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RESEARCH PAPER FOR APPLIED PROJECT

GESTURES & DESIGN PATTERNS IN TOUCHSCREEN SOFTWARE DEVELOPMENT: A USABILITY STUDY

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ABSTRACT

This goal of this research is to examine several common usability design flaws and to present a plan to create a set of best practices that will contain both user-tested design patterns and proper gesture use that bring about better user task outcomes. It also describes how a usability study would be carried out, including the process of analyzing the study results and finding the best design patterns for those tasks. This research is needed, because there are a limited amount of usability-tested software design patterns for use on mobile touchscreen devices and this researcher believes that usability has understandably suffered in this medium. As any mobile touchscreen device user can attest, it can be surprisingly frustrating to perform a simple task - such as copying and pasting text from one location to another, or filling out a simple form. These tasks and more were tested on a mobile touchscreen device in order to identify and attempt to solve these common usability problems.

KEYWORDS:

Touchscreen, Gestures, Software, Usability, Affordances, Usability Study, Software Design Patterns

1. INTRODUCTION

Touchscreen devices can be a nightmare to operate. Nearly everyone has experienced the “Fat Finger Problem” when trying to type some text on a tiny touchscreen keyboard. And how many times have you accidentally “clicked” a navigation element when you simply wanted to scroll up or down? Not to mention, the only ways to learn how to use these devices are through trial and error or through direct or indirect observation. These issues, and others like it, are everywhere on mobile touchscreen devices. Using a mobile touchscreen device (i.e. smart phones, tablets, etc.) can be extremely frustrating to users because many software developers simply ported over design elements from websites and other desktop PC applications. However, adding the element of touch does not make navigating through or entering data automatically easier when utilizing these familiar design patterns. This researcher believes that the mobile touchscreen device adds additional complexities that should be taken into consideration when designing the user interface software [4], [7].

One good example of a common problem in touchscreen applications is there can be too many actionable items on the screen. This may be due to a confusing design layout or the “click-able” objects were too close together making it hard for users to select the desired item. Another common issue is when a user performs a gesture that is incorrectly interpreted by the device. In addition, software developers often fail to consider in what location users will be using the device/software (i.e. low light, bright light of the outdoors, using device while distracted or in heavy vibration settings). Moreover, in many cases, the text is too small to read comfortably and there is not always an option to make the text larger while viewing it [4], [7].

This researcher believes that many of these issues seem to come from software developers utilizing website application design patterns in touchscreen applications. These design patterns do not always translate into good usability when users are trying to perform tasks. For example, in Android, the flick gesture is often used to scroll through text or lists of items. However, it is all to easy to select an option or linked text while scrolling when the user did not intend to perform this operation. Furthermore, this often results in navigating the user away from the user's desired location.

Finally, this researcher believes that there seems to be a general lack of affordances and proper feedbacks being used in many design patterns. This researcher reached this conclusion while carefully analyzing several common design patterns present on most mobile touchscreen devices. For example, lists do not always appear to suggest that users can scroll through the options or rows presented.

There would be many benefits from the creation of a set of usability tested design patterns and gesture use cases. Users will get more use out of better designed software programs because they will be able to utilize more functionality and make less errors all while taking less time to perform a task. Software development companies will get larger revenues from higher touchscreen software sales because their applications are so easy to use, compared with the competition who did not use a well-thought-out user interface design pattern.

The main motivation behind this research is to contribute a set of design patterns and gesture use cases that can be used to make touchscreen software applications that are both usable and versatile (can be used in a variety of mobile settings).

Definitions of Commonly Used Terms:

Affordance - is a quality of an object, or an environment, that allows an individual to perform an action. For example, a knob affords twisting, and perhaps pushing, while a cord affords pulling [8].

Gesture - A gesture is comprised of 3 stages: Registration - the moment the type of action is set; Continuation - the adjustment of the parameters of the gesture; Termination - when the gesture ends. For example, with the Pinch gesture is registered when 2 fingers are present and start to move towards one another. The continuation aspect is applied as long as the fingers are still moving toward one another and the corresponding item is being shrunk in response to and scale to the action. The termination phase is complete when the fingers stop moving toward one another [7].

Fat Finger Problem - This is when the user accidentally selects a target that he/she did not intend to because the target area was too small in relation to the finger or due to the device reading the input improperly [7].

Design Pattern - is a general reusable solution to a commonly occurring problem within a given context in software design [10].

WIMP - Windows, Icons, Menus, Pointers - denoting a type of user-friendly screen display used on small computers [9]

2. PROBLEM STATEMENT AND JUSTIFICATION

While there are many usability design flaws present within most mobile touchscreen software, this researcher believes that this may be due to the fact that software developers are lacking a comprehensive set of usability tested software design patterns and gestures for mobile touchscreen devices backed by rigorous research and usability testing. This report outlines a plan for creating this set. It will involve creating a usability study which has the following aims:

- Create a prototype touchscreen software application and conduct a usability study utilizing the prototype in order to gauge the usability of the standard user interface design patterns already available on the standard device by recording measurements of overall task outcomes
- Analyze the study results and propose a set of software design patterns and gesture use cases and best practices for mobile touchscreen systems

Touchscreen software developers also need a set of overarching principles that will help to guide them to making the most usable systems that enhance functionality and improve user task outcomes. There are many informal best practice guides on the internet in the form of blogs or on vendor websites (Apple, Google, Windows, etc.), but there is a definite need to create a set of design patterns and gesture best practice guidelines that can be used to create solid, usable and standards-based designs that should be used to avoid common usability problems. This is why a usability study is necessary in order to test alternate design patterns that may alleviate these problems.

The main deliverables of this research will be a prototype and usability test plan for some of the most common usability issues that plague mobile touchscreen device users. Out of the iterative

usability testing of the prototypes will be a set of best practices for use in designing software for mobile touchscreen devices. The ultimate goal of this research is to discover what improves usability in touchscreen applications from actual users. This researcher believes that a set of best practices can be produced from the results of the usability testing (please see Figure 1: Iterative Usability Study).

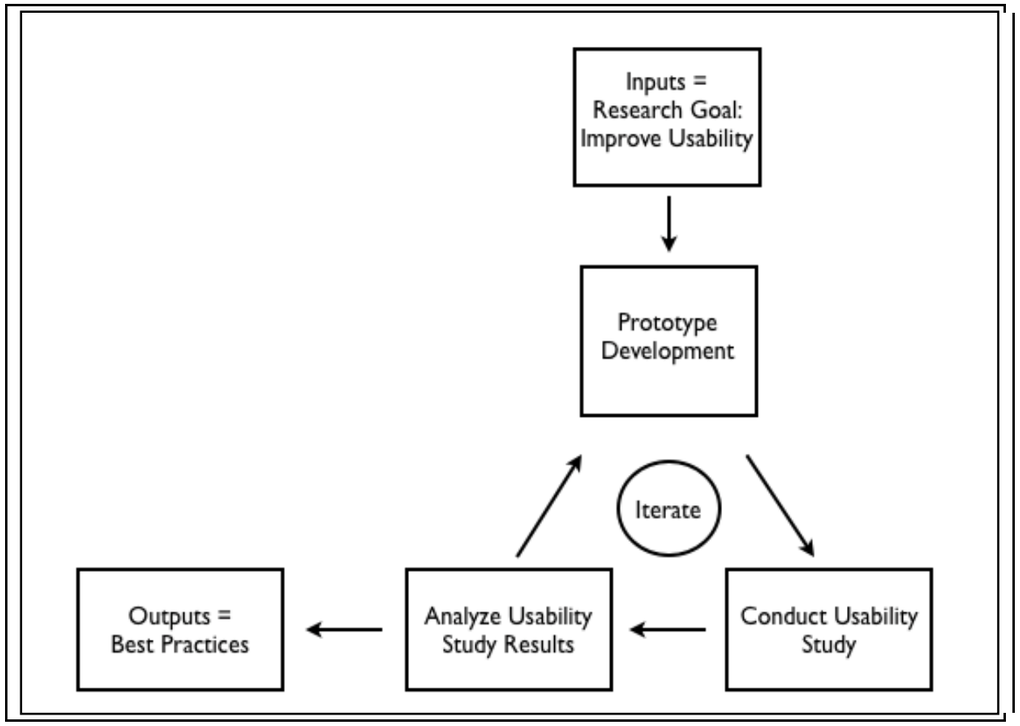

Figure 1: Iterative Usability Study

3. LITERATURE REVIEW -- ANALYSIS OF RELATED WORK

There were only two books that this researcher could find on touchscreen software design utilizing gestures (that were not vendor-specific) when this paper was written. In addition, this researcher found only a handful of research papers published in journals that deal directly with touchscreen software design that utilize gestures or software design patterns. Usability and mobile touchscreen software design is an area where research is needed in order to understand the unique challenges mobile touchscreen devices place on both the users and the software designers. Research in this area should lead to more usability friendly software.

This researcher suspects that the predominant reason there is not much literature on the subject is because the technology is new and still emerging in the market and not many researchers have analyzed it yet. Certainly, touchscreen software vendors had to race to market in order to compete with the iPhone and iPod Touch, the first to market the, now ubiquitous, mobile touchscreen devices at an affordable price [15]. Furthermore, this researcher speculates that after the market is super saturated with mobile touchscreen devices and more major companies are vying for market share, the usability aspect will be a hot topic for consumer research and will naturally get more mainstream attention.

