Creative Commons license at anywhereballot.com.

4. LESSONS LEARNED FOR DESIGNING ACCESSIBLE BALLOT INTERFACES

Based on our observations and iterative testing of multiple interface revisions, we have articulated the following broad principles for design of digital ballot interfaces—with reference to established findings from the previous research literature related to usability for low literacy readers, the elderly, and those with disabilities.

⁵ *Plain language* has been defined as “language that avoids obscurity, inflated vocabulary and convoluted sentence construction” (Eagleson), and as “language that reflects the interests and needs of the reader and consumer rather than the legal, bureaucratic, or technological interests of the writer or of the organization that the writer represents” (Steinberg, 1991).

We define *plain interaction* as interaction designed to help the user clearly understand the information presented to them, the action or actions expected of them, and the results of their actions. Guidelines that help achieve plain interaction are discussed in this paper, including supporting immediate action, creating a linear flow, and supporting a narrow field of view and staying in the user’s current locus of attention. We are indebted to Shaun Kanefor the term “plain interaction,” which he used in a phone conversation with our team to sum up the interaction design findings we were sharing from our study.

4.1 Plain Language: Test Language to Ensure Usability

Every ballot needs instructions. But a digital ballot also needs instructions for using its interface, as well as button labels and messages that paper ballots don't need. Redish et al. (2009) tested conventional instructions for ballots on a touchscreen tablet voting system, and found that voters performed better with plain-language instructions, as opposed to instructions that included technical voting terminology. At the end of their report, they proposed a new set of ballot instructions based on their research. This work by Redish et al. (2009) provided valuable guidance, but our testing with participants who had low literacy skills, or mild cognitive impairment, or who were seniors unfamiliar with touchscreen technology, demonstrated that instructions can sometimes be too complete. Designers may try to accommodate vulnerable voters by adding more instructions. But if the system and the ballot design are tightly integrated, and the interface design of the ballot is simple and plain, fewer instructions are needed. Keeping instructions minimal allows voters to focus their attention and effort on the tasks of voting, rather than on the interface or the interaction.

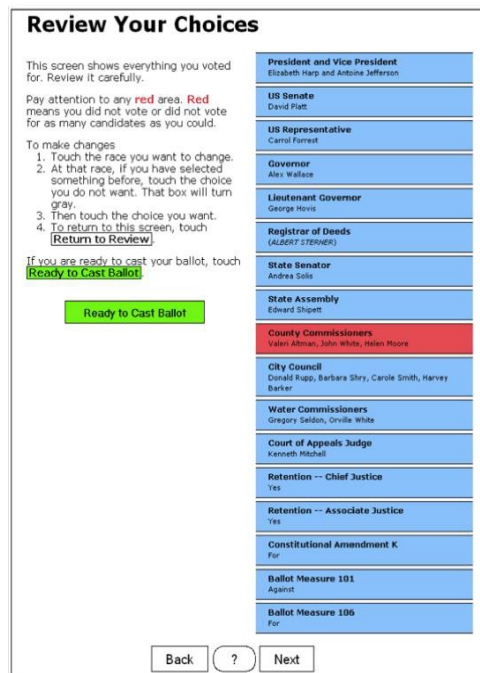


Figure 4. Redish, et al. (2009) recommended thorough and complete instructions in plain language.

We started with simple instructions, but found that we needed to simplify even further. Based on prior research, we knew that participants with lower literacy needed simple, familiar words, and that they would not be familiar with election jargon (Doak et al., 1996; Redish et al., 2009). So our initial instructions were written to be very simple, with short sentences. Vocabulary use was consistent, so that we did not use multiple terms to refer to the same concept. The most helpful instructions were those that used positive, specific, prescriptive wording, and that were designed for immediate action.

Despite our best efforts, however, some election jargon made its way into the instructions, causing participants to hesitate and stumble over the words. Thus, “Touch to see more candidates”

and “Touch here to write in a candidate” needed to become “Touch to see more names” and “Touch here to write in another name.”

As other researchers have found, people with low literacy skills tend to take words very literally and to act on every word (Doak, Doak, & Root, 1996; Summers et al, 2006). If the instructions said to touch the screen, they touched the screen, even if they were temporarily on a help screen rather than the ballot page. If the instructions said, “You have two choices left,” participants thought they were obligated to make two more selections, thus potentially changing their voting behavior.

Sometimes small language tweaks have a very big impact. In the first version of the ballot interface, the word “choices” appeared throughout. Participants had a hard time with the word “choices” due to the diphthong “oi,” often misreading this word as “choose” or “chose” (Burrows & Lourie, 1963; Gleason & Ratner, 2009). As a result, multi-candidate voting posed a problem for participants: not only was there too much wording in the instructions, but participants also had a hard time understanding how many candidates *could* be voted for and how many they had already voted for. Subsequent iterations simplified the language, leading to improved participant success.

