THESIS

A MIXED-METHODS ANALYSIS OF BEST PRACTICES FOR LAND-GRANT UNIVERSITY MOBILE APPLICATIONS FROM A USER EXPERIENCE DESIGN PERSPECTIVE

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ABSTRACT

A MIXED-METHODS ANALYSIS OF BEST PRACTICES FOR LAND-GRANT UNIVERSITY MOBILE APPLICATIONS FROM A USER EXPERIENCE DESIGN PERSPECTIVE

A content analysis of 30 mobile applications for the largest land-grant universities in the United States was conducted to examine the use of recognized best practices for mobile application development. A total of 49 variables were identified as best practices across five hierarchical categories of user experience (UX) design based on a model proposed by Garrett (2011). These included: visual design, user interface and navigation design, interaction design and information architecture, content and services offered, and functional and technical specifications. Based on quantitative scores for each of the variables, the best overall apps were identified and reviewed using qualitative description analysis. The best overall app was created by the University of New Hampshire; other top apps examined in the study were developed by the University of Arizona, Ohio State University, University of Florida, Washington State University and Michigan State University.

The findings revealed that it was very difficult for a mobile app to be exemplary in all five of the UX categories and thus comply with best practices. Analysis of the top six ranked applications portrayed how the UX categories and best practices interacted with and relied on one another to create a successful user experience. The study provided guidelines for universities to build more effective mobile apps and a foundation for further research into mobile application best practice measures, mobile app strategies, and the user experience of mobile applications.

ACKNOWLEDGEMENTS

Thanks to my family and friends who have supported me on this long journey through graduate school and the ups and downs of life these past three years.

DEDICATION

This thesis is dedicated to my father who always believed in me.

While you he is not here to see this day finally come, I know that he is proud!

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CHAPTER 1

INTRODUCTION

Statement of the problem

Mobile communication, while not a new phenomenon, has in recent years become an increasingly important topic for universities. With the outpouring of a variety of web capable mobile devices and a wave of incoming students that have grown up using smartphones, it is necessary for universities to develop a mobile presence.

The facts show that students, as well as faculty and staff, are utilizing mobile devices at a substantial rate (Jones, Ramanau, Cross, & Healing, 2010; Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013; Rainie, 2013; Amini et al., 2013; Johnson, Means, & Khey, 2013). While much research exists to provide statistics and facts about mobile usage, very little research exists about how universities should approach mobile communication and the development of mobile applications/mobile web. Knowing the current best practices in mobile development and determining if and how current universities are applying the user experience approach to mobile development will aid universities in the growth of their mobile strategy.

Rationale for the Study

As many universities begin to build their mobile initiatives or advance those that are already in place, this research will provide professionals with the background knowledge they will need to build an effective mobile communication strategy. Simply providing a comprehensive list of the best practices for mobile applications will be of benefit to universities. Taking this a step further and evaluating current university mobile applications with an eye toward – best practices and the user experience approach - will be beneficial for universities

going forward with mobile application development. This thesis begins with an assessment of the different types of mobile applications, which will be followed by an evaluation of why universities should establish or re-develop a mobile strategy and how they can do so.

Mobile Applications

According to Klein (2012), "A mobile application is a software application that works on a specific mobile device's operating system and is downloaded to the device to perform a specific set of functions." One of the great debates today in the mobile universe is whether to develop a mobile application or a mobile website. So why create a mobile application? McWherter and Gowell (2012, p. 17) state that while the decision of whether or not to create a mobile app is difficult, a mobile app helps create brand awareness and improves interactions with customers. One mobile analytics company Flurry, performed a study in June 2011, in which findings revealed that time spent using mobile applications surpassed time spent using mobile browsers in the United States (McWherter & Gowell, 2012, p. 17).

Mobile applications are categorized in various ways by different researchers. Some categorize mobile applications as simply mobile websites and native mobile applications (Sambasivan, Jon, Udayakumar, and Gupta, 2011; Heitkotter, Hanschke, and Majchrzak, 2012; Mikkonen & Taivalsaari, 2011). Others have added a third category to the mix, which has been classified as hybrid apps (Jobe, 2013; Budiu, 2013; Hellbom, 2013; Serrano, Hernantes, & Gallardo, 2013, Christ, 2011). Determining which type of mobile application to implement -- native, mobile web, or hybrid -- can be challenging. Understanding the nature of each application type, as well as the advantages and disadvantages of each is essential for the successful implementation of a mobile app.

Native Mobile Apps

Native mobile applications are installed onto the mobile device from an application store (Google Play or Apple's App Store), live on the device and are accessible from the device's home screen (Budiu, 2013). Jobe (2013) adds that, native apps are written and designed for one specific operating system, such as, Google's Android, Apple's iOS, and Windows, which are considered the three leading operating systems. When developing a native mobile application, it is paramount to know which devices to target, have the ability to test and certify the app, as well as have a strategy to distribute the app to the appropriate users (Fling, 2009, p. 78).

Mobile Websites

According to Budiu (2013) "Web apps [or mobile websites] are not real applications; they are really websites that, in many ways, *look and feel* like native applications, but are not implemented as such" (p. 1). Fling (2009) adds that mobile web apps do not require installation, but rather use HTML, or more recently HTML5, CSS, and JavaScript to create that "native app like feel" and can be accessed and run through any mobile web browser (p. 75). Interestingly mobile web apps, while accessed like any other web page, have the capacity for users to "install" them on their device by creating bookmarks (Budiu, 2013, p. 1). Mobile websites became extremely popular with the rise of HTML5, which enables native-like-functionality in a browser, which eliminates the need to develop device specific native apps (Budiu, 2013, p. 1).

Hybrid Apps

Hellbom (2013) defines hybrid apps as being, "mobile web apps placed in a native container that enable them to access the devices native functionality" (p. 14). Christ (2011) adds that hybrid apps combine the benefits of both native and web apps. To create a hybrid app, developers utilize a platform product such as Adobe's PhoneGap that enables developers to

create an app using HTML, CSS and JavaScript that is compatible with a variety for mobile devices (Traeg, 2014). Once an application is developed the HTML, CSS and JavaScript files are bundled into platform-specific deployment packages (Traeg, 2014). PhoneGap, which is open-source, is not the only platform utilized in the mobile industry to develop hybrid apps. Christ (2011) identifies three other platforms - Titanium, appMobi, and rhomobile – as popular for developing hybrid applications (p. 30). Despite hybrid apps combining the best of native and web, Serrano et al. (2013) warn about always considering the risks that come with the lack of control over the platform.

It is exceedingly important for large entities – colleges and universities for example – to develop a mobile strategy due to the overwhelming number of target populations and services offered. Determining what works and what does not, and following the best practices for mobile applications, will allow universities to create a strong mobile presence. Developing a mobile approach can be expensive and cumbersome, as is evident in the evaluation of the different types of mobile applications, so why should universities go mobile?

Universities and Mobile: The why and how of going mobile

Why Go Mobile?

According to the Nielsen Company, "Today's consumer is more connected than ever, with more access to and deeper engagement with content and brands, thanks to the proliferation of digital devices and platforms" (2014, p. 2). The Nielsen Company and the Pew Research Center's Internet and American Life Project are two of the most authoritative sources about technology, the Internet, and now mobile. Both companies perform extensive research every year to provide the latest information on technological trends and statistics.

Based on a nationally representative survey of 802 teens ages 12-17 and their parents -- performed by the Pew Research Center -- 78% of teens have cell phones, with nearly 47% owning smartphones (Madden, Lenhart, Duggan, Cortesi, & Gasser , 2013, p. 2). Findings also revealed that, of those that stated they were internet users, one in four teens say they prefer to go online on their phones rather than on a desktop or laptop computer (p. 2). In another Pew Study, Rainie (2013) found that cell phone ownership has hit 91% of adults and of those adults 56% have smartphones. According to Amini et al. (2013), the same trends are occurring within higher education:

> In 2011, 55% of students surveyed owned a smartphone and 33% deemed smartphones as extremely valuable for academic success, using them to e-mail professors (66%), check grades (62%), search the Internet (59%), and communicate with other students about coursework (61%) (Amini et al., 2013, p. 4).

Texas A&M University performed its own study to determine the use of mobile technologies on campus and found that 95% of students attending Texas A&M own a cell phone, 81% own a smartphone and 93% used their phone to access the Internet (Ritter, 2012, p. 6). Ritter (2012, p. 7) also found that 92% of students owning a mobile phone said they used apps. In another mobile device survey, at the University of Florida from 2010-2011, researchers looked at ownership and usage of mobile devices for students, faculty, and staff. Results revealed that 87.2% own a mobile device that has access to the Internet, 27.9% had iPhone's and 16.3% had Android/Google devices, while 71.9% said they use the Internet on their mobile device (Johnson, Means, & Khey, 2013, pp. 4-6). Incoming university students don't simply have a desire for mobile computing, but have an expectation that it is available and conducive to their needs (Amini et al., 2013, p. 4).

The incoming generation of college students, who have grown up with computers, mobile devices, and the Internet, have an acquired aptitude for using new technologies (Jones,

Ramanau, Cross, & Healing, 2010, p. 722). It would seem that this generation, often referred to as digital natives, has extreme confidence in their ability to use smartphones and mobile technology. In a study at Purdue University, Bowen and Pistilli (2012), asked students to characterize their level of smartphone usage as one of the following: (1) Novice – using a smartphone for calls, texting, and e-mail for less than six months, and having a few apps installed, (2) Intermediate – using a smartphone for more than six months and installing apps in the event of need or friend recommendation, (3) Advanced – using a smartphone for two years, using a variety of apps, evaluating differences in similar apps, and recommending apps to friends, and (4) Expert – I have developed my own mobile apps. The study found that 42% of students identified as Intermediate and 43% classified themselves as advanced (Bowen and Pistilli, 2012, p. 4). As the digital native generation continues to proliferate higher education institutions, due to their confidence in and desire for mobile technology, universities will have to focus their efforts on going mobile. In a survey conducted by Johnson, Means and Kay (2013), in 2010-2011, at the University of Florida results showed that:

> Most campuses provide a variety of services, from registration to fee payment to course activities to news about campus events, that students, faculty, and staff desire to access through mobile devices. As a result, it is increasingly likely that mobile access to services will become a decision point that will help prospective students and employees decide where to attend, where to work, and how to rank an institution. Therefore, it is increasingly important for institutions to "go mobile" (p. 11).

How to Go Mobile

Dixon (2012), discusses how it is important to determine the available options to implement technology effectively. For app development Dixon (2012) identifies two options at different ends of the spectrum: (1) "write it yourself options" which provide great flexibility but are costly to develop, and (2) "free, out of the box options", often referred to as vendor or white label apps, that can be implemented quickly but offer limited flexibility. Custom mobile apps

allow the freedom to define all the features as well as the global structure of the application. Maintaining a custom mobile app is expensive and most likely the job will have to be redone due to advances in technology. White label apps offer already developed and tested features along with a proven app structure. These apps offer a significant amount of flexibility with regard to branding and customizing (Dixon, 2012).

In a 2012 survey of 100 Universities in the U.S., Bishop (2012) found that of the universities with a mobile presence (90%), 32% were using an outside vendor, 49% were developing in house, and 19% were using an open source platform to implement their mobile apps. Some of the most popular and highly regarded vendors and producers of white label apps for higher education are Modo Labs, Ellucian, Blackboard Mobile, and campusM.

Overview of the Study

While the battle between native apps and mobile websites, as well as between custom and white label apps continues, there are certain best practices that are essential to explore and that pertain to any type of mobile app regardless of how it is developed. This thesis is divided into four additional chapters. Chapter 2, the literature review, will interpret best practice methodology and provide a representation of the current best practices for mobile apps. An evaluation of the concept of User Experience (UX) will follow, and the best practices will be categorized based on a User Experience approach. Chapter 3 will identify the methods used for this mixed methods study. A code sheet based on the UX categories and best practices was developed to evaluate current university mobile applications from a user experience perspective. Chapter 4 will include a discussion of the content analysis findings and a descriptive qualitative analysis of the top apps, to provide further insight into the nature of university mobile application development and design.

CHAPTER 2

LITERATURE REVIEW

Best Practices Methodology

Understanding proven best practices within the mobile industry as well as best practices specific to mobile in higher education, will allow universities to meet the needs of students, faculty, and staff, while addressing concerns about "IT infrastructure, planning and governance, security practices, support strategies, teaching and learning, and fiscal implications" (Dahlstrom & diFilipo, 2013, p. 4).

Although there is no unifying theory surrounding best practices, there has been some research that speaks to the methodology of the concept through the lens of applied fields such as public administration. Over forty years ago, Simon (1963) noted in his classic work, *Sciences of the Artificial,* that many applied fields shared a common concern over design and action. Bretschneider, Marc-Aurele, and Wu (2005) concluded that many of the same applied fields, such as medicine, management, computer science, and law, are now "concerned with how to improve actual performance through identification and codification of something typically referred to as a best practice" (p. 307). Bretschneider et al. (2005) adds that, "while most of the so called best practices literature comes from management consultants and practicing managers, it has also found its way into a variety of more academic settings" (p. 307).

It is evident that this concept of best practices came out of a need to understand what worked and what did not. What convolutes the concept of best practices is the lack of consensus on a definition. Vesely (2011) discusses how best practices research (BPR) uses the terms "best

practice", "good practice" and "smart practices" interchangeably (p. 100). As stated in "Best Practices", in the *Encyclopedia of Management* (2012):

> In a general sense, the term best practice refers to the most efficient way of doing something. The fastest method that uses the least resources (including labor and parts) to create the highest quality output is the "best practice." Almost every industry has adopted best practices in some aspect of its processes, but those that have made use of it successfully and publicly have typically done so in the fields of technology development, quality control, project management, education, manufacturing, health care, and sales ("Best Practices", p. 56).

Vesley (2011) explains that, "the primary goal of BPR [Best Practice Research] is to improve the working of a social institution, typically a business or a non-profit organization, by adopting certain principles of the working of another institution that appears more successful" (p. 103). Bretschneider et al. (2005), consider a best practice as the best option or action when compared to any alternatives when attempting to achieve a deliberative end (p. 309). Burton (2011) identifies best practices as stemming from the concept of benchmarking, in that when a process is uniform enough a best practice can be distinguished and accepted more or less "as is" by another entity (p. 115).

According to Stenström and Laine (2006) definitions of good practice are rather ambiguous due to the reliance on people, organizations, and the context in which the practice is identified. While the concept of good practice has been used inconsistently and employed differently, there are some commonalities surrounding the concept. "Good practice is the continual process of learning about, feedback concerning, reflection on and analysis of what works and why something, on the other hand, does not work" (Stenström & Laine, 2006, p. 12). A comprehensive definition for best practices is: A set of criteria, determined through research, specific to an industry that can be used by different organizations to measure the effectiveness of their own procedures or products in order to analyze and improve upon performance.

According to Blackboard Mobile (2011),

> When it comes to mobile, every organization has unique long-term needs, community expectations, and user requirements that extend beyond a specific technology or implementation. A mobile strategy is essential to the creation of an experience that reflects the priorities, values, and vision of your organization (para. 1).

To develop a strategy it is increasingly important to know how mobile apps and more specifically university mobile apps are developed most efficiently. In other words, evaluating the best practices for mobile application development and use will allow universities to create a successful mobile strategy. General organizations work specifically to determine "best practices" related directly to mobile. The World Wide Web Consortium, more commonly known as W3C, is an international community that works to develop web standards, and web application standards for mobile (World Wide Web Consortium, 2014). The App Quality Alliance (AQUA) is nonprofit group that works to develop and improve mobile application quality standards (App Quality Alliance, 2014). EDUCAUSE is a nonprofit association that aids IT professionals in transforming and advancing technology in higher education. EDUCAUSE (2014) has over the past few years done research specific to mobile communication development within higher education.

Mobile and mobile applications are relatively new topics within the research arena, and therefore little scholarly research exists about "best practices" for mobile applications and university mobile applications. Organizations like AQUA, W3C and EDUCAUSE, as well as various bloggers, white app mobile developers, and various whitepapers provide a conceptual foundation for evaluating the best practices or suggested practices of mobile applications and university mobile applications. Most of the best practices identified through this research can be categorized through a user experience perspective and will be identified in the following chapter.

User Experience (UX)

User Experience (UX) is a concept that has become an integral piece of the web and mobile industries in recent years. Similar to the concept of best practices, there is no one defining theory or concept pertaining to user experience. In the last decade researchers have begun to really define the concept and build practical models that break the concept down and provide a means to measure the user experience. Usability, user interface, information design, visual design, information architecture, interaction design, accessibility, desirability, credibility, navigation, functionality, control, feedback, consistency, error prevention, content and services offered, technical aspects, affect, user value, efficiency, effectiveness, and satisfaction are common terms often identified as being a part of the user experience (Morville, 2004; Garrett, 2011; Al-Khalifa, 2014; Park, Han, Kim, Oh, & Moon, 2011; Psomas, 2007).

According to Nielson and Norman (2014) "User experience encompasses all aspects of the end-user's interaction with the company, its services, and its products." The International Organization for Standardization (ISO) defines user experience in ISO 9241-110 (2010), a multi-part standard that addresses human-centered design for interactive systems, as "a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service." According to Harvey (2013), when discussing user experience software developers and web designers will often use the following related terms: (1) user-centered design, (2) user interface (UI) or graphical user interface (GUI), (3) usability, (4) human factors and ergonomics, and (5) human-computer interaction. Just as the ISO (2010) and Nielsen and Norman (2014) definitions indicate, user experience encompasses all of these concepts. "The goal of user experience design in industry is to improve customer satisfaction and loyalty through the utility,

ease of use, and pleasure provided in the interaction with a product" (Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos, & Sinnelä, 2011, abstract).

Research shows that the broad concept of user experience design can be broken down into seven distinct categories: (1) user needs or user goals (usability), (2) functional and technical specifications, (3) content strategy, (4) interaction design, (5) information architecture, (6) user interface, information design, and navigation design, and (7) visual design. Table 2.1 shows the user experience elements or categories identified through research and their prevalence.