The most comprehensive book on the usability and touchscreen devices is titled “Brave NUI World: Designing Natural User Interfaces for Touch and Gesture” and was written by two researchers who were heavily involved in the creation of Microsoft Surface, which utilizes a large coffee-table sized touchscreen device where users can interact with the device utilizing both hands simultaneously.

NUI stands for Natural User Interfaces. The authors suggest that one think of this as a ***Natural User*** Interface, not a ***Natural*** User interface. Essentially, this means that the user should feel natural while using the software, not that the software should mirror the "natural" world. The authors also make two other interesting points. First, most designers have never had to "truly design a user interface", instead they rely on the work of others before them or what WIMP objects are already available. Links, clicks and buttons are so ingrained into users and software developers, they can't see new possibilities. Touchscreen applications have less restrictions in terms of user interfaces because custom objects can be build and interacted with more naturally and intuitively with touch. Muscle memory can more easily be incorporated for certain tasks, which makes repetitive actions faster. Second, in an ideal situation, users should feel like experts when dealing with touchscreen devices. Ideally, it should feel like second nature to use and learn new tasks with them rapidly [7].

According to the NUI authors, the following principles are the most important things to consider when designing touchscreen software:

- Create an experience that can feel like an extension of one's body
- Create experience that feels just as natural to a novice as an expert user
- Create an experience authentic to the medium, don't mimic real-world necessarily
- Build a UI that considers context, including right metaphors, visual indications, feedback and input/output methods for the context.
- Avoid copying other UI design patterns verbatim from other non-touchscreen platforms [7]

More principles and overall design guidelines can be found in Appendix A: NUI Design Principles Considered [7].

The second book, titled “Designing Gestural Interfaces: Touchscreens and Interactive Devices”, was more generic and gave a 30,000 foot view. So, while it was good for understanding the overall principles used in the consideration of gesture utilization, it was lacking the technical specifications for actual software design. There were two main concepts that this researcher took away from this book, relating to usability on touchscreen devices. First, the author suggested using people to determine the correct gesture to use (e.g. usability studies). Second, he stated that the “tap is the new click”. There was an entire chapter on this topic that essentially provided an overview of how powerful and ubiquitous the tap was to touchscreen software as the mouse was to traditional desktop computing [4].

The first study, titled “Experimental Analysis of Touch-Screen Gesture Designs in Mobile Environments”, dealt with how situational impairments affect touch-screen users. They used two types of situational impairment: motor activity and distraction level. For motor activity they compared sitting and walking, while using no distraction, light distraction and attention-saturating distraction. They found that gestures allowed users to perform many activities with a greater degree of success on their mobile devices while their attention was distracted. Another interesting finding was the observation that some gestures could be performed without looking at the screen. They also found that bezel-initiated gestures had the best overall user performance. A bezel-initiated gesture is one that requires the user to slide one finger from one side of the screen (from the black outer part) to the other side of the screen. Finally, the researchers found

that mark-based gestures were the most accurate. A mark-based gesture is “typically comprised of axis-aligned [redacted] rectilinear mark segments that form a compound path, e.g. “up” followed by “right”...”. See image below for an example [1]:

Another study was done that used a case study styled approach, called “Building an interaction design pattern language: A case study”. This study was intriguing because it showed a systematic approach to validating design patterns. The authors later used those design patterns to improve an existing application. Of particular interest to this researcher, were the sections on User Research, Prototyping and Testing Individual Design Patterns. For example, one of the design patterns that was tested included a series of different solutions for organizing tabs for navigation through a system. There were too many tabs to fit on one horizontal row, so the researchers created several design patterns and tested them. This researcher will utilize a similar methodology when planning the design of the prototype and the usability studies of the prototypes, in that several experimental design patterns will be tested and evaluated [3].

The final study this researcher found was titled “Design patterns for user interface for mobile applications”. This study built on previous work the researchers had done, but added a questionnaire that was distributed to participants who were mostly between 25 and 40 years old, were mostly male and had an average of 5+ years of user interface design experience. The results of the questionnaire showed that many of these designers found the recommended design patterns, provided by the researchers, both relevant and useful [2].

No analysis of usability and touchscreen computing would be complete without consulting the major software vendors for the mobile touchscreen device platforms. The three largest vendors of touchscreen mobile operating systems (Apple, Google and Windows) have all provided design guidelines on their respective websites. This researcher went to each site and read all the recommendations, and was surprised to see how different each vendor's approach was (please see Figure 1: UI Recommendations for Apple, Google and Microsoft). In summary, Apple was most concerned with creating a homogenous look-and-feel for all applications that run on the iOS platform, providing specific specifications and somewhat rigid guidelines that must be followed or developers run the risk of not getting their applications approved and distributed. At the opposite end of the spectrum, Google is most concerned with providing developers with the most robust, cutting-edge functionality and flexibility in user interface design. In other words, Android is very appealing to developers who want to create experimental designs or games while not being too concerned about getting their applications "approved". Google allows their application market to regulate itself to a degree [14]. Finally, Microsoft is perched somewhere in the middle, while taking a more pragmatic approach by emphasizing the combination of time-saving functionality with consistency in user interaction metaphors [8], [9], [10].

UI Recommendation	Google (Android)	Apple (iOS)	Microsoft (Windows 7)
Consistency in all visuals and in object manipulation or gesture use	X	X	X
Simplify all interactions/reduce complexity		X	X
Avoid using custom gestures		X	
Optimize all interactions to take least amount of time			X
Start application instantly – avoid splash or start-up screen on load		X	
Make all actionable targets finger-tip size		X	
Uphold aesthetic integrity		X	
Use direct manipulation of onscreen objects instead of separate controls		X	X
Use set of pre-made design patterns that mirror those already part of OS	X	X	
Walk through experience/get user feedback			X
Provide good haptic (i.e. vibration/sound) and visual feedback	X	X	X
Focus screen on primary task		X	X

Figure 2

Sources: [8], [9], [10]

4. SOLUTION APPROACH

The end result of this study will be a set of software design patterns and gesture use cases for mobile touchscreen software. This set will be created from the results of detailed usability testing utilizing a prototype application that will require users to perform a variety of commonly executed tasks on a mobile touchscreen platform.

The usability study will require the following steps:

1. Design and build a prototype application that contains the common usability issues that are being investigated.
2. Design the usability test script and questionnaire. The questionnaire will be given to the usability study participants. This questionnaire will ask subjective questions about the tasks the users performed. The answers to the questions will be out of a 1-5 scale to aid in quantifying the results. These results will also be used in the analysis and formulation of the design patterns.
3. Test the prototype and (informally) gather baseline statistics and metrics from a small sample of people using the initial prototype application (5-10 people).
4. The results from the initial prototype test will be analyzed and the prototype will be refined to include the experimental design patterns and gestures. Also, user feedback will be considered in the design.
5. The formal usability testing will be done with the redesigned application. Statistics and other metrics will be gathered from test subjects just as before (the goal is at least 385 total users). Please note: the overall structure of the prototype application and tasks the users will be asked to perform will be the same.

6. The results from round 2 of the usability study will be analyzed and the final conclusions formed and documented in this report.

The usability study will have the following objectives:

1. Test the nested list design pattern for utilizing lists of actionable items (see Figure 3 for a screen shot depicting scrollable lists that lack proper affordances).
2. Test the affect of text size on task outcomes.
3. Test the overall usability of the copy and paste functionality on the testing platform (an Android device). This test will determine how many times users attempt to copy and paste and fail on average.
4. Test the overall usability of users filling in basic form fields (there will be a form at the end to gather information from users about their experiences while taking the test).

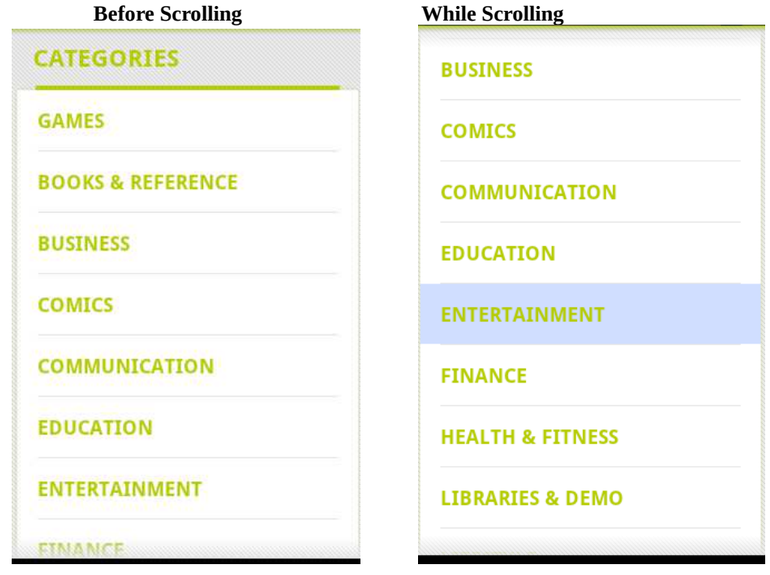

Figure 3: Android List Design Pattern Showing Little Affordances for Scrolling

For example, in order to test the nested design patterns for list usage, the application will require users to choose an item from a list that will require the user to scroll in order to find the item and to dig deeper into the nested items. For another example, when trying to test how text size played a role in performing a user task in a low light setting, this researcher will design the application to allow text resizing while performing the task. Another task will focus on testing the effect of text size while not allowing the user to resize the text. This text will purposefully be made very small. Finally, while trying to measure the overall usability of the copy and paste functionality that comes standard on Android devices (version 3.1), the prototype will ask users to copy a block of bold text and paste it into a text box below. If the user has trouble, a hint will be given to help the user complete the task in the prototype. Also, this researcher will, after one

minute's time, help the user to complete the task. The user will also have the opportunity to skip the task after 3 minutes.