On the Review screen, this difficulty was compounded by the fact that for most of the ballot, the word “choices” meant “options.” As a result, when the review screen instructions (and the navigation button to go to the Review screen) said, “Review your choices,” participants thought they had to make *more* choices on the Review screen. The concept of reviewing decisions that were already made was lost, and the page became a source of confusion and delay.

Our solution was to eliminate the word “choice” throughout the ballot.

“You have 2 choices left” became “You can choose 2 more.” This revision eliminated the difficult diphthong in “choice” and emphasized opportunity rather than obligation, so participants felt free to undervote if they wished. The navigation button to go to the Review screen became “Review your votes,” and the instruction on the Review screen was revised to read, “This screen shows everything you voted for. Review it carefully. If you are ready to cast your ballot, touch Cast your vote.” With this version, participants were more successful with reviewing their ballot and moving forward to casting their vote.

Similarly, the instructions for contests allowing multiple votes and the undervote message on the Review screen for these contests made some participants feel obligated to avoid undervoting. For the Review screen, we replaced “You could have voted for 5 candidates, but you only voted for 2” with “You voted for 3 people. You can vote for 2 more.” The revised version moves from the familiar to the new—what is known to what is unknown—and sounds more optional.

4.2 Plain Language: Make It Look Easy to Read

To keep instructions and actions tightly integrated, we eliminated all but the most necessary instructions. We also made the typesize large and inviting.

Because reading is such a demanding cognitive activity for those with low literacy, we needed to minimize the amount of reading participants had to do. We did not want to divert cognitive resources from the process of voting to the task of using the ballot interface. When text needed to be longer than a sentence, we bolded key phrases to guide those who might be intimidated by full paragraphs to the most essential information, as shown below:

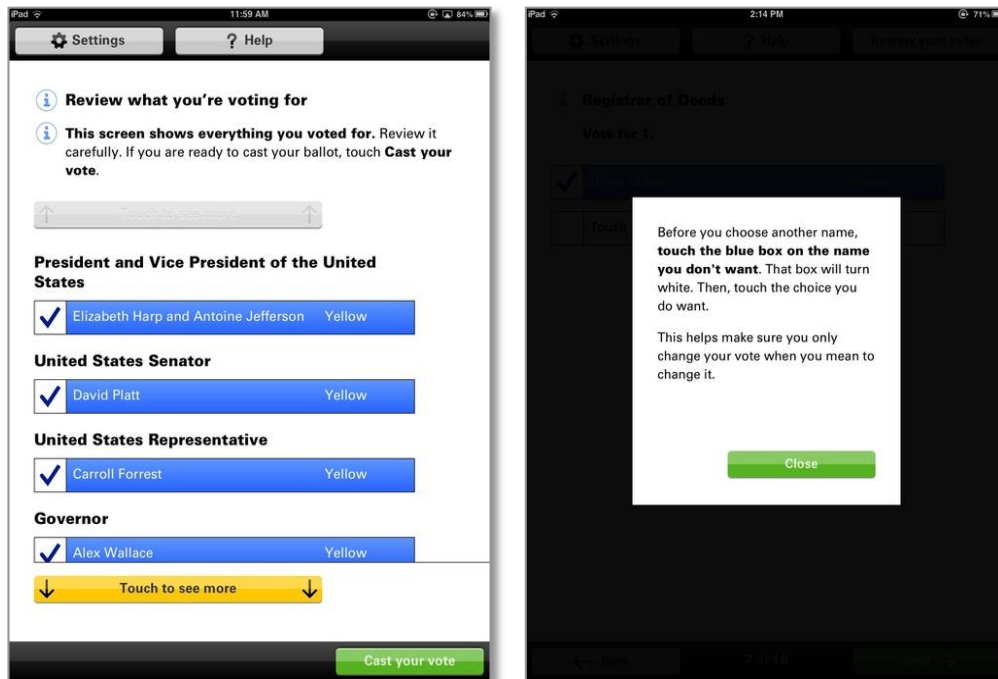


Figure 5. Bolding key phrases made long instructions easier to process

We also identified ways to reduce participant anxiety during ballot marking. Anxiety can affect comprehension and willingness to move forward, as well as comfort. The original text on the “Cast Your Vote” screen inspired fear of making an error, and participants backed away from casting their vote and returned to the ballot—sometimes more than once. Revising this message reduced anxiety and allowed voters to cast their vote successfully.