Table 2.1: Elements of User Experience – Prevalence in Literature

Elements of the User Experience	Park et al. 2013	Garrett, 2011	U.S. Department of Health & Human Services, 2014	Psomas, 2009	Harvey, 2013	Design, n.d.	Stern, 2014	Lew & Olsina, 2013	DigitalGov, 2014	Cerejo, 2012
Visual Design	X	X	X	X	X	X	X	X	X	X
User Interface & Navigation Design		X	X	X	X	X		X		X
Interaction Design		X	X	X	X	X	X			X
Information Architecture		X	X	X	X	X	X	X	X	X
Functional/Technical Specifications		X			X			X	X	X
Content Strategy		X	X		X		X	X	X	X
User Needs/ User Goals/ Usability	X	X	X	X	X	X	X	X	X	X

As an alternative approach, a model proposed by Garrett (2011) will be used as the conceptual framework for this study. Garrett (2011, p. 29) classifies the above elements of user experience into five levels: (1) The Surface Level (visual/sensory design), (2) The Skeleton Level (interface design and navigation design), (3) The Structure Level (interaction design and information architecture), (4) The Scope Level (functional specifications and content requirements), and (5) The Strategy Level (user needs and product objectives). Combining these

five levels, the user(s), the developer or organization, best practices, as well as user feedback, -- all of which are key constituents in the user experience -- a model has been created that reflects a continuous flow between all of these entities (Figure 2.1). A developer would enter the user experience flow from the strategy level and continue up to the surface level and have a completed mobile application. The user would then enter the workflow and start their use or evaluation of the application at the surface level and continue down to the strategy level, at which point they would be able to determine if the application met their needs, which will in turn determine if they will be a future and repeated user of the application. The developer would then want to elicit feedback from the user(s) in order to step back into the process and make any necessary revisions that will advance their strategy and product to garner more use and meet user needs. The following sections will define each of the levels and elements of user experience design, in order to classify the mobile application best practices in the corresponding UX category. Since we are taking a developer perspective, the next section will begin with the most abstract user experience concept, user needs and product objectives and continue up the levels to the most concrete user experience element of visual or sensory design.

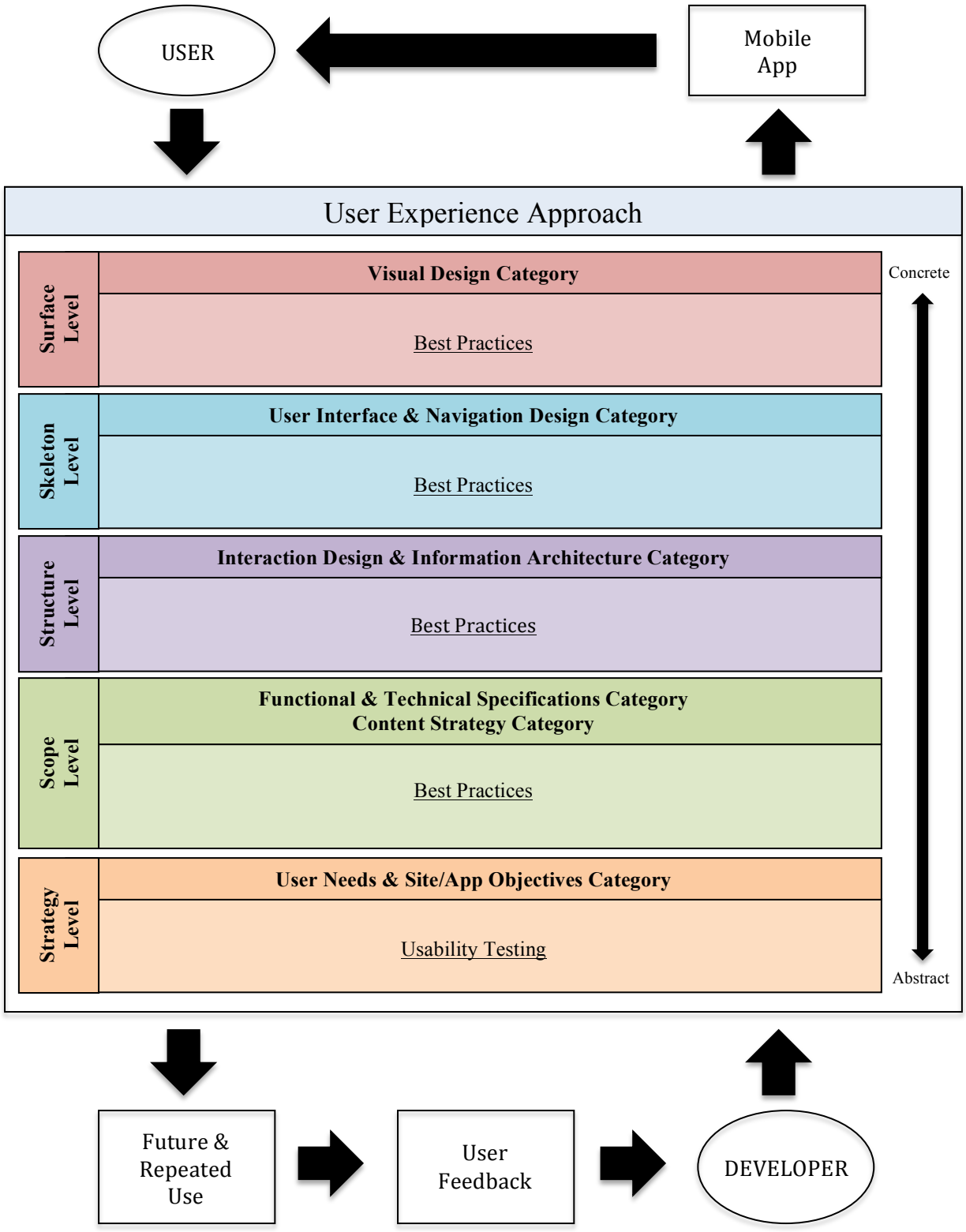

Figure 2.1: Mobile application user experience workflow

Strategy Level

User Needs/Goals and Product Objectives

As a foundation for the model, Garrett (2011) classifies user needs and goals as being a part of an organization's strategy.

> The foundation of successful user experience is a clearly articulated strategy. Knowing both what we want the product to accomplish for our organization and what we want it to accomplish for our users informs the decisions we have to make about every aspect of the user experience (Garrett, 2011, p. 35).

Stern (2014) takes an in-depth look at user goals and breaks the concept into five layers: (1) user types, (2) user needs, (3) user motivations, (4) user behaviors, and (5) user outcomes. User types looks at who the different users might be and where, when, and how they will use a product (Stern, 2014). Garrett (2011) states that user segmentation is a great way to divide the audience into more manageable, smaller groups that share key characteristics (p. 42). Identifying user needs, such as, personal progression, mastery, belonging, and expression are important to determining how a product can fulfill the user's goals. Next it is necessary to understand what motivates users to fulfill their needs. Understanding user's current behaviors will result in a greater likelihood of users "developing new habits and loyalty to a product and brand…The combination of needs, motivations, and behaviors can then translate into meaningful and measureable outcomes for users" (Stern, 2014). User research is integral to determining user types, needs, motivations, behaviors, and outcomes. There are a variety of approaches to user research that can be used individually or collaboratively to identify user goals. Garrett (2011) identifies the following as substantiated user research methods: (1) market research methods (i.e. surveys and focus groups), (2) contextual inquiry (i.e. "observing users in the context of their everyday lives"), and (3) user testing, in which users are observed testing an actual product. User testing is often referred to as usability testing, which "seeks to make products easier to use" and

is often applied in a web context (pp. 46-48). Once user and business needs or in other words a strategy are established, Garrett (2011) identifies scope as being the next essential element to the user experience (p. 29).

Scope Level

"Strategy becomes scope when you translate user needs and product objectives into specific requirements for what content and functionality the product will offer to users" (Garrett, 2011, p. 57).

Functional/Technical Specifications

Cerejo (2012) defined functionality in a mobile user experience context as the tools and features that enable a user to complete tasks and achieve their goals. Cerejo (2012) provides a few key guidelines for implementing functionality into a mobile application. A mobile application should "offer relevant mobile-only functionality (like barcode scanning and image recognition)" and "ensure that fundamental features and content are optimized for mobile. For example, make the phone numbers click-to-call" (Cerejo, 2012). Aside from providing functional features, in order for users to complete tasks and meet their goals, the application must work. Mobile application developers must take into consideration the speed at which an app loads and runs, the capability of an app to save settings when interrupted and/or when returning to the app, as well as the importance of security and privacy measures (Leggett, 2011; Cerejo, 2012; Al-Khalifa, 2014; App Quality Alliance, 2013). In other words the developer must understand and implement a variety of technical features to improve functionality.

Content Strategy

According to the U.S. Department of Health and Human Services (2014), "Content strategy focuses on the planning, creation, delivery, and governance of content." Content not

only refers to the words or text on the screen, but the images and multimedia as well (U.S. Department of Health & Human Services, 2014; Garrett, 2011). Nielsen (2011) identifies that users on mobile devices want to know the main points and therefore developers should avoid adding extra, secondary, fluff, especially since mobile apps should be designed for "quick information consumption." Any additional background material should be deferred to secondary screens for those who have additional time and a desire to find out more about a topic. Cerejo (2012) adds that mobile applications should present a balanced mix of content types, such as "product information, social content, instructional and support content, and marketing content." Multimedia should be used only when it adds value and supports the goals of the website and the user's tasks and users should be given control over multimedia. Content must also be appropriate for the context of mobile; it should be succinct, useful, up-to-date, consistent, and accessible to all people (Cerejo, 2012; Al-Khalifa; U.S. Department of Health & Human Services, 2014).

Al-Khalifa (2014) developed a framework for evaluating university mobile websites. One of the four categories Al-Khalifa identified, as being imperative to evaluating university mobile websites was content and services offered (p. 173). The following are the services Al-Khalifa (2014) included in his framework as being imperative on university mobile websites: (1) About the University, (2) announcements, (3) news, (4) events, (5) calendar, (6) maps, (7) emergency, (8) bus/shuttle information, (9) contact information, (10) directory of people/staff, (11) admission, (12) schools/colleges, (13) course catalogue, (14) library, (15) sports/athletics, (16) alumni, and (17) social media (p. 174). Developers must determine which of these services are essential to their strategy and incorporate content in those categories appropriately. Some of these services, such as alumni, sports/athletics, and library involve different audiences and user needs and it might be beneficial for a university to create multiple mobile applications that are

geared specifically toward these audience segmentations. No matter what, developers need to determine which content items and services are most important to their users and develop the scope of the mobile application around them. Once the scope, or the functional specifications and content and services offered are established a developer will need to determine how the pieces fit together into a cohesive mobile application (Garrett, 2011, p. 79).

Structure Level

Garrett (2011) identifies the structure level as the next element in the user experience. "The structure defines the way in which the various features and functions of the site fit together" (p. 20-21). Garrett breaks the structure level into interaction design and information architecture (p. 80).

Interaction Design

Interaction design is defined by Fling (2009) as the way in which a user can participate directly or indirectly with the application to accomplish goals and create a meaningful experience (p. 90). Due to interactive nature of mobile devices, especially with the proliferation of touch screens, mobile developers must consider the ergonomics, system interactions, device interactions, and mobile-specific interaction patterns in order to build engaging interfaces (U.S. Department of Health & Human Services, 2014; McVicar, 2013; Stern, 2014).

Ergonomics. According to The International Ergonomics Association (2014) "Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance." When considering ergonomics for mobile devices and interaction design, developers must "pay attention to device dimensions as well as the pragmatic concerns of touch screens" (McVicar,

2013). Determining the appropriate size(s) of touch areas to enable accuracy and confidence when users interact with mobile devices is a form of ergonomics in the mobile industry. Different mobile devices recommend different sizes for touch areas, though those numbers tend to range between 44px and 57px on standard screens and 88px to 114px on retina screens (McVicar, 2013).

System Interaction. Stern (2014) identifies system interaction as consisting of "navigation, flows, feedback, and notifications to help the user progress and achieve their goals." Giving users clues through appearance about how a feature will function, anticipating and mitigating errors, providing error messages when an error has occurred, providing feedback once an action is performed, and aiming to provide an immediate response time (less than 0.1 second) are specific ways in which developers can address interaction at a system level (U.S. Department of Health & Human Services, 2014; Stern, 2014).

Device Interaction. According to Stern (2014) "When designing for an experience it's key to understand the capabilities and constraints of the target devices, including screen sizes, connectivity, user interface conventions, and other factors." Gestures, geolocation, audio recording, camera capabilities, and push notifications are components specific to mobile phones and these as well as other mobile-specific features should be integrated into mobile applications to enhance the interactive nature of the app. Gestures are actions that all major touch operating systems employ that allow users to perform specific tasks. Some of the most common gestures used in touch technology include: (1) press, which in an iOS platform selects a primary action, (2) double press, enables zoom in or zoom out functionality, (3) small swipe, will reveal a delete button by sliding horizontally on a table view, (4) large swipe, allows for scrolling across content, and (5) pinch/spread, is another option for zooming in and out (McVicar, 2013).

Pattern Interaction. Stern (2014) identifies everything from headers and menus to calendars and maps as being patterns. McVicar (2013) adds that "some of the most valuable [interaction patterns] include those used to improve navigation, select content, sign in/out, and negotiate forms." Typical navigation patterns consist of the expanding menu, the side menu, the hub and spoke menu, the coverflow, and the flip over/peel back. When an application requires a username, email, and password, providing users with auto sign in and providing an option for the system to remember sign in details, will enable create a more positive user experience (McVicar, 2013). Filling out forms can be an extremely frustrating task on a mobile device. Saving or recalling user details by utilizing a login process and ensuring that the relevant keyboard is displayed for the task at hand (for example display the number keyboard when asking users to enter a phone number) are essential for creating effective forms with input capabilities. Interaction design can make or break a mobile application. Interaction is at the heart of mobile and mobile applications and it is therefore essential for developers to provide an intuitive interactive experience to elicit user satisfaction and repeated use.

Information Architecture

Just as interaction design emphasized patterns and sequences, information architecture deals with the sequences and options involved in presenting content to the user (Garrett, 2011, p. 80-81). Fling (2009) defines information architecture as, "The organization of data within an informational space. In other words, how the user will get to information or perform tasks within a website or application" (p. 90). "On content sites, information architecture is concerned with creating organizational and navigational schemes that allow users to move through site content efficiently and effectively" (Garrett, 2011, p. 89). McVicar (2012) identifies mobile devices as

having distinctive information architecture patterns: (1) hierarchy, (2) hub and spoke, (3) nested doll, (4) tabbed view, (5) bento box/dashboard, and (6) filtered view.

In a hierarchy pattern, information is structured with a standard index page and a series of subpages. Hierarchy patterns organize complicated site structures efficiently and are often associated with desktop architecture (McVicar, 2012). The hub and spoke pattern begins with a central index or "hub" and users navigate out. In order to reach another "spoke" users must navigate back to the "hub." The hub and spoke pattern is the iPhone's default pattern. This pattern is ideal for users focused on a specific task, but can become frustrating for users wanting to multi-task (McVicar, 2012). A nested doll pattern is linear and leads users from general to more detailed information and provides a perception of moving forward and backward. Nested doll patterns are "good for apps or sites with singular or closely related topics" and "can also be used as a sub section pattern inside other parent patterns, such as the standard hierarchy pattern or hub and spoke" (McVicar, 2012, Mobile Information Architecture: Nested doll section, para. 2). A tabbed view is a group of sections that are linked together through a toolbar or menu. Tabbed views allow for multi-tasking and quick understanding of the complete functionality of the app at initial launch (McVicar, 2012). The bento box or dashboard pattern allows for more detailed content to be displayed directly on the index screen. The pattern is better suited for tablet devices due to the complexity (McVicar, 2012). Filtered view patterns use filters and search options that allow users to explore content through alternative views. This pattern is effective for sites that contain large amounts of articles, images, and videos (McVicar, 2012).

Picking one of the above information architectures is dependent on context (business goals, culture, politics, technology, and resources), content (objectives, document and data types, and volume), and users (audience, tasks, needs, behavior, and experience), which is referred to as

the "information ecology" (U.S. Department of Health & Human Services, 2014). Cerejo (2012) identifies the following as key elements of mobile information architecture: (1) links to the main features and content are presented on the landing page, (2) users are able to navigate in as few taps as possible to the most important content, (3) navigation is broad and shallow not deep.

Skeleton Level

According to Garrett (2011) the skeleton level identifies aspects of the interface and navigation, which allows for further refinement of the structure in to something more concrete (p. 107).

User Interface

The design of the user interface "is all about selecting the right interface elements for the task the user is trying to accomplish and arranging them on screen in a way that will be readily understood and easily used" (Garrett, 2011, p. 114). Interface elements include: (1) input controls – buttons, text fields, checkboxes, radio buttons, dropdown lists, list boxes, toggles, and date fields, (2) navigational components – breadcrumbs, slider, search field, pagination, tags, icons, (3) informational components – tooltips, icons, progress bar, and notifications, and (4) containers – accordion (U.S. Department of Health & Human Services, 2014). When designing the interface of a mobile application it is paramount that developers create consistency in terms of action sequences, terms, layouts, and buttons. Navigation should be easy and intuitive, use native icons consistently, and support standard back button navigation where appropriate. User Interface elements such as text and graphics should display without distortion, blurring, pixilation, and aliasing, or in other words have a high level of visual quality. The interface of a mobile application should also be adaptable to landscape and portrait orientations on a mobile device (App Quality Alliance, 2013). With all of these complex elements available to

developers, the key to a successful interface design is simplicity (U.S. Department of Health & Human Services, 2014).

Navigation Design

According to Garrett (2011) "Navigation design is the specialized form of interface design tailored to presenting information spaces" (p. 108). Garrett (2011) identifies navigation design as consisting of three simultaneous goals that need to be accomplished: (1) navigation elements must be able to facilitate real user behavior by means of getting users from one point to another, (2) "the navigation design must communicate the relationship between the elements it contains", and (3) "the navigation must communicate the relationship between its contents and the page the user is currently viewing" (p. 118-119). Cardello (2014) does a great job of differentiating between navigation, information architecture, and user interface, all of which as Garret (2011) identified are interrelated as elements of the user experience approach. According to Cardello,

> The information architecture (IA) is not part of the on-screen user interface (UI) – rather, IA informs UI…Navigation is a collection of user interface components which can include, global navigation, local navigation, utility navigation, breadcrumbs, filters, facets, related links, footers, and fat footers (Cardello, 2014, What is website information architecture section, para. 1, What is website navigation section, para. 1).