This study will require an Android mobile phone for the testing. It will also require gathering around 400 total volunteers who will agree to perform the usability tests and take the questionnaire afterwards. The target user group will be college students. HU may not have enough students who are available and willing to participate and if this is the case, this researcher will go to other universities in the area and recruit students to participate (but only with the proper permission attained beforehand). This study may also necessitate recruiting volunteers to help administer the usability tests and record the results.

The total number of users needed for this usability study, using the common statistical Normal Distribution method, is at least 385. This researcher arrived at the figure by assuming there are at least a million mobile touchscreen users in the United States, by allowing a 5% margin of error/needing a confidence level of 95% and by assuming a response distribution of 50% [16].

The validity and quality of results will be dependent upon the software's internal measurements of user task outcome. The total time taken to complete the task, and the number of failed attempts will be recorded for each task the users perform. Statistical analysis will be performed on the results to detect any patterns in the data. Every reasonable precaution will be taken to assure that the measurement methods for each version of the prototype application and for each action performed within the prototype application will be consistent. Each task will be timed and the user will have to press a start button to initiate the timer and begin the task. The prototype's test-

ing structure will not change during the duration of the usability testing study. Finally, the instructions and environment will be set up the same for each user taking the usability study [16].

In addition, for the formal usability testing, there will be a strict policy that no usability study participants will be family of or friends with this researcher to assure that the results will be as unbiased as possible. The usability script will be clear, concise and will only state that the application is being tested as part of a student research project. The script will not mention that it is testing design patterns or what the goals of the study are. It will only give instructions specific to the tasks the users will be expected to perform. Participation will be voluntary only and any participant may stop the study at any time without penalty. Participants may be offered candy or any other small incentives as a “thank you” for participating. Any volunteers that may assist this researcher with the study will be trained and agree to follow the stipulations provide above [16].

5. WORK PLAN

This researcher expects to design and build the prototype and complete the usability studies in the fall of 2011 as part of ISEM 699 (for a task breakdown, please see Figure 3 below). This researcher also plans to gather enough data from the study results to write a thesis pertaining to improving usability on touchscreen devices. In the spring or summer of 2012, this researcher will prepare a separate proposal for the thesis and enroll in GRAD 699.

Proposed Due Date (Fall 2011)	Event
Aug. 28th - Sept. 3rd	Complete paper prototype of each application.
Sept. 4th - Sept. 10th	Complete shell of prototype application for Android devices.
Sept. 11th - Sept. 24th	Complete prototype application 1 utilizing standard recommended design patterns and gestures.
Sept. 25th - Oct. 1st	Complete usability test script with specific procedures to follow. Schedule a time/place to conduct usability study.
Oct. 2nd - Oct. 15th	Conduct informal study with baseline application that includes common usability issues.
Oct. 16th - Oct. 29th	Analyze usability study results, modify prototype to include experimental design patterns and gestures to test.
Oct. 30th - Dec. 8th	Conduct formal usability study with modified prototype that contains experimental design patterns and gestures (need a total of 400 people).
Dec. 9th - Dec. 17th	Analyze usability study results, prepare findings.

Figure 4: Proposed Timeline of Events in Usability Study

5. PROTOTYPE IMPLEMENTATION

This researcher has created a web application that can be used on most mobile touchscreen devices as of 3rd quarter of 2011 (phones, pads, etc.).

The following pages contain actual screenshots depicting the usability tasks users were asked to perform.

