December 2015

Determining Accessibility for iOS Applications: Piloting a Checklist for Practitioners

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DETERMINING ACCESSIBILITY FOR iOS APPLICATIONS: PILOTING A CHECKLIST FOR PRACTITIONERS

by

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A Thesis Submitted in

Partial Fulfillment of the

Requirements for the Degree of

Master of Science

in Occupational Therapy

at

The University of Wisconsin-Milwaukee

December 2015

ABSTRACT

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by

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The University of Wisconsin-Milwaukee, 2015
Under the Supervision of Professor Roger O. Smith

Background: Mobile technologies have infiltrated every part of daily life, including the school system. While these technologies are highly customizable, there are 6.4 million children with disabilities who may not be able to utilize these devices because of their lack of accessibility. The iOS Application Accessibility Checklist (iA2C) is a "first of its kind" tool, used to determine if an iOS app is accessible for users with a variety of disabilities.

Hypothesis: When using the iA2C, novice users with little experience in accessible design will determine apps to have a statistically similar number of accessibility features as experts, assessing the app in the same way. Additionally, users will better be able to rank apps, based on accessibility, when using the iA2C.

Method: Fifteen participants assessed a total of six apps. They evaluated three apps with the use of the iA2C and three without. Apps were matched across groups as educational, classroom support or entertainment apps. The assessments addressed both the positive and negative features of the app. Novice ratings were then compared to a "gold standard" rating created from a collaborative evaluation of three experts. Experts assessed the apps in the same way as the novices. Groups were statistically compared using 1-sample t-tests.

Results: When the participants assessed the apps without the iA2C, there was a significant difference between novices and experts for all assessments. However, when apps were assessed using the iA2C, no significant differences was observed between expert and novice ratings for the number of positive features present in the entertainment app and the accessibility features absent in educational and classroom support apps.

Discussion: Results of this small preliminary study suggests that novice participants may be more likely to assess an app similar an expert, when using the iA2C. The tool needs to undergo continued modifications to meet the changing technology and user demands. Additionally, future testing needs to be conducted regarding the measure in order to increase the power of the findings.

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Mobile Technology

Mobile technologies are a class of devices including smart phones, tablets and to a lesser extent PDA's. The development of mobile technology created the fastest growing technology trend in history (Bansenese, 2011). These devices now play a major role in every part of an individual's life including: personal, professional and educational. Smart phones and tablets are so pervasive, in part, because of their customizability. Millions of applications (apps) are available across devices and interfaces allowing mobile technology to be as unique as the person using it. Apps allow users to run business transactions, check medical records and take classes all from a single device. Unfortunately, many of the applications that make these things possible are not accessible to individuals with disabilities. This study focuses on mobile application accessibility features and the iOS Application Accessibility Checklist (iA2C). This is a tool to determine which accessibility features are present within a given app, which disability category may most benefit from the inclusion of that feature and focuses on eventual use in an elementary school setting.

Mobile Technology and Schools

According to Apple Inc., 10 million iPads are being utilized in schools worldwide. Four and a half million of those are in classrooms in the United States (Apple, 2013). This increase in mobile technology use is due to a variety of factors. Some of these are innate to the devices, such as portability, convenience and ease of use. Others are a function of technology advancement as a whole. Previous research concluded that mobile technology can create a comprehensive learning environment that promotes educational experiences inside and outside the traditional classroom environment (Holzinger, 2005, Cobcroft, 2006, Wu, 2013). Mobile technology also shifts the classroom to a more student centered and directed environment (Holzinger, 2005,

Cobcroft, 2006). As a result, there is increased collaboration among peers and faculty, as well as a greater use of educational resources outside of the traditional classroom (Cobcroft, 2006). This leads to higher performance and greater satisfaction with the learning experience (Jung, 2002). A meta-analysis, conducted by Wu (2013), indicated that 86% of studies investigating the benefit of mobile technology reported that students and teachers support the integration of mobile technology into the classroom experience.

Regardless of the increased use of technology in schools, not all students are able to access this vital resource, because schools often exemplify the inequalities that already exist in our society (UNESCO, 2011). Due in part to the fact that many students do not have access to the devices that would make a mobile technology program functional (Fink, 2003). A gap also exists in the ability of some individuals to utilize the technology that is available to them (Fink, 2003). This is often the result of user impairment that can make mobile technology difficult if not impossible to use. In the United States school system, there are 6.4 million children who qualify for disability services (NCES, 2013). Countless more have some level of impairment but they do not qualify for services. Under the Individuals with Disabilities Education Act and Free and Public Education, all of these identified children have the right to free and accessible education, which includes the use of technology integrated into the classroom experience (US Dept. of Edu., 2010). Even as the pace of mobile technology integration into education continues to increase, many people's view on the needs of the disabled community fails to keep pace (Kouroupetroglou, 2012).

Current Mobile Technology Accessibility

Apple Inc. is at the forefront of creating mobile technology that incorporates accessible design features. Apple's iOS devices are currently considered to have the most accessible

interfaces direct "out of the box" (Enable Ireland, 2015). This follows a long history of being on the cutting edge of technology accessibility. In 1992, when the question of accessibility became a topic of interest, Apple computers alone contained access features built directly into the operating system (Vanderheiden, 2008). This included features such as StickyKeys and MouseKeys (Vanderheiden, 2008). Now Apple products come standardly equipped with these as well as numerous other features including: VoiceOver, Mono Audio, Assistive Touch, et cetera. Despite the inclusions of these features, limitations to the usability of these devices for those with disabilities still exist.

Past Research

Technology changes faster than universal design features can be implemented (Vanderheiden, 2008). This resulted in there currently being no formalized research available looking at the accessibility of iOS applications. Much of the information available specifically about apps is provided directly from Apple. Apple published features of their devices that all apps should be compatible with (2014). They also publish the requisite code for app developers to take advantage of the accessibility tools native to iOS (Apple, 2014). However, there are no checks to ensure apps actually imbedded these features. Some of the individual apps provide information regarding their accessibility or are designed for people with a specific disability. Unfortunately, these are often apps only intended for that specific disability population.

With over 1.2 million apps in the iTunes App Store it can be overwhelming for consumers trying to figure out what makes a good app. Online blogs, comments and reviews are available from individual users with disabilities. However, these are often specialized to an individual impairment and applications of interest to the person publishing the information. Due to the nature of the information, it is difficult to know how reliable it is.

Much of the information available is geared towards adults and the applications they would use most often. This makes it difficult for teachers, occupational therapists and assistive technology practitioners to transfer the available information to what would be most beneficial to students in the classroom. It is not reasonable to expect elementary school students to research and experiment blindly to determine which applications meet their specific needs.

Measuring Accessibility

Creating a measure of accessibility requires the designer to assess the qualifications of general usability and modify them to conform to the standards of universal design. These general components are effectiveness, efficiency and satisfaction (Kerkmann, 2012). When creating for universal design, effectiveness determines whether or not a user with additional accessibility demands is able to glean all of the same information from the app as a traditional user would. Efficiency is the difference in time it takes a disabled user to perform a task compared to a user not requiring device modifications. Satisfaction is the subjective rating of the experience had by the user, whether impaired or not.

Website Accessibility

Since there is no standardized information regarding application accessibility it is important to determine how other accessibility measures were created and implemented. The most relevant of these measures is the accessibility guidelines for websites. Many of the important aforementioned accessibility features are included in the usability guidelines created by W3C Web Accessibility Initiative (2008). This is considered the premiere web accessibility guidelines. These guidelines require:

1. Content to be perceivable

    1.1 Text alternatives are provided for all non-text content

1.2 Alternatives are provided for time based media (captions, interpreters & audio descriptions)

1.3 Content can be presented in a simpler form without losing content

1.4 There is a distinction between foreground and background content (audio & visual)

2. Content to be operable

2.1 All components can be accessed via the keyboard

2.2 There is enough time provided to read content

2.3 The content design does not induce seizures

2.4 It is easy to navigate the content to access desired features

3. Content and interface are understandable

3.1 All text is readable and written in a way that is easy to understand

3.2 Content appears and operates in a predictable way

3.3 There is a means to help users avoid and correct mistakes

4. Content is robust and can be interpreted reliably by a variety of users and devices

4.1 The device is compatible with the maximum number of users and devices

The W3C Web Accessibility Initiative (2008) proposed a three tier approach to determining web accessibility, based on these guidelines. The first step requires a preliminary review to identify potential accessibility problems, followed by a conformance evaluation to determine whether established standards are met. Finally, the web site must undergo user testing by those with disabilities. All levels of evaluation are performed by manual, automatic or semi-automatic means. (Kerkmann, 2012).

Accessibility Measures for the Classroom

A variety of other accessibility measures exist. Many of these are part of the ACCESS-ed project, which serves to provide solutions to the difficulties that arise when attempting to create inclusive classes (ACCESS-ed, 2011). The Accessibility and Universal Design Information Tools (AUDITs) are one of the many ways the ACCESS-ed program attempts to meet this goal. Specific AUDITs include the Classroom, Syllabus and On-line Course. (Anson, 2008a, 2008b & 2009). All of these measures aide in determining the specific accessibility and general usability of the item being assessed. The accessibility sections are used to identify any serious barriers to those with disabilities. The usability sections are intended to determine the ability of the item to be adapted to meet the users' needs.

The Classroom AUDIT focuses on the physical features of the room itself. There are questions regarding the accessibility of the entry way, floor plan and lighting (Anson, 2008a). The Syllabus AUDIT addresses the availability, formatting and content of the syllabus (Anson, 2008b). The On-line Course AUDIT looks at the format of the course material and the layout of the interface (Anson, 2009).

The AUDITs are all presented in the form of a checklist. Questions can be answered one of four ways: yes, no, partially/sometimes or not applicable. Questions are divided based on import factors that affect the AUDIT topic; this may be general design aspects or specific features that would affect accessibility. AUDITs are scored automatically to provide an overall accessibility score for the item in questions.

Development of the iOS Application Accessibility Checklist

The iOS Application Accessibility Checklist (iA2C) is a newly created tool intended to provide educators, therapists, specialists and parents another resource to help create an inclusive

school environment for children with disabilities. Due to the increase of mobile technology use in schools and the number of children classified as having disabilities, it is important to have a tool to ensure the accessibility of new frontiers in the classroom.

The iOS Application Checklist is based off of an extensive literature review of accessibility features for websites and mobile technologies. Many of the questions are based on concepts addressed by the W3C Web Accessibility Guidelines, due to the fact that some apps are an altered version of existing web content. As a result many of the important accessibility features are valid across interfaces. The iA2C can be viewed in its entirety in Appendix A. It is designed for use with iOS 8. However, the iA2C is compatible with the features present in iOS 7 and iOS 9. There are small changes in each iteration of iOS that make the manual less accurate as iOS evolves.

Many questions address the accessibility features that are innate to iOS devices. Many of these features are intended to transfer over to the user selected apps. Features such as VoiceOver allow users with visual impairments to navigate their device without use of visual output. Switch Controls allows users to control functions without even touching the screen. Tactile alerts increase the accessibility of alarms and notifications for users with auditory impairments. Apple publishes codes for app developers to be able to easily integrate innate iOS accessibility features (Apple, 2014).

The iA2C was organized in much the same way as an AUDIT. Questions are divided up into sections based on the disability category they address. The categories are as follows: visual impairments, hearing impairments, motor impairments and cognitive impairments. These are the same categories that Apple uses to categorize their accessibility features. This allows for continuity of information among sources regarding iOS accessibility.

All questions are intended to be as objective as possible. However, there is room to interpret the degree to which a feature is meeting an intended need. Therefore, questions can be answered as yes, no or sometimes. If a question is irrelevant to a given application, a response of not applicable is allowed. As with the AUDITs, a manual is provided to guide even novice technology users through how to complete the iA2C. This gives step-by-step instructions, regarding how to assess whether or not individual features exist within or are compatible with a given app. The manual is included as Appendix B.

As with the AUDITs, the iA2C contains a data completion check to ensure every question was answered and answered only once. It is scored automatically and scores are graphed upon completion. The iA2C results can then be referenced and compared by any user of the application to determine accessibility of an individual app or compare accessibility features among a group of apps.