Global or main navigation can take many forms in a mobile application including the following four options. One option is the expanding menu, which utilizes a menu icon (often three horizontal, stacked lines) housed in the header. When the icon is tapped a list of menu items is revealed. Another type of navigation structure is the side menu or sliding side menu. An icon is touched (similar to that of the expanding menu) and a menu expands or slides open to the side and displays a vertical list of menu options. A side menu will often have categories, as it is an effective menu for apps with a high volume of menu options. The next navigation option is

the tabbed menu. With a tabbed menu there is a static toolbar that is displayed in either the footer or header. Finally there is the hub and spoke menu option. Hub and spoke utilizes a central home screen that provides various menu options pointing to different sections. Returning home is achieved through a back button (McVicar, 2013)

Surface Level

Visual/Sensory Design

According to U.S. Department of Health and Human Services (2014) "Visual design focuses on the aesthetics of a site [application] and its related materials by strategically implementing images, colors, fonts, and other elements." Garrett (2011) identifies visual design as the aspects that the user will notice first and classifies visual design as belonging to the surface plane. According to Garrett (2011) "Here, content, functionality, and aesthetics come together to produce a finished design that fulfills the goals of the other four planes [strategy, scope, structure, and skeleton]" (p. 141). Specific components of visual design include: (1) contrast, (2) unity or consistency, (3) typography, (4) visual hierarchy, (5) brand consistency, (6) texture, shape, and space (Psomas, 2007; U.S. Department of Health & Human Services, 2014; Garrett, 2011). McVicar (2014) classifies designing for mobile in terms of designing for communication. In other words, communication can be enhance through visuals and imagery, and the overall user experience can be improved by providing good visual styling that supports the purpose of the application.

Contrast. "Contrast between colors on a page both draws attention to page elements and enhances readability" (Barnes, 2010, p. 171). Contrast is a great tool for creating emphasis and can be accomplished through the use of different sizes, colors, and direction (U.S. Department of Health & Human Services, 2014). McVicar (2014) adds that creating contrast between content

and functionality will help communicate connections and actions within the interface. “Using a mix of neutral and bright colors, or colors at opposing ends of the color wheel will ensure that specific items stand out to the user” (McVicar, 2014). Contrast between headlines, type, buttons, as well as backgrounds will improve functionality of the interface and improve ease of use for mobile app users.

Unity or Consistency. Consistency is one of the most important elements of visual design, as it applies to all other elements including but not limited to color, typography, space, and visual hierarchy. In fact “unity has to do with all elements on the page visually or conceptually appearing to belong together. Visual design must strike a balance between unity and variety to avoid a dull or overwhelming design” (U.S. Department of Health & Human Services, 2014). Research shows that consistency in visual design leads to fewer errors, reduction in task completion times, increased user satisfaction, and reduction in learning time (Galitz, 2007). Creating usable layouts is a great way to establish a sense of unity or consistency across a mobile application. Grid-based layouts help establish a consistent visual design.

> The structure of evenly spaced vertical lines acts as a guide for arranging content. The grid identifies event spaces, making it easier for designers to determine the most effective placement for buttons, headlines, or images. Placing these components along a grid helps to lead users on their journey, while simultaneously creating a clean and aesthetically pleasing visual (McVicar, 2014, Usable layouts: structure of the layout section, para. 1).

Consistency can make or break a mobile application and applying the concept to all aspects of mobile application visual design will create a stronger overall user experience.

Typography. The arrangement, style, and appearance of text is referred to in the design world as typography (Bennett, 2005). “Whether or not a site is readable impacts its credibility” (Barnes, 2010). Choosing the appropriate size, alignment, color, and spacing of fonts/type are key elements to an effective visual design. Galitz (2007, p. 169) states that the characteristics of

fonts [such as size, alignment and color] are great tools for organizing and identifying the important screen elements, establishing reading order, and generating specific moods. Research reveals that when working with large blocks of text it is ideal to keep fonts and text elements simple. More specifically it is advisable to use familiar fonts such as Arial or Verdana to achieve the best reading speed and not to use more than two font families, e.g. Arial and Times New Roman (Galitz, 2007, Garrett, 2010). One of the easiest ways to keep fonts simple, yet establish differentiation is to use different sizes of the same font (Bennett, 2005). Garrett (2010) adds that when working with headlines or short labels, such as navigation elements, it is appropriate to use fonts with "a little more personality" (p. 147). The key to good typography is to eliminate visual clutter, establish a visual hierarchy through the use of different font families, font sizes, and font colors.

Visual Hierarchy. According to Barnes (2010) "A visual hierarchy is a group of visual (and verbal) elements arranged according to emphasis in a layout" (p. 171). Visual hierarchy is often created through the use of different font sizes, colors, as well as spacing of elements and content sections on the screen. Creating hierarchy through visual design creates what McVicar (2014) refers to as vertical rhythm, which aids in the communication and therefore understanding of content within mobile applications (McVicar, 2014; U.S. Department of Health & Human Services, 2014). Utilizing a grid system can aid a mobile app in creating visual hierarchy and vertical rhythm. "The structure of evenly spaced vertical lines acts as a guide for arranging content. Placing these components [buttons, headlines, or images] along a grid helps to lead users on their journey, while simultaneously creating a clean and aesthetically pleasing visual" (McVicar, 2014).

Brand Identity. "Enforcing design consistency across media presents your audience – customers, prospects, shareholders, employees, or casual observers – with a uniform impression of your brand identity" (Garrett, 2011). Brand identity should be evident throughout the visual design from navigation elements appearing consistently across all screens, to the color palette, as well as the use of a logo or other brand identifier (Garrett, 2011).

Texture, Color, Shape, and Space. Lines, shapes, texture, and space are all basic elements of visual design that can engage users and help build trust and interest in a brand (U.S. Department of Health & Human Services, 2014). Lines define shapes, create space, and produce texture. While shapes can be created with lines, they are also defined by variations in color and texture. Color helps to create depth, emphasis, and aids in the organization of information (U.S. Department of Health & Human Services, 2014). Texture is often used to enhance detail, which in turn makes elements of a design appear more realistic. Texture is also used to make empty space more visually appealing, and often creates a sense of depth when used as backgrounds (Bennett, 2005). The use of space within visual design works to "reduce noise, increase readability, and create illusion" (U.S. Department of Health & Human Services, 2014). Space also plays an important role in the functionality of the mobile interface. "It is essential that users can explore content without committing to an action that they did not intend, and without activating an item when they were attempting to scroll. In other words, the spacing between elements must be sufficient to allow a user to easily navigate through these elements" (McVicar, 2014). The elements of visual design, like space, are not only essential to create an aesthetically pleasing mobile application, but it is these concrete visual details that the user will see first and the success of these elements will dictate the entire user experience.

Garrett (2011) stated that user experience design "means taking into account every possibility of every action the user is likely to take and understanding the user's expectations at every step of the way through the process." He also adds that, "By breaking the job of crafting the user experience down into its component elements, we can better understand the task as a whole" (p. 19). By evaluating university mobile applications through these component elements it becomes apparent what best practices associated with the user experience design process are being utilized effectively and which could be improved upon within university mobile apps. Table 2.2 provides a comprehensive summary of the mobile application best practices and their corroborating user experience categories. The five user experience elements that will be evaluated in this study are listed horizontally across the top of the table. Below the user experience elements are the university mobile application best practices that will also be assessed in this study. There are eight to ten best practices that are listed vertically below their respective user experience element.

Table 2.2: User Experience Elements and University Mobile Application Best Practices

USER EXPERIENCE ELEMENTS				
Functional & Technical Specifications	**Content & Services Offered**	**Interaction Design & Information Architecture**	**User Interface & Navigation Design**	**Visual & Sensory Design**
BEST PRACTICES				
Privacy Policy *App provides a clearly visible link to the privacy policy and/or terms and conditions*	**Organization** *Content and services offered are organized efficiently for easy navigation (i.e. by target audience)*	**Gestures** *App employs gestures that are consistent with the operating systems standards*	**Page Titles** *App provides descriptive yet concise page titles that clue the user into the content of the page*	**Contrast** *App uses high contrast color schemes (mix of neutral and bright colors)*
Trustworthy *App provides user with a sense of security and is transparent (informs users about what personal information is required, who it will be shared with, and why)*	**Target Audiences** *Which of the following audiences does the app target? Select all that apply (Current Students, Prospective Students, Faculty/ Staff, Campus Visitors, Donors, Alumni)*	***Walkthroughs*** *Overlay instructions or coach marks are provided upon initial launch to show users how to use different features of the app when deemed necessary*	**Consistent Interface Design** *The interface of the app is consistent – when app directs users to webpages they are mobile friendly and fit with the app interface design*	**Visual Hierarchy** *App creates a sense of visual hierarchy and flow (i.e. elements are arranged according to emphasis in the layout – different font sizes, colors, spacing elements, and sections)*
Load Time & Speed *Load time & speed is acceptable for the purpose of the app and does not alter the user experience – is controllable*	**Succinct Copy** *Copy is reflective of the main points that are ideal for quick information consumption. Additional info is deferred to secondary screens*	**Error Messages** *App provides helpful error messages when a task does not go as planned (i.e. messages when login fails)*	**Orientation** *App supports landscape and portrait orientation and is capable of rapid transition between orientations*	**Typography** *Fonts and text elements are simple and readable; No more than 2 fonts are used throughout the app*
Interruptions *App has the capability to accept an incoming call while running*	**Logo/Name** *The university name and/or logo appear on the landing page or main page*	**Repeated Use** *App encourages repeated use through interaction with features of the app*	**Screen Space** *Design is for a single window or full screen. Main task is front and center*	**Texture & Shape** *App uses texture and/or shape to enhance detail and make empty space more appealing*
Continuation *App has the capability to resume tasks from the same place or a logical restarting point*	**Sharing Content** *App has easy access to social media platforms and the ability to share content to these platforms*	**Notifications** *App notifies user when it is leaving the app to access other phone features and apps*	**Graphics/Text** *Graphics and text are not distorted, blurred or pixelated*	**Unity & Consistency** *Colors, space, typography, and layout are consistent and create unity*

Opt-In Consent *App obtains opt-in consent prior to accessing location data and/or geo-tagging with photos and videos; provides an option to opt-out*	**Services Offered** *App offers services that are appropriate for a university mobile app; services offered are usable and enhance the user experience*	**Device Features** *App enables interaction with mobile device features (camera, location functions, and other apps available on the device)*	**Labels & Icons** *Labels and Icons are descriptive, clear, concise, and consistent (inform the user about what content will be provided when clicked)*	**Brand Identity** *The brand of the university is consistent throughout the app with the use of university colors, logos, and/or brand identifiers*
Function Progress *App provides visual indication of activity (i.e. prompt for user input, splash screens, progress bars, "please wait" text, etc.)*	**Multimedia** *Images and video are used appropriately to supplement content and provide a good user experience*	**Input** *Default values are displayed for input and appropriate keyboard is available when entering data (i.e. numbers are available when asking for a phone number)*	**Navigation** *Buttons and navigation are consistent; communicates the relationship between navigation elements and the content they are linked to*	**Color** *Color is used to give prominence to content items, demonstrate how items are connected, and helps structure content (i.e. separates content)*
User Feedback *App provides users with a means to contact the organization with questions and/or provide feedback*	**Up-to-Date Content** *Content is updated with current and accurate information*	**Architecture Pattern** *App utilizes a consistent architecture pattern that is shallow not deep in nature*	**Button Size** *App uses appropriately sized buttons and touch targets (i.e. buttons are easy to click and react appropriately to touches)*	**Aesthetics** Overall design is aesthetically pleasing
Click-to-Call *App provides phone numbers that can be clicked and prompt the user to make a call*			**Horizontal Scrolling** *App avoids horizontal scrolling*	
Login Security *App asks users to login appropriately (i.e. when accessing personal info). Logins are not overused*			**Back Button Navigation** *App supports/uses standard back button navigation*	

CHAPTER 3

RESEARCH QUESTIONS AND METHODS

Research Questions

The user experience of mobile applications and more specifically university mobile applications is a complex ecosystem consisting of: user needs or user goals (usability), functional and technical specifications, content strategy, interaction design, information architecture, user interface, information design, navigation design, and visual design. Best practice methodology goes hand-in-hand with user experience, as both these concepts work to achieve an optimum product. In this case the product is a mobile application for a university, and by establishing the best practices associated with the elements of user experience, current university mobile applications can be evaluated to determine current mobile presence at universities as well as inform future university mobile application development. The following research questions will help establish a consensus as to how current universities adhere to user experience best practices for mobile applications.

RQ1: Do university mobile applications achieve functional and technical best practices?

By evaluating university mobile applications based on the following best practices compiled through research, I was able to determine if and how universities are achieving the functional and technical elements of user experience.

1. Load Time and Speed: Load time and speed of app is acceptable for the purpose of the app and does not alter the user experience by being uncontrollable
2. Trustworthiness: App provides user with a sense of security and is transparent (informs users about what personal information is required, who it will be shared with, and why)
3. Privacy Policy: App provides a clearly visible link to the privacy policy and/or terms and conditions
4. Interruptions: App has the capability to accept an incoming call while running

5. Continuation: App has the capability to resume tasks from the same place or a logical restarting point
6. Click-to-Call: App provides phone numbers that can be clicked and prompt the user to make a call
7. Opt-In Consent: App obtains opt-in consent prior to accessing location data and/or geo-tagging with photos and videos; provides an option to opt-out
8. User Feedback: App provides users with a means to contact the organization with questions and/or provide feedback about the app
9. Function Progress: App provides visual indication of activity (i.e. prompt for user input, splash screens, progress bars, "please wait" text, etc.)
10. Login Security: App asks users to login appropriately (i.e. when accessing personal info). Logins are not overused

Sources: Garrett, 2011; Harvey, 2013; Lew & Olisina, 2013; DigitalGov, 2014; Cerejo, 2012; App Quality Alliance, 2013.

RQ2: Do university mobile applications employ best practices related to content and services offered?

By evaluating university mobile applications based on the following best practices compiled through research, I was able to determine what type of content was most prevalent throughout university mobile applications (informational, social, instructional support, and marketing content) and what services universities offer to its users. This evaluation may also be able to shed light onto the target audience(s) for university applications and whether individual audience based applications exist and/or should be developed.

1. Target Audiences: Current students, prospective students, faculty/staff, campus visitors, donors, and alumni
2. Organization: Content and services offered are organized efficiently for easy navigation
3. Succinct Copy: Copy is reflective of the main points that are ideal for quick information consumption. Additional info is deferred to secondary screens
4. University Logo/Name: The university name and/or logo appear on the landing page or main page of the app
5. Multimedia: Images and video are used appropriately to supplement content and provide a good user experience
6. Sharing Content: App has easy access to social media platforms and the ability to share content to these platforms
7. Up-to-Date Content: Content is updated with current and accurate information

8. Services Offered: App offers services that are appropriate for a university mobile app environment; services offered are usable and enhance the user experience
9. Which services are available on the mobile application?

Sources: Garrett, 2011; U.S. Department of Health & Human Services, 2014; Al-Khalifa, 2014; Stern, 2014; Lew & Olsina, 2013; DigitalGov, 2014; Cerejo, 2012; App Quality Alliance, 2013.

RQ3: How are interaction design and information architecture achieved within university mobile applications?

Evaluation of the best practices associated with interaction design and information architecture allowed for an analysis of how universities were employing interaction design and information architecture into their mobile applications. Elements such as gestures, auto sign-in, input, error messages, repeated use, and architecture patterns were measured.

1. Gestures: App employs gestures that are consistent with the operating systems standards
2. Walkthroughs: Overlay instructions or coach marks are provided upon initial launch to show users how to use different features of the app when deemed necessary
3. Error Messages: App provides helpful error messages when a task does not go as planned (i.e. messages when login fails)
4. Input: Default values are displayed for input and appropriate keyboard is available when entering data (i.e. numbers are available when asking for a phone number)
5. Repeated Use: App encourages repeated use through interaction with features of the app
6. Device Features: App enables interaction with mobile device features (camera, location functions, and other apps available on the device)
7. Notifications: App notifies user when it is leaving the app to access other phone features and/or apps
8. Architecture Pattern: App utilizes a consistent architecture pattern that is shallow not deep in nature (i.e. hierarchy, hub and spoke, tabbed view, nested doll)
9. Which information architecture patterns are used; hierarchy, hub and spoke, nested doll, tabbed view?

Sources: App Quality Alliance, 2013; Nielsen, 2011; Cerejo, 2012; McVicar, 2012 & 2013; Psomas, 2009; Harvey, 2013; Stern, 2014; Lew & Olsina, 2013; DigitalGov, 2014.

RQ4: Which interface and navigation design best practices are prevalent throughout university mobile applications?

By evaluating university mobile applications based on the following best practices compiled through research, I was able to determine if and how universities are utilizing the user experience elements of interface and navigation design.

1. Horizontal Scrolling: App avoids horizontal scrolling
2. Graphics/Text: Graphics and text are not distorted, blurred or pixelated
3. Orientation: App supports landscape and portrait orientation and is capable of rapid transition between orientations
4. Screen Space: Design is for a single window or full screen; main task is front and center
5. Consistent Interface Design: The interface of the app is consistent – when app directs users to webpages they are mobile friendly and fit with the app interface design
6. Button Size: App uses appropriately sized buttons and touch targets (i.e. buttons are easy to click and react appropriately to touches)
7. Back Button Navigation: App supports/uses standard back button navigation
8. Labels and Icons: Labels and Icons are descriptive, clear, concise, and consistent (inform the user about what content will be provided when clicked)
9. Page Titles: App provides descriptive yet concise page titles that clue the user into the content of the page
10. Main navigation utilizes a navigation format consistently (expanding menu, side menu, tabbed menu, hub and spoke menu)

Sources: App Quality Alliance, 2013; Nielsen, 2011; Cerejo, 2012; McVicar, 2012; Garrett, 2011; U.S. Department of Health & Human Services, 2014; Psomas, 2009; Harvey, 2013.

RQ5: Do university mobile applications utilize visual design best practices?

By evaluating university mobile applications based on the following best practices compiled through research, I was able to determine how universities are applying the user experience element of visual design to their apps.