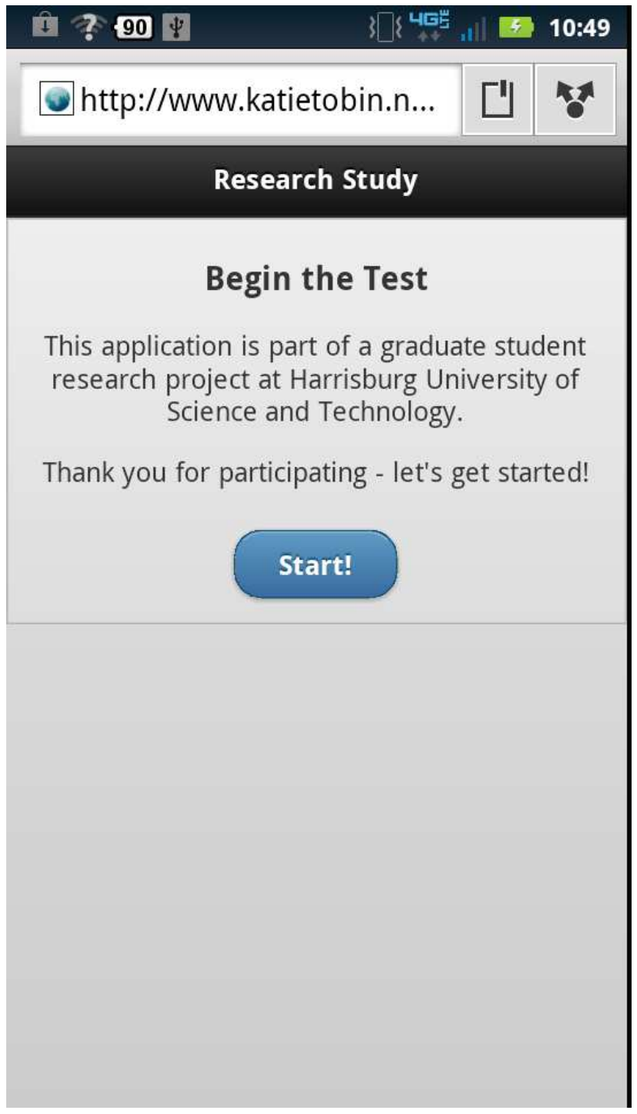

Figure 5. Usability Test Web Application - Start Screen

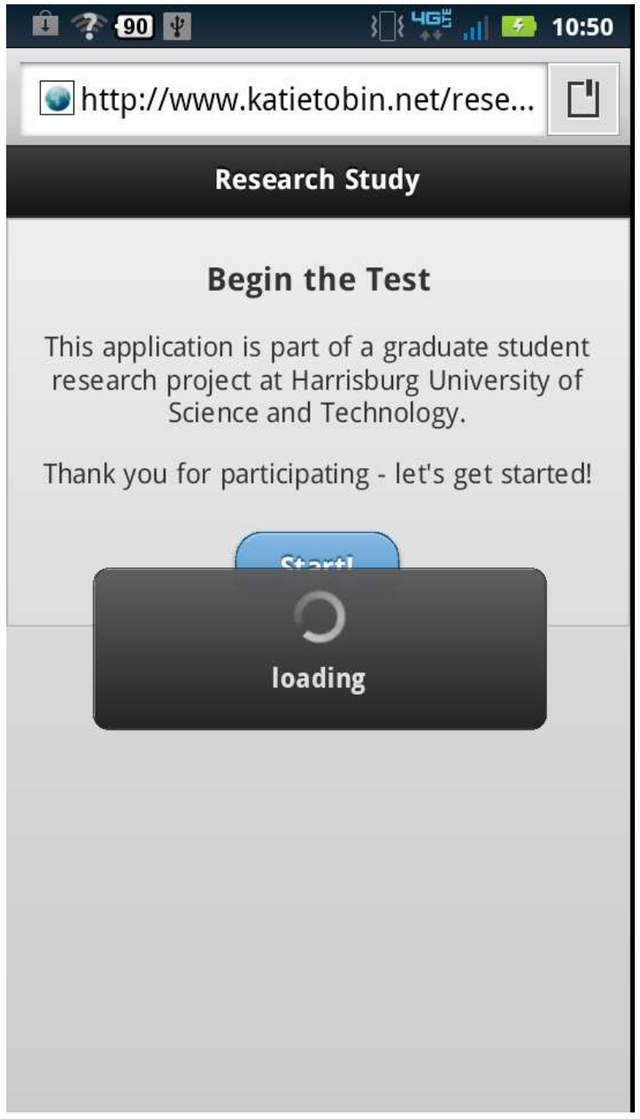

Figure 6. Usability Test Web Application - Loading Graphic

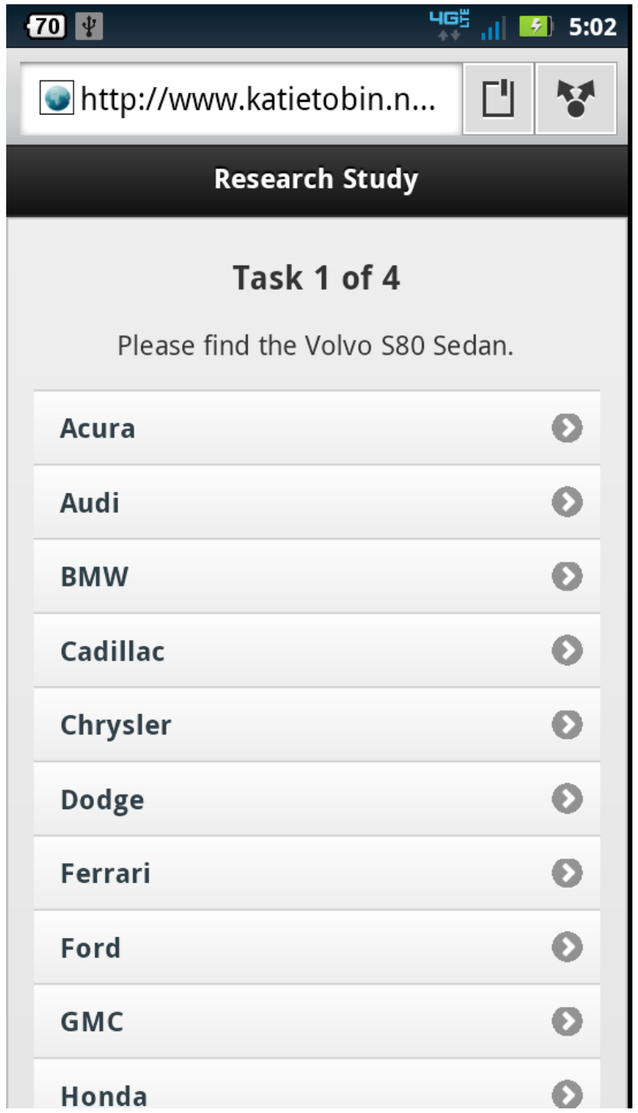

Figure 7. Usability Test Web Application - Task 1 of 4 Part A

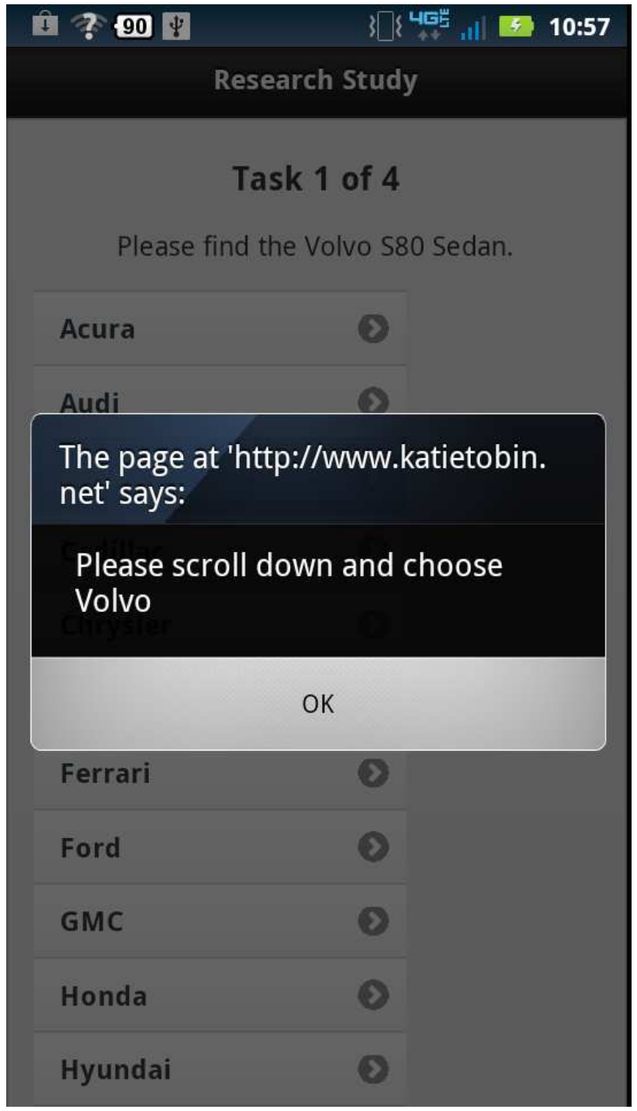

Figure 8. Usability Test Web Application - Task 1 of 4: Warning

The user will be warned if he/she chooses an incorrect option and will be reminded which option to search for and choose.