The iOS Application Accessibility Checklist intended to guide the users focus when considering the important features of an application. As a result, it can be a static checklist that does not modify the questions based on previous answers (Winters, 2009). A checklist format conveys this accessibility information because it is a common cognitive tool that can be used to guide more complex tasks (Winters, 2009). It is also an easy way to reduce errors when performing cognitively demanding tasks (Hales, 2006 & Oxman, 1994). This is achieved by presenting information in a clear and systematic way (Oxman, 1994). Errors are also reduced by evening the playing field among users with regards to background knowledge and understanding of topic specific jargon (Winters, 2009). However, this is only effective if the information in the checklist is clearly explained and defined. This issue is addressed via the step by step manual that accompanies with the checklist.

Contextual Purpose of the iA2C

The iA2C could be used in one of two ways. First, it can be used as a way to rank similar apps in order to determine which the most accessible overall is. Secondly, it can be used to determine if a specific app is appropriate for a specific person. For this study, focus was on the first context and the general ranking capability of the tool was examined.

Validation

Currently, there is no research available regarding the iOS Application Accessibility Checklist. This is due to the fact that it is a newly created measure. Therefore, this study is a preliminary criterion validation of the effectiveness of the iA2C as a tool for determining which features are relevant and necessary for an application to be accessible to users with disabilities.

Hypothesis

By using the iOS Application Accessibility Checklist, novices with little to no experience in accessible design will identify a statistically equivalent number of accessibility features present, or absent, in a mobile application when compared to experts in accessible design who also have access to the iA2C. Additionally, when novices assess apps without access to the iA2C will identify a different number of accessibility features than experts. Lastly, novices will be able to distinguish different levels of accessibility between apps.

Methods

Research Design

This study utilized methodological research strategy as described by Portney and Watkins (2009). Methodological research is the development and testing of a measure for use in practice and research (Portney, 2009). Step one was the creation of a measure and step two piloted the

validity of the instrument using expert and novice groups. One way to determine if the iA2C could be a useful tool for determining which features are important to making an application accessible is that novice accessibility ratings of apps could be compared with expert accessibility ratings. The combined expert rating is the criterion, which is assumed to be valid (Portney, 2009). Therefore a criterion-referenced test can be run comparing novice assessment of accessibility attributes to the expert assessment. Using a classic between-subject design, novices and expert ratings were compared with and without the use of the iA2C. This quasi-experiment compared non-equivalent groups. Figure 1 shows the overall study design.

Variables

Use of the iOS Application Accessibility Checklist is the independent variable in this study. The dependent variable is the number of accessibility features novice users identified, with and without using the iA2C. The "gold standard' criterion used for the study was the expert's list of accessibility features.

Participants

Experts. Experts are individuals with training or expertise associated with title and credentials (Cicourel, 2008). For the purpose of this experiment the three experts possessed extensive training in the area of accessible design or accessible app development. All taught at a university and served on projects related to accessibility either in research or practical roles. This group of experts had a working knowledge of the difficulties a user with a disability may encounter when attempting to use applications on an iOS device.

Novices. Fifteen participants made up the novice group. They were all college age students with little to no knowledge regarding accessible design. They came from a variety of fields. Occupational therapy students accounted for nine of the fifteen participants. However, students

from other humanities and STEM fields participated as well. Three engineering students participated, one kinesiology student and two history students. All participants completed both sessions. Table 1 contains a full breakdown of demographic information.

Procedure

This experiment assessed the variability in accessibility ratings between experts and novices. The experiment required all participants to complete two separate trials within a single session. This took participants between 90 minutes and three hours total to complete. Researchers imposed no time limits on the completion of the trials. However, participants blocked a full three hours in their schedule for completion. Only one participant took the whole three hours and the majority took less than two hours.

Prior to completion of any trials participants filed out consent forms (Appendix F) and basic demographic information (Appendix G). Table 1 contains the demographic information.

Phase 1. During the first phase of the study participants created lists regarding the accessibility features of three different apps. All apps were assessed using a full size iPad. Participants created two lists for each app. The first list contained the features of the individual app that made it accessible to those with visual, hearing, motor or cognitive impairments (positive attributes). The second list contained the features of the app that made it difficult for people with those same impairments to use (negative attributes). They utilized a structured form to divide up the features based on the disability categories. These categories are the same as in the iA2C. This form is in Appendix C. During phase one; participants could access to the W3C Web Accessibility Guidelines in order to aide their classifications of accessibility features. All participants assessed the same three apps, but in a randomized order. The three experts collaborated during this phase

in order to create a master expert positive and negative attribute list for each app, using the same forms and resources as the novices.

Phase 2. During the second part of the study participants assessed a matched set of three apps, using the iA2C and the accompanying manual. Once again, participants reviewed the apps in a randomized order. No additional resources were provided during this portion. The experts collaborated to create a 'gold standard' assessment for each of these three apps as well. The principle researcher remained present during all trials in order to progress participants from one trial to the next and ensure use of the correct forms and apps for each trial.

Coding. The principle research later tallied the number of features that participants identified in the first trial, for each disability category. While features could be repeated across categories they were not counted if listed twice within a single category. The researcher made no assessments of accuracy or pertinence with regards to the features listed within each disability category. No participants provided extraneous answers that were not pertinent to the task. If that happened those responses would have been disregarded. Participant answers provided on the iA2C were scored automatically.

Applications. Participants assessed a total of six applications. They were divided into two sets, generally matched for content and accessibility features. All applications fell into one of three categories. These included: educational, classroom support or entertainment. Each app set contained one app from each category. Apps considered educational are curriculum based and serve to advance a child's learning. Classroom support apps exist to help organize a child's classroom experience. They include schedules and timers. Entertainment apps include child appropriate games and activities that are likely to be used during free time. The apps utilized in the first trial were BrainPop (BP), Inventioneers (IN) and Real Timer (RT). The apps assessed

with iA2C were TED Talks (TED), Pettson's Inventions 2 (I2) and Sand Timer (ST). Participants assessed apps in a randomized order. All participants assessed the apps on an iPad in order to eliminate variation in app structure and usability across devices. Appendix D contains a full list of applications, versions used and a description of each.

Results

Compiled data, including tallies of the positive and negative features identified by each participant for each app, along with the means and standard deviations can be found in Table 2 for the apps assessed without the iA2C and in Table 3 for the apps assessed with the iA2C.

One sample t-tests served to compare the novice participant ratings to the expert standard. The combined expert ratings served as the point with which all novice ratings of the same app were compared. This was done for the combined positive features for each individual app as well as the combined negative features. For all apps assessed without the use of the iA2C there was a significant difference between the average novice user assessment of the applications and the collective expert rating. This was true regarding both positive and negative accessibility features. Table 4 and 5 show the results of all the t-tests regarding apps not assessed with the iA2C. Graphical representations are seen in Figures 2-7.

Results were more variable regarding apps assessed with the iA2C. There was a non-significant difference between the mean novice rating and expert rating for the positive features of Pettson's Inventions 2 ($t(14) = .000$, $p < 1.000$). There was also a non-significant difference between the assessments of negative features of TED and Sand Timer, ($t(14) = .617$, $p < .547$ and $t(14) = -.406$, $p < .691$). Table 6 and 7 show the results of the t-tests regarding apps assessed with the iA2C. Graphical representations can be seen in Figures 8-13.

When assessing the variance between novice and expert ratings it becomes apparent that novice participants as a group perform more similar to experts when they have access to the iA2C. This is seen in figure 14-17. Individual participant assessment of apps can still be highly varied. The novices identified an average of -2.98 less positive attributes and -4.24 less negative attributes than experts when assessing apps without the iA2C. However, when using the iA2C novices identified an average of .67 more positive attributes and .62 negative attributes than experts when assessing apps with the iA2C.

Table 10-13 shows the variation between expert ranking of apps and novice ranking. Expert ratings indicate that apps were matched across groups. While there was no change in novice agreement with experts regarding the positive features, novices were more similar to experts when ranking apps based on negative features. This is conducive with past research showing that missing items are more difficult to identify without cues (Agostinelli, 1986).

In general OT students averaged ratings closer to those of the experts than non-OT students. This may be due to the fact that most of the OT students reported having at least one entry level course regarding assistive technology. Those who reported having this knowledge performed better than those who did not.

Each app scored differently in both positive and negative features when assessed by the iA2C. This is true of both the expert and novice ratings. On average the novices identified more negative features of an app with the use of the iA2C, compared to the matched apps without the use of the iA2C.

Participants who took more time did not perform better in either phase of the study than those who took less time. All participants assessed apps with the iA2C last. However, these assessments were more similar to the expert ratings than the independent lists made first.

Discussion

The results of this study lead to the conclusion that there is some benefit to utilizing the iA2C when attempting to determine whether or not an app has certain accessibility features. The benefit is most apparent when multiple people are assessing the same app or when attempting to rank apps based on accessibility. All but one of the average novice ratings using iA2C were within one standard deviation from the expert rating. Only three out of six novice app rating averages, without the use of the iA2C, were within one standard deviation of the expert rating. This suggests that novice app ratings are more similar to experts with the use of the iA2C. A non-significant difference between expert and novice user ratings also suggests higher congruence between ratings when using the iA2C. While this was not seen across all apps and all features, it was not seen at all when users were creating a list of accessibility features without the iA2C. The iA2C possibly served as a means to create some level of consistency among user assessment of apps.

The iA2C also potentially helped to eliminate some fallacies in logic among the novice users. For example, more than one person listed that having an auditory alarm for a timer app would be a benefit to someone with a hearing impairment, when in fact this would be more useful to someone with a visual impairment who could not see the timer. By having questions divided based on disability category a user could potentially use the checklist to aide in finding apps that would be beneficial for a particular client rather than just scoring based on overall accessibility.

Despite taking approximately two hours for most participants to finish both phases, participants performed more similarly to experts during the second phase, with the use of the iA2C. This may indicate that fatigue did not adversely affect performance of the task. All

participants assessed the apps quicker with the use of the iA2C and subsequent manual. The tool may aid in the decision making process in such a way that the assessors did not have to spend as much time using the app in order to determine if it was accessible or not. It is possible that novices performed more like experts when using the iA2C due to learning. However, the innate objective structure of the iA2C limits the impact this could have on performance.

The fact that OT students, with a basic familiarity of accessible design, performed better than non-OT students, indicates that the tool may be most useful to those with experience. Therefore, it could be beneficial to teach the use of the iA2C to students and practitioners. There are currently no tools to assess app accessibility, so this would fill a need in practice. If future research continues to show the iA2C's effectiveness there is an obligation for practitioners to utilize it to guide decision making regarding apps.

The iA2C was able to aide in distinguishing between apps and improve novice ability to rank apps. Each app scored differently. This leads to the idea that the tool is working as planned within the designed context. Novice users being able to identify more features that made the app inaccessible with the use of the iA2C also support its usefulness. It makes sense that the tool aided in identifying the missing features that limited accessibility. Research shows that people struggle to pinpoint absent items unless they are aware of the potential for the missing items (Agostinelli, 1986). Therefore, those without a disability would be less able to identify missing features that would aide in improving accessibility for that disability.

Limitations and Future Aims

Future research looking at the reliability and validity of the iA2C would need to include a larger sample population, and include practitioners who are likely to be responsible for making decisions regarding app use. This increased knowledge regarding accessibility and iOS devices

may lead to even less variability among app assessments. Additional apps ranging in content and accessibility also need to be assessed. Future research should also switch which apps are being assessed in which way so as to allow for comparisons between groups. In order to do this, analyses would have to be completed to ensure the apps are matched across groups.

Future studies could also assess how the researcher's presence affects performance. While it seemed beneficial for the researcher to be present to answer questions or progress the participant, this may have innately altered their performance. This study may also have been limited by having the primary research conduct all coding and data analysis. Future research would use outside sources to avoid any biases.

As research continues the iA2C can be modified with additional questions and clarifications. Possible adaptations include: distinguishing whether or not accessibility modifications can be made within the app or have to be made through the iOS system and clarification regarding questions that are more objectively based.

While the iA2C will be an ever changing measure as technology changes and the measure itself is improved, it is a starting point in the assessment of app accessibility. It can serve as a common tool among practitioners, which would allow for equivalent comparisons between apps and create some level of continuity in assessment.