1. Contrast: App uses high contrast color schemes (mix of neutral and bright colors)
2. Unity and Consistency: Colors, typography, space, and layout are designed consistently and create a sense of unity throughout the app
3. Typography: Fonts and text elements are simple and readable; No more than 2 fonts are used throughout the app

4. Visual Hierarchy: App creates a sense of visual hierarchy and flow (i.e. elements are arranged according to emphasis in the layout – through the use of different font sizes, colors, spacing elements, and content sections)
5. Brand Identity: The brand of the university is consistent throughout the app with the use of university colors, logos, and/or brand identifiers (i.e. slogans)
6. Texture and Shape: App uses texture and/or shape to enhance detail and make empty space more appealing
7. Aesthetics: The overall design of images, colors, fonts, and other elements are visually and sensually pleasing; design enhances user engagement and interest
8. Color: Color is used to give prominence to content items, demonstrate how items are connected, and helps structure content (i.e. separates content)

Sources: App Quality Alliance, 2013; Al-Khalifa, 2014; World Wide Web Consortium, 2008; McVicar, 2014; Garrett, 2011

RQ6: Overall, what were the most prevalent and least evident best practices?

Subsequent to collecting data, the researcher attempted to analyze the reliability of the dichotomous variables and interval measures with the idea of combining them into a reliable summary index for the five UX categories. However, when the Cronbach reliability analysis was conducted only a couple of measures proved satisfactorily reliable and as a result no indices were used. Instead, percentage and mean scores from the five user experience design categories were combined into summary tables, in order to determine the most prevalent and least evident best practices among all categories.

RQ7: Which university mobile applications were ranked highest based on prevalence of best practices and what made them exemplary?

Once each app was evaluated, the use of descriptive and non-parametric statistics was used to rank the applications based on their use of best practices. A descriptive qualitative analysis revealed which best practices these top apps used effectively and what made the apps exemplary with regard to best practices and user experience design.

Methods

To investigate these questions a content analysis was performed of the primary university native application, for 30 of the 50 largest land-grant universities in the United States.

Content Analysis

According to Stempel (2003) "Content analysis is a formal system for doing something we all do informally rather frequently – draw conclusions from observations of content" (p. 209). The history of modern content analysis dates back to World War II, when researchers performed studies in which they counted words to verify document authenticity and used content analysis to determine changes in troop concentration across occupied Europe. The most notable use of content analysis began in the 1950s when researchers began using it as a tool for media analysis of newspapers and radio (p. 150). According to Busch et al. (2012) when performing a content analysis, "researchers quantify and analyze the presence, meanings and relationships of…words and concepts, then make inferences about the messages within the texts, the writer(s), the audience, and even the culture and time of which these are a part." Understanding that content analysis is systematic, objective, and quantitative aids in researchers' capability to perform a content analysis competently and efficiently (Stempel, 2003; Wimmer & Dominick, 2006). Stempel states that:

> Systematic means, first that a set procedure is applied to all content being analyzed. Second, it means that categories are set up so that all relevant content is analyzed. Finally, it means the analysis is designed to secure data relevant to a research question or hypothesis (Stempel, 2003, p. 210).

"Objectivity is achieved by having the categories of analysis defined so precisely that different persons can apply them to the same content and get the same results" (Stempel, 2003, p. 210). "Quantitative means simply the recording of numerical values or frequencies with which the various defined types of content occur" (Stempel, 2003, p. 210).

Content analysis was selected to evaluate the best practices and corresponding user experience categories. The systematic component of content analysis was met through the use of a coding sheet and categories of user experience and best practices were defined precisely to achieve objectivity. The study met the third content analysis criteria by counting the frequency and prevalence of the best practices and user experience elements of the 30 land-grant university mobile applications. Content analysis was the research method of choice due to its ability to glean great insight from what has already been done. Other research approaches that would have been appropriate for this study include in-depth interviews, surveys, or focus groups with either developers or students at universities. Since the goal of this study is to determine whether universities utilize the user experience best practices and not to gather information regarding user or developer perspectives a content analysis was deemed the most appropriate form of research.

Sampling and Selection of Apps

According to the Association of Public and Land-Grant Universities (2012) "A land-grant college or university is an institution that has been designated by its state legislature or Congress to receive the benefits of the Morrill Acts of 1862 and 1890" (What Section, para. 1). There are currently a total of 111 land-grant universities designated by the United State Department of Agriculture (2014), which are located across all 50 States, as well as the American Samoa, Guam, Micronesia, Northern Marianas, Puerto Rico, and the Virgin Islands (p. 2). The study selected the 50 largest land-grant universities in the United States and randomly selected 30 of the 50 largest to use in the study.

The 50 largest land-grant universities were determined based on total enrollment numbers and excluded the University of California System since there is not a main campus. To select the 30 universities an online random number generator was used, in which 30 numbers from 1 to 50

were selected. Table 3.1 shows the 50 largest land-grant universities and each university's corresponding number 1 to 50, which is based on enrollment numbers, with 1 having the largest enrollment and 50 the lowest enrollment. If a selected university was found to not have a mobile application, another university was selected at random from the remaining list of 20 universities.

Random Sample

According to Trochim (2006) when researchers use some form of random selection they are performing probability sampling (Probability Sampling Section, para. 1). Simple random sampling is the simplest form of random sampling, where the objective is to "select *n* units out of N such that each ${}_{N}C_{n}$ has an equal chance of being selected" (Trochim, 2006, Simple Random Sampling Section, para. 1). As defined by Trochim (2006) "N = the number of cases in the sampling frame" while "n = the number of cases in the sample" and "${}_{N}C_{n}$ = the number of combinations (subsets) of n from N" (Some Definitions Section).

Numbers were randomly selected from within the range of 1 to 50 (including numbers 1 and 50) therefore N = 50. Duplicate numbers were not allowed. The following numbers were automatically generated (n = 30) by an online random number generator: 03 11 01 31 40 39 43 16 22 29 08 21 20 36 42 34 23 15 50 33 35 05 32 37 47 30 17 18 44 02. Out of the sample of 30 land-grant universities, eight schools (North Dakota State University, Montana State University, Cornell University, Mississippi State University, University of Massachusetts Amherst, University of Maine, University of Delaware, and West Virginia University) did not have a designated university mobile application and therefore further random selection was required. In the end, 20 of the 50 schools did not have a main university application or their app had insufficient functionality to be evaluated in this study. Table 3.2 displays the final 30 land-grant universities that were evaluated in this study.

Table 3.1: 50 Largest Land-Grant Universities (Total Enrollment)*

1	Ohio State University	64,930	**26**	University of Kentucky	29,802
2	University of Minnesota	63,929	**27**	University of Connecticut	28,218
3	University of Florida	56,683	**28**	Oklahoma State University	27,756
4	Texas A&M University	53,966	**29**	University of Nebraska	27,233
5	Michigan State University	53,371	**30**	Kansas State University	27,119
6	Pennsylvania State University	49,223	**31**	Auburn University	27,046
7	University of Illinois	47,684	**32**	University of Hawaii Manoa	23,898
8	University of Wisconsin	46,020	**33**	University of Delaware	23,304
9	Rutgers University	44,809	**34**	Mississippi State University	22,956
10	Purdue University	44,267	**35**	Clemson University	22,675
11	University of Maryland	43,352	**36**	Cornell University	21,626
12	University of Arizona	43,038	**37**	University of Nevada – Reno	20,947
13	North Carolina State University	40,720	**38**	University of Rhode Island	19,257
14	University of Georgia	38,837	**39**	North Dakota State University	16,935
15	Utah State University	37,770	**40**	University of New Hampshire	16,611
16	University of Missouri	37,074	**41**	University of Puerto Rico	16,403
17	Colorado State University	34,703	**42**	University of Alaska Fairbanks	16,370
18	West Virginia University	33,896	**43**	Montana State University	16,209
19	Virginia Tech	33,164	**44**	University of Vermont	15,560
20	University of Tennessee	33,096	**45**	South Dakota State University	14,966
21	Iowa State University	32,981	**46**	University of Wyoming	14,707
22	Louisiana State University	32,189	**47**	University of Idaho	14,472
23	University of Massachusetts (Amherst)	32,000	**48**	Florida A&M University	14,383
24	Washington State University	30,816	**49**	New Mexico State University	13,011
25	Oregon State University	29,868	**50**	University of Maine	12,910

** Data was retrieved from CollegeStats, an informational website, which aggregates publicly available information provided by the U.S. Department of Education (http://nces.ed.gov) from the 2012-2013 school year*

Table 3.2: 30 Land-Grant Universities (Simple Random Selection)

01	Ohio State University	**15**	Utah State University	**28**	Oklahoma State University
02	University of Minnesota	**16**	University of Missouri	**29**	University of Nebraska
03	University of Florida	**17**	Colorado State University	**31**	Auburn University
04	Texas A&M	**19**	Virginia Tech	**32**	University of Hawaii Manoa
05	Michigan State University	**20**	University of Tennessee	**35**	Clemson University
08	University of Wisconsin	**21**	Iowa State University	**37**	University of Nevada Reno
11	University of Maryland	**22**	Louisiana State University	**40**	University of New Hampshire
12	University of Arizona	**24**	Washington State University	**42**	University of Alaska Fairbanks
13	North Carolina State University	**25**	Oregon State University	**47**	University of Idaho
14	University of Georgia	**26**	University of Kentucky	**48**	Florida A&M

Coding Sheets and Coder Reliability

Coding Sheets

A coding sheet was developed based on the user experience categories and the best practices associated with each user experience element. The coding sheet was structured as if the evaluator was a user of the mobile application and therefore began with the visual and sensory category and continued through the user experience to the interface and navigation design, then the interaction design and information architecture category, followed by the content and services offered category, and finished up with the functional and technical specifications category. The coding sheet examined 49 user experience best practices for mobile applications. The coding sheet incorporated *yes/no*, five-point Likert scale, where *5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, and 1=Strongly Disagree*, and choose all that apply scoring options. For all five UX categories there were 34 *yes/no* scores, 15 scaled scores, and three questions that utilized select all that apply checkboxes.

Visual Design. There were eight best practices associated with visual design. Three of the eight best practice items used a *yes/no* evaluation to indicate whether the best practices

associated with contrast, typography, scale, and texture were present or absent. Five of the eight best practices used a five-point scale to evaluate the degree of consistency in design, the visual hierarchy, brand identity, overall aesthetics, and use of color (Appendix 1A).

Interface and Navigation Design. There were eleven best practices related to interface and navigation design that were evaluated. Eight of the eleven best practice items used a *Yes/No* evaluation to indicate whether the best practices associated with horizontal scrolling, distortion, orientation, screen space, button size, back button navigation, labels and icons, and page titles were present or absent. Two of the eleven best practices used scaled scores to evaluate the degree of consistency in the navigation and the interface design. The remaining question used checkboxes to determine which of the following navigation formats were used consistently: (1) expanding menu, (2) side menu, (3) tabbed menu, and (4) hub and spoke (Appendix 1B).

Interaction and Information Architecture. There were eight best practices related to interaction design and information architecture that were evaluated. The first best practice – gestures – incorporated six individual *Yes/No* evaluation items to determine which gestures the app employs appropriately. There were five best practices that used a *yes/no* evaluation to indicate whether gestures, walkthroughs and coach marks, error messages, input values, and notifications were present or absent. Two best practices used the five-point scale to evaluate the degree to which the app encouraged repeated use through interaction and utilized mobile device features. Finally, one best practice used checkboxes to determine which of the following information architecture patterns were used: (1) Hierarchy, (2) Hub and Spoke, (3) Nested Doll, and (4) Tabbed View (Appendix 1C).

Content Strategy: Content and Services Offered. There were eight best practices related to content and services offered that were evaluated. The first best practice – target audiences –

incorporated six individual *yes/no* evaluation items to determine which university specific audiences were targeted. Three additional best practice items used a *yes/no* evaluation to indicate whether the best practices associated with university name and logo, content sharing, and up-to-date content were present or absent. Three of the eight best practices used scaled scoring to determine the degree to which the copy was deemed succinct and non-repetitive, content and services offered were organized, and multimedia was used appropriately. One of the eight best practices used checkboxes to indicate which services were offered within the application (Appendix 1D).

Functional and Technical Specifications. There were nine best practices related to content and services offered that were evaluated. Eight of the nine best practices used a *yes/no* evaluation to indicate whether the best practices associated with load time, privacy policy, interruptions, continuation, click-to-call, opt-in active consent, user feedback, and functional progress were present or absent. The remaining best practice used the five-point scale to determine the effectiveness of the apps' security and transparency (Appendix 1E).

Coder Reliability

All coding for this study was conducted by the researcher. As an exploratory study combining quantitative and qualitative approaches a second coder was not employed and thus inter-coder reliability was not an issue. To ensure consistency in coding the researcher analyzed each app starting with the visual design and proceeding down the *Mobile application user experience workflow* (Figure 2.1) to the functional and technical specifications. Due to the ever-changing nature of digital media, all applications were downloaded on the same day and the analysis was performed over a two-week period. The validity of the data measured – the applications – was high, since there was no opportunity for any of the 30 apps to be updated

and/or changed during the analysis time frame. At no point did the researcher go into the app store and perform any updates to the 30 applications.

Data Collection and Archiving Procedures

To determine the effectiveness of each of the user experience elements and the best practices associated with each element, the study looked at the home page of the app, the landing pages for each feature in the main navigation, and all links made available on the landing pages. This process took the evaluator three levels deep into the app to be sure that there was sufficient information to evaluate the user experience elements and best practices. If the app was so badly designed that there was no information to evaluate, a notation was made to indicate that the app failed in the specified user experience element.

Devices Used

The native applications were evaluated within an iOS platform on an iPhone 5 mobile device. Since this study was not interested in determining the similarities and differences in mobile application best practices for different mobile devices, it was ascertained that comparing the 30 apps on one type of mobile device was a valid approach. The iPhone 5 was selected due to the availability the researcher had to that particular device.

Pretest

A pretest of the coding sheet was performed for three university apps to validate the coding sheet and confirm that the order of items within the code sheet was appropriate for coding expediency. The three universities were randomly selected from the remaining 20 universities of the original N sample of 50 land-grant universities. The three universities selected were: (1) Purdue University, (2) South Dakota State University, and (3) University of Connecticut. The coding sheets were adjusted appropriately based on the pretest results.

Visual Records

Screen shots of the application were taken during analysis to provide a visual reference to the use or lack-thereof, of user experience best practices. Screen shots were saved directly to the device's camera and were saved in a dropbox folder following evaluation of the apps. The screen shots were then used as exhibits and references in the analysis of the data as well as the discussion of the findings.

Data Analysis Procedures

Quantitative Analysis

After completing the code sheets, scores were generated for each variable in each of the user experience categories. For the 34 *yes/no* questions, an answer of *Yes* was given a 1 and an answer of *No* was given a 0. There were 15 five-point Likert scale questions, which were scored as follows: 5=5 points, 4=4 points, 3=3 points, 2=2 points, and 1=1 point. Checkbox questions were not included in the calculations, but were used in the in-depth descriptive qualitative analysis. Once each variable was scored for each mobile application (Appendix 2A-2E), descriptive statistics were calculated including the frequency of each numbered score for each variable, as well as the mean and standard deviation for each variable.

From there, the university applications were ranked within each of the five User Experience categories, in order to determine which universities were the top in each category. Once the ranking scores for each UX category were determined, a final ranking analysis was performed to determine which were the top apps across all UX categories.

Qualitative Analysis

Post quantitative analysis, a descriptive qualitative analysis was used to explore the university apps that were exemplary in the user experience categories. According to Cohen,

Manion, and Morrison (2007) descriptive research methods set out to "describe, compare, contrast, classify, analyze, and interpret the entities and the events that constitute their [the studies] fields of inquiry" (p. 205). Based on the content analysis and ranking analysis performed, the six highest-ranking university applications were evaluated in-depth. The descriptive analysis compared and contrasted the top apps based on the best practice criteria in each user experience category. The descriptive analysis was supplemented with screen shots taken during the content analysis. Conclusions about the notable features of the apps were established through the descriptive qualitative analysis.

CHAPTER 4

RESULTS

This chapter describes the findings from the quantitative analysis, addresses the seven research questions presented in this study, and presents a descriptive qualitative analysis of the top six mobile applications. The first section answers the first six research questions by presenting and analyzing the descriptive statistics for each UX category and the ranking of the mobile apps based on those statistics. The second section answers research question seven and provides an in-depth narrative about the best practices that were present and absent from the six overall best applications.

Quantitative Analysis

RQ1: Do university mobile applications achieve functional and technical best practices?

Table 4.1 summarizes the results for the 10 variables that pertain to functional and technical specifications. (In Tables 4.1-4.5, percentages are provided for dichotomous measures (yes/no) and means and standard deviations are presented for interval measures in a consolidated table for easy comparison.

Table 4.1: Descriptive Statistics for Functional and Technical Specifications (Category E)

Variable	Frequency						Percentage or Mean	Std. Deviation
	0	1	2	3	4	5		
Loads fast, speed is appropriate	8	22					73.3%	
Privacy policy provided	25	5					40.0%	
Accepts interruptions	0	30					100.0%	
Ability to continue task	0	30					100.0%	
Click to call capability	4	26					86.7%	
Opt in consent	9	21					70.0%	
Provides user feedback option	8	22					73.3%	
Function progress visually indicated	5	25					83.3%	
Login security used appropriately	1	29					96.7%	
Trustworthy and transparent		1	5	9	11	4	3.40	1.04

The data reveal that eight of the nine dichotomous best practices had a strong presence within the 30 mobile applications. The load time and speed of the app were acceptable for the purpose of the app and did not alter the user experience by being uncontrollable 73.0% of the time. All applications were capable of accepting incoming calls while running and effectively resumed the tasks at the same place or logical restarting point after an interruption (continuation). Click-to-call, an important functional specification for mobile applications was present 86.7% of the time. The applications provided some kind of visual indication of activity, such as a progress bar, 83.3% of the time. 73.3% of universities provided the user with an option for providing feedback about the app, while 96.7% of the apps utilized login security measures in appropriate circumstances and were not overused. One of the technical best practices for applications is that the app provides a clearly visible link to the privacy policy and/or terms and conditions.