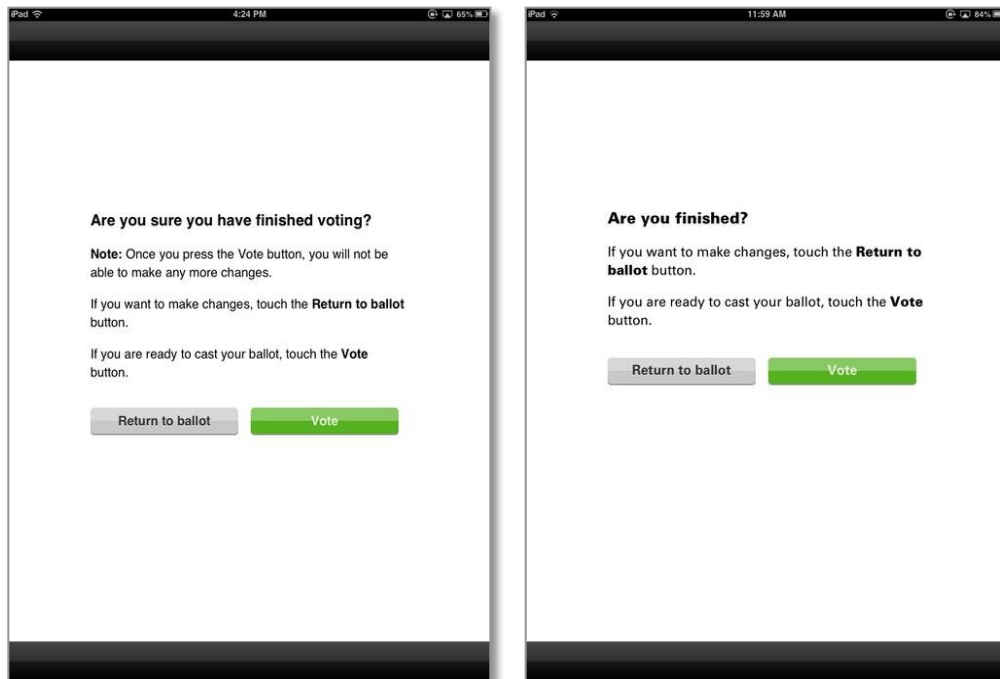


Figure 6. The early version of the confirmation screen on the left triggered anxiety for some voters. They responded as if it were an error message, and worried that they had somehow made a mistake. The final version on the right reassured voters that they were proceeding as planned, but allowed them to return to the ballot if they still wanted to make changes.

4.3 Plain Interaction: Support Users' Preferred Actions

We also watched to see how users expected to interact with the interface, so we could make these natural user behaviors successful if possible. For voters who are familiar and comfortable with a gestural, touch interface, we supported dragging the scrollbar and flicking a finger near the content area. But not everyone knows how to use a gestural or touch interface, so we included buttons for scrolling and specific interaction for selecting. Likewise, having reasonably large button targets that didn't rely on subtle physical motion helped voters with dexterity or coordination problems.

The final interface supports multiple behaviors, so that users can scroll by using a button, using a scrollbar, or flicking a finger. Users can select a name by touching anywhere on the box containing the name; they can close a message box using the CLOSE button or by touching anywhere outside the box.

We also had to reduce distractions by eliminating some kinds of interactions. We initially thought voters might benefit from layering in supplemental voter education content about the candidates or measures. But the extra icons on the interface created a strong call to action for voters with mild cognitive impairment: these voters repeatedly tried to select names by tapping the information icons. We tried various design changes to reduce this call to action, but ultimately we had to remove this supplemental content⁶.

⁶ Providing supplemental information about candidates could possibly be valuable for voters. However, this kind of supplemental content is not currently supported by any voting interface, and could potentially raise issues of biasing the act of voting. Thus, it seemed unwise to jeopardize the activity of ballot marking by adding supplemental content that was itself fraught with potential and mostly unstudied complications.