Figures

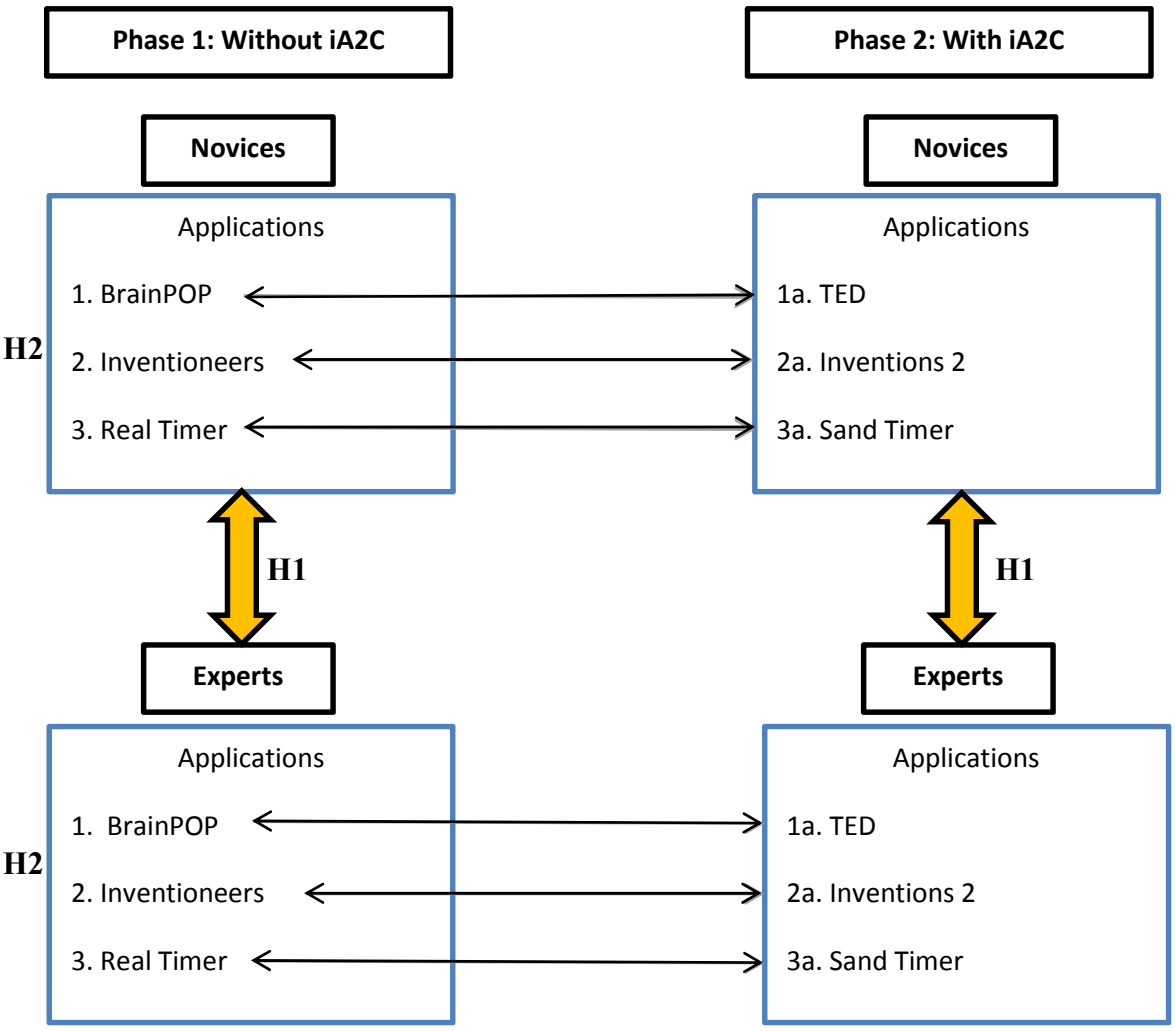

Figure 1: Research Design

*Note: Apps were matched across groups (as indicated by connecting grey arrows). Apps were assessed in a randomized order.

H1: When using the iA2C, novice users with little experience in accessible design will determine apps to have a statistically similar number of accessibility features as experts, assessing the app in the same way.

H2: Users will better be able to rank apps, based on accessibility, when using the iA2C.

Figure 1 text description

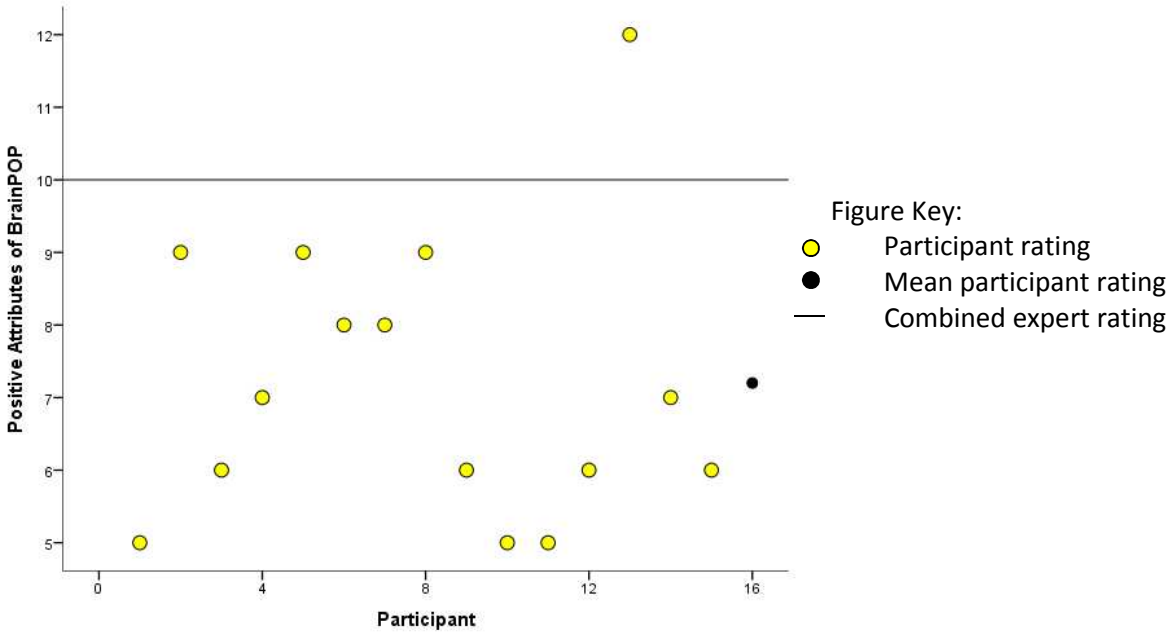

Figure 2: Positive attributes of BrainPOP identified without the use of the iA2C

Figure 2 text description

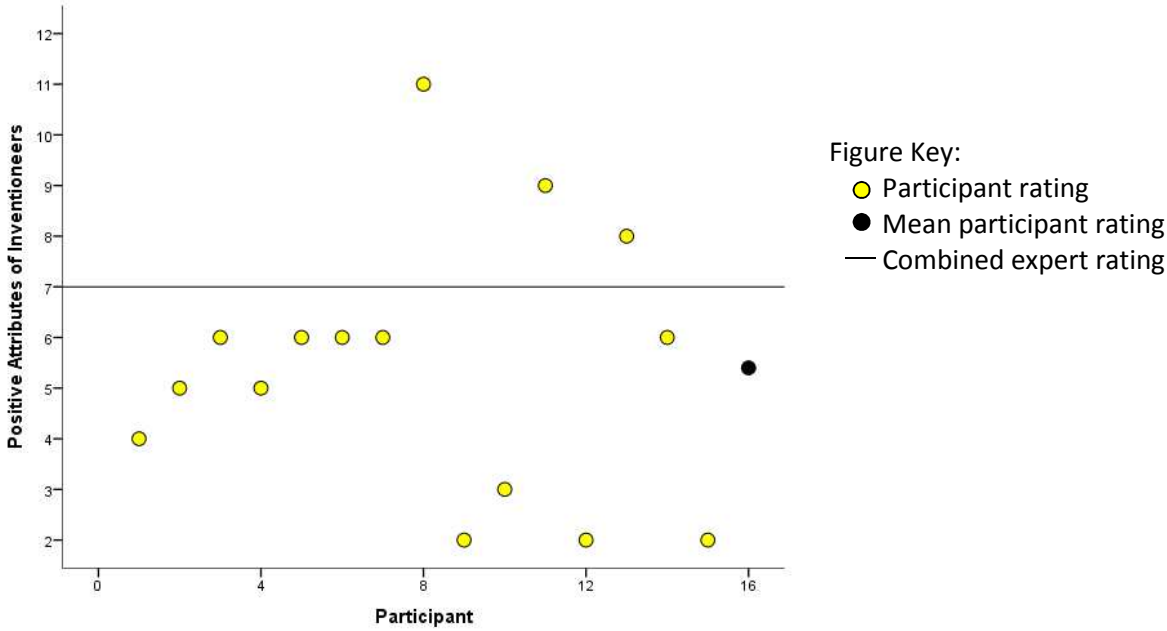

Figure 3 Positive attributes of Inventioneers identified without the use of the iA2C

Figure 3 text description

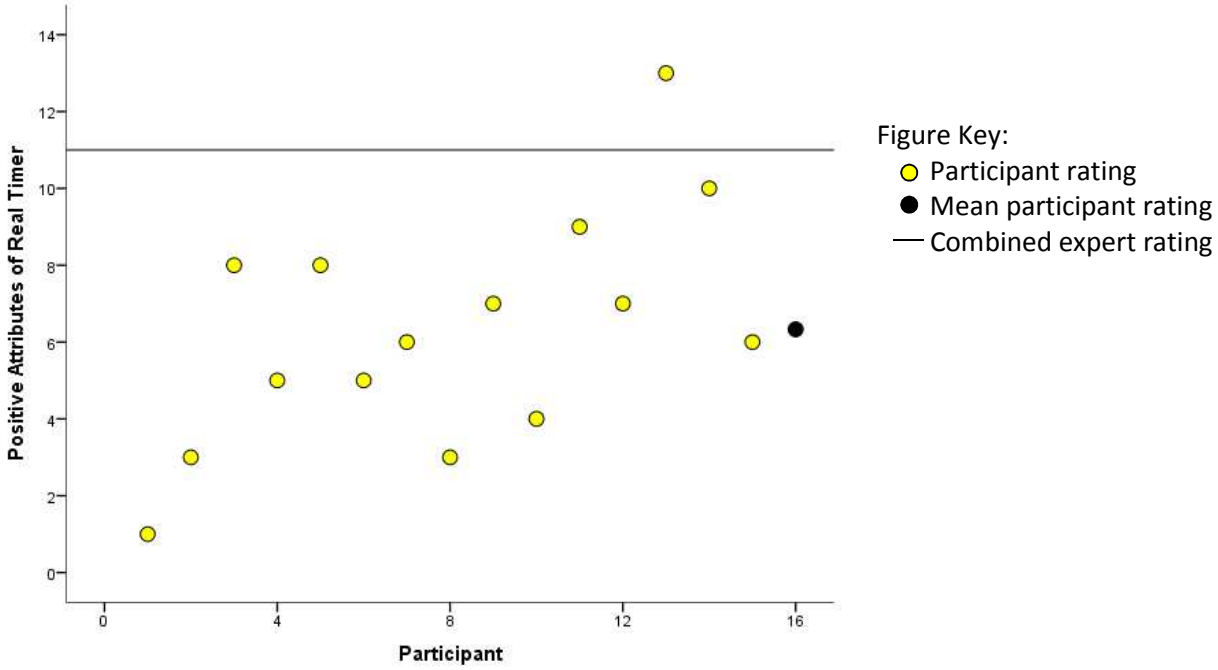

Figure 4: Positive attributes of Real Timer identified without the use of the iA2C