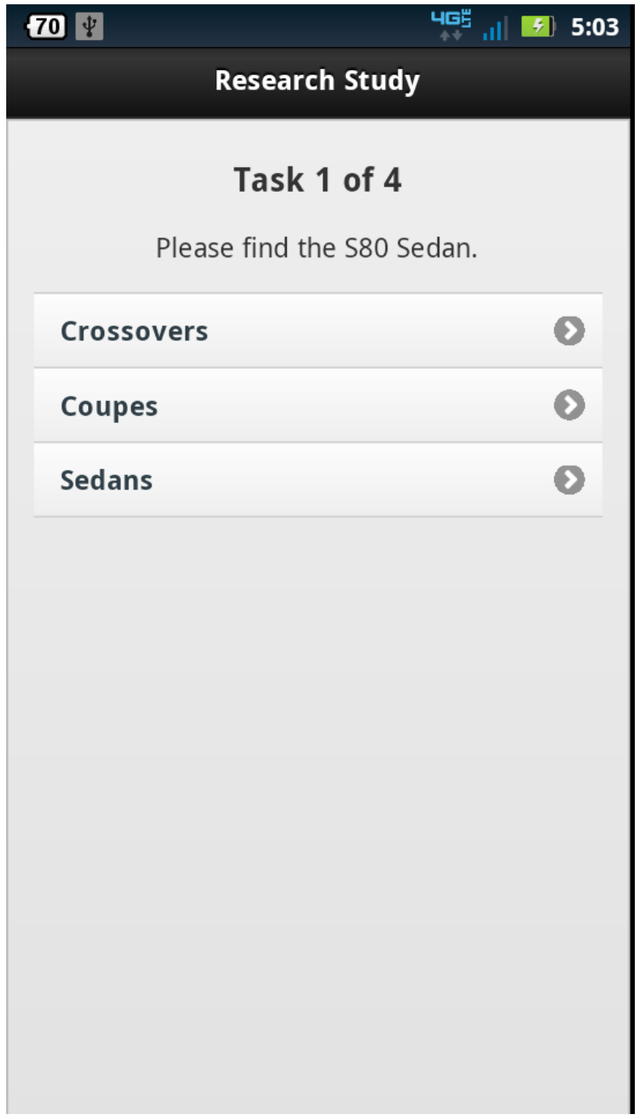

Figure 9. Usability Test Web Application - Task 1 of 4 Part B

Figure 10. Usability Test Web Application - Task 1 of 4 Part C

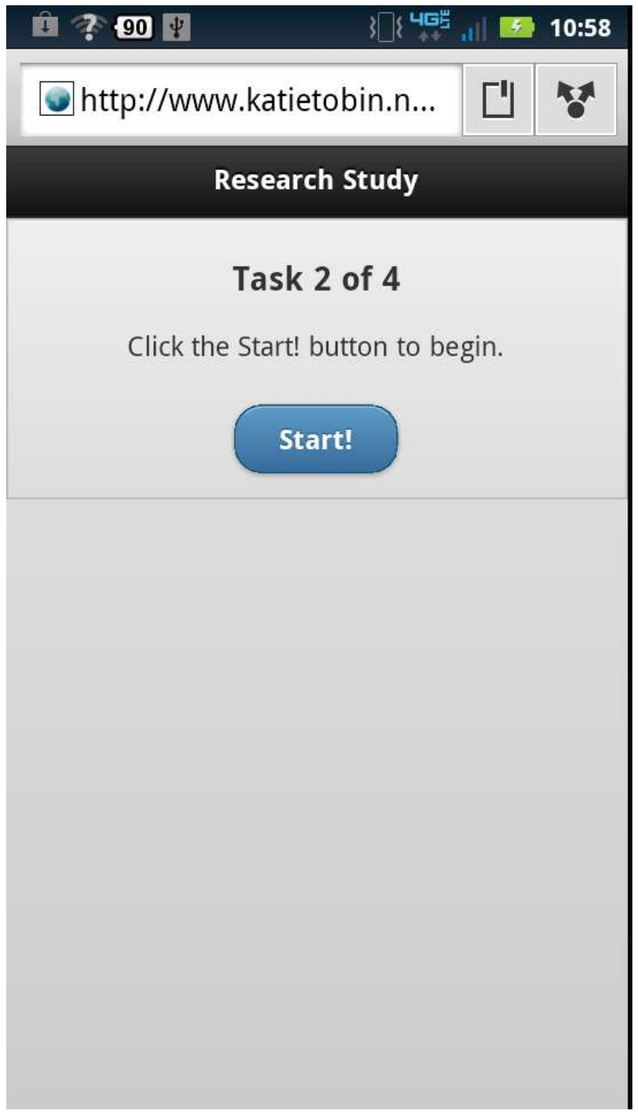

Figure 11. Usability Test Web Application - Task 2 of 4 Start Screen

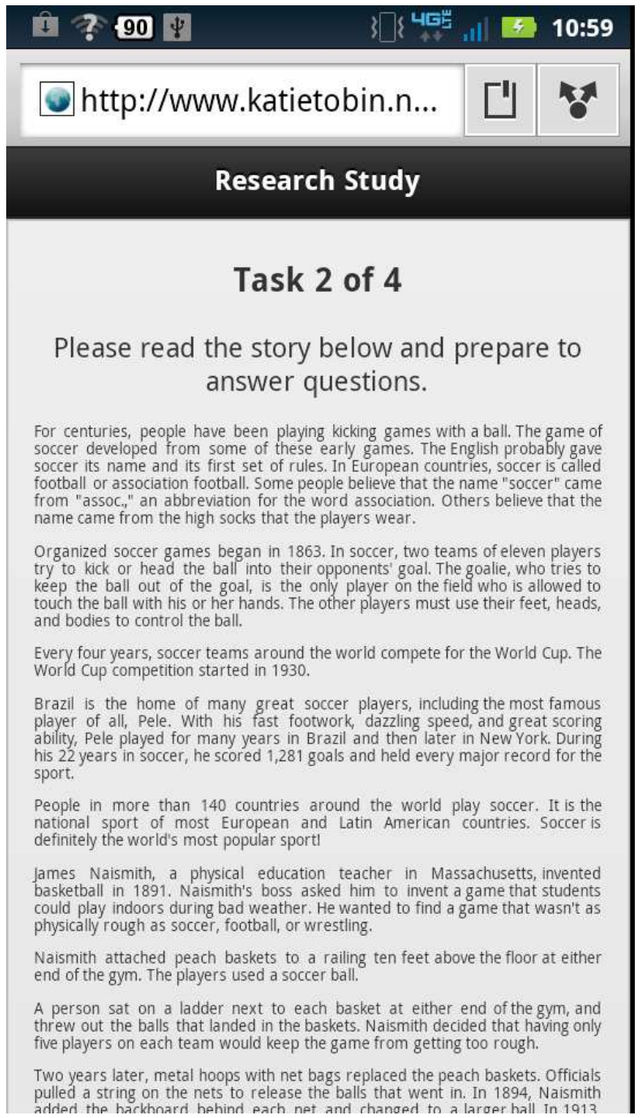

Figure 12. Usability Test Web Application - Task 2 of 4 Part A

Users will be required to read few paragraphs of text, intentionally made too small to read comfortably.

Figure 13. Usability Test Web Application - Task 2 of 4 Part B

The second part of task two asks users to answer questions about the what the user has just read on the previous screen.