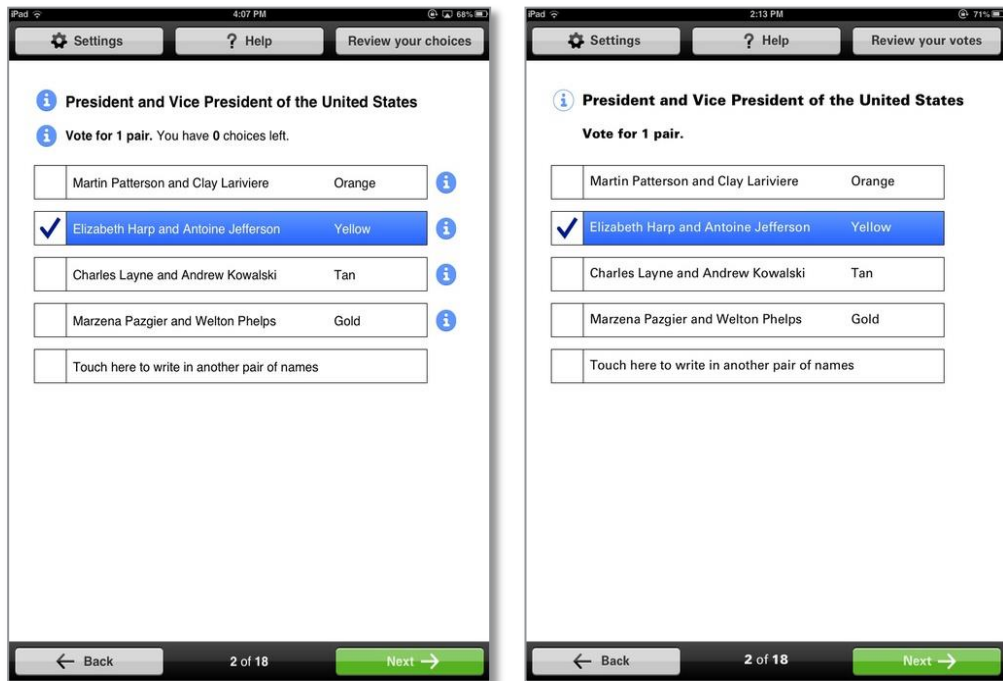


Figure 7. Ballot before and after removing extra icons

Other icons leading to supplemental content remain in the interface, because some voters with low education are missing basic civics knowledge (Redish, et al., 2009; Center for Information & Research, 2010). For example, we saw voters confuse U.S. Senator with State Senator, or not know what a water commissioner does. We moved these icons slightly farther away from the action area of marking ballot choices and reduced their visual impact, so they were available as support when needed but did not interfere with ballot marking.

4.4 Plain Interaction: Support Immediate Action

Our low-literacy participants tended to act on every word. This meant that instructions needed to be integrated with the interface so that instructions were designed to be read and followed right away, in the same location (see also Summers et al., 2008).

Our initial design had a landscape orientation, with instructions on the left and the action area for marking choices on the right. Many electronic ballots follow this format. Our final design has a portrait orientation, with instructions minimized and integrated into the action area. This design allowed for a tighter coupling between reading and action, while simultaneously preparing for future development of the ballot for smaller screens.

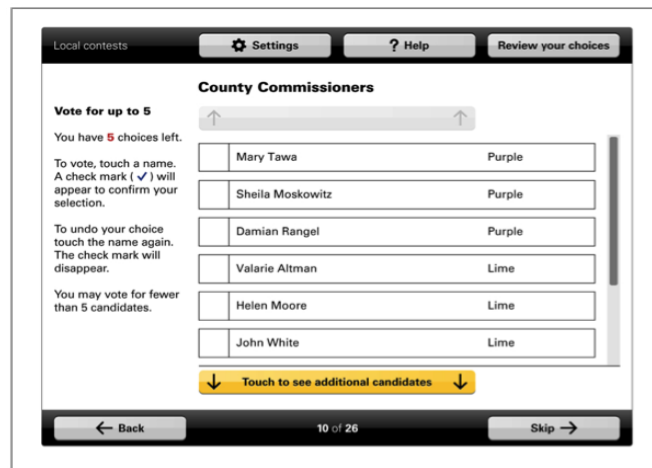


Figure 8. The first iteration of the ballot interface, based on the work from Design for Democracy.

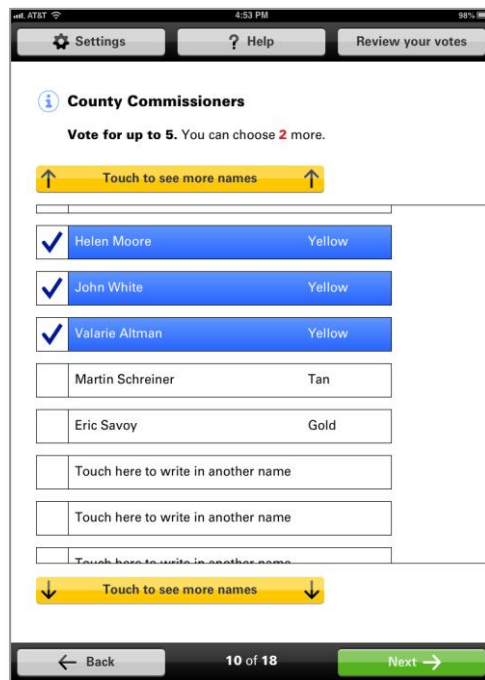


Figure 9. The final version of the same contest.