Figure 4 text description

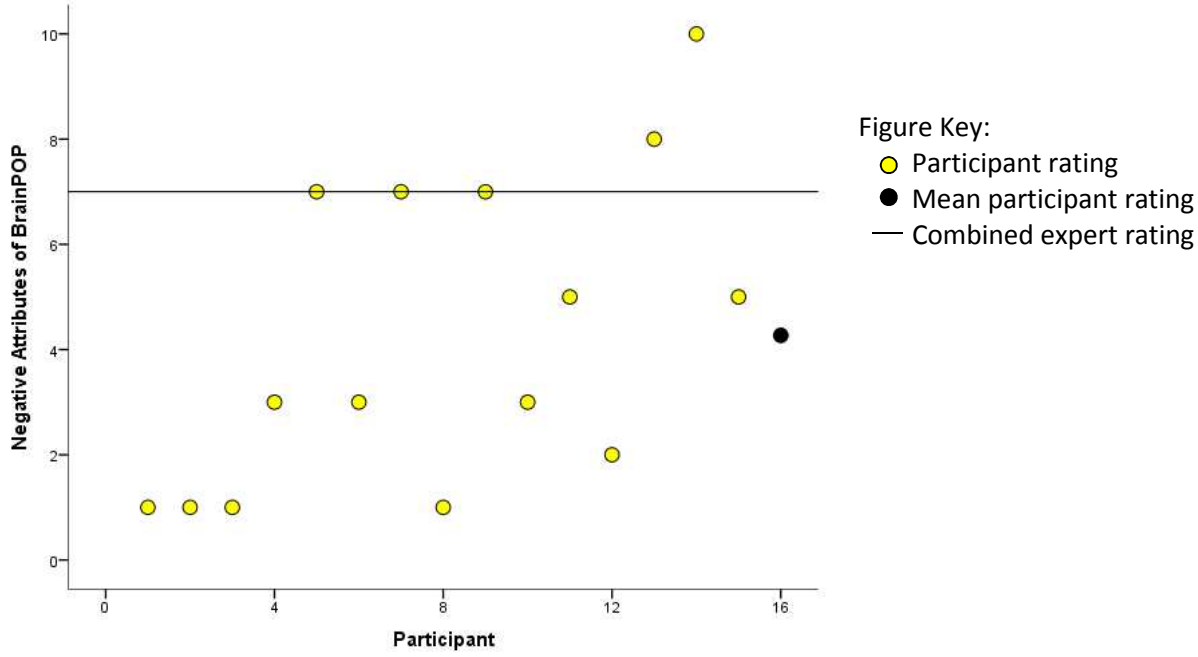

Figure 5: Negative attributes of BrainPOP identified without the use of the iA2C

Figure 5 text description

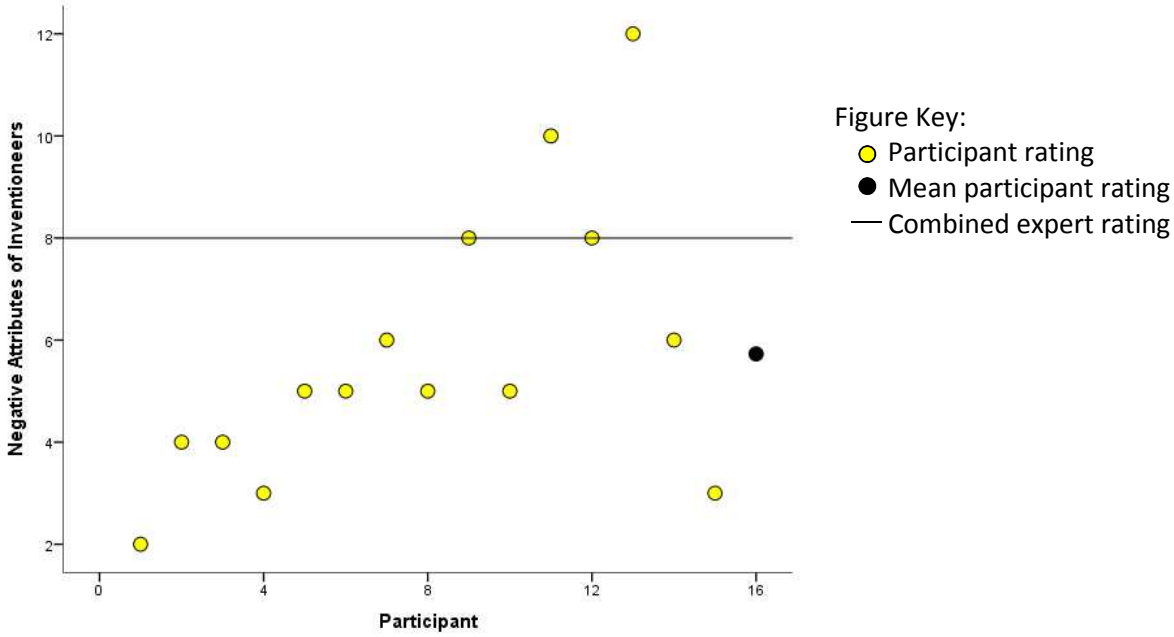

Figure 6: Negative attributes of Inventioneers identified without the use of the iA2C

Figure 6 text description

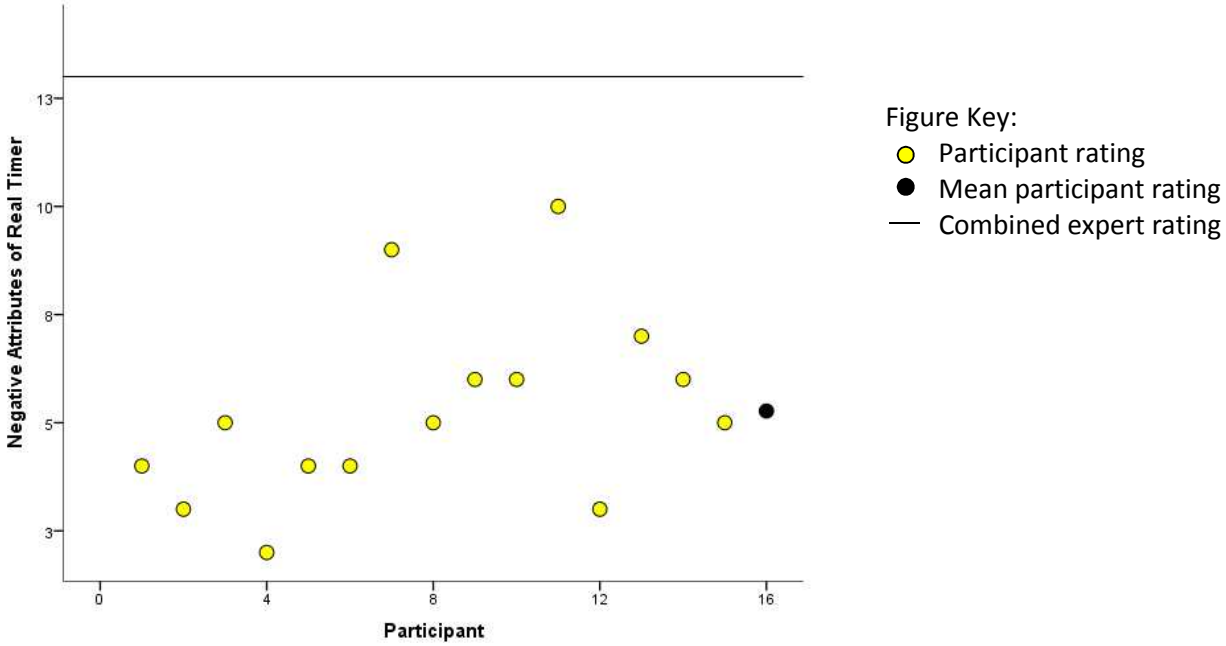

Figure 7: Negative attributes of Real Timer identified without the use of the iA2C

Figure 7 text description

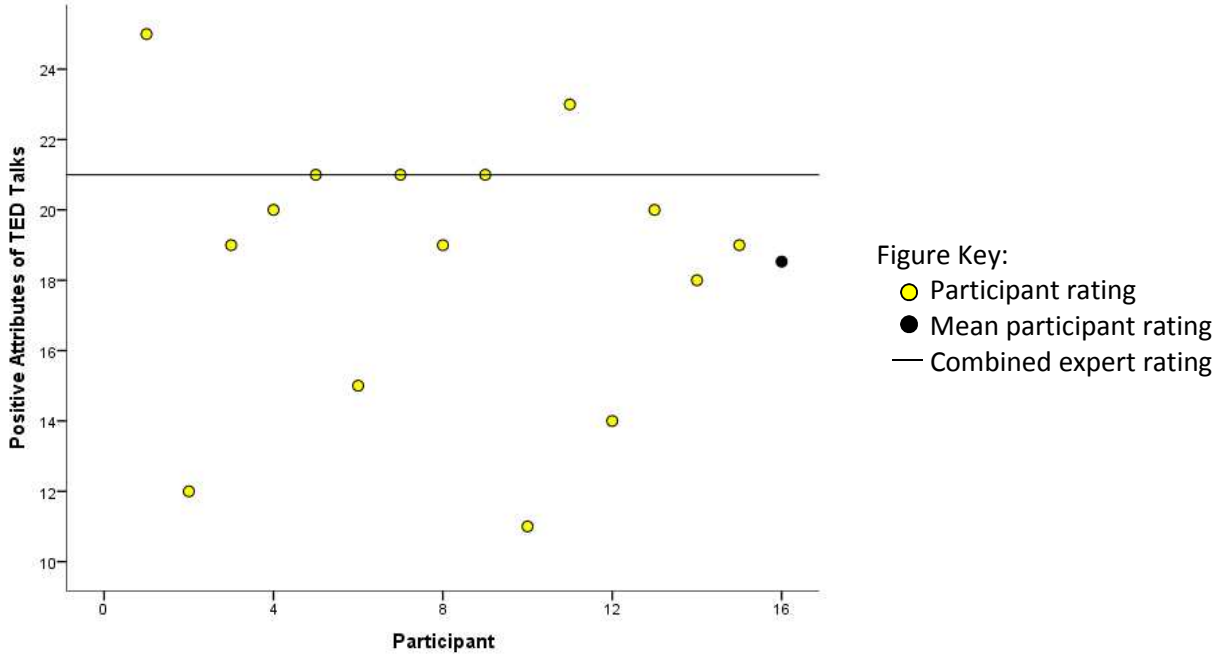

Figure 8: Positive attributes of TED Talks identified with the use of the iA2C

Figure 8 text description

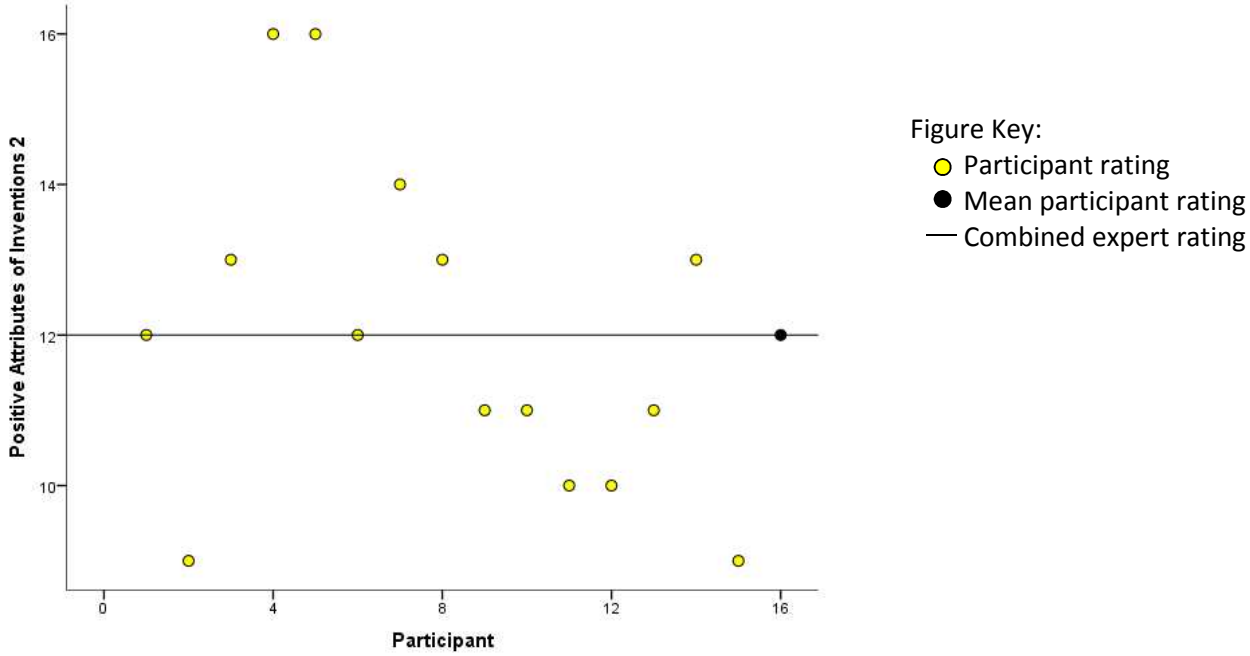

Figure 9: Positive attributes of Inventions 2 identified with the use of the iA2C