Providing users with access to information about privacy and security settings is important, so users have the ability to manage their own privacy and determine whether to use the app (App Quality Alliance, 2013, p. 26). Only five of the 30 apps achieved this best practice. There was only one scaled variable evaluated in the study, which dealt with whether the app provided the user with a strong sense of security and transparency. The App Quality Alliance (2013) identifies transparency, choice, and control over privacy and security measures as a guiding principle for app development (p. 26). Overall the applications were rated moderately trustworthy ($M = 3.40$, $SD = 1.04$) suggesting that it was unclear from this study whether the level of transparency and security practices would create an app environment that users would feel comfortable in. Overall, the 30 mobile applications seemed to achieve a high level of functional and technical best practices.

RQ2: Do university mobile applications employ best practices related to content and services offered?

While it is not necessarily a best practice to target all audiences in one mobile application, it is important to understand whom universities are targeting with their mobile applications, in order to judge their effectiveness. This section reported on the organization, timeliness, and breadth of the content and services offered, as well as how easily that content could be shared with others and whether that content was appropriate for the app. Table 4.2 displays the frequency and percentages or the mean scores and standard deviations for the 13 Content and Services Offered best practices.

Table 4.2: Descriptive Statistics for Content and Services Offered (Category D)

Variable	Frequency						Percentage or Mean	Std. Deviation
	0	1	2	3	4	5		
Current students [Audience]	5	25					83.3%	
Prospective students [Audience]	24	6					20.0%	
Faculty/staff [Audience]	19	11					36.7%	
Visitors [Audience]	22	8					26.7%	
Donors [Audience]	27	3					10.0%	
Alumni [Audience]	24	6					20.0%	
Logo and/or name present	7	23					76.7%	
Content is easily shareable	18	12					40.0%	
Content is up to date	5	25					83.3%	
Content is organization		4	11	6	6	3	2.77	1.22
Copy is succinct		2	8	7	9	4	3.17	1.18
Multimedia used appropriately		4	9	5	9	3	2.93	1.26
Offers appropriate services		1	9	14	4	2	2.90	0.92

The frequency statistics reveal that current students clearly were the primary targeted audience for 83.3% of the applications evaluated. Only 11 universities provided content geared toward faculty and staff. The remaining university audiences of prospective students (20.0%), visitors (26.7%), donors, (10.0%), and alumni (20.0%) were less of a focus for the university apps. Twenty-three of the 30 apps (76.7%) featured the university name and or logo on its

welcome or main page. Content proved to be timely and up-to-date in 83.3% of the apps, while only 40.0% contained easy access to social media platforms-- with the ability to share content to those platforms. Statistics for the scaled variables had average scores that were fairly neutral. Organization of content and services offered (M = 2.77) scored below the midpoint of the scale and thus could be judged as not overly efficient for easy navigation. It was observed that organizing menu items alphabetically would have been a simple organizational method that the apps could have employed. Copy that was reflective of the main points and ideal for quick information consumption received an average score of M = 3.17. The applications did not display a great deal of multimedia (M = 2.94) and the services offered were did not consistently enhance the user experience (M = 2.90). The descriptive statistics divulged that the apps neutrally adhered to best practices for content and services offered.

RQ3: How are interaction design and information architecture achieved within university mobile applications?

The descriptive statistics for the variables related to interaction design and information architecture are represented in Table 4.3.

Table 4.3: Descriptive Statistics for Interaction Design and Information Architecture (Category C)

Variable	Frequency						Percentage or Mean	Std. Deviation
	0	1	2	3	4	5		
Gestures are consistent	0	30					100.0%	
Walkthroughs present	24	6					20.0%	
Error messages provided	3	27					90.0%	
Default input values displayed	4	26					86.7%	
Notifications upon exit	14	16					53.3%	
Encourages repeated use		6	11	4	3	6	2.73	1.44
Device feature interaction		2	10	2	9	7	3.30	1.34
Consistent architecture pattern		1	5	15	8	1	3.10	0.84

The frequency statistics reveal that three of the five dichotomous variables had a strong presence within the 30 apps. Appropriate gestures - actions that all major touch operating

systems employ that allow users to perform specific tasks (McVicar, 2013) - for the Apple operating system were employed in all 30 apps. Error messages that were helpful when tasks did not go as planned were evident in 90.0% of the apps, while default values for input and appropriate keyboards for data entry were displayed in 26 out of the 30 mobile apps. When a task takes the user outside of the mobile application environment and fails to provide notification of that action, it could be extremely frustrating for the user. Only 16 (53.3%) of the university applications notified users when an action triggered the use of phone features and other applications and took the user outside the app environment. Walkthroughs or coachmarks, which are overlay instructions that show the user how to use different features of the app, were present in 20.0% of the apps. With a score of M = 2.73, roughly half of the applications did not encourage repeated use of the application. Just over half of the applications enabled users to interact with features of their mobile devices, such as social apps, map applications, and the camera (M = 3.30). With an overall score of M = 3.10, the use of consistent information architecture patterns was somewhat inconclusive. The descriptive statistics in Table 4.3 provided great insight into which interaction design and information architecture best practices the university mobile applications achieved.

RQ4: Which interface and navigation design best practices are prevalent throughout university mobile applications?

Table 4.4 summarizes the results for the 10 variables that pertain to functional and technical specifications.

Five of the eight dichotomous variables were prevalent in 80.0% or more of the 30 applications. Graphics and text were not distorted, blurred, or pixelated in 24 of the applications. The size of buttons and touch areas were appropriate and page titles were descriptive, concise,

Table 4.4: Descriptive Statistics for User Interface and Navigation Design (Category B)

Variable	Frequency						Percentage or Mean	Std. Deviation
	0	1	2	3	4	5		
Avoids horizontal scrolling	12	18					60.0%	
Clear graphics & text	6	24					80.0%	
Supports both orientations	25	5					16.7%	
Single screen space (design)	10	20					66.7%	
Button size appropriate	5	25					83.3%	
Back button functionality	2	28					93.3%	
Clear labels & icons	3	27					90.0%	
Descriptive page titles	5	25					83.3%	
Consistent interface present		13	4	3	3	7	2.57	1.68
Consistent navigation		0	2	4	12	12	4.13	0.90

and clued the user into the purpose of the page in 25 of the apps. Labels and icons were descriptive, clear, concise, and consistent within 27 applications and 28 apps supported standard back button navigation. Of the 30 apps, 60.0% avoided horizontal scrolling, while 66.7% had an interface design that was for a full mobile screen, where the main task was front and center. Over 80.0% of the apps failed to support landscape orientation on a mobile device. About half of the apps lacked a consistent interface (M = 2.57), and often directed users to webpages that were not housed within the mobile application. Buttons and the format of the navigation generally were consistent (M = 4.13), and the relationship was communicated effectively between navigation elements and the pages or content they were linked to in 24 of the 30 applications. The mobile apps complied with user interface and navigation design best practices at a seemingly high rate.

RQ5: Do university mobile applications utilize visual design best practices?

The frequency, means, and standard deviations for the eight visual design variables are presented in Table 4.5, revealing how university mobile applications utilized these best practices.

Visual design focuses on the strategic implementation of images, colors, fonts, and other elements within a mobile app environment (U.S. Department of Health & Human Services,

2014). The eight visual design best practices incorporated the concepts of color, contrast, typography, consistency, visual hierarchy, brand identity, and aesthetics. The use of high contrast color schemes, or a mix of neutral and bright colors was present in 22 or 73.3% of the apps. Nineteen apps, 63.3%, used no more than two fonts and those fonts were simple and readable.

Table 4.5: Descriptive Statistics for Visual Design (Category A)

Variable	Frequency						Percentage or Mean	Std. Deviation
	0	1	2	3	4	5		
Uses high contrast	8	22					73.3%	
Typography simple & readable	11	19					63.3%	
Texture & Shape	11	19					63.3%	
Consistent & unifying design		6	8	6	4	6	2.87	1.43
Visual hierarchy evident		3	7	8	7	5	3.13	1.25
Consistent brand identity		0	11	7	7	5	3.20	1.13
Strong overall design (Aesthetics)		7	10	4	4	5	2.67	1.42
Color creates structure		1	9	5	9	6	3.33	1.21

Nineteen of the 30 apps also used texture and or shape to enhance detail and make empty space more appealing. Unity and consistency – where colors, typography, space, and layout were designed consistently – was lacking throughout many of the apps (M = 2.87), with fourteen applications earning a one or two for the variable. The visual design of the 30 apps did not create an overwhelming sense of visual hierarchy (M = 3.13). Twelve apps were deemed to have strong visual hierarchy, where the elements were arranged according to emphasis in the layout to create flow, while eight were inconclusive, and 10 lacked a sense of visual hierarchy. The brand of the university (M = 3.20), or the use of university colors, logos, and university identifiers, was used consistently throughout only 12 of the university apps. Color was used inconsistently (M = 3.30) to give prominence to content items, demonstrate how items were connected, and provide structure to content. Aesthetics is essentially the combination of contrast, unity and consistency, typography, visual hierarchy, brand identity, texture, shape, and space to create a visually

pleasing product. The overall beauty or aesthetics of the mobile applications was less than satisfactory with a score of M = 2.67.

RQ6: Overall, what were the most prevalent and least evident best practices?

To understand where universities performed best and worst in terms of designing effective apps, the scores for all best practices across the five design levels reported in Tables 4.1- 4.5, were combined into two summary tables. Table 4.6 compiles the frequencies for the 34 dichotomous variables that measured the presence or absence of key features. Table 4.7 summarized the prevalence of best practices for the 15-scaled items based on means. Variables were listed from highest to lowest, and were coded based on the design category they represented: A=Visual Design, B=User Interface & Navigation, C=Interaction Design & Information Architecture, D=Content and Services Offered and E=Technical and Functional Specifications.

Table 4.6 reveals that among the dichotomous measures only three best practices were evident in 100.0% of the apps: gestures, interruptions, and continuation. Meanwhile, four others were found in at least 90.0% of the cases: login security, back buttons, labels and icons and error messages. Overall, it was clear that schools designed their apps primarily for students (evidenced in 86.0% of apps) and did not design for multiple or secondary audiences. For example, only 36.0% of the apps provided evidence they were intended for faculty, while one-quarter or less appeared to target visitors, prospective students, alumni or donors. These might be important missed opportunities.

The areas of poorest performance among the dichotomous variables examined included the lack of privacy policy disclosures, walkthroughs, and the ability to display content in landscape orientation. Privacy policy statements are important because they provide users with a

sense of transparency and security, which elicits confidence in the app and the organization.

Walkthroughs provide details about using an application, which can be extremely beneficial in

Table 4.6: Overall Prevalence of Best Practices (Dichotomous Variables) Organized by Percent

Variable	Frequency						Percentage	Std. Deviation
	0	1	2	3	4	5		
C-Gestures	0	30					100.0%	
E-Interruptions	0	30					100.0%	
E-Continuation	0	30					100.0%	
E-Login Security	1	29					96.7%	
B-Back Button	2	28					93.3%	
B-Labels & Icons	3	27					90.0%	
C-Error Messages	3	27					90.0%	
C-Input	4	26					86.7%	
E-Click to Call	4	26					86.7%	
E-Function Progress	5	25					83.3%	
D-Current [Audience]	5	25					83.3%	
D-Up to Date Content	5	25					83.3%	
B-Button Size	5	25					83.3%	
B-Page Titles	5	25					83.3%	
B-Graphics & Text	6	24					80.0%	
D-Logo Name	7	23					76.7%	
E-Load & Speed	8	22					73.3%	
E-User Feedback	8	22					73.3%	
A-Contrast	8	22					73.3%	
E-Opt in Consent	9	21					70.0%	
B-Screen Space	10	20					66.7%	
A-Typography	11	19					63.3%	
A-Texture & Shape	11	19					63.3%	
B-Horizontal Scrolling	12	18					60.0%	
C-Notifications	14	16					53.3%	
E-Privacy Policy	25	5					40.0%	
D-Sharing Content	18	12					40.0%	
D-Faculty [Audience]	19	11					36.7%	
D-Visitors [Audience]	22	8					26.7%	
D-Prospective [Audience]	24	6					20.0%	
D-Alumni [Audience]	24	6					20.0%	
C-Walkthroughs	24	6					20.0%	
B-Orientation	25	5					16.7%	
D-Donors [Audience]	27	3					10.0%	

{Letter indicates the User Experience Design Category: A = Visual Design, B = User Interface & Navigation Design, C = Interaction Design & Information Architecture, D = Content & Services Offered, and E = Functional & Technical Specifications}

certain situations and cumbersome in others. In retrospect, it would have been more beneficial to evaluate walkthroughs based on the effectiveness of including or excluding them from the app. Landscape orientation is essential in order to play videos, which are being used in increased numbers to supply information to students as well as others.

Table 4.7 summarizes on a consolidated basis the mean scores and standard deviations for all 15-scaled items rated by the researcher. Among these, apps performed best on navigation (M=4.33). As the part of the overall framework for getting around the application, having consistent buttons and navigational components, that effectively communicate relationships within the app, is essential. Most of the universities (roughly 24 of 30) succeeded in presenting a consistent and communicative navigation framework.

Table 4.7: Overall Prevalence of Best Practices (Scaled Variables) Organized by Mean

Variable	Frequency						Mean	Std. Deviation
	0	1	2	3	4	5		
B-Navigation		0	2	4	12	12	4.13	0.90
E-Trustworthy		1	5	9	11	4	3.40	1.04
A-Color		1	9	5	9	6	3.33	1.21
C-Device Features		2	10	2	9	7	3.30	1.34
A-Brand Identity		0	11	7	7	5	3.20	1.13
D-Succinct Copy		2	8	7	9	4	3.17	1.18
A-Visual Hierarchy		3	7	8	7	5	3.13	1.25
C-Architecture Pattern		1	5	15	8	1	3.10	0.84
D-Multimedia		4	9	5	9	3	2.93	1.26
D-Services Offered		1	9	14	4	2	2.90	0.92
A-Unity & Consistency		6	8	6	4	6	2.87	1.43
D-Organization		4	11	6	6	3	2.77	1.22
C-Repeated Use		6	11	4	3	6	2.73	1.44
A-Aesthetics		7	10	4	4	5	2.67	1.42
B-Consistent Interface		13	4	3	3	7	2.57	1.68

{Letter indicates the User Experience Design Category: A = Visual Design, B = User Interface & Navigation Design, C = Interaction Design & Information Architecture, D = Content & Services Offered, and E = Functional & Technical Specifications}

Notably the means were below the scale's midpoint (3.00) for seven measures. The low performing best practices included multimedia, services offered, unity and consistency,

organization and repeated use. The poorest ratings were found for aesthetics and consistent interface. While aesthetics and consistent interface are best practices associated with two different UX categories, they are perfect examples of the relationships among the categories and the best practices. It was evident that an app that had a consistent interface, which directed users to mobile friendly websites housed within the application, and which fit with the app design framework, often received a higher score for aesthetics.

Tables 4.6 and 4.7 suggest that there was no distinct pattern for prevalence of best practices based on UX categories among the 30 applications. Category D, Content and Services Offered held six of the bottom ten spots for the dichotomous variables. However, it is important to note, that these variables might have benefited from an alternate evaluation method. It may have been more telling to evaluate the best practice of target audience as a scaled measure and simply indicate which audiences the app targeted through a check-box method. No matter the effectiveness of the audience evaluation factor, there was much room for improvement in the UX category of Content and Services Offered.

Functional and Technical Specification best practices were among the most prevalent. Except for the privacy policy best practice, which was present in only 40.0% of the apps, the functional and technical specification best practices were existent in at least 70.0% of the applications. Overall, visual design (Category A) performed poorly among the 30 apps, which no doubt led to a low mean score for aesthetics ($M = 2.67$), which takes into consideration all of the other variables measured. User interface and interaction design (Category B), as well as interaction design and information architecture (Category C), had some best practices that the universities seemed to comply with and others that many of the apps failed to adhere to.

Descriptive Qualitative Analysis

User Experience Design was readily examined in Chapter 2, and a model proposed by Garrett (2011) was used as the conceptual framework for this study (Figure 2.1). The model, with its five levels (surface, skeleton, structure, scope, and strategy) was used throughout the study to organize the five user experience categories (Functional and Technical Specifications, Content and Services Offered, Interaction Design and Information Architecture, User Interface and Navigation Design, and Visual Design), identify best practices, and develop appropriate research questions. In order to effectively determine what made the top 6 applications exemplary, a descriptive qualitative analysis for each of the top 6 applications was performed based on the model in Figure 2.1.

RQ7: Which university mobile applications were ranked highest based on prevalence of best practices and what made them exemplary?

Selection Procedure for Identifying Exemplary Apps

In order to determine which universities had the best university mobile applications overall, a ranking analysis was performed. Five tables were created, one for each user experience category (Appendix 2A, 2B, 2C, 2D, and 2E) depicting the score each university received for each of the 49 variables. Anytime an app received the highest possible score for a category (a 1 for a dichotomous variable or a 5 for a scaled variable) the score was highlighted The number of highlights each university received was added up to determine which schools scored best across the 49 best practice variables.

Visual design (Appendix 2A) included 8 variables, so the top score a university could receive was an 8, if it received all 1s and 5s. User interface and navigation design (Appendix 2B) had 10 variables; interaction design and information architecture (Appendix 2C) contained 8

variables, content and services offered (Appendix 2D), was made up of 13 variables, and functional and technical specifications incorporated 10 variables (Appendix 2E*)*. Once scores for each UX category were determined for the 30 universities, those scores were added to give each university an overall ranking score (Table 4.8). Since there were 49 variables or best practices, the highest score a university could receive was a 49.

The top six schools based on scores were the University of New Hampshire, University of Arizona, Ohio State University, University of Florida, Washington State University, and Michigan State University. Their apps were evaluated in a qualitative descriptive analysis to determine what made these apps exemplary. The University of New Hampshire excelled, with a high score of 10 out of 10 in User Interface and Navigation Design, a 7 of 8 in Interaction Design and Information Architecture, and a 12 of 13 for Content and Services Offered. A second place score of 7, behind Ohio State and University of Florida for Visual Design and a score of 8 for Functional and Technical Specifications, along with the other three scores were enough to give the University of New Hampshire the top spot with an overall ranking score of 44. The University of Arizona, Ohio State University, University of Florida, Washington State University, and Michigan State University ranked second, third, fourth, fifth, and sixth respectively. These schools had a range of 6, with highest score being 39 and the lowest being 33. As the next university had a score of 29, making the range between the sixth ranked and seventh ranked schools a 4, it was determined that a qualitative analysis of the top 6 schools would be appropriate.