During testing, we also discovered that including images on instruction screens had a negative effect in the context of a tablet: participants tried to use these images to make changes to the ballot. They assumed these images would be interactive, and were frustrated when they were not.

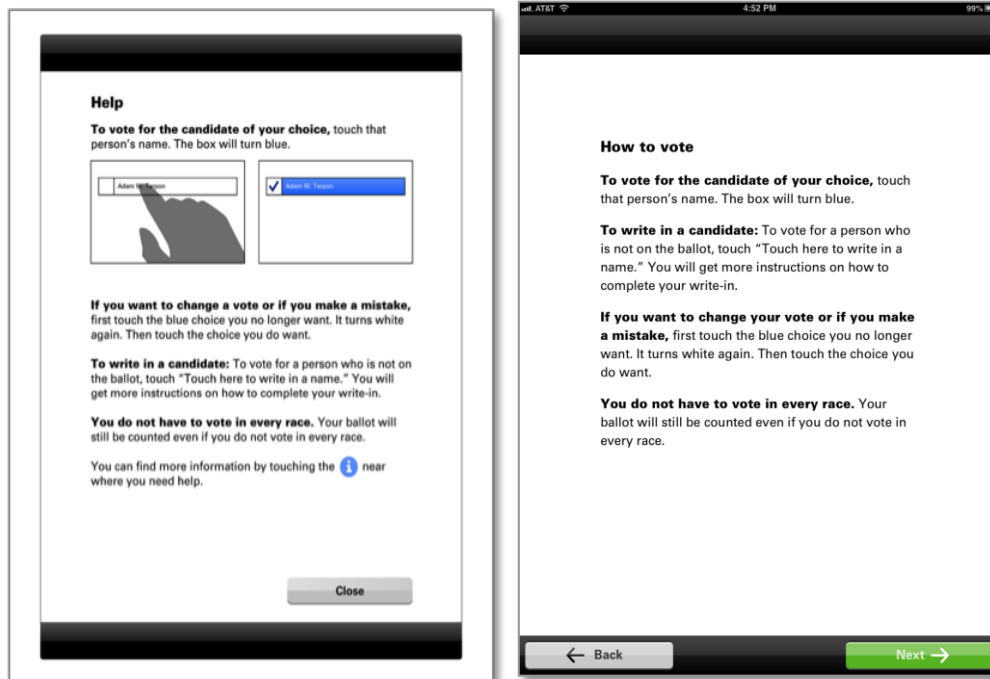


Figure 10. Initial version and final version of the Help screen. Voters expected to be able to interact with visual elements and were frustrated if they could not. Instruction and help pages were more successful when images were removed, text was minimized, and key messages were visually emphasized.

4.5 Plain Interaction: Create a Linear Flow

Participants did not always have a clear understanding of the hierarchy of government, which sometimes made navigating the ballot more difficult. This problem was most apparent when they tried to move around in the ballot after leaving the “Review Your Votes” screen. This problem was resolved by making each visit to a ballot screen initiated from the Review screen into an “out and back” interaction: the navigation buttons on the ballot screens were replaced with a single button that returned users to the Review screen⁷. The structure provided by the Review screen itself allowed participants to find their way among races to revise their selections (Summers, et al., 2014).

⁷ The superior usability of “out and back” interactions for users with low literacy was confirmed by the Summers et al. (2005) study on navigational behaviors of users with low literacy skills. It has also been confirmed in recent testing with 34 participants (low literacy, seniors, blind, low vision, low dexterity, and hearing-impaired) performed for the Maryland State Board of Elections (Summers, et al., 2014).

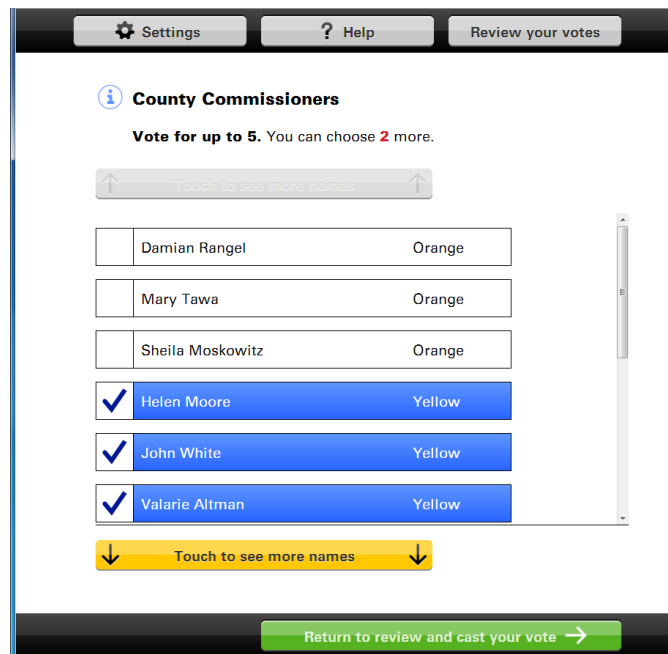


Figure 11: An example of an “out and back” visit to change votes for county commissioners.