Figure 9 text description

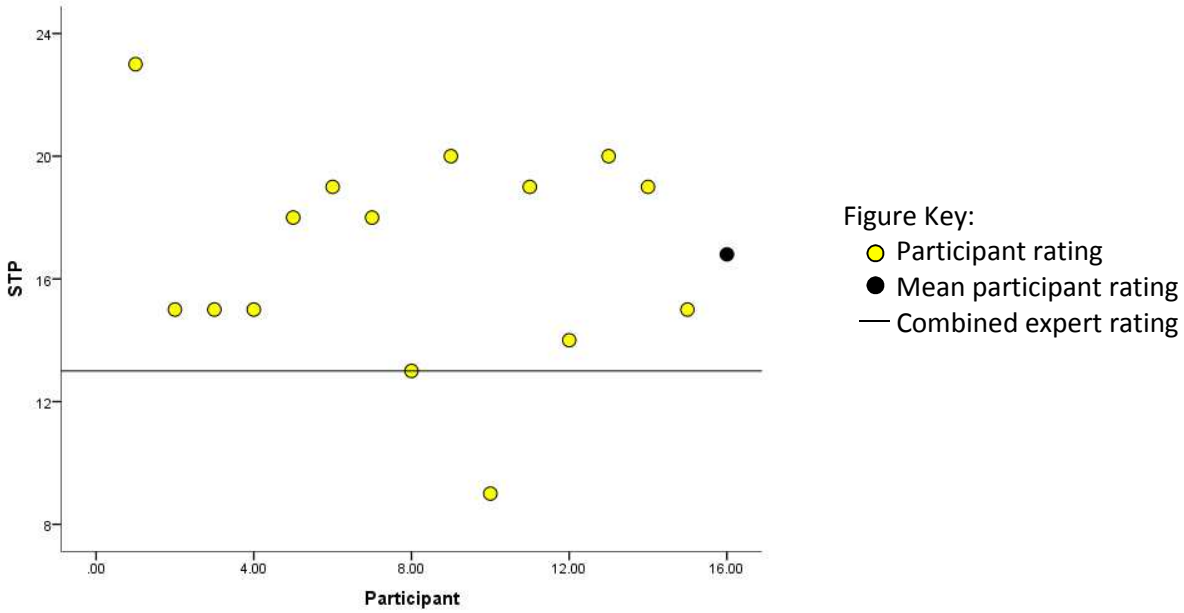

Figure 10: Positive attributes of Sand Timer identified with the use of the iA2C

Figure 10 text description

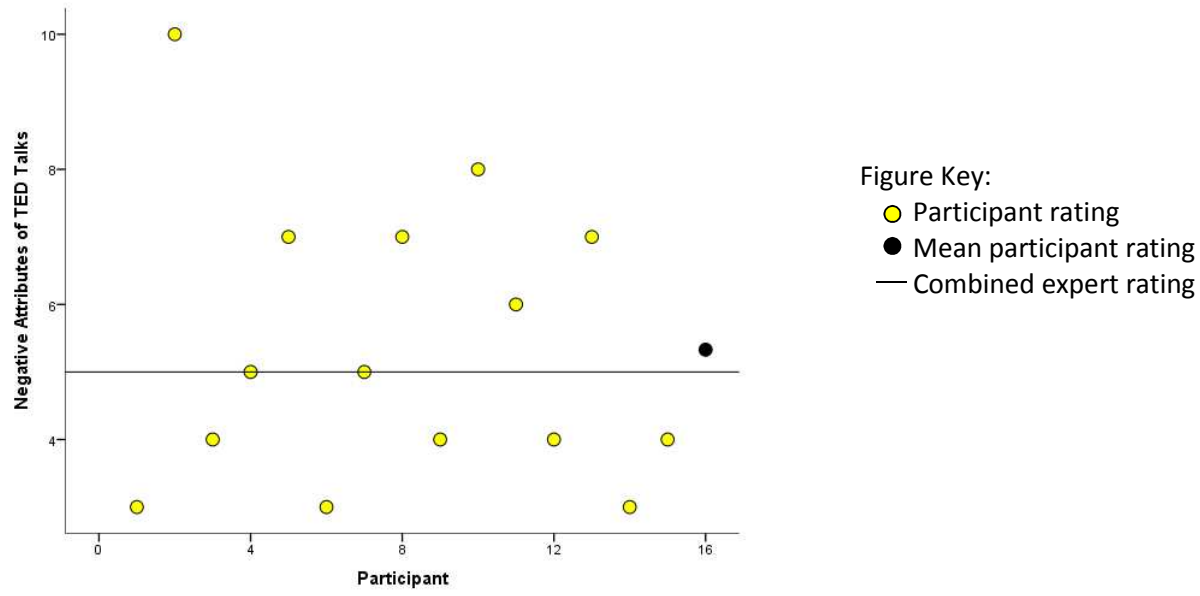

Figure 11: Negative attributes of TED Talks identified with the use of the iA2C

Figure 11 text description

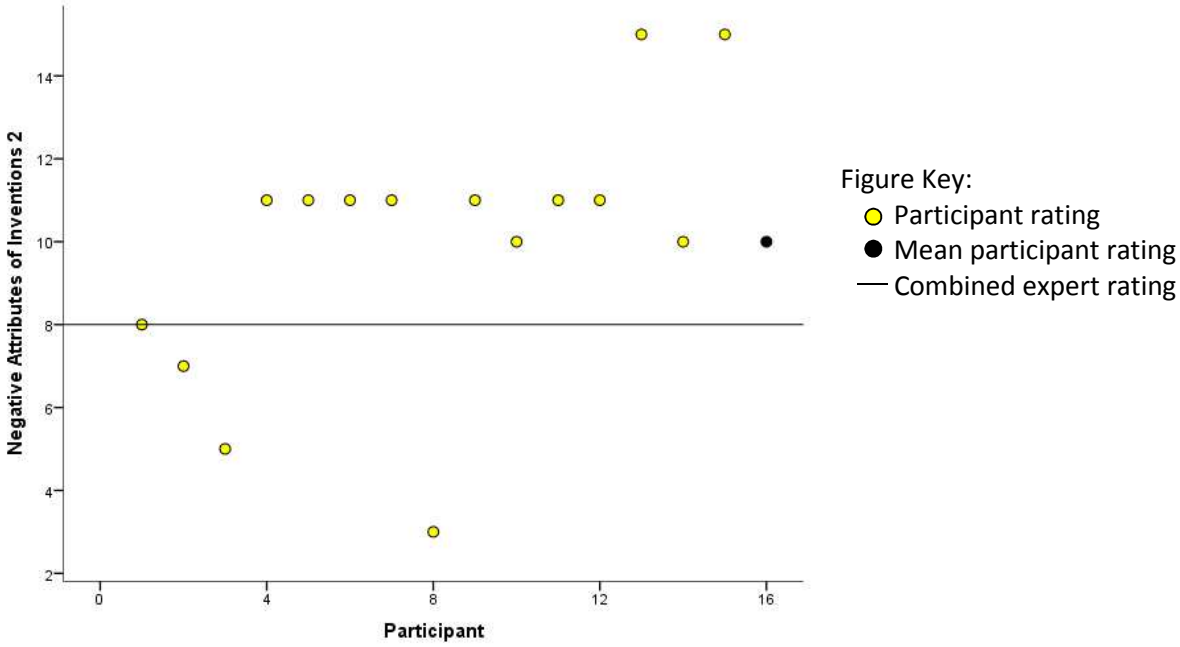

Figure 12: Negative attributes of Inventions 2 identified with the use of the iA2C

Figure 12 text description

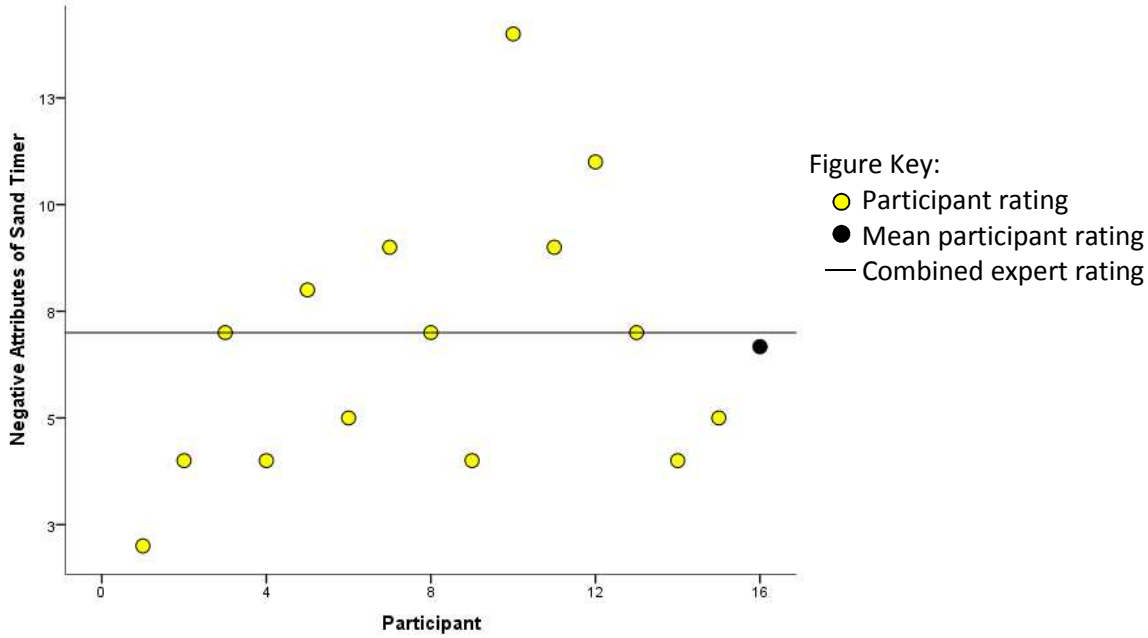

Figure 13: Negative attributes of Sand Timer identified with the use of the iA2C

Figure 13 text description

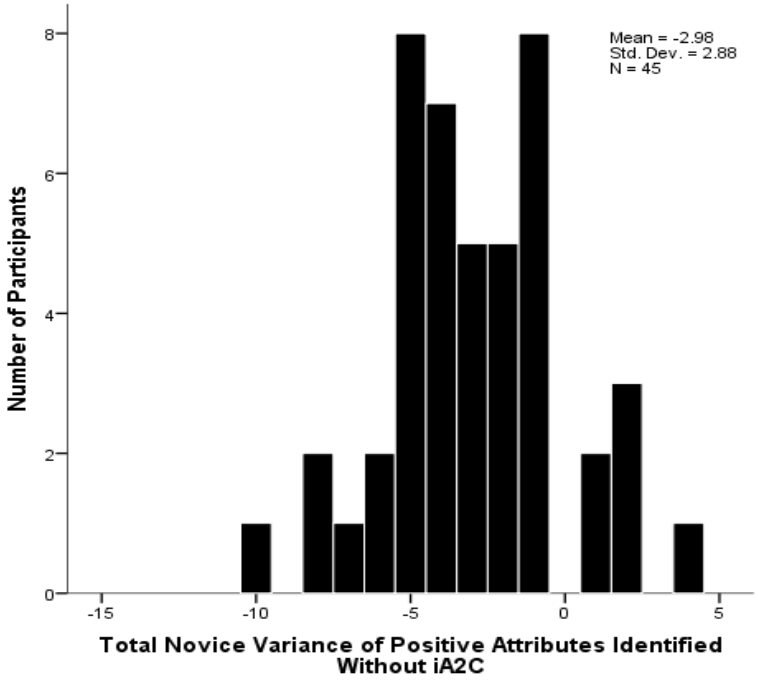

Figure 14: Variance between the number of positive app attributes identified by novices without the use of iA2C compared to experts.