Table 4.8: Summary Scores Based on Rankings for University Mobile Applications

University	(A) Visual Design (8)	(B) User Interface & Navigation (10)	(C) Interaction Design & Information Architecture (8)	(D) Content & Services Offered (13)	(E) Technical & Functional Specifications (10)	Overall Ranking Totals (49)
University of New Hampshire	7	10	7	12	8	**44**
University of Arizona	7	10	5	10	6	**38**
Ohio State University	8	7	7	6	9	**37**
University of Florida	8	8	4	6	9	**35**
Washington State University	7	9	5	6	7	**34**
Michigan State	5	9	6	5	8	**33**
Colorado State University	3	9	4	4	9	**29**
North Carolina State	2	8	5	5	8	**28**
Oregon State	2	8	6	5	5	**26**
University of Kentucky	3	6	4	4	8	**25**
University of Hawaii	3	5	4	4	7	**23**
University of Nebraska	2	6	4	4	7	**23**
Auburn University	1	8	4	3	7	**23**
Florida A&M	3	4	4	3	8	**22**
Virginia Tech	2	6	3	4	7	**22**
University of Missouri	3	6	3	2	8	**22**
Iowa State University	3	6	3	1	9	**22**
University of Tennessee	3	5	3	3	8	**22**
Clemson University	2	5	5	3	7	**22**
University of Minnesota	2	5	5	5	5	**22**
Texas A&M	3	6	3	2	7	**21**
University of Nevada	1	5	3	4	8	**21**
University of Idaho	1	6	3	4	7	**21**
Oklahoma State	2	7	2	4	5	**20**
University of Wisconsin	0	3	5	6	6	**20**
University of Georgia	0	4	3	4	8	**19**
University of Alaska	1	6	2	4	6	**19**
Utah State University	1	5	3	5	4	**18**
University of Maryland	3	6	1	1	6	**17**
Louisiana State University	0	3	3	3	7	**16**

{Letter indicates the User Experience Design Category: A = Visual Design, B = User Interface & Navigation Design, C = Interaction Design & Information Architecture, D = Content & Services Offered, and E = Functional & Technical Specifications}
{Number indicates the total number of best practice variables measured in each User Experience Design Category}

University of New Hampshire

As the top overall ranked school, the University of New Hampshire (UNH) excelled across all user experience categories. The simplicity, organization, content and services offered and overall usability of the application made UNH a great app. UNH was one of two schools to score a perfect 10 out of 10 for its user interface and navigation design. The app successfully implemented a user interface that was simple and consistent, and navigational components that were intuitive. The descriptive statistics evaluated in the quantitative analysis revealed that the majority of applications failed in the best practice areas of orientation and interface consistency. UNH, along with only four other schools successfully supported portrait and landscape orientations along with the capability of rapidly transitioning between the two orientations (Figure 4.1).

The App Quality Alliance (2013) established that it is paramount for developers to create a mobile application interface that is consistent in terms of action sequences, terms, layouts, and buttons. It was strongly agreed that UNH had generated an app interface that was indeed consistent. A majority of the 30 apps directed users to webpages and/or required the user to leave the application interface, often without informing the user this was happening. UNH created an interface that never took the user outside of the application framework and that had consistent sequences, terms, layouts and buttons (Figure 4.2 and 4.3).

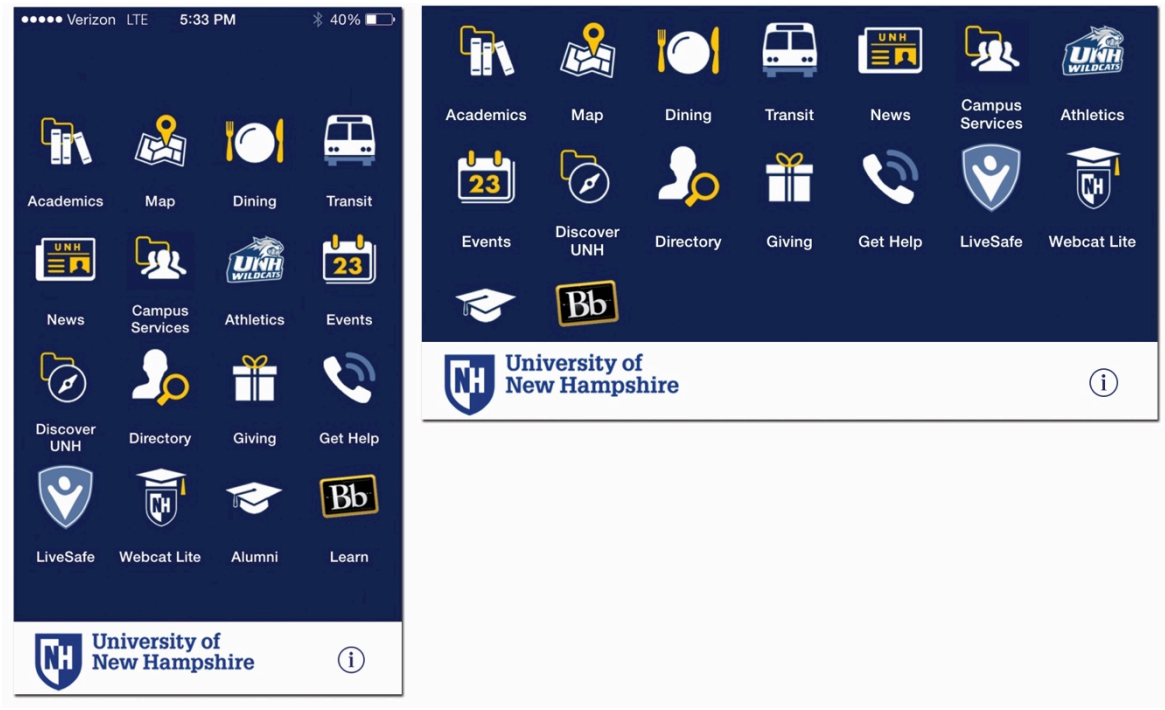

Figure 4.1: University of New Hampshire portrait and landscape orientations

The organization of the UNH app and its content created a great user interface. The app utilized two navigation and user interface workflows or action sequences. Figure 4.2 shows how the app went from the home screen to a secondary screen, in this case Campus Services and Discover UNH. Both the home and secondary screens utilized labels and icons that were descriptive, clear, and concise, while informing the user about what content was provided when items were clicked. The third level consisted of a vertical list of items where each item had a descriptive title and informative details and an arrow indicating that the item could be clicked on to get more information. Each screen shot reveals that the icons, labels, button/touch size, and navigation were appropriate and effective in moving the user through the app.

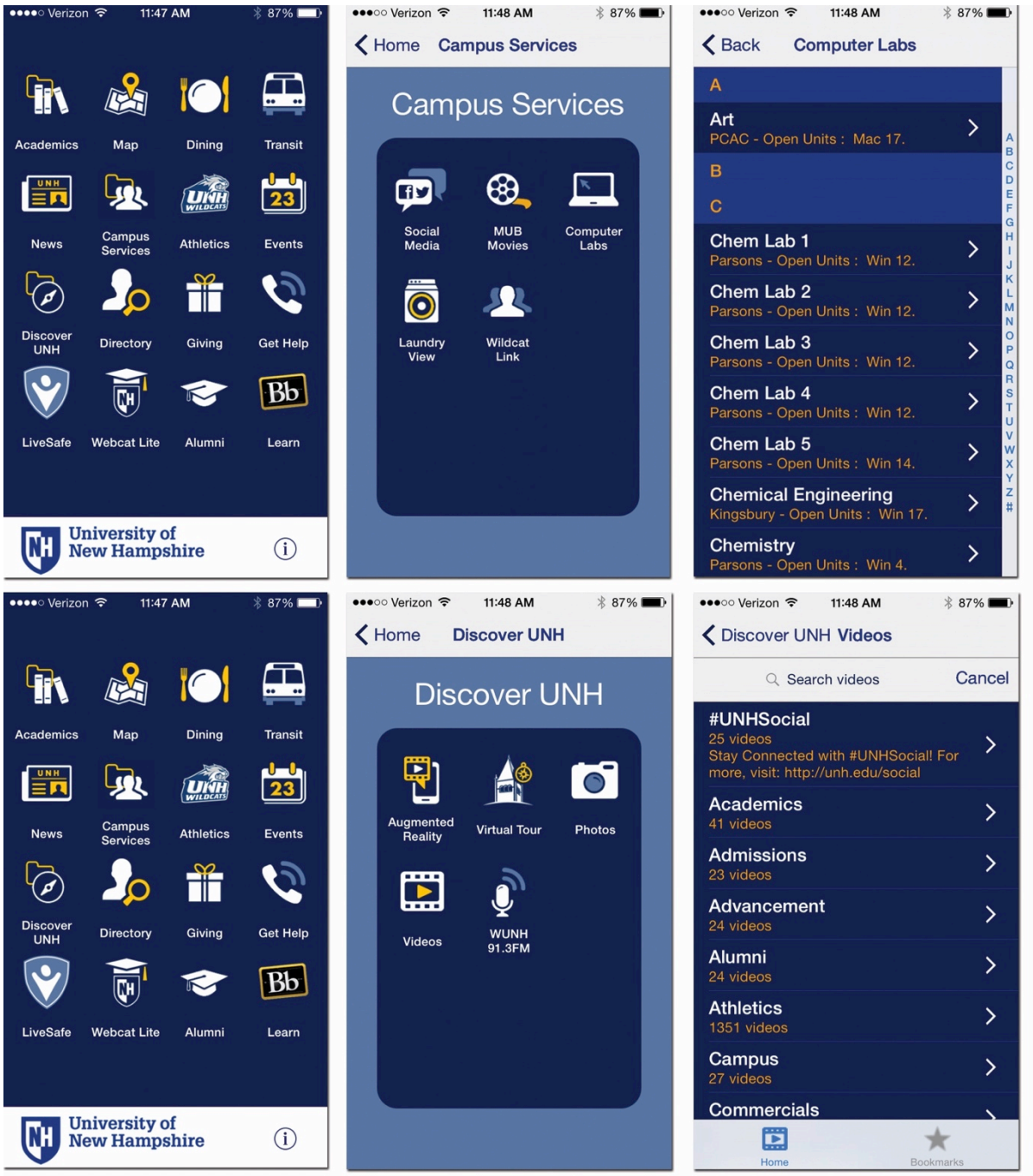

Figure 4.2: University of New Hampshire mobile application interface consistency

Figure 4.3, shows the other action sequence, where the app takes the user to a mobile website framework that is housed inside the mobile application. UNH utilized this hybrid method of app development for areas such as dining and events, both of which already had an established

mobile web interface that could easily be integrated into the mobile application and still create a sense of consistency within the app.

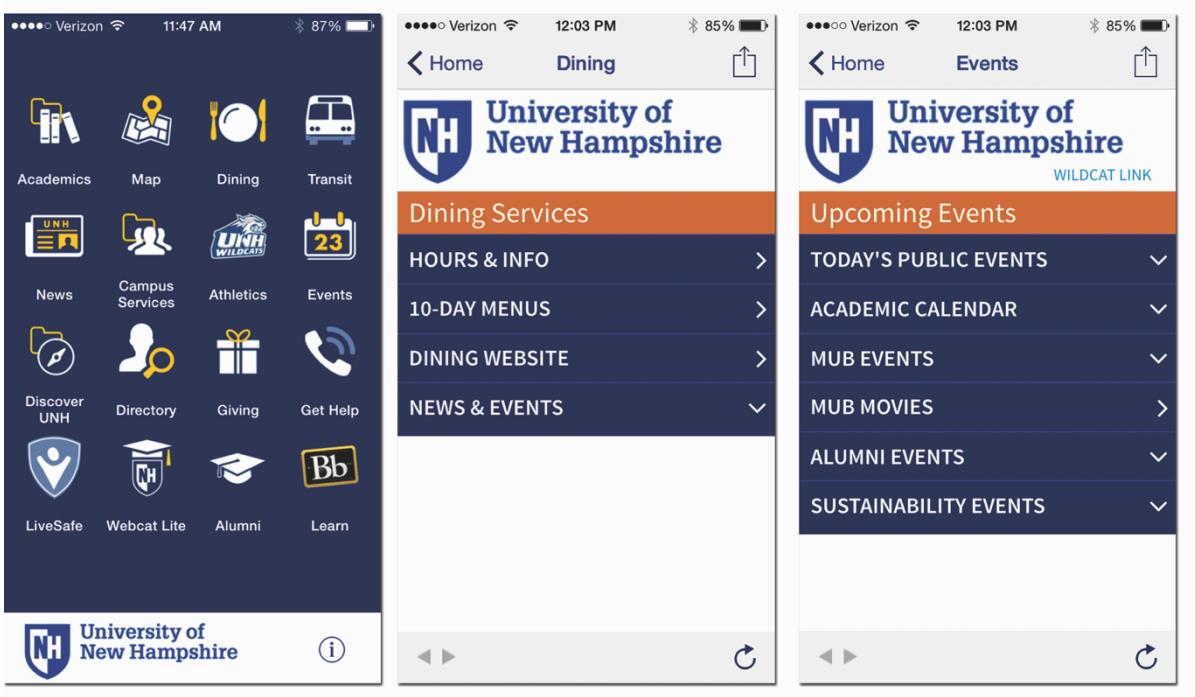

Figure 4.3: University of New Hampshire mobile application hybrid mobile web integration

The UNH mobile application utilized a hub and spoke navigation style, where there was a centralized home screen that allowed users to select a menu option, which took the user to a specific section that then had its own internal navigation pattern (Figures 4.2 and 4.3). Through a hub and spoke navigation style, UNH was able to generate a navigation framework that was consistent and that communicated the relationship between the navigation elements and the pages and content they were linked to.

The UNH app targeted all audiences, current and prospective students, faculty and staff, visitors, donors, and alumni, with content that was relevant and that cultivated repeated use. News, transit, campus maps, campus directory, emergency information, and events were some of the content items that were seen consistently across the majority of university mobile

applications. In addition to these standard services, UNH provided information about the computer labs on campus, which highlighted the platform (Windows or Mac) and indicated how many computers were free and in use (Figure 4.4), a feature that was unique to this school.

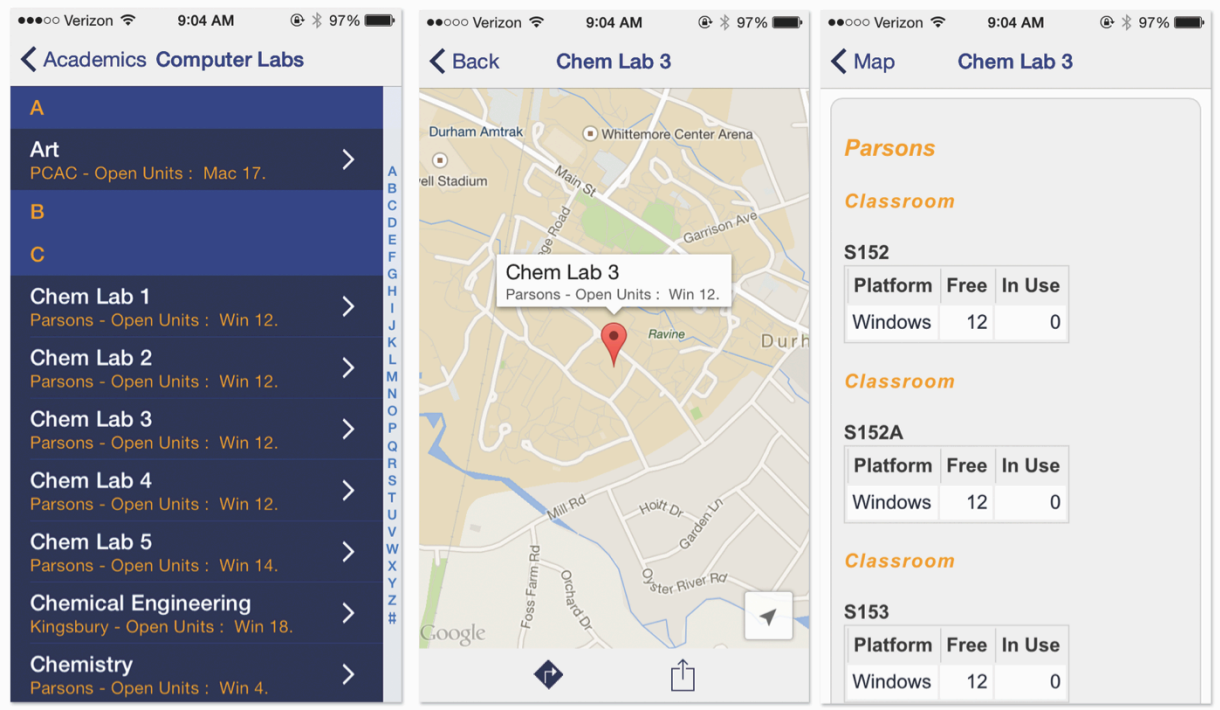

Figure 4.4: University of New Hampshire computer labs

A dining section was also included in the app that provided hours and information about each dining center, 10-day menus, and dining news and events. Providing a comprehensive list of courses offered, with detailed information, the schedule, and instructor details was another service that other universities either did not have or failed to execute effectively in their own apps (Figure 4.5).