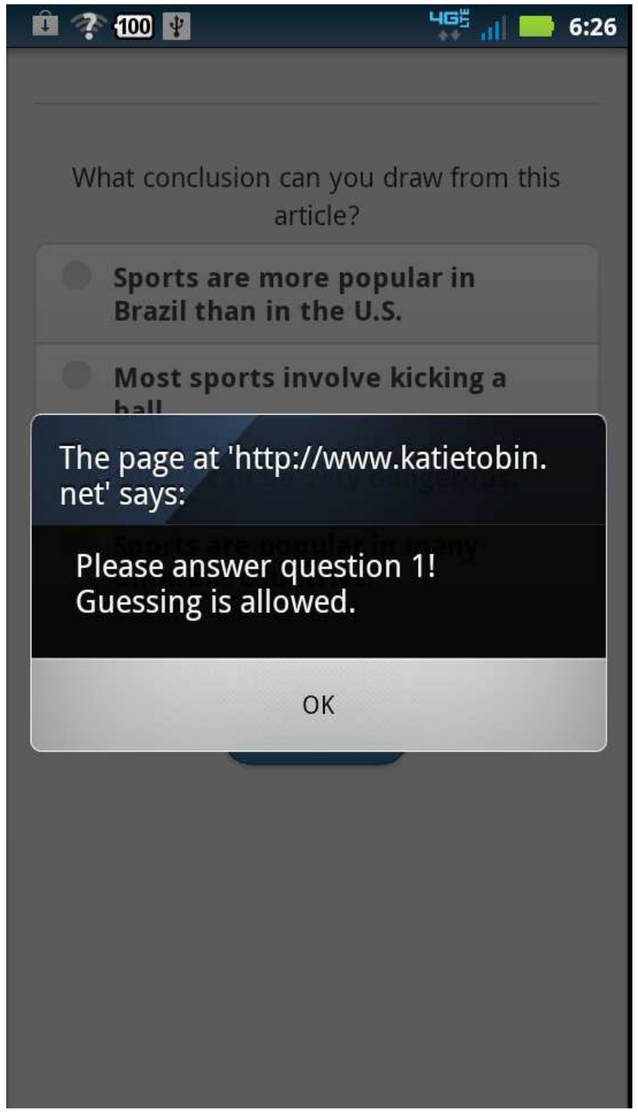

Figure 14. Usability Test Web Application - Task 2 of 4 Validation

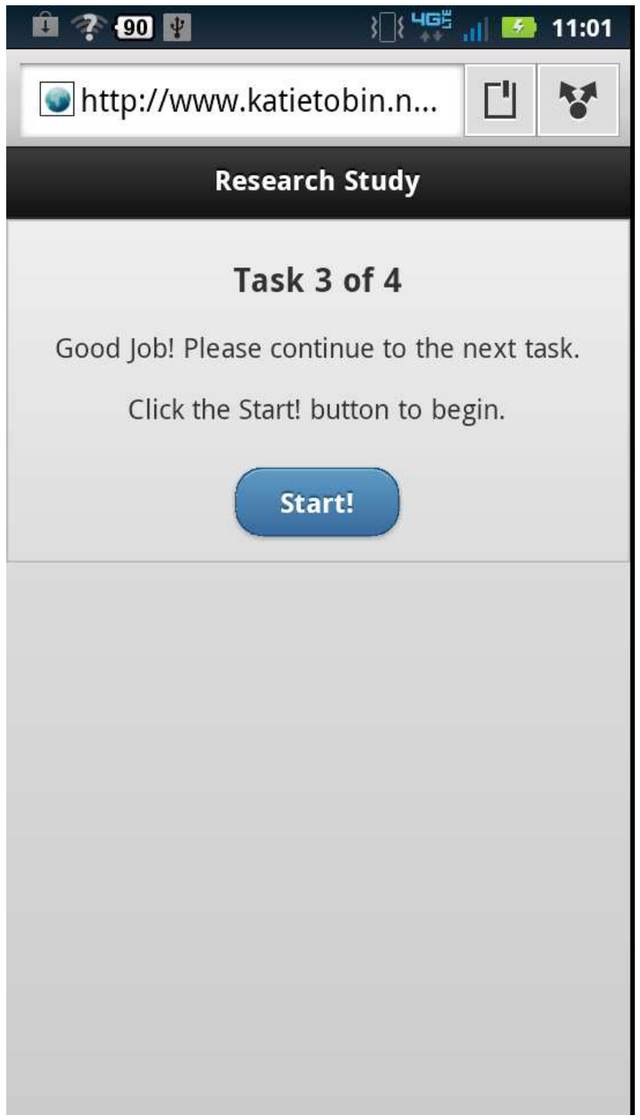

Figure 15. Usability Test Web Application - Task 3 of 4 Start Screen

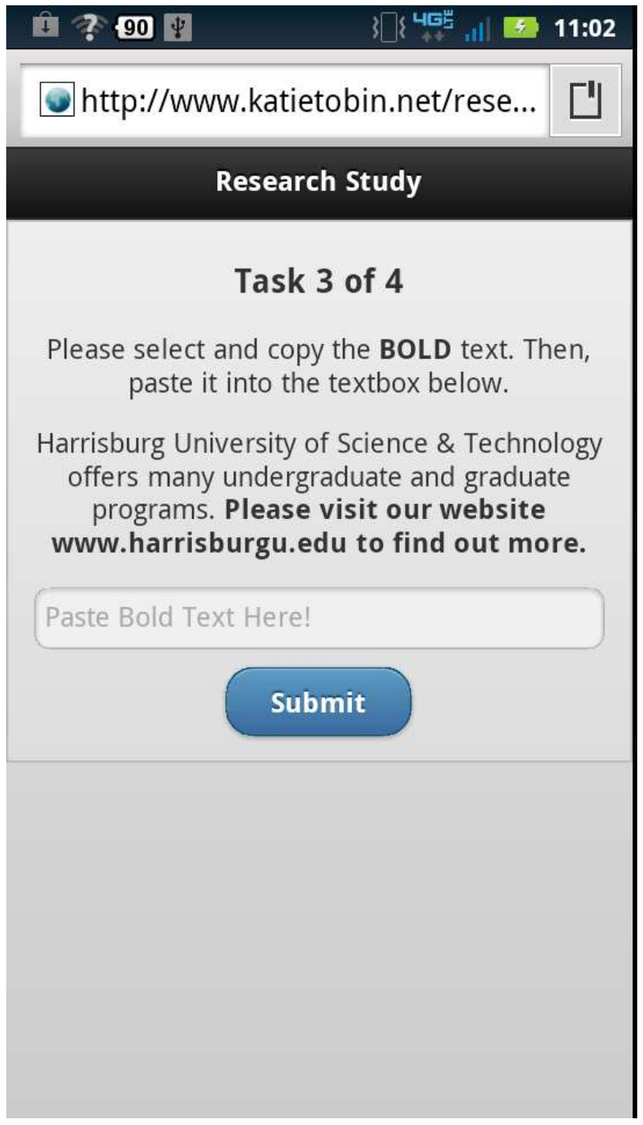

Figure 16. Usability Test Web Application - Task 3 of 4 Part A

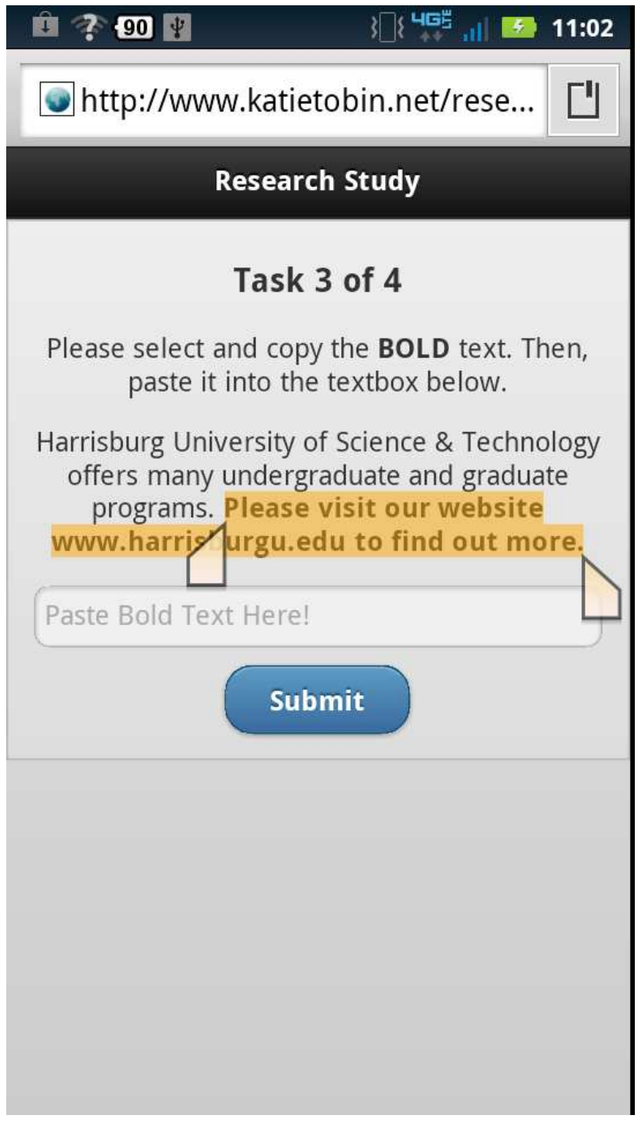

Figure 17. Usability Test Web Application - Task 3 of 4 Part B

Depicts a user selecting text to ‘copy’.

Figure 18. Usability Test Web Application - Task 3 of 4 Part C

A user has activated the selected text and can now Share selected text or Copy it.

Figure 19. Usability Test Web Application - Task 3 of 4 Part D

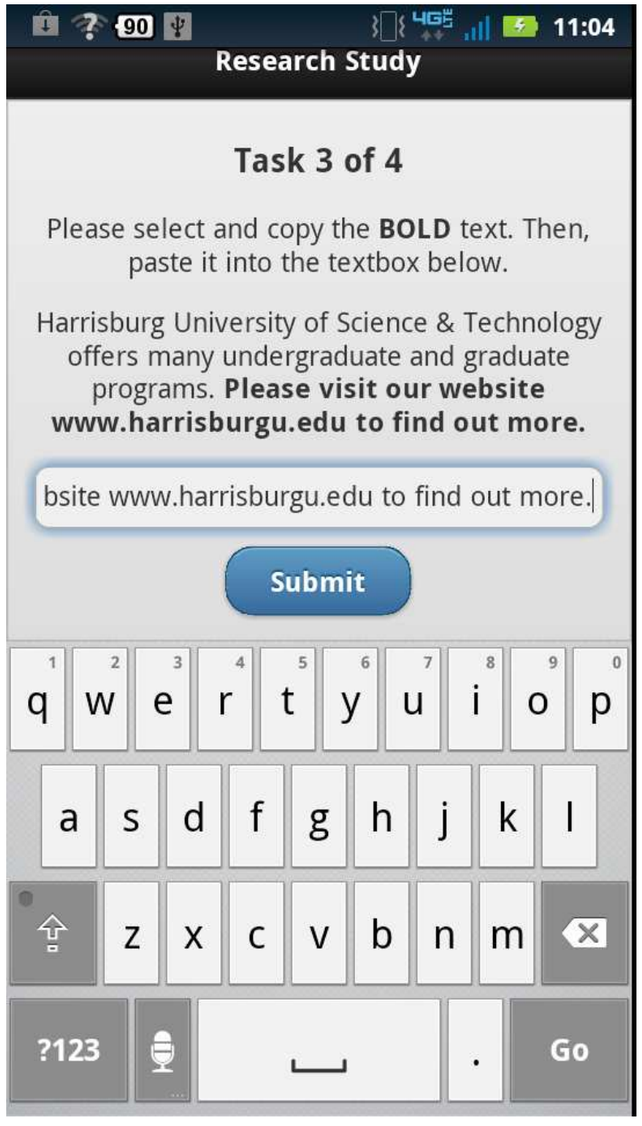

Figure 20. Usability Test Web Application - Task 3 of 4 Part E

Depicts copied text in the text box.