Figure 14 text description

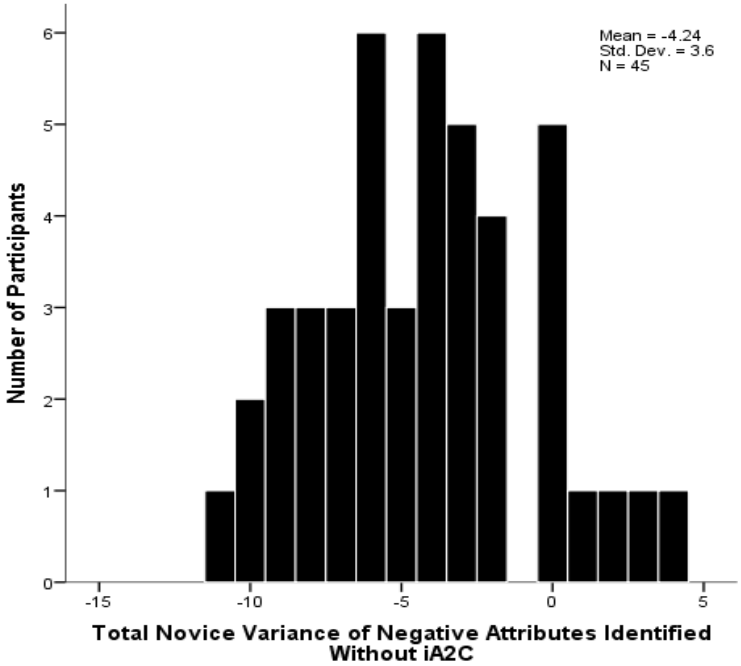

Figure 15: Variance between the number of negative app attributes identified by novices without the use of iA2C compared to experts.

Figure 15 text description

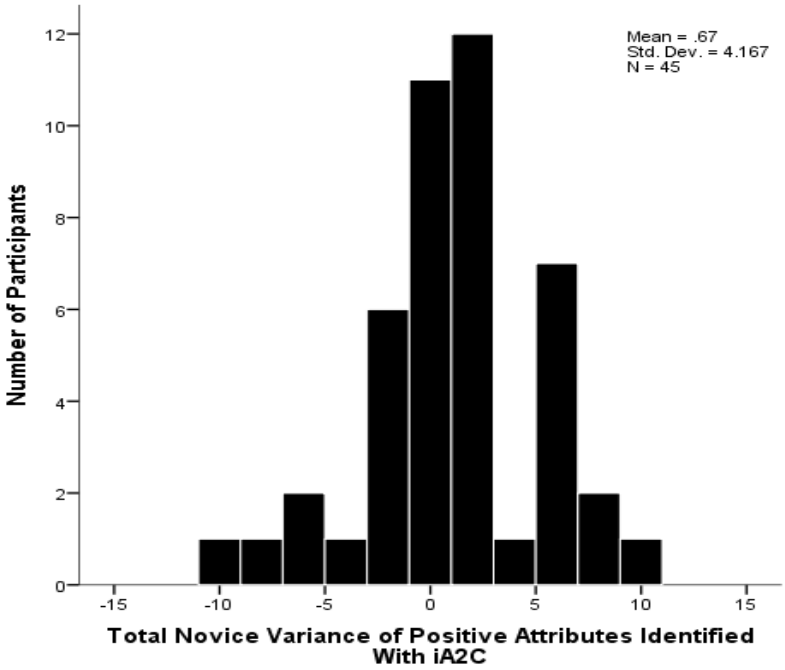

Figure 16: Variance between the number of positive app attributes identified by novices with the use of iA2C compared to experts.

Figure 16 text description

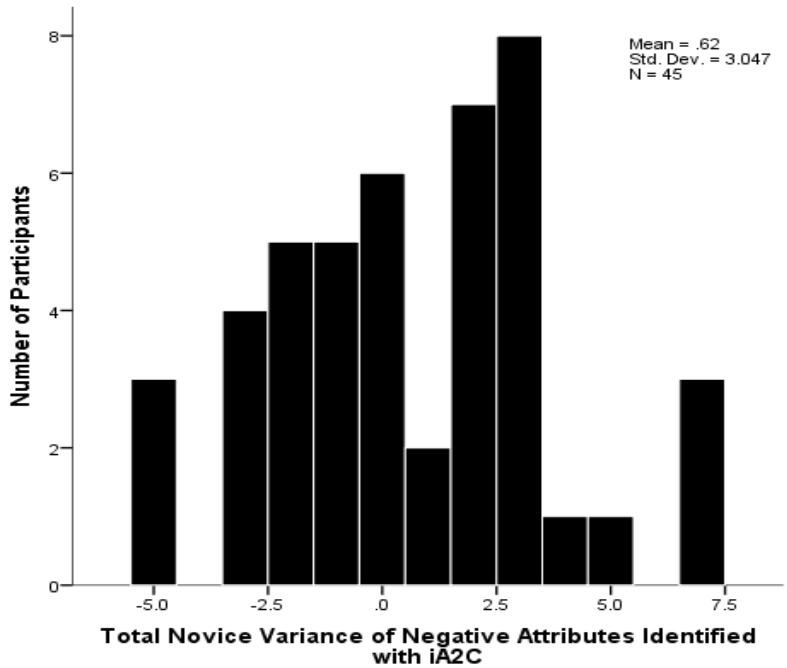

Figure 17: Variance between the number of negative app attributes identified by novices with the use of iA2C compared to experts.

Figure 17 text description

Tables

Table 1: Participant demographic information

Demographics	n = 15
Age (20-31)	15
Male	4
OT	9
Course work regarding assistive technology	10
Course work regarding universal design	7
Experience working with a disability population	11
Experiencing designing/programming apps	1
Course work for app design/programming	3
Familiar with iOS	15

Table 2: Number of attributes identified by novice users without the use of theiA2C

	Positive Attributes			Negative Attributes		
Participant	BrainPOP	Inventioneers	Real Timer	BrainPOP	Inventioneers	Real Timer
1 – non-OT	5	4	1	1	2	4
2 – non-OT	9	5	3	1	4	3
3 – non-OT	6	6	8	1	4	5
4 – non-OT	7	5	5	3	3	2
5 – non-OT	8	6	8	7	5	4
6 – non-OT	9	6	5	3	5	4
7 – OT	8	6	6	7	6	9
8 – OT	9	11	3	1	5	7
9 – OT	6	2	7	7	8	4
10 – OT	5	3	4	3	5	14
11 – OT	5	9	9	5	10	9
12 – OT	6	2	7	2	8	11
13 – OT	12	8	13	8	12	7
14 – OT	7	6	10	10	6	4
15 - OT	6	2	6	5	3	5
Experts	10	7	11	7	8	13
Novice μ	7.20	5.40	6.33	4.27	5.73	5.27
Novice σ	1.97	2.61	3.06	2.96	2.74	2.19
Novice $\sigma_{\bar{x}}$	0.51	0.68	0.79	0.77	0.71	0.57
Non-OT μ	7.33	5.33	5.00	2.67	3.83	5.00
OT μ	7.11	5.44	7.22	5.33	7.00	7.78

Table 3: Number of attributes identified by novice users with the use of theiA2C

	Positive Attributes			Negative Attributes		
Participant	TED Talks	Inventions 2	Sand Timer	TED Talks	Inventions 2	Sand Timer
1 –non-OT	5	12	23	3	8	2
2 –non-OT	9	9	15	10	7	4
3 –non-OT	6	13	15	4	5	7
4 –non-OT	7	16	15	5	11	4
5 –non-OT	9	16	18	7	11	8
6 –non-OT	8	12	19	3	11	5
7 – OT	21	14	18	5	11	9
8 – OT	19	13	13	7	3	7
9 – OT	21	11	20	4	11	4
10 – OT	11	11	9	8	10	14
11 – OT	23	10	19	6	11	9
12 – OT	14	10	14	4	11	11
13 – OT	20	11	20	7	15	7
14 – OT	18	13	19	3	10	4
15 - OT	19	9	15	4	15	5
Experts	21	12	13	5	8	7
Novice μ	18.53	12	16.8	5.33	10	6.67
Novice σ	3.94	2.20	3.51	2.10	3.21	3.18
Novice $\sigma_{\bar{x}}$	1.02	0.57	0.91	0.54	0.83	0.82
Non-OT μ	18.67	13.00	17.50	5.33	8.83	5.00
OT μ	18.44	11.33	16.33	5.33	10.78	7.78

Table 4: 1-sample t-test results for positive accessibility attributes identified without the use of the iA2C

						95% Confidence Interval of the Difference	
App	Test Value	t	df	Sig (2-tailed)	Mean Difference	Lower	Upper
BP +	10	-5.501	14	.000	-2.800	-3.89	-1.71
IN +	7	-2.371	14	.033	-1.600	-3.05	-0.15
RT +	11	-5.901	14	.000	-4.667	-6.36	-2.97

Table 5: 1-sample t-test results for negative accessibility attributes identified without the use of the iA2C

						95% Confidence Interval of the Difference	
App	Test Value	t	df	Sig (2-tailed)	Mean Difference	Lower	Upper
BP -	7	-3.572	14	.003	-2.733	-4.37	-1.09
IN -	8	-3.207	14	.006	-2.267	-3.78	-0.75
RT -	13	-13.698	14	.000	-7.733	-8.94	-6.52

Table 6: 1-sample t-test results for positive accessibility attributes identified with the use of the iA2C

						95% Confidence Interval of the Difference	
App	Test Value	t	df	Sig (2-tailed)	Mean Difference	Lower	Upper
TED +	21	-2.422	14	.030	-2.467	-4.65	-0.28
I2 +	12	-0.000	14	1.000	-0.000	-1.22	-1.22
ST +	13	-4.194	14	.001	3.800	1.86	5.74

Table 7: 1-sample t-test results for negative accessibility attributes identified with the use of the iA2C

						95% Confidence Interval of the Difference	
App	Test Value	t	df	Sig (2-tailed)	Mean Difference	Lower	Upper
TED -	5	.617	14	.547	0.333	-0.83	1.49
I2 -	8	2.415	14	.030	2.000	0.22	3.78
ST -	7	-0.406	14	.691	-0.333	-2.09	1.43

Table 8: Variation of attributes identified by novices without the iA2C relative to the expert standard

APP	Equal	Within ±1	Within ±2	Within ±3	Within ±4	≥5
BPP	0	3	6	8	12	15
INP	0	6	9	10	12	15
RTP	0	1	3	5	7	15
BPN	3	4	6	7	10	15
INN	2	2	5	9	12	15
RTN	0	0	0	1	2	15
Total	5	16	29	40	55	90

Table 9: Variance of attributes identified by novices with the iA2C relative to the expert standard

APP	Equal	Within ±1	Within ±2	Within ±3	Within ±4	≥5
TEDP	3	5	9	10	11	15
I2P	2	8	11	13	13	15
STP	1	2	6	6	7	15
TEDN	2	7	13	14	14	15
I2N	1	2	4	12	12	15
STN	3	4	8	11	12	15
Total	12	28	51	66	69	90

Table 10: Participant ratings of apps based on positive features identified without the use of the iA2C.

App	RT+	BP+	IN+
Expert Rank of Accessibility	1	2	3
Number of novices in agreement	53%	40%	47%

Table 11: Participant ratings of apps based on the positive features identified with the use of the iA2C.

App	TED+	ST+	I2+
Expert Rank of Accessibility	1	2	3
Number of novices in agreement	53%	40%	47%

Table 12: Participant ratings of apps based on the negative features identified without the use of the iA2C.

App	BP-	IN-	RT-
Expert Rank of Accessibility	1	2	3
Number of novices in agreement	53%	53%	40%

Table 13:Participant ratings of apps based on the negative features identified with the use of the iA2C.