5. DISCUSSION

5.1 Moving Toward the Goal of Using Voters’ Own Assistive Technology

One of the goals of our research was to develop a ballot marking interface that would allow voting on voters’ own devices. The creation of an easily usable interface format using current Web standards represents an important step forward. Informal quality assurance testing of the developed interface using common assistive devices is in process. Before this interface is used in actual elections, more exhaustive user testing should be conducted on how well it works with a wide variety of commonly used assistive devices.

5.2 Creating Mobile Access to Citizenship Activities

While voting using mobile devices raises substantial concerns, particularly with respect to voting security, it poses substantial potential benefits as well. Current patterns and trends in mobile device adoption and use indicate that mobile devices represent an increasingly important resource for many citizens (Smith, 2010; Zickuhr & Smith, 2012; Zickuhr & Madden, 2012). Particularly noteworthy is the use of mobile devices by African Americans and Hispanics, who tend to use such devices more extensively and for a broader range of activities than white Americans (Horrihan, 2009; Zickuhr & Smith, 2012). Younger adults are also highly likely to use mobile devices (Lenhart et al., 2010). In short, creation of a ballot interface that supports mobile devices has the potential to substantially expand voting, particularly among groups that are historically less likely to vote.

6. CONCLUSION

We have a vision of every eligible adult being able to vote independently and successfully. Although we are very proud of our final ballot marking interface, which takes long strides towards

a universally usable ballot marking interface, there is further work to do. We'd like to do additional testing with participants with short-term memory loss and aphasia and with participants who use screen readers and other assistive devices. (Informal "friends and family" testing with a few blind users trying the interface with iOS accessibility features and the JAWS screen reader show that our ballot design has real promise but needs more testing.) We still need to establish settings for font size, contrast, language, etc., so that voters can personalize the interface. We need to pilot the ballot in a real election with real choices, which we hope to do soon. And in the context of a real election, we need to deepen our understanding of whether the interface is successful in encouraging voters to review the summary of their ballot choices thoroughly before casting their vote.

There are also many system architecture issues to deal with in voting that were not addressed in this project—chief among them security issues. When security elements are added, they must be designed and tested with universal usability in mind, so that the security elements also embody principles of plain language and plain interaction. For example, the voting system must support pausing and resuming the ballot marking process to support the needs of those with traumatic brain injuries for rest breaks.

Moreover, by making the activity of marking one's ballot possible, usable, and accessible on any mobile device, we make voting much more available not only to people with disabilities, but also for people who want to vote but who may face a variety of convenience barriers or comfort barriers. By developing a portable, technology-independent ballot front end that will work for people with low literacy and cognitive issues, we anticipate a direction that many election jurisdictions are already pursuing.

ACKNOWLEDGEMENTS

We thank the Information Technology & Innovation Foundation for the grant that made this research possible, the University of Baltimore for providing lab space for our testing and logistical support for our grant, and Whitney Quesenberry for inspiring the project and shepherding it to fruition.