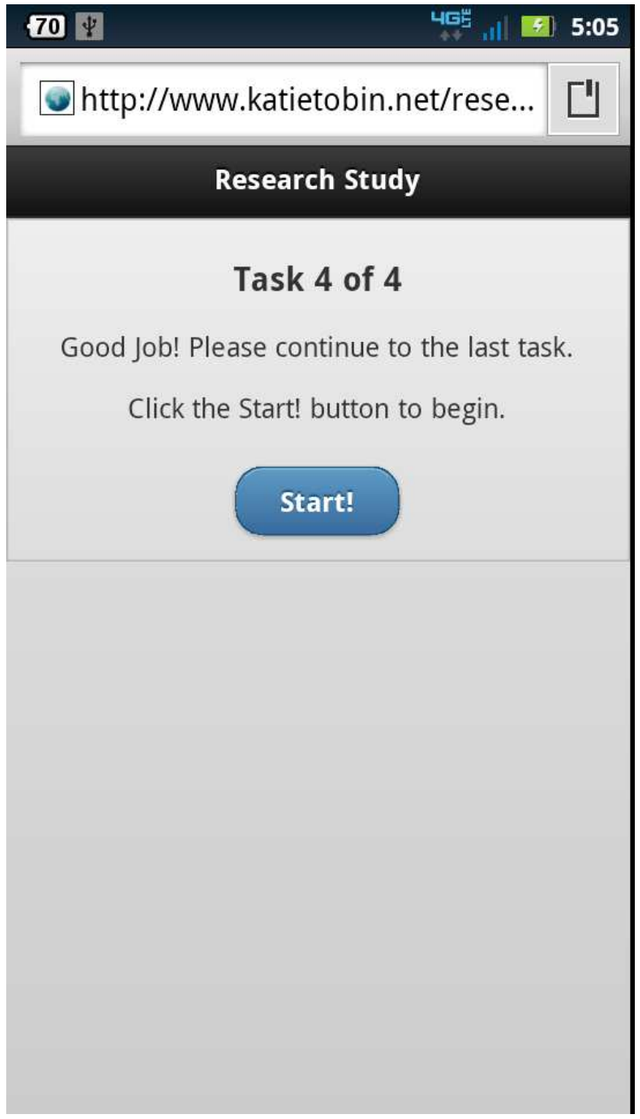

Figure 21. Usability Test Web Application - Task 4 of 4 Start Screen

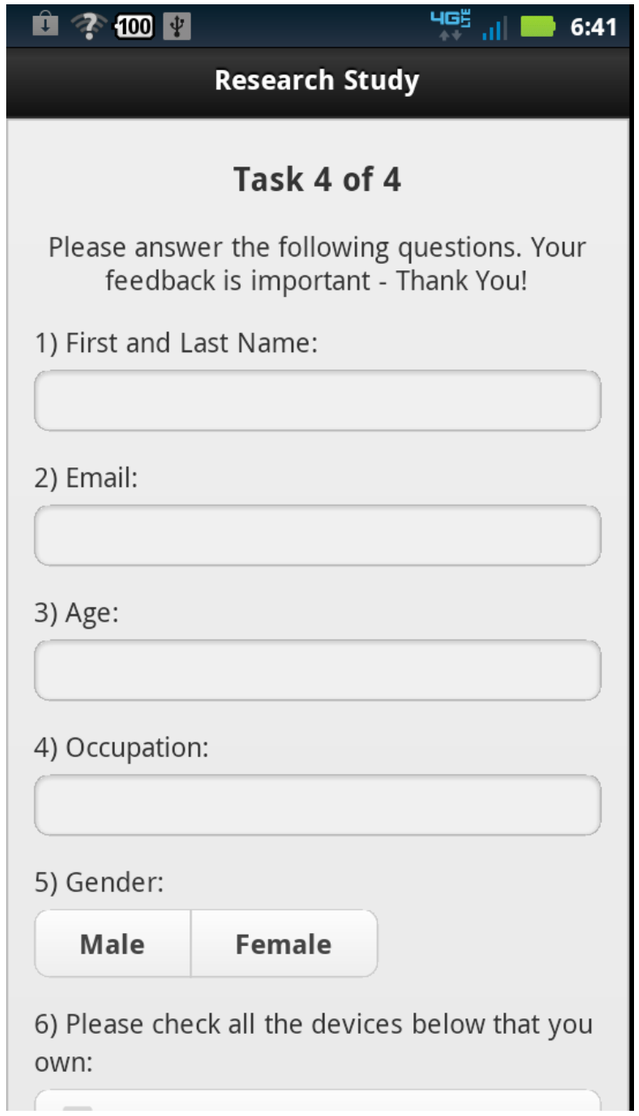

Figure 22. Usability Test Web Application - Task 4 of 4: Form Questions 1-5

Figure 23. Usability Test Web Application - Task 4 of 4: Form Question 6-6b

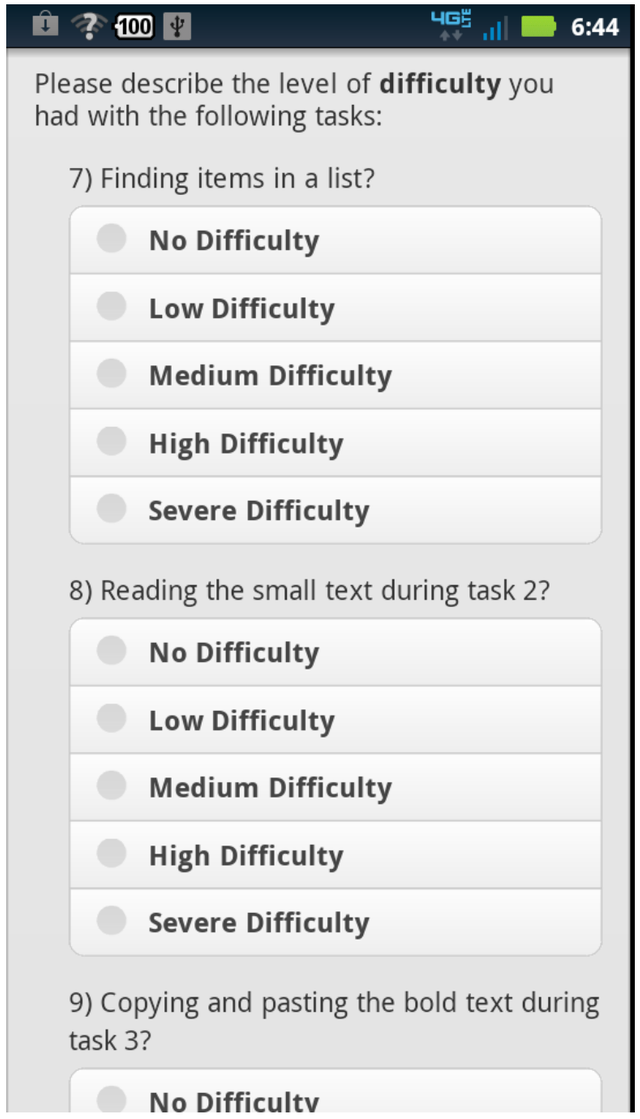

Figure 24. Usability Test Web Application - Task 4 of 4: Form Questions 7-8

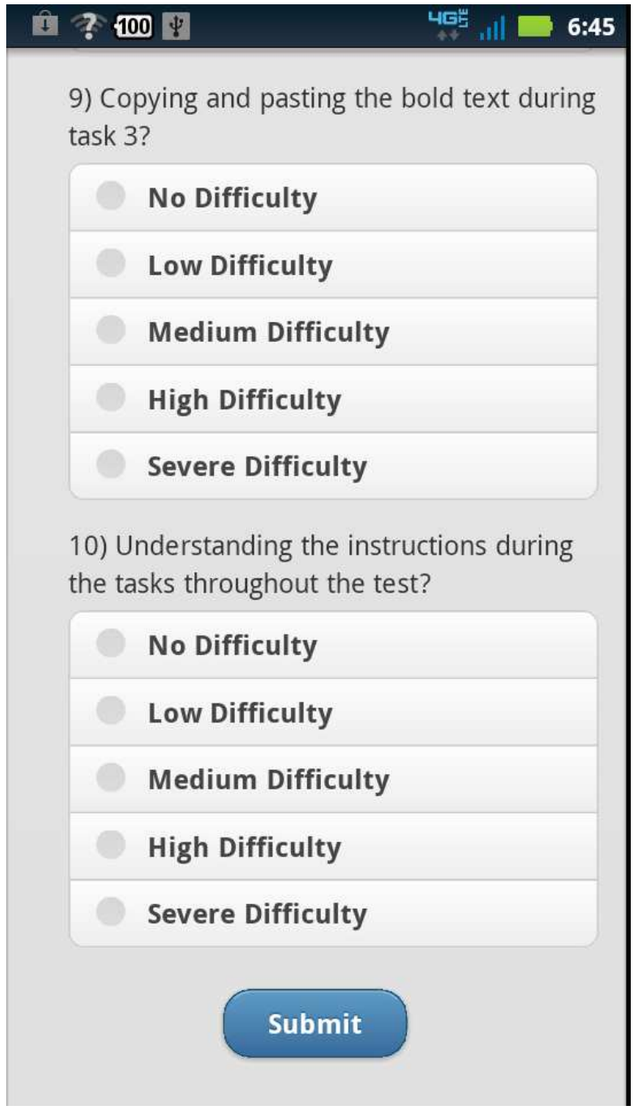

Figure 25. Usability Test Web Application - Task 4 of 4: Form Questions 9-10

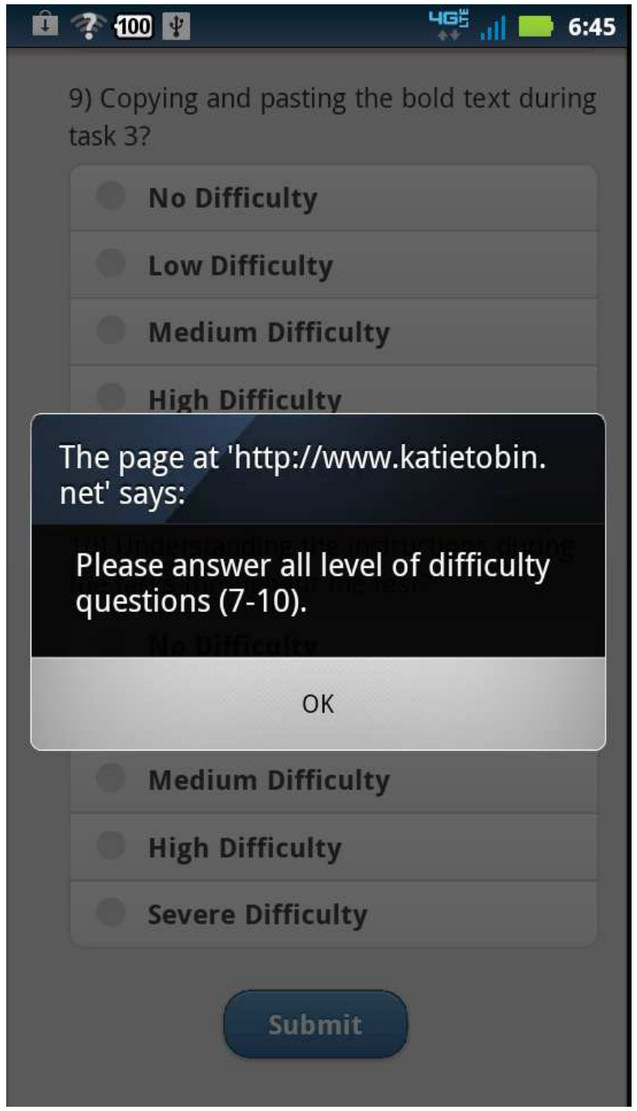

Figure 26. Usability Test Web Application - Task 4 of 4: Form Validation

Figure 27. Usability Test Web Application - Thank You Screen

Usability Test Script

Thank you for agreeing to volunteer as a subject for a student research project. You will be asked to perform a series of tasks. Please keep in mind that there are no wrong ways to accomplish the tasks. You are permitted to ask questions, but the researcher asks that you try to complete the task first on your own before asking questions. Also, as you are going through the test the researcher asks that you narrate what you are trying to do and thinking about. The researcher will take notes.

Privacy Statement

All information provided during the study will be kept confidential as part of the study. Study participants have a very small chance of being contacted via email to verify participation in the study. However, study participants are not required to respond, and will not be contacted for any further information. By participating and providing your information within the study's mobile device application, you agree to these statements.

Thank you!

Researcher Notes

Take notes on what users seem to struggle with or hesitate on and write down any questions asked by the user next for each task below.

Task 1:_____

_____

_____

_____

Task 2:_____

_____

_____

_____

Task 3:_____

_____

_____

_____

Task 4:_____

_____

_____

_____

Task 5:_____

_____

_____

_____

Did the user skip any tasks? Yes/No (circle one)

If yes, which ones? 1/2/3/4/5 (circle all applicable)

Notes on why tasks were skipped: _____

_____

_____

_____

_____

_____

Rationale for Each Task in the Usability Study

In order to expose the common problems users of mobile touchscreen software will run into, this researcher devised an application that would call upon many of the most common actions performed in a web application. The four tasks chosen were:

1. Finding an item in a set of nested lists.
2. Read a few paragraphs of very small text and then answer some questions to gauge reading comprehension.
3. Copy and Paste some bold text as instructed.
4. Fill out a questionnaire as directed.

This research observed a general lack of affordances in lists inside of many touchscreen applications and reasoned that finding items within a set of nested lists, may pose an even greater usability challenge for users to find the required information.