App	TED-	ST-	I2-
Expert Rank of Accessibility	1	2	3
Number of novices in agreement	73%	53%	67%

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Appendix A: iOS Application Accessibility Checklist

App	
Version	
Date	
Instructions	See Manual
Key	Y - yes S - sometimes N - no NA - not applicable

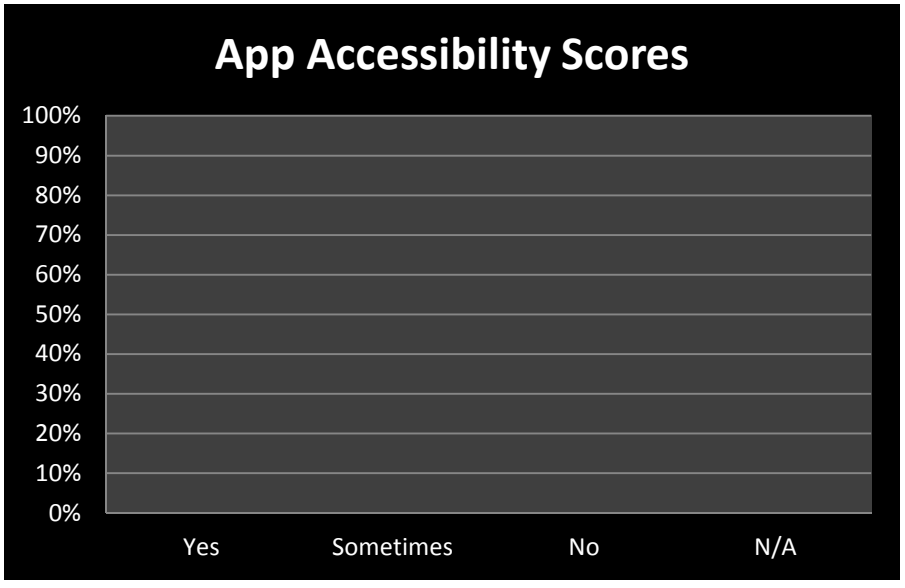
		Y	S	N	NA
Accessibility Section 1 – Vision					
1	Does the app have audio output?				
2	Is the app compatible with VoiceOver?				
3	Is the app compatible with Speak Screen>				
4	Is all relevant non-text content also available in text form?				
5	Can text size be changed?				
6	Can you zoom within the app?				
7	Does the app recognize inverse colors?				
8	Does the app recognize grayscale?				
9	Is foreground and background information distinguishable?				
10	If color is used to emphasize information, is the same information apparent without the use of color?				
11	If highlighting or alternate fonts are used to emphasize information, is the same information apparent without these modifications?				
Accessibility Section 2 – Hearing					
1	Are in app videos enabled with closed captioning?				
2	Is the app compatible with Mono Audio?				
3	Are all app notifications visual, tactile and auditory?				
4	Do audio items allow for the modification of volume?				
5	Can audio be paused if it plays automatically or for more than 3sec?				

Accessibility Section 3 – Motor					
1	Is the app compatible with assistive touch?				
2	Is the app compatible with Switch Controls?				

Accessibility Section 4 – Cognition					
1	Is the app compatible with guided access?				
2	Is information presented in a predictable pattern?				
3	Are headings used to assist navigation?				
4	Is the language used simple, direct and at an appropriate reading level for the target population?				
5	Is the app compatible with dictionary functions?				
6	Is there enough time for users to read information provided?				
7	Are all abbreviation expanded the first time they are used?				
8	Are user mistakes identified?				
9	Are user mistakes corrected?				

Accessibility Section 5 – General					
1	Is the app accessible?				
2	Is the app user friendly?				
3	Would you use the app?				

	Y	S	N	NA
Total	0	0	0	0
Total Possible	30	30	30	30
Percent	0%	0%	0%	0%



Appendix B: iA2C User Manual

General instructions
Turn on your Apple device and ensure it has had the latest software upgrade.
Turn the device volume to a comfortable level.
Turn the screen brightness to the desired level.
Download the listed versions of the specified applications.
Answer the questions by placing an x in the appropriate box to indicate whether yes- the app has a specified feature, sometimes-it has the specified feature, no-it never has the specified feature or not applicable – this feature is not relevant to this app.
These instructions for turning on device features and answering each individual question are listed below.
Feel free to add additional comments to the comments page as necessary.

Accessibility Section 1 – Vision

1. This is addressing whether or not the app produces any sound that can be heard through traditional audio output methods (speakers or headphones). In order to properly assess this make sure the device volume is turned up. Also, if the application has a means to control volume independently, make sure this is turned on.
2. VoiceOver is a screen reader that allows for the operation of an iOS device even if the user cannot see the screen.
    a. To turn on Voiceover:
        i. Go to Settings > General > Accessibility > VoiceOver
        ii. Turn on VoiceOver
        iii. Adjust voice settings to desired levels
        iv. Double tab an icon to activate it
        v. Use a three finger swipe to scroll
    b. To turn off Voiceover:
        i. Go to Settings > General > Accessibility > VoiceOver
        ii. Double click VoiceOver to deactivate it
3. Speak Screen can be used to read any text displayed on the screen.
    a. To turn on Speak Selection
        i. Go to Settings > General > Accessibility > Speech
        ii. Turn on Speak Selection
        iii. In desired app select the text you want to hear by pressing and holding the word
    b. To turn off Speak Screen
        i. Press pause
        ii. Deselect text
4. If non-text content is also available in a text form this indicates that all relevant, pictures and graphics have a text alternative that could be read by VoiceOver or Speak Selection.

5. Larger Text allow the user to change the size and format of text elements only.
    a. To activate font adjustments:
        i. Go to Settings > General > Larger Text
        ii. Adjust the slider to the preferred size
    b. To enable additional, larger font sizes:
        i. Go to Settings > General > Accessibility > Larger Text
        ii. Turn on Larger Dynamic Type
    c. To turn off Dynamic Type:
        i. Go to Settings > General > Accessibility > Larger Text
        ii. Turn off Larger Accessibility Sizes
6. Zooming changes the size of all features visible on the screen. This allows all features of the apps to maintain their size proportions.
    a. To begin to zoom:
        i. Use three fingers to double-tap the screen
        ii. With fingers still on the screen move up to increase the size, move down to decrease the size
7. Inverse colors show the natural opposite of the colors being displayed on the screen. Black becomes white, blue becomes yellow and vis-a-verse.
    a. To activate inverse colors:
        i. Go to Settings > General > Accessibility
        ii. Switch invert colors to on
    b. To deactivate inverse colors:
        i. Go to Settings > General > Accessibility
        ii. Switch invert colors to off
8. Grayscale changes all of the colors in the spectrum to shades of gray. If enabled contrast will only be provide via shading.
    a. To activate grayscale:
        i. Go to Settings > General > Accessibility
        ii. Switch grayscale to on
    b. To deactivate grayscale:
        i. Go to Settings > General > Accessibility
        ii. Switch grayscale to off
9. If foreground and background information is distinct the user should be able to clearly read and see all information provided on the page. Information may not be distinguishable if colors are too similar, font is too small or blank spaces are not provided.
10. Increased contrast allows you to dim colors, reduce whiteout and reduce transparency respectively.
    a. To activate Increase Contrast:
        i. Go to Settings > General > Accessibility > Increase Contrast
        ii. Adjust transparency, color and white scale as desired

b. To deactivate Increase Contrast:
    i. Go to Settings > General > Accessibility > Increase Contrast
    ii. Return transparency, color and white scale to original settings

11. This question indicates multiple design features were taken into consideration when setting up the application. For example if a start button is green, it is also labeled and outlined. This would allow the button to remain visible even without even if the color could not be seen.
12. This question is much the same as the last. This indicates that important text is indicated in multiple ways that would be obvious even to someone utilizing a screen reader.
13. Button shapes add a boarder to the function buttons of an application. This feature may not be necessary as some apps provide boarders to buttons automatically.
    a. To turn on Button Shapes:
        i. Go to Settings > General > Accessibility > Button Shapes
        ii. Switch Button Shapes to on
    b. To turn off Button Shapes:
        i. Go to Settings > General > Accessibility > Button Shapes
        ii. Switch Button Shapes to off

Accessibility Section 2 – Hearing

1. Closed captioning provide the matching text for words and sounds occurring during a video. Closed captioning should be innate to any videos. However, if it is not, the iOS device has a closed captioning feature available.
    a. To turn on the devices closed captioning:
        i. Go to Settings > General > Accessibility > Subtitles & Captioning
        ii. Switch Closed Captions + SDH to on
    c. To turn off the devices closed captioning:
        i. Go to Settings > General > Accessibility > Subtitles & Captioning
        ii. Switch Closed Captions + SDH to off

2. Mono audio is a setting that changes how audio output is heard. When listening with headphones, this setting allows all audio to be heard through both headphones. Traditionally, recordings have left and right channel audio to create a stereo effect.
    a. To turn on Mono Audio:
        i. Go to Settings > General > Accessibility
        ii. Switch Mono Audio to on
    d. To turn off Mono Audio:
        i. Go to Settings > General > Accessibility
        ii. Switch Mono Audio to off

3. Many applications notify the user of a variety of different things. This can include alarms, timers, updates, achievements, etc. These notifications should make noise if the phones volume is on. They should also vibrate and a light indicator should go off on the phone and be visible even if the phone is locked.

4. This indicates that audio volume can be controlled, either by changing the overall device volume, or by changing a volume setting within the app itself.
5. This simply indicates that there is a means to pause or stop any audio that starts without input from the user or plays for a time span lasting more than 3 seconds.

Accessibility Section 3 – Motor

1. Assistive Touch is an iOS feature that allows for the modification of gestures that may be difficult for some users.
    a. To turn on Assistive Touch:
        i. Go to Settings > General > Accessibility > Assistive Touch
        ii. Switch Assistive Touch to on
        iii. Select the desired gestures to use
            1. Triple click the home button to open
            2. Go to Device > More > Gestures
                a. Select the number of fingers associated with the desired gesture
                b. When circles appear swipe in the required direction
                c. To finalize tap the menu button
    b. To turn off Assistive Touch:
        i. Triple click the home button
2. Switch Control allows users to navigate their device using various switch hardware. It also allows the user to operate the device through head actions tracked by the camera.
    a. To turn on Switch Control
        i. Go to Settings > General > Accessibility > Switch Control
        ii. Add the desired switch and choose an action
            1. Go to Settings > General > Accessibility > Switch Control > Switches
            2. Use the Face Time camera to track head movements
    b. To turn off Switch Control:
        i. Triple-click the home button or
        ii. Go to Settings > General > Accessibility > Switch Control

Accessibility Section 4 – Cognitive

1. Guided Access is designed to help the user stay focused on the immediate task. This is done by limiting the device to only operating one application at a time. It also allows for the control of application features as well.
    a. To turn on Guided Access:
        i. Go to Settings > General > Accessibility > Guided Access
        ii. Switch Guided Access to on
        iii. Set a passcode to activate and deactivate Guided Access

iv. Open the desired app
    1. Triple click the home button
    2. Adjust settings for the session
    3. Click start
    4. Circle components of the screen to disable

c. To turn off Guided Access:
    i. Triple click the home button
    ii. Enter the passcode

2. If the information is presented in a predictable way the user should know how to interact with the app without prior experience. Information should be laid out in a conceivable order that is easy to follow.
3. This indicates that new topics or sections have clear headings to indicate the purpose for the information.
4. All instructions within the app should be simple and easy to understand. The language used needs to be clear and grammatically correct.
5. The dictionary feature allows any selected text to be defined instantly.
    a. To activate Dictionary
        i. Tap and hold on the word needing defining
        ii. Select "Define" to open the dictionary
        iii. Tap done when finished reading the definition
6. This is regarding whether or not the user is able to read text before it moves, flashes, scrolls or changes in any way.
7. This indicates that abbreviations are explained and expanded to help users understand the information fully.
8. This is regarding whether or not a user is notified in some way if they have entered information wrong or answered a question wrong. This does not indicate that the app informs the user if they have performed the wrong action with regards to navigating the application, seeing as the app cannot know the users intentions.
9. This is regarding whether or not mistakes are corrected by the application or if the user must correct their own mistakes. This is based off of the same information that is identified as a mistake in the previous question.

Accessibility Section 5 – General

1-3. These are all opinion questions, regarding whether you would use this app with young children in a school or home setting, so answer as seen fit.