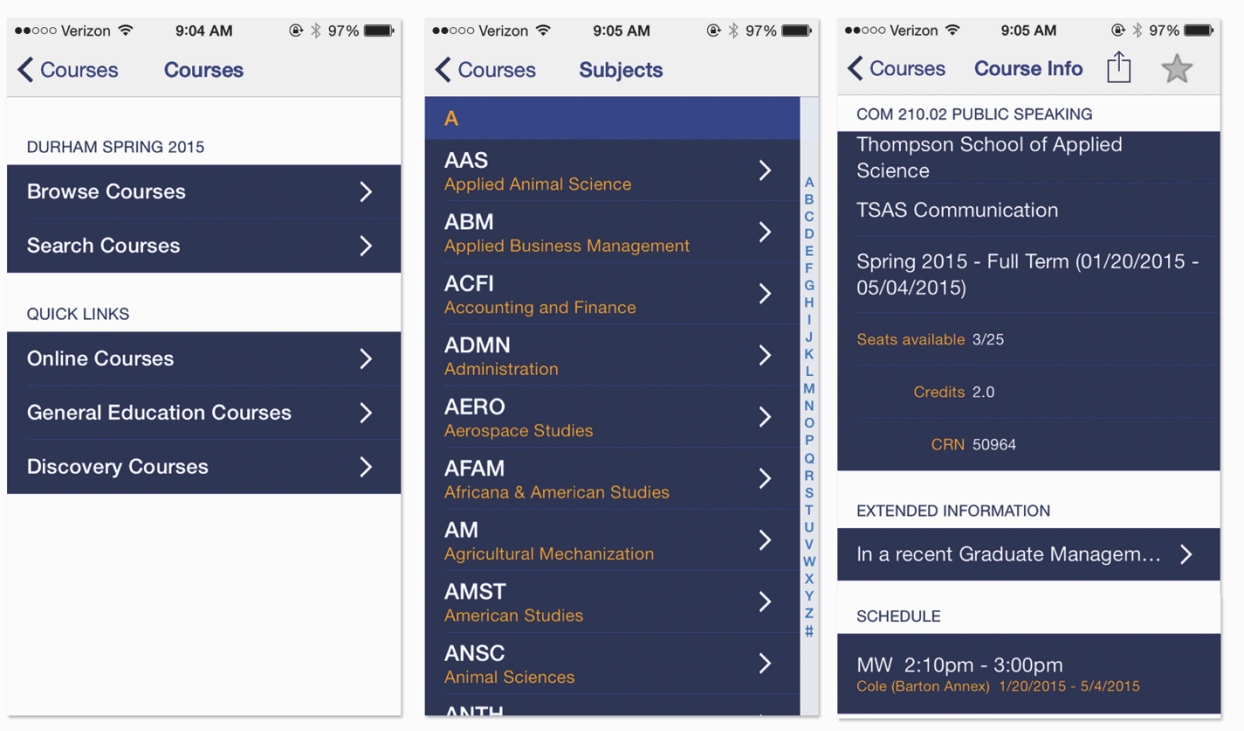

Figure 4.5: University of New Hampshire courses

The University of Arizona

The University of Arizona ranked second overall among the 30 university mobile applications. The app excelled in the user experience categories of user interface and navigation design, content and services offered, and visual design. Like the UNH app, the Arizona app received a perfect score, a 12 out of 12, for its user interface and navigation design. The icons and labels were communicative of the content provided when touched and the labels were aesthetically pleasing in their design and simplicity (Figure 4.6). The Arizona app used high contrast color with white text on red and black text on white. The brand identity of Arizona was evident throughout the app with the use of these high contrasting color schemes and the prominent university logo and name on the home screen. The consistency of the interface and navigation was one of the apps' overall strengths. The second- and third- level pages continually used shape and color to differentiate between headings and different content items. Arrows

indicated that a section was in fact a button and that there was further information when clicked (Figure 4.6). The consistent navigational components as well as the strong visual hierarchy allowed users to move back and forth throughout the app with ease. Arizona, like UNH, used a hybrid approach to mobile app development with the use of mobile websites housed within the mobile application.

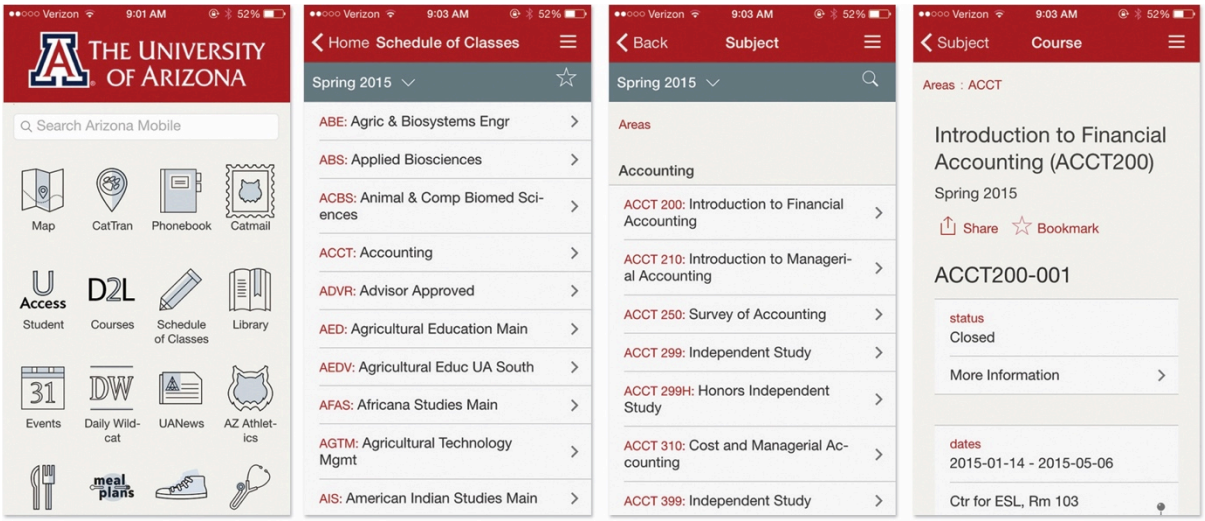

Figure 4.6: University of Arizona user interface and visual design

Most notable was how well the various mobile websites fit into the overall design of the app (Figure 4.7). Arizona was one of the only schools to address accessibility issues by allowing users to change the size of the text (Figure 4.8). The app also utilized breadcrumbs, further enabling the user to know where they had been and where they were within the mobile app framework. Another notable feature of the Arizona app was the successful targeting of various audiences. Users had the ability to select whether they were a current student, a prospective student, or alumni, and the services of the app would be filtered to match the selected audience category (Figure 4.8). The Arizona app offered an extensive number of services, many of which would encourage repeated use of the application. Events, news, contacts, athletics, a campus map, emergency information, and public transportation were some of the standard services

present. In addition, the Arizona app provided access to the bookstore, campus health, campus recreation, and library mobile websites. Dining center, meal plan, alumni, and donor campaign information were also available. Multimedia was used appropriately in the sections dedicated to videos, tours, and social media. The app enabled users to share content through social media and bookmark content within the app. The user had the ability to save events to the mobile device calendar, as well as open directional information in the device's map application (Figure 4.9*)*. The University of Arizona mobile application demonstrated that all of the user experience categories affect the others and that a successful app applies best practices from each category.

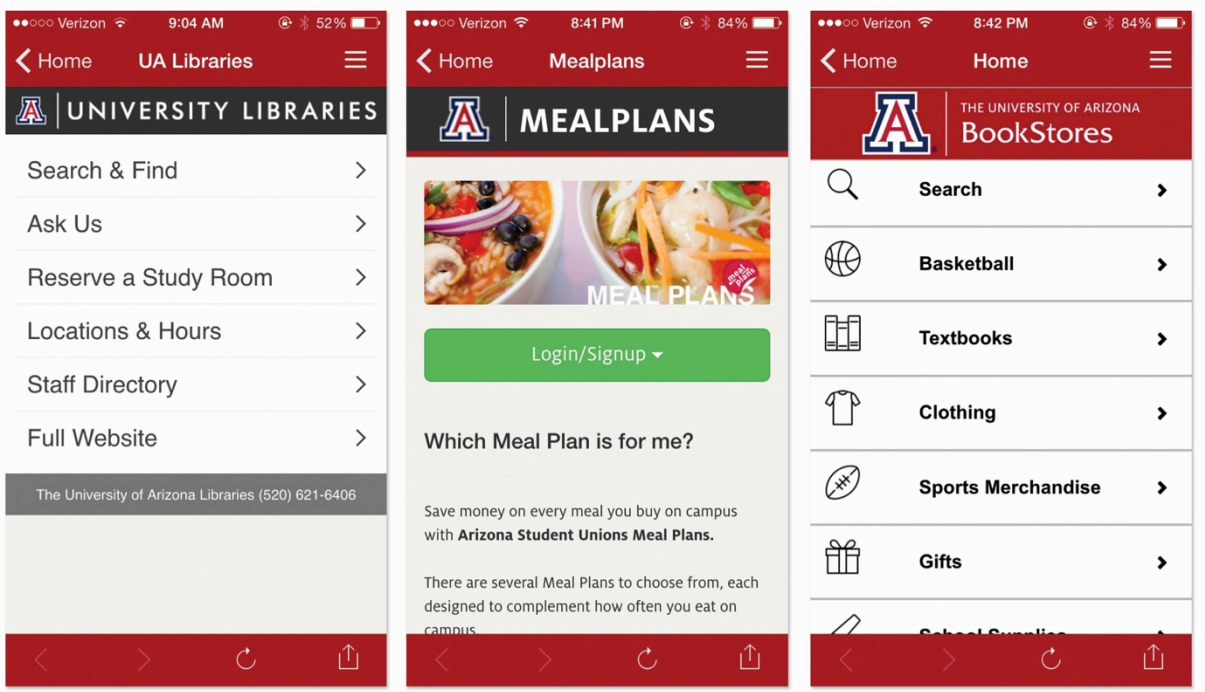

Figure 4.7: University of Arizona mobile websites within mobile app

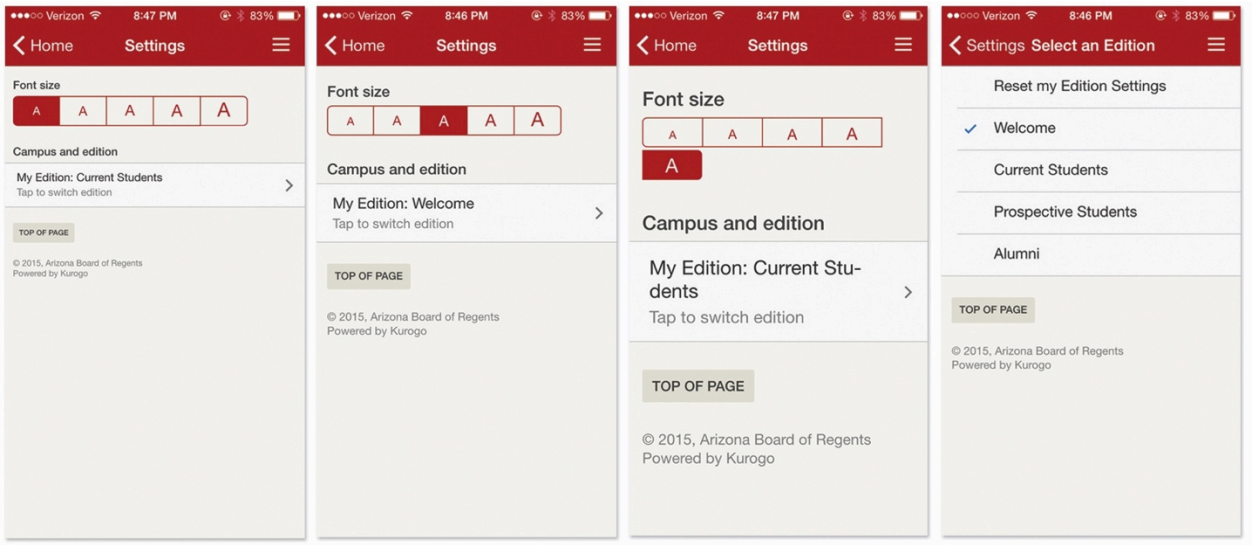

Figure 4.8: University of Arizona font size and audience options

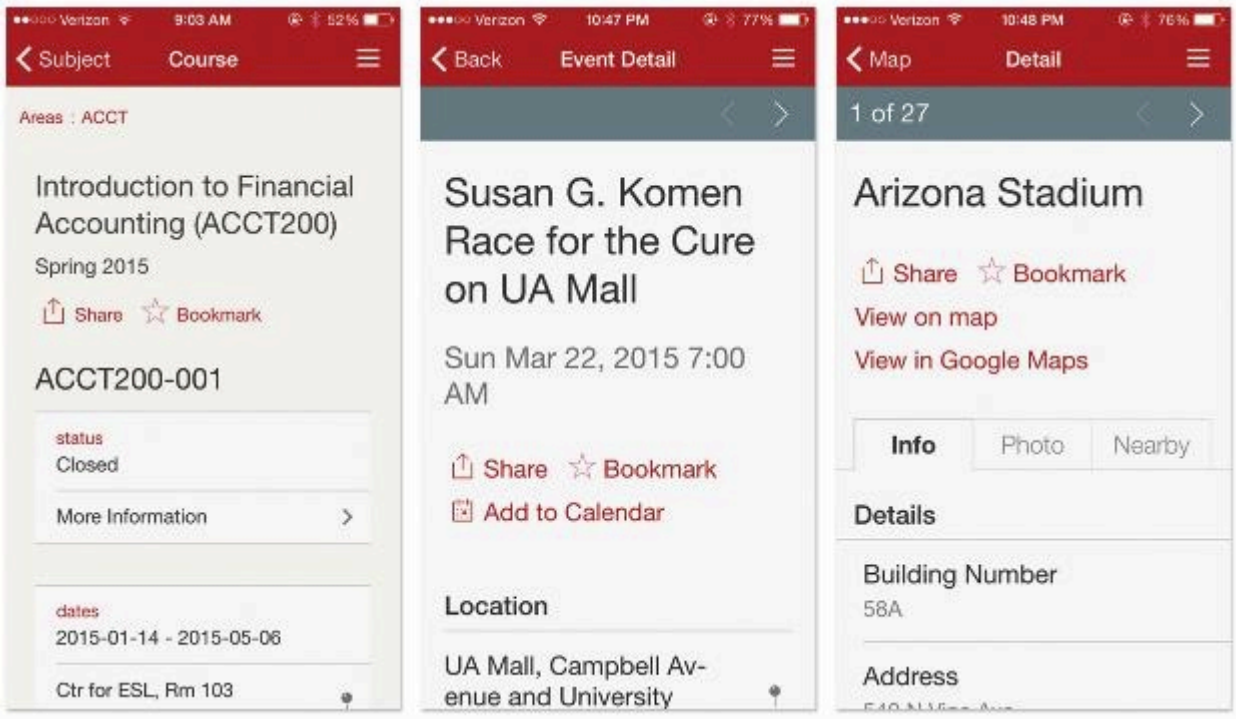

Figure 4.9: University of Arizona share, bookmark, calendar, and view in map options

Ohio State University

Visual appeal and design seemed to be the top priority for the Ohio State University (OSU) mobile application, while less emphasis was placed on the interface, navigation,

interaction, and architectural components, as well as the content and services offered. The overall design of the app was aesthetically and sensually pleasing. The use of color, shape, and contrast, were used to create unity and an effective visual hierarchy within the app. The Ohio State brand was apparent throughout the app through the use of the famous Ohio State "O" and the Buckeye colors of red, white, and grey. The Ohio State homepage was one of the best designed among all the apps. The use of dark and light grey and white to create sections on the homepage was consistent with current trends in web and mobile design. Icons and labels effectively portrayed the services that the OSU app had to offer and were visually appealing (Figure 4.10).

Despite top marks in visual design, the app fell short with its user interface, navigation design, and content and services offered. That is not to say that the university failed completely in these areas, but it was apparent that less emphasis was placed on the importance of these user experience categories. The app did not support landscape orientation and while it successfully utilized a hybrid framework, the websites housed within the app were not mobile, but desktop versions that required the user to zoom in and scroll horizontally to see all content. While the app did offer standard university services such as a campus map, news, events, bus information, a directory, course information, and athletics, the execution of these services was substandard. Instead of providing a list of courses for the user to browse through, searching was the only option available. The athletics section provided a brief summary of the news with text that was small and difficult to read and then took the user to the athletics desktop website for the full article.

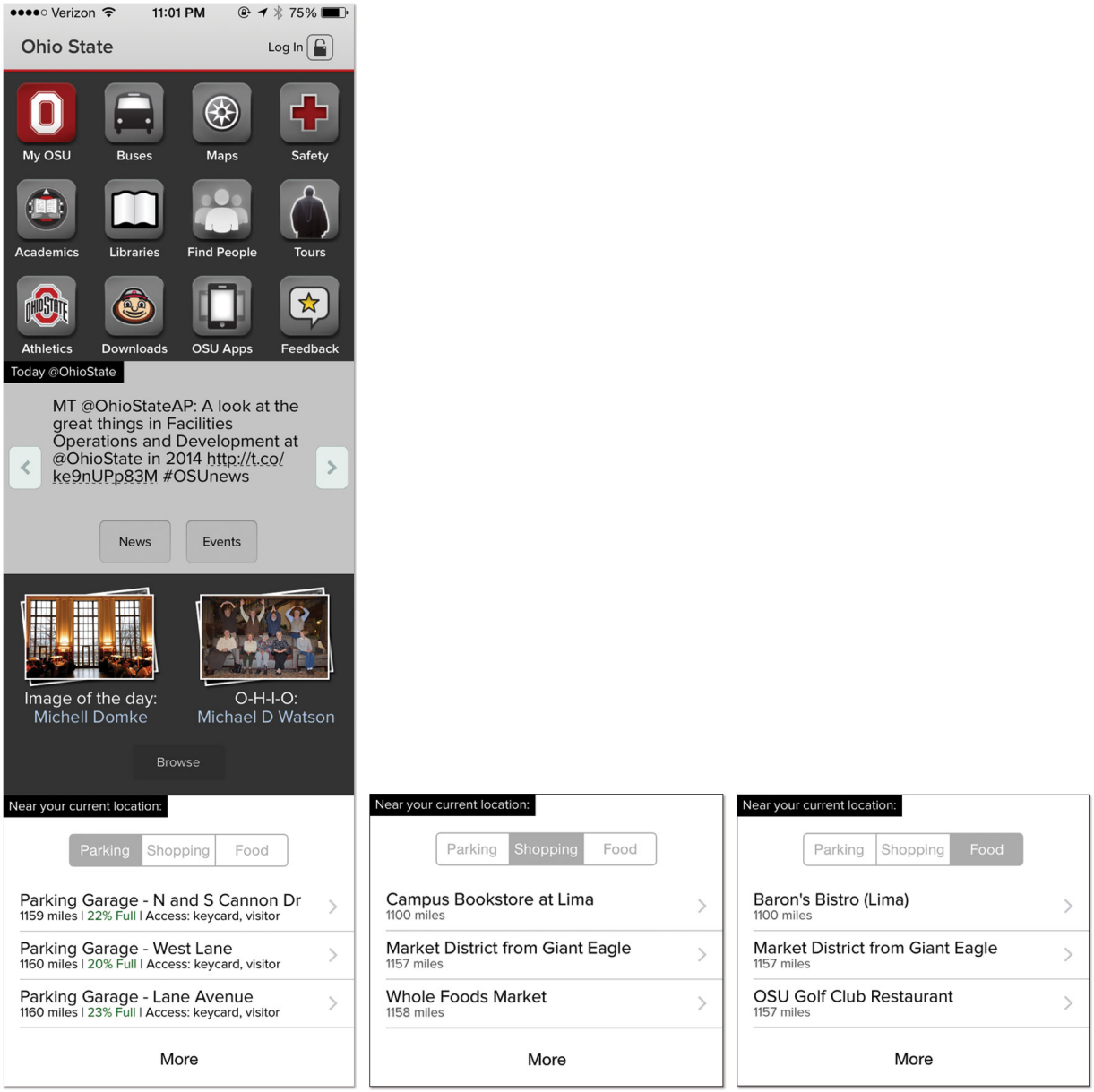

Figure 4.10: Ohio State University application home page. This figure illustrates screen shots that depict the continuity of the continuous scroll capabilities of the OSU homepage and the additional options in the "Near your current location" section of the homepage.