REFERENCES

- J. A. Brinkman. 1992. Methodological Problems When Determining Verbal Protocol Accuracy Empirically. *Travail Humain*, 57(2), 97-110.
- A. T. Burrows, & Z. Lourie. 1963. When "Two Vowels Go Walking." In *The Reading Teacher*, 17(2), 79-82.
- B. A. Campbell, C. Tossell, M. D. Byrne, & P. Kortum. 2011. Voting on a Smartphone: Evaluating the Usability of an Optimized Voting System for Handheld Mobile Devices. In *Proceedings of the Human Factors and Ergonomics Society 55th Annual Meeting* (pp. 1100-1104). Las Vegas, NV: Human Factors and Ergonomics Society.
- A. Carstens. 2004. Tailoring Print Materials to Match Literacy Levels: A Challenge for Document Designers and Practitioners in Adult Literacy. In *Language Matters: Studies in Languages of Africa*, 35(2), 459-484.
- The Center for Information & Research on Civic Learning and Engagement, Tufts University. 2010. High School Civic Education Linked to Voting Participation and Political Knowledge, No Effect on Partisanship or Candidate Selection. Retrieved Jan. 29, 2014 from <http://www.civicyouth.org/high-school-civic-education-linked-to-voting-participation-and-political-knowledge-no-effect-on-partisanship-or-candidate-selection/>.
- A. Chadwick-Dias, M. McNulty, & T. Tullis. 2003. Web Usability and Age: How Design Changes Can Improve Performance. In *Proceedings of the 2003 Conference on Universal Usability*, 30-37. doi:10.1145/957205.957212
- D. Chisnell, S. Becker, S. Laskowski, & S. Lowry. 2009. Style Guide for Voting System Documentation: Why User-Centered Documentation Matters to Voting Security. In *Proceedings of the 2009 Conference on Electronic Voting Technology/Workshop on Trustworthy Elections* (pp. 2-2). USENIX Association
- D. Dill, B. Schneier, & B. Simons. 2003. Voting and Technology: Who Gets to Count Your Vote?. *Communications Of The ACM*, 46(8), 29-31.
- T. Davis, M. Crouch, S. Long, R. Jackson, P. Bates, R. George. 1991. Rapid Assessment of Literacy Levels of Adult Primary Care Patients. *Family Medicine*, 23(6), 433-435.
- D. K. Detterman, L. T. Gabriel, & J. M. Ruthsatz. 2000. Intelligence and Mental Retardation. In R. J. Sternberg (Ed.), *Handbook of Intelligence*. Cambridge: Cambridge University Press, 141-158.
- C. Doak, L. Doak, & J. Root. 1996. *Teaching Patients with Low Literacy Skills* (2nd ed.). Philadelphia: J. B. Lippincott

Company.

- J. Dumas, & B. Loring. 2008. *Moderating Usability Tests*. United States: Morgan Kaufmann.
- S. Dutke, & J. Stöber. 2001. Test Anxiety, Working Memory, and Cognitive Performance: Supportive Effects of Sequential Demands. *Cognition and Emotion*, 15, 381-389.
- J. Frascara. 2003. *Design and Social Sciences: Making Connections*. London: Taylor and Francis.
- K. Fuglerud, & T. Rossvoll. 2012. An Evaluation of Web-Based Voting Usability and Accessibility. *Universal Access in The Information Society*, 11(4), 359-373.
- R. Gallo, H. Kawakami, R. Dahab, R. Azevedo, S. Lima, & G. Araujo. (2010). T-Dre: A Hardware Trusted Computing Base for Direct Recording Electronic Vote Machines. In *Proceedings of the 26th Annual Computer Security Applications Conference*, Austin, Texas. doi:10.1145/1920261.1920291
- J. B. Gleason, & N.B. Ratner. 2009. *The Development of Language* (7th Ed). Boston: Pearson.
- L. Harper, M. McMacken, L. Appelt, & K. Summers. 2013. The Importance of Choice Design for Low Literate User Experience. In *Communications in Computer and Information Science*, 374, 430-434.
- Help America Vote Act (2004). Retrieved from http://www.eac.gov/assets/1/workflow_staging/Page/41.PDF
- P.S. Herrson, R.G. Niemi, M.J. Hammer, B.B. Bederson, F.G. Conrad, & M. Traugott. 2006. The Importance of Usability Testing of Voting Systems. In *Proceedings of the 2006 USENIX/ACCURATE Electronic Voting Technology Workshop*, Vancouver, B.C., Canada.
- J. Horrigan. 2009. *Wireless Internet Use*. Washington, DC: Pew Internet & American Life Project. Retrieved from <http://www.pewinternet.org/Reports/2009/12-Wireless-Internet-Use.aspx>
- C. Jarrett, J. Redish, & K. Summers. 2012. Designing for People Who Do Not Read Easily. In L. Meloncon (Ed.), *Rhetorical Accessibility: At the Intersection of Technical Communication and Disability Studies*. New York: Baywood.
- C.J.M. Johnstone. 2006. Using the Think Aloud Method (Cognitive Labs) to Evaluate Test Design for Students with Disabilities and English Language Learners. University of Minnesota, National Center on Educational Outcomes. Minneapolis, MN: University of Minnesota.
- A. Lenhart, R. Ling, S. Campbell, & K. Purcell. 2010. *Teens and Mobile Phones*. Washington, DC: Pew Research Center's Internet & American Life Project. Retrieved from <http://pewinternet.org/Reports/2010/Teens-and-Mobile-Phones/Summary-of-findings/Findings.aspx>
- M. C. Medlock, D. Wixon, M. Terrano, R. Romero, & B. Fulton. 2002. Using the RITE Method to Improve Products: A Definition and a Case Study. In *Proceedings of the Usability Professionals Association*.
- M. Nagle, & E. Zietlow. 2012. An Exploratory Comparison of Two Website Usability Testing Methods: Concurrent Think-Aloud and Eye-Tracking with Retrospective Think-Aloud. (Master's Thesis). University of Baltimore, Baltimore, MD.
- J. Nielsen. 1997. Be Succinct! (Writing for the Web). Retrieved from <http://www.nngroup.com/articles/be-succinct-writing-for-the-web/>
- N.S. Parikh, R.M. Parker, & J.R. Nurss. 1996. Shame and Health Literacy: The Unspoken Connection. *Patient Education and Counseling*, 27(1), 33-39.
- J.G. Redish, D.E. Chisnell, E. Newby, S.J. Laskowski, & S. Lowry. 2009. Report of Findings: Use of Language in Ballot Instructions. Retrieved from <http://www.nist.gov/itl/vote/upload/NISTIR-7556.pdf>
- J.G. Redish, D.E. Chisnell, S.J. Laskowski, & S. Lowry. 2010. Plain Language Makes a Difference When People Vote. *Journal of Usability Studies*, 5(3), 81-103.
- T. Salthouse. 1985. *A Theory of Cognitive Aging*. Amsterdam: North Holland.
- B. Shneiderman. 2000. Universal Usability. *Communications of the ACM*, 43(5), 84-91.
- L. Schur, T. Shields, D. Kruse, & K. Schriener. 2002. Enabling Democracy: Disability and Voter Turnout. *Political Research Quarterly*, 55(1), 167-190.
- A. Smith. 2010. *Mobile Access 2010*. Washington, DC: Pew Internet & American Life Project. Retrieved from <http://www.pewinternet.org/Reports/2010/Mobile-Access-2010.aspx>
- C. Snyder. 2003. *Paper Prototyping: The Fast and Easy Way to Design and Refine User Interfaces*. New York: Morgan Kaufmann.
- J. Spool, & W. Schroeder. 2001. Testing Web Sites: Five Users is Nowhere Near Enough. In *CHI'01 Extended Abstracts on Human Factors in Computing Systems* (pp. 285-286). ACM.
- K. Summers, & M. Summers. 2005. Reading and Navigational Strategies of Web Users with Lower Literacy Skills. In *Proceedings of the American Society for Information Science and Technology*, 42(1). doi:10.1002/meet.1450420179
- K. Summers, M. Summers, & C. Helm. 2008. *PAP Application Usability and Lessons Learned*. Center for Business Intelligence Patient Assistance Programs, Baltimore, MD.
- K. Summers, J. Langford, J. Wu, C. Abela, & R. Souza. (2006). Designing Web-Based Forms for Users with Lower Literacy Skills. In *Proceedings of the American Society for Information Science and Technology*, 43(1), 1-12. doi:10.1002/meet.14504301174
- K. Summers, C. Rinn, E. Rhodes, N. Alton, & J. Lee. 2014, Jan. 13. Maryland Online Ballot Marking Tool Usability Testing Report. Submitted to the Maryland State Board of Elections. Retrieved January 29, 2014 from http://www.elections.maryland.gov/press_room/documents/OnlineBallot_UsabilityTestResults.pdf.
- M.F. Theofanos, & J. G. Redish. 2003. Guidelines for Accessible and Usable Web Sites: Observing Users Who Work with