Appendix C: Session 1 Positive and Negative Attribute Form

Participant _____ App _____

Please list features that make this app easier for someone who is visually impaired/blind to use

Please list features that make this app easier for someone who is deaf/hard of hearing to use

Please list features that make this app easier for someone with motor impairments to use

Please list features that make this app easier for someone with cognitive impairments to use

Please list the features that make this app difficult for someone who is visually impaired/blind to use

Please list the features that make this app difficult for someone who is deaf/hearing impaired to use

Please list features that make this app difficult for someone with motor impairments to use

Please list features that make this app difficult for someone with cognitive impairments to use

Appendix D: Applications Utilized

Educational Applications		
Name	Version	Description
Brain Pop Featured Movie	3.0.6	This app uses short animated videos to educate students on a variety of topics. Users can select topics ranging from biology to poetry. Each video defines unfamiliar terms and aims to provide basic understanding of the chosen topic.
TED Conferences	2.4.3	The official TED app presents lectures from experts in a variety of fields. Each video serves to provide the user with a broader knowledge of the chosen topic.
Support Applications		
Name	Version	Description
Realtimer	1.1	This app provides a simple 3D hourglass. As with a real timer it can be flipped to countdown. The timer can be paused and adjusted for time and color.
Best Sand Timer	1.02	This app provides a digital hourglass with pixelated "sand". Time can be adjusted as needed. As with Realtimer the app provides both visual and audio indications of time passing.
Entertainment Applications		
Name	Version	Description
Pettson's Inventions 2 Lite	1.1	This app provides the user with a given set of items that can be combined to create the intended "invention". The invention serves to meet a predetermined whimsical goal. Items used can be found in everyday life.
Inventioneers	1.0.7	As with Pettson's Inventions, the user is given a select set of items which can be used to meet an intended goal. The items are once again common objects, but are used in an uncommon way. Users progress through available levels and receive more objects to use at each level.

*Note: Applications may have been updated since the completion of the study. However, these were the versions utilized during data collection.

Appendix E: Text Descriptions

Figure 1.

Brief Description: Research design

Summary Description: This image shows that in session one participants assess three apps (BrainPOP, Inventioneers and Real Timer). Participants assessed the apps without the use of the iA2C. Novice participant ratings were directly compared to the combined expert rating. In session two participants assed three matched apps (TED Talks, Inventions 2 and Sand Timer). All participants assessed these apps using the iA2C. Novice participant ratings were then directly compared to the combined expert rating of the same apps.

Figure 2.

Brief Description: Positive attributes of BrainPOP identified without the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the positive accessibility features of BrainPOP. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly higher than the combined expert rating, which is indicated by a black line. All ratings were made without the use of the iA2C.

Figure 3.

Brief Description: Positive attributes of Inventioneers identified without the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the positive accessibility features of Inventioneers. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly higher than the combined expert rating, which is indicated by a black line. All ratings were made without the use of the iA2C.

Figure 4.

Brief Description: Positive attributes of Real Timer identified without the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the positive accessibility features of Real Timer. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly higher than the combined expert rating, which is indicated by a black line. All ratings were made without the use of the iA2C.

Figure 5.

Brief Description: Negative attributes of BrainPOP identified without the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the negative accessibility features of BrainPOP. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly higher than the combined expert rating, which is indicated by a black line. All ratings were made without the use of the iA2C.

Figure 6.

Brief Description: Negative attributes of Inventioneers identified without the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the negative accessibility features of Inventioneers. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly higher than the combined expert rating, which is indicated by a black line. All ratings were made without the use of the iA2C.

Figure 7.

Brief Description: Negative attributes of Real Timer identified without the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the negative accessibility features of Real Timer. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly higher than the combined expert rating, which is indicated by a black line. All ratings were made without the use of the iA2C.

Figure 8.

Brief Description: Positive attributes of TED Talks identified with the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the positive accessibility features of TED Talks. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly higher than the combined expert rating, which is indicated by a black line. All ratings were made with the use of the iA2C.

Figure 9.

Brief Description: Positive attributes of Inventions 2 identified with the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the positive accessibility features of Inventions 2. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is not significantly different than the combined expert rating, which is indicated by a black line. All ratings were made with the use of the iA2C.

Figure 10.

Brief Description: Positive attributes of Sand Timer identified with the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the positive accessibility features of TED Talks. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly lower than the combined expert rating, which is indicated by a black line. All ratings were made with the use of the iA2C.

Figure 11.

Brief Description: Negative attributes of TED Talks identified with the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the negative accessibility features of TED Talks. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is not significantly different than the combined expert rating, which is indicated by a black line. All ratings were made with the use of the iA2C.

Figure 12.

Brief Description: Negative attributes of Inventions 2 identified with the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the negative accessibility features of Inventions 2. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is significantly lower than the combined expert rating, which is indicated by a black line. All ratings were made with the use of the iA2C.

Figure 13.

Brief Description: Negative attributes of Sand Timer identified with the use of the iA2C

Summary Description: This image shows the distribution of novice user ratings for the negative accessibility features of Sand Timer. These are indicated by individual yellow dots. A single black dot represents the average novice rating. This is not significantly different than the combined expert rating, which is indicated by a black line. All ratings were made with the use of the iA2C.

Figure 14.

Brief Description: Variance between the number of positive app attributes identified by novices without the use of theiA2C compared to experts.

Summary Description: This image shows the variation of positive features identified by novices for all apps assessed without the use of the iA2C. Expert ratings are not included but would be at the zero point. A zero indicates perfect agreement with the experts regarding determination of features present. However, based on this image, most novices identified fewer positive attributes than the experts with the average difference being -2.98.

Figure 15.

Brief Description: Variance between the number of negative app attributes identified by novices without the use of theiA2C compared to experts.

Summary Description: This image shows the variation of negative features identified by novices for all apps assessed without the use of the iA2C. Expert ratings are not included but would be at the zero point. A zero indicates perfect agreement with the experts regarding determination of features absent. However, based on this image, most novices identified fewer negative attributes than the experts with the average difference being -4.24.

Figure 16.

Brief Description: Variance between the number of positive app attributes identified by novices with the use of theiA2C compared to experts.

Summary Description: This image shows the variation of positive features identified by novices for all apps assessed with the use of the iA2C. Expert ratings are not included but would be at the zero point. A zero indicates perfect agreement with the experts regarding determination of features present. However, based on this image, novice ratings are relatively evenly distributed around the zero point, with a slight negative skew. The average novice variation was 0.67.

Figure 17.

Brief Description: Variance between the number of negative app attributes identified by novices with the use of theiA2C compared to experts.

Summary Description: This image shows the variation of negative features identified by novices for all apps assessed with the use of the iA2C. Expert ratings are not included but would be at the zero point. A zero indicates perfect agreement with the experts regarding determination of features present. However, based on this image, novice ratings are relatively evenly distributed around the zero point, with a slight negative skew. The average novice variation was 0.62.

Appendix F: Consent Form

UNIVERSITY OF WISCONSIN – MILWAUKEE

CONSENT TO PARTICIPATE IN RESEARCH

1. General Information

Study title: Assessing the Usability of iOS Applications
Person in Charge of Study (Principal Investigator):
Supervising Professor
Roger O. Smith
Professor: Occupational Science and Technology
Student Researchers
KateLyn White

2. Study Description

You are being asked to participate in a research study. Your participation is completely voluntary. You do not have to participate if you do not want to.
Study description:
The purpose of this study is to assess the how different resources affect how participants determine what accessibility features are or are not present within an app. This will be done by having participants assess the accessibility of applications while using the W3C Web Accessibility Guidelines or the iOS Application Accessibility Checklist (iA2C). The differences in the features identified, will help determine which tool is a useful tool for practitioners to use when deciding what applications to use with a child with disabilities.

3. Study Procedures

What will I be asked to do if I participate in the study?
If you agree to participate you will be asked to complete 6 app assessments across 2 sessions using a provided iPad. Each session should take around an hour. During each session you will be asked to list the accessibility features present and absent in 3 different apps that allow them to be utilized by people with a variety of disabilities. During one session, you will be asked to complete this task with the aide of the W3C Web Accessibility Guidelines. During the opposite session you will be asked to fill out the iA2C in order to aide you in determining which accessibility features are present or absent. You will then be asked to list any additional features not addressed by the iA2C.

4. Risks and Minimizing Risks

What risks will I face by participating in this study?
There are minimal foreseeable risks to participating in this study. You are able to stop the study at any time, for any reason and are not under any obligation to complete testing. If unable to complete a session can opt out of that session and reschedule for a later time.

5. Benefits

Will I receive any benefit from my participation in this study?
Participation in this study will help increase your knowledge regarding application accessibility for those with disabilities. This study is designed to further research in the field.

6. Study Costs and Compensation

Will I be charged anything for participating in this study?
There is no cost to you for participating in this study.

Are subjects paid or given anything for being in the study?
Subjects will receive no reimbursement for their participation in the study.

7. Confidentiality

What happens to the information collected?
All information collected about you during the course of this study will be kept confidential to the extent permitted by law. We may decide to present what we find to others, or publish our results in scientific journals or at scientific conferences. Only the research team will have access to the information. However, the Institutional Review Board at UW-Milwaukee or appropriate federal agencies like the Office for Human Research Protections may review this study's records. All data forms will be coded using an identification number assigned to you by the research team. This information will be stored in a locked cabinet and only used for the purpose of this particular investigation. A link will exist between your name and subject code. This link will be destroyed once you are no longer actively participating in the investigation. De-identified data will be securely held until 2016, at which time it will be destroyed.

8. Alternatives

Are there alternatives to participating in the study?
There are no alternatives to participation in this study. However, you have no requirement to participate in this study.

9. Voluntary Participation and Withdrawal

What happens if I decide not to be in this study?
Your participation in this study is entirely voluntary. You may choose not to take part in this study. If you decide to take part, you can change your mind later and withdraw from the study. You are free to not answer any questions or withdraw at any time. Your decision will not change any present or future relationships with the University of Wisconsin Milwaukee. If you chose to withdraw after data has been collected all data pertaining to you will be destroyed immediately.

10. Questions

Who do I contact for questions about this study?
For more information about the study or the study procedures or treatments, or to withdraw from the study, contact:

Principal Investigator	Student Investigator	Investigators Emails
Roger O. Smith	KateLyn White	white259@uwm.edu
Professor	MSOT	
Enderis Hall 9735	2350 W Good Hope Rd.	
(414)229-5625	(920) 471-6718	

Who do I contact for questions about my rights or complaints towards my treatment as a research subject?
The Institutional Review Board may ask your name, but all complaints are kept in confidence.

Institutional Review Board
Human Research Protection Program
Department of University Safety and Assurances
University of Wisconsin – Milwaukee
P.O. Box 413
Milwaukee, WI 53201
(414) 229-3173

11. Signatures

Research Subject's Consent to Participate in Research:
To voluntarily agree to take part in this study, you must sign on the line below. If you choose to take part in this study, you may withdraw at any time. You are not giving up any of your legal rights by signing this form. Your signature below indicates that you have read or had read to you this entire consent form, including the risks and benefits, and have had all of your questions answered, and that you are 18 years of age or older.

_____
Printed Name of Subject/ Legally Authorized Representative

_____ _____
Signature of Subject/Legally Authorized Representative Date

Principal Investigator (or Designee)
I have given this research subject information on the study that is accurate and sufficient for the subject to fully understand the nature, risks and benefits of the study.

_____ _____
Printed Name of Person Obtaining Consent Study Role

_____ _____
Signature of Person Obtaining Consent Date

Appendix G: Demographic Information

Participant # _____
Session # _____
Age _____
Major _____

Have you taken courses regarding assistive technology? _____ Y _____ N
If so which courses? _____

_____

Have you taken courses regarding universal design? _____ Y _____ N
If so which courses? _____

_____

Do you have experience with a disability population? _____ Y _____ N
If so which ones? _____

_____

Have you taken courses regarding disabilities/disability rights? _____ Y _____ N
If so which ones? _____

_____

Do you have experience designing/programming apps? _____ Y _____ N
If so how many apps? _____

Have you taken courses regarding app design/programming _____ Y _____ N
If so which ones? _____

_____

Have you used an iPad before? _____ Y _____ N
How often do you use an iPad? _____

Are you familiar with iOS? _____ Y _____ N
How often do you us iOS devices? _____