For the reading comprehension test, the text was purposefully made to be too small (9pt.) for the average reader to see easily without squinting. The way the standard browser renders the text and screen, makes it difficult to resize the text and also read it without scrolling from left to right. This researcher believes this is a basic usability flaw, present in many other applications, not just mobile touchscreen software. This researcher wanted to capture statistics on how many times a user had to scroll back and forth and change the screen orientation while trying to read the text. In addition, this researcher also wanted to gauge if this had a negative affect on reading comprehension of text presented in this manner.

In addition, the copy and pasting, navigating nested lists and filling out a form (the survey) tasks, this researcher wants to test how usability-friendly the default design patterns are while utilizing test subjects. The metrics gathered while administering the test will be compared against a base-line. This researcher will also have a group of users click through the web application on a standard PC. Metrics gathered during this phase will be the baseline of comparison between standard PC and touchscreen devices.

7. USABILITY STUDY RESULTS

This researcher was only able to recruit 10 subjects to use the application as part of the usability study. The website is hosted at http://www.katietobin.net/research and will remain there until the study is complete. As such, the results detailed below only apply to the 10 subjects who participated thus far.

The results for task 1 (finding items in a series of lists) were fairly consistent among users. All rated the task subjectively as none to low difficulty (4 none, 5 low). Only 1 out of 10 subjects had to ask for assistance in completing the task.

For task 2 (reading comprehension of very small text), all 10 subjects answered question 1 incorrectly, 2 out of 10 answered question 2 incorrectly and 0 out of 10 answered the 3rd question incorrectly. None of the subjects asked the researcher for assistance with completing the task. On average, it took the subjects 1 minute and 38 seconds to read the very small text. Subjectively, the subjects rated the difficulty of this task as low, on average (2 medium, 3 low, 2 none). Overall, this was another very consistent result amongst the subjects.

For task 3 (copying and pasting text into a textbox), 9 out of 10 users experienced some difficulty completing the task. These subjects required this researcher to describe and sometimes show them how to physically perform the gesture to copy and paste. A few subjects took 4-5 minutes to finally complete the task. The average completion time was 3 minutes and 6 seconds and was the task that took, on average, the longest for the subjects to complete (including task 10, which was to fill out a 10 question form, that took, on average, 1 minute and 27 seconds to complete).

Subjectively, the subjects rated the difficulty of this task as, on average medium (1 severe, 1 high, 4 medium, 1 low, 1 none) .

Finally, for task 4 (filling out a questionnaire form as directed) all 9 out of 10 subjects reported using a touchscreen device daily. Also, there were 8 males and 2 females who completed the study. The average time the subjects took to fill in the form was 1 minute and 27 seconds. This researcher also noted that some users (3 out of 10) accidentally pushed the “Go” button on the keyboard, which resulted in submitting the form prior to the user wanting this event to occur. Users were trying to hit a different key that was in very close approximate range from the desired key. Finally, 8 subjects rated their understanding of the instructions to complete the tasks in the study as having a difficulty level of none and 1 subject rated the difficulty level as low.

8. CONCLUSIONS REACHED

Currently, this researcher believes that more subjects need to be recruited to participate in the survey and more results from the study gathered in order to draw final conclusions. However, the results so far have consistently shown some areas that have proven difficult for many of the subjects. It seemed that on tasks where there are little affordances and feedback within the user interface interaction, the subjects struggled to figure out how to perform the tasks.

Nowhere was this most basic usability flaw more evident, than in task 3 (copying and pasting text into a textbox). This researcher observed that the subjects seemed to understand what to do, just not how to execute the complex set of gestures that consisted of pressing one finger over a part of the desired text to be copied and waiting until a section of this text was highlighted. Then, subjects have to drag each end of the highlighted section so that all of the desired text to be copied is highlighted. Third, the user must tap the highlighted text once, with a single finger and a modal window will pop over the screen. This modal window has two options: Copy and Cancel. After a subject chooses the Copy option, the user must then press on the text field for a moment until the textbox becomes “editable”. The keyboard will appear in the bottom half of the screen. A modal window will appear with two options: Paste and Cancel. Upon choosing the paste option, the subject will see the copied text pasted into the textbox. So it is no surprise that task 3 took the longest amount of time for the subjects to complete – 3 minutes and 6 seconds, on average. This was almost double what it took to read the very small text in task 2 or to fill in 10 fields on the form in task 4.

9. FUTURE WORK

This researcher intends to continue this investigation into usability issues on mobile touchscreen devices next semester in GRAD 699. This researcher will perform the following tasks:

1. Continue recruiting volunteers to take part in the usability study and record results
2. Conduct detailed literature survey utilizing secondary sources
3. Draw conclusions based on research results
4. Create recommendations for usability methodology for mobile touchscreen devices

9. REFERENCES

[1] Bragdon, Andrew, et al (2011), CHI2011, May 7–12, 2011, Vancouver, BC, Canada. *Experimental Analysis of Touch-Screen Gesture Designs in Mobile Environments*

[2] Nilsson, Erik G., (2009), *Design patterns for user interface for mobile applications*, Advances in Engineering Software, Vol. 40 1318-1328

[3] Pauwels, Stefan L., et al (2010), University of Basel, Faculty of Psychology, Department of Cognitive Psychology and Methodology, Switzerland. *Building an Interaction Design Pattern Language: A Case Study*

[4] Saffer, Dan, (2009), Designing Gestural Interfaces: Touchscreens and Interactive Devices, O'Reilly Media, Canada

[5] Stone, Roger, (yyyy?), Loughborough University, England, *Mobile Touch Interfaces for the Elderly*

[6] Unger, Russ; Chandler, Carolyn, (2009), A Project Guide to UX Design For User Experience Designers in the Field or in the Making, New Riders, Berkeley, California

[7] Wigdor, Daniel; Wixon, Dennis, (2011), Brave NUI World: Designing Natural User Interfaces for Touch and Gesture, Morgan Kaufman, Burlington, Massachusetts

[8] Android. User Interface Guidelines. http://developer.android.com/guide/practices/ui_guidelines/index.html. Accessed August 8th, 2011.

[9] Apple Inc. iOS Human Interface Guidelines. http://developer.apple.com/library/ios/#documentation/UserExperience/Conceptual/MobileHIG/Introduction/Introduction.html%23//apple_ref/doc/uid/TP40006556-CH1-SW1. Accessed August 8th, 2011.

[10] Windows. User Experience Design Principles. http://msdn.microsoft.com/en-us/library/dd834141.aspx. Accessed August 8th, 2011.

[11] Wikipedia. http://en.wikipedia.org/wiki/Affordance. Accessed August 6th, 2011.

[12] The Free Dictionary. http://www.thefreedictionary.com/WIMP. Accessed August 6th, 2011.

[13] Wikipedia. http://en.wikipedia.org/wiki/Design_pattern_(computer_science). Accessed August 6th, 2011.

[14] Android. Publishing to Android Market. http://developer.android.com/guide/publishing/publishing.html#market. Accessed August 15th, 2011.

[15] Kaneshine, Tom. CIO.com. Why Apple Owns the High End: First Mover Advantage. http://www.cio.com/article/499151/Why_Apple_Owns_the_High_End_First_Mover_Advantage. Accessed August 15th, 2011.

[16] Kumar, Ranjit, (2011), Research Methodology a step-by-step guild for beginners, Sage, Washington, DC

APPENDIX A

NUI Design Principles Considered [7]
Less is more: where possible, build on simple interactions in order to do more complex tasks
Interface control elements should not be presented if they are not needed
Most interface elements should emerge in response to user action only to communicate the state of the system or suggest next action or consequence of action.
Software developers should not change the state of the system mid-gesture
The number of system states should be few
The system must respond to every contact immediately
Make every transition fluid, no abrupt appearance or disappearance of objects - too jarring
Make interactions as realistic as possible by mimicking mass, acceleration, friction, viscosity and gravity
Controls for starting/ending should always be visible (do not embed major functions in menus)
All interaction metaphors start with physical manipulation and extend it
Enable users to manipulate content directly - rather than though interface controls. For example, use a scale manipulation (2-finger gesture to zoom in/out) instead of a zoom slider button.
Ensure all actions lead to either prompting for the next step in an action sequence or foreshadowing the state of system/object when action is finished
At appropriate times, show affordances that guide user to access the unseen content or functionality (example: a list of songs showing an incomplete list that when the user selects and moves will show more songs).

NUI Design Principles Considered [7]
Require explicit and intentional user input for destructive functions or to cause larger changes or transitions
Give users the opportunity to decide to undo or traverse their previous actions by foreshadowing what will happen next
Reduce number of features in an application, but provide “premium experience” for primary actions
Make sure essential features are immediately discoverable (For example, make a blank document load automatically in a text processing app, don’t make user select one in a menu first), but do not explain saving files and folders until user has something to save.
Encourage discovery through exploration so functionality is revealed as users continue through experience, but be sure visual responses communicate cause and effect
Demonstrate functionality wherever possible and
Make sure feedback contributes to better understanding of the system and its state. For example, when users touch a control, it moves to the front, grows, and displays a drop shadow, indicating a change in its position along the z-axis and reinforces position “on top” of the content.
Put users in control; don’t provide too many automated actions and keep controls enabled and logical at all times
To avoid the Fat Finger Problem make actionable targets larger. When this isn’t feasible, designers can auto-target main items on screen so that when user touches near one, the nearest one is selected (like first person shooter games). Or they can create iceberg targets that are larger than the item being selected.

NUI Design Principles Considered [7]
Mobile phone users predominantly use thumbs, while touchscreen or tablet users can use more fingers and arms may be outstretched