- Screen Readers. *Interactions*, 10(6), 38-51.
- W.E. Tunmer, & P.B. Gough. 1986. Decoding, Reading, and Reading Disability. *Remedial and Special Education*, 7, 6-10.
- United States Election Assistance Commission. 2007. Effective Designs for the Administration of Federal Elections. Retrieved from http://www.eac.gov/election_management_resources/designing_polling_place_materials.aspx
- United States Election Assistance Commission. 2009. Voluntary Voting Systems Guidelines (v 1.1). Retrieved from http://www.eac.gov/testing_and_certification/voluntary_voting_system_guidelines.aspx
- A. Ward, P. Baker, N. Moon. 2009. Ensuring the Enfranchisement of People with Disabilities. *Journal of Disability Policy Studies*, 20(2), 79-92.
- R.A. Virzi. 1992. Refining the Test Phase of Usability Evaluation: How Many Subjects is Enough?. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 34(4), 457-468.
- Voting Accessibility for the Elderly and Handicapped Act of 1984. Retrieved from <http://codi.tamucc.edu/archives/legislation/voting.access.htm>
- K. Zickuhr, & M. Madden. 2012. *Older Adults and Internet Use*. Washington, DC: Pew Research Center's Internet & American Life Project. Retrieved from http://www.pewinternet.org/~media/Files/Reports/2012/PIP_Older_adults_and_internet_use.pdf
- K. Zickuhr, & A. Smith. 2012. *Digital Differences*. Washington, DC: Pew Internet & American Life Project. Retrieved from <http://pewinternet.org/Reports/2012/Digital-differences/Main-Report.aspx>