The app did encourage repeated use, especially with its homepage features. News, events, and continuously updated photos would most likely cultivate daily interaction with the app. Most notable on the homepage was the "near your current location" portion. Here visitors to the app could find the nearest parking, shopping, and food to their current location. The parking feature

even included information about the availability of spaces and the access capabilities of each parking facility (Figure 4.10). Ohio State's distinction in visual design and functional and technical specifications along with its mediocre interface and navigation design, interaction and information architecture, and content and services offered resulted in an overall third place ranking.

University of Florida

The biggest strength of the University of Florida (UF) mobile application was the simplicity of the design and navigation. The home page provided the UF logo and name, clearly indicating the brand identity of the app, and had a vertical list of services separated by lines, with arrows that indicated the option to move forward and get more information. The app consistently used the UF colors of blue, orange, and white and used white and black text to provide contrast between background colors and text. Icons were well designed and reflective of the services and content offered within each section (Figure 4.11).

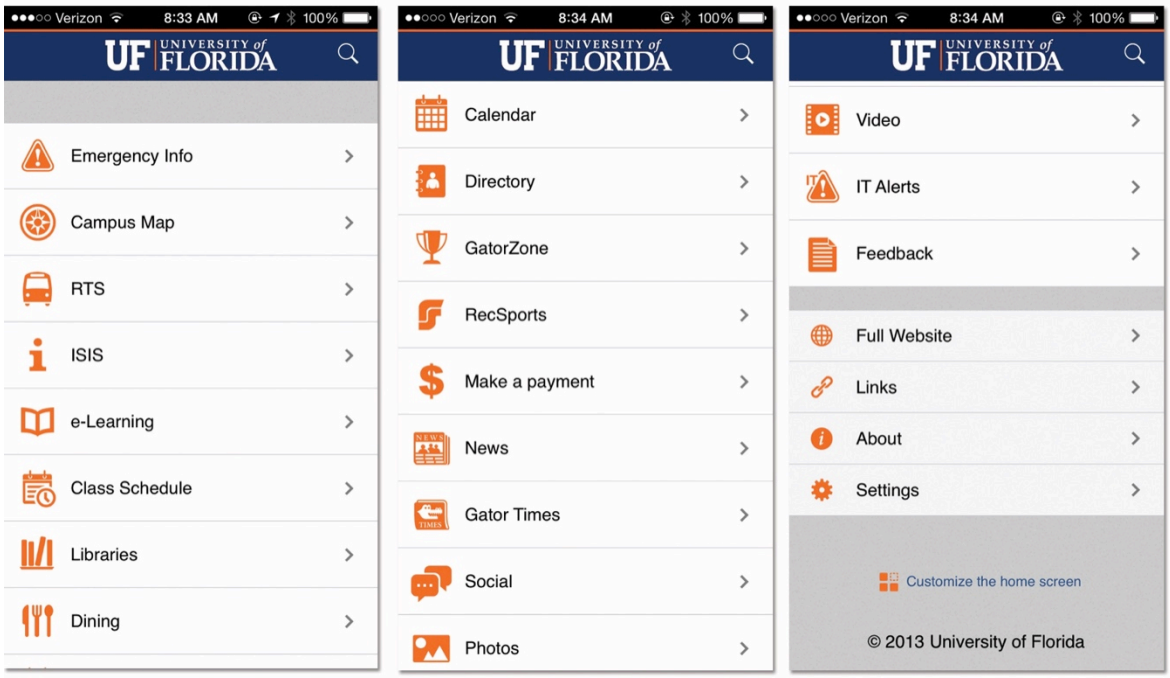

Figure 4.11: University of Florida home screen. This figure illustrates the continuous scroll feature of the home screen depicted in three separate screen shots.

Navigation throughout the app was fluid, offering forward and back options consistently in the top left corner of the app, however, the tabbed menu navigation that appeared at the bottom of the screens within the various sections, was somewhat difficult to use due to the small size of the touch areas. The app's interface was consistent by keeping the user within the app and directing users to mobile websites rather than desktop sites. However, the different mobile websites detracted from the overall visual appeal of the app. The library section utilized a different blue that clashed with the app's color scheme and had icons that were pixelated, while the rec sports menu used yet another shade of blue, as well as black header bars (Figure 4.12). Sending the user to mobile websites located within the app framework with distinctly different navigation configurations was confusing. It was difficult to distinguish between the mobile application and mobile website navigation. For instance, the home back button of the app was often clicked, when the user wanted to go back within the mobile website architecture.

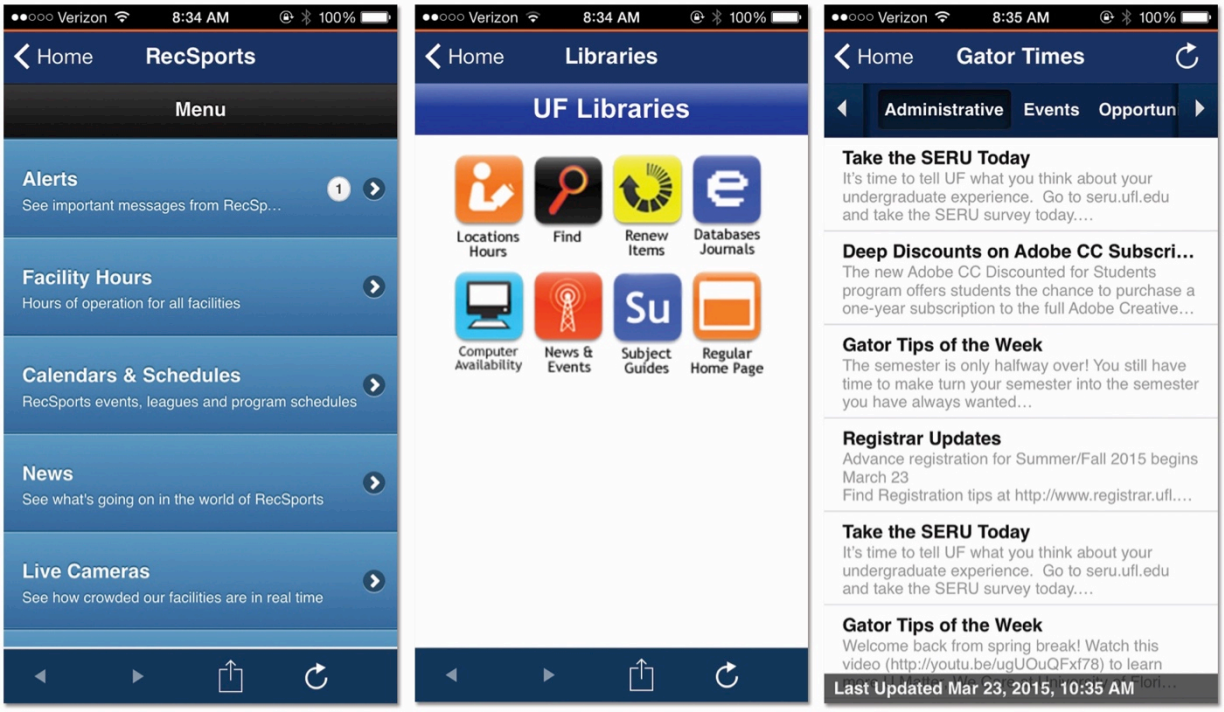

Figure 4.12: University of Florida mobile websites

The content of the UF app was comprehensive, covering emergency information, maps, transportation, e-learning, class schedules, libraries, dining, events, a directory, athletics, recreation sports, news, social media, photos, and video, and even offered an option to login and make a payment to the user's university account. There was an option to provide feedback about the app, links to other UF apps and social media accounts and information about the app and the University of Florida. One great feature of the app was the ability to customize the home screen by showing or hiding the various modules or services (Figure 4.13*)*. Overall, the app had great services to offer, but the execution of those services was not entirely effective. The interface, visual, and navigational components were good but fell short of excellence.

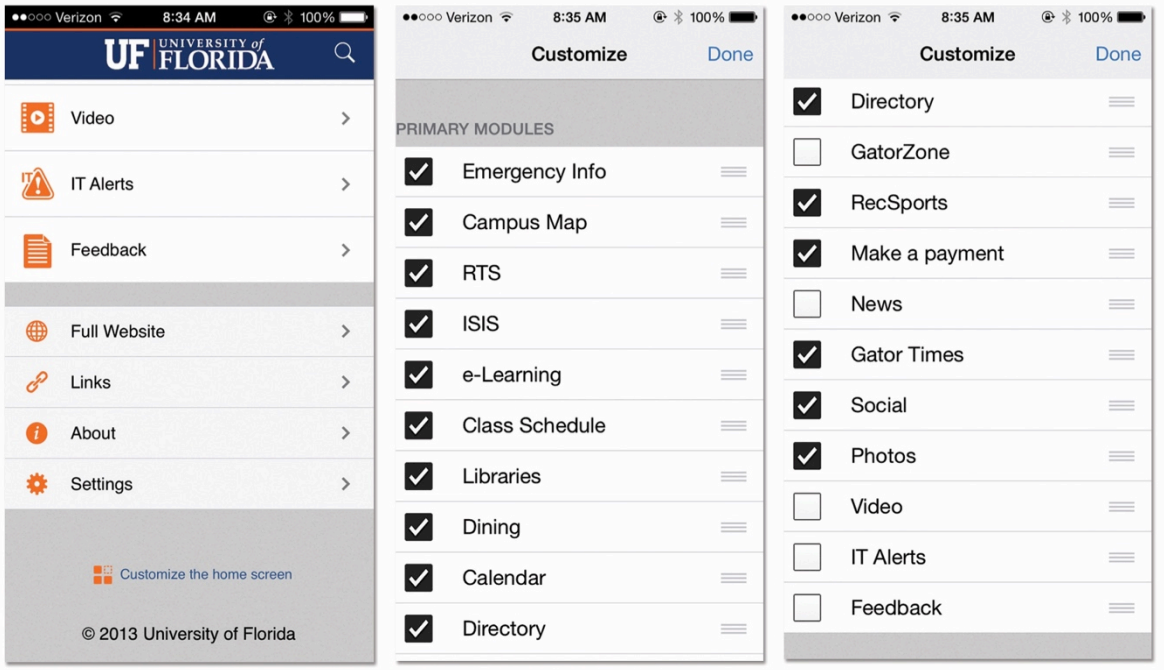

Figure 4.13: University of Florida customization screens

Washington State University

The Washington State University mobile app had strong visual appeal with its use of compelling photos within the app. As an app with its primary focus on prospective students, the photo backgrounds on the home page, the directory, about WSU, and the gallery provided a great

glimpse of life at WSU (Figure 4.14). Although photos as backgrounds are often a distraction from content, the app was successful in using an effect, where the photo was blurred when a user scrolled down through the content (Figure 4.15) to make the content more readable.

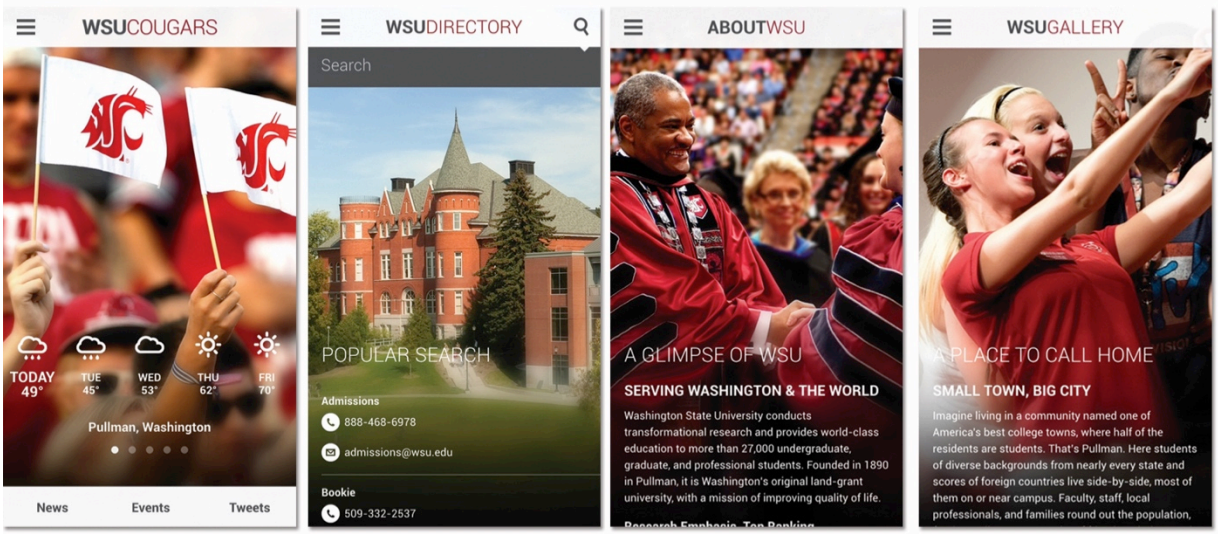

Figure 4.14: Washington State University photography

The use of color and shape created an effective visual hierarchy throughout the app. Most notable were the use of white header bars with grey and red text or red bars with white text to indicate what page the user was on and the red highlighted menu item also denoting the current page (Figure 4.16). The About WSU page's use of color blocks to separate the sections of content added to the app's attractiveness. The location detail pages were well designed while also providing relevant content and options to view the location in the map or get directions (Figure 4.16). Icons were standard, simple designs that would be recognized by most mobile users. Navigation buttons and format were consistent and effectively communicated the relationship between navigation elements and the pages or content they were linked to and page titles helped to strengthen this relationship.

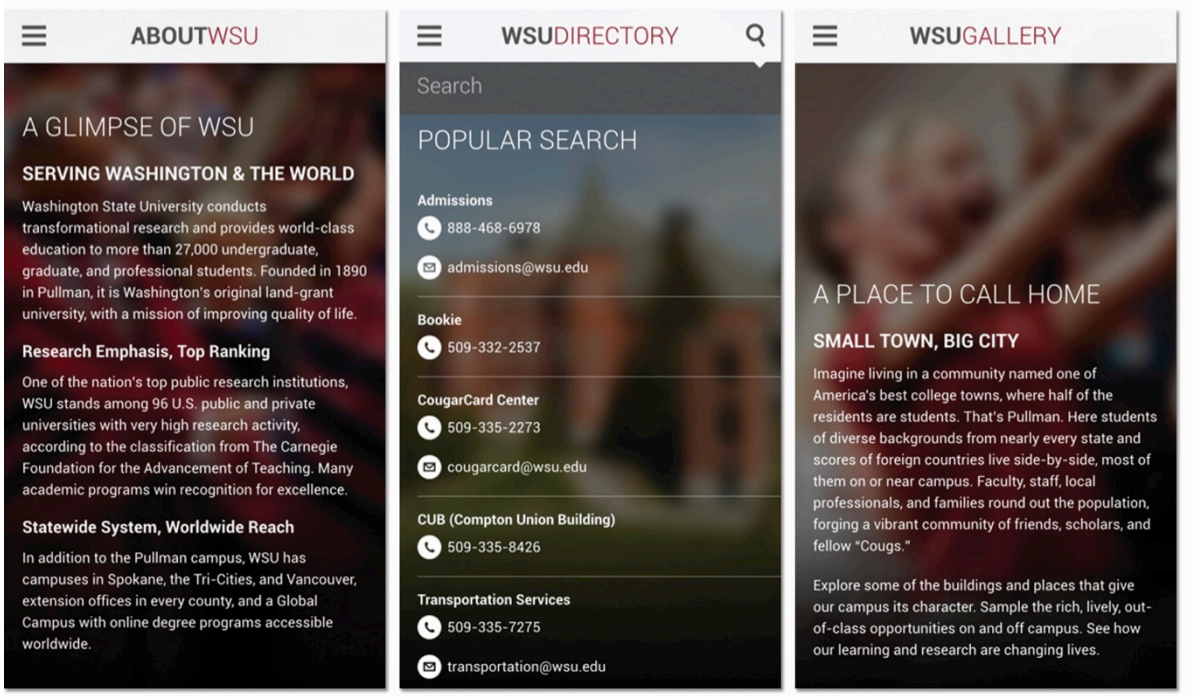

Figure 4.15: Washington State University blurred photo effect

The app used two distinct navigation patterns, side menu and tabbed menu. The main navigation was housed in the side menu while the tabbed menu was present on the home and map pages to provide additional options to the user (Figure 4.16). The app had one of the most consistent interfaces and never directed users to webpages, mobile or desktop. Roughly half of the mobile applications provided an indicator or notification when an action would take the user outside of the application framework. WSU was one of the apps that provided notifications across multiple situations. Users were prompted prior to making a phone call and were notified when leaving the app to access directions. Despite the visual appeal and strong interface and navigational components, the WSU app lacked content that would encourage repeated use of the app. The services that the WSU app offered were indicative of an app designed to target prospective and possibly current students. The about page, gallery, and map services provided a great deal of information that would be of benefit to students and parents considering the

university, but would hardly elicit repeated use of the app by these audiences. The alerts, news, events, and tweet sections might also be informative for prospective students, but could also be beneficial for current students, interested in getting involved or wanting to know what's happening on campus. While these were great services, the app lacked some of the offerings other universities had that would most likely entice students to use the app on a daily basis. The WSU app would benefit from further exploration into what content their users would like to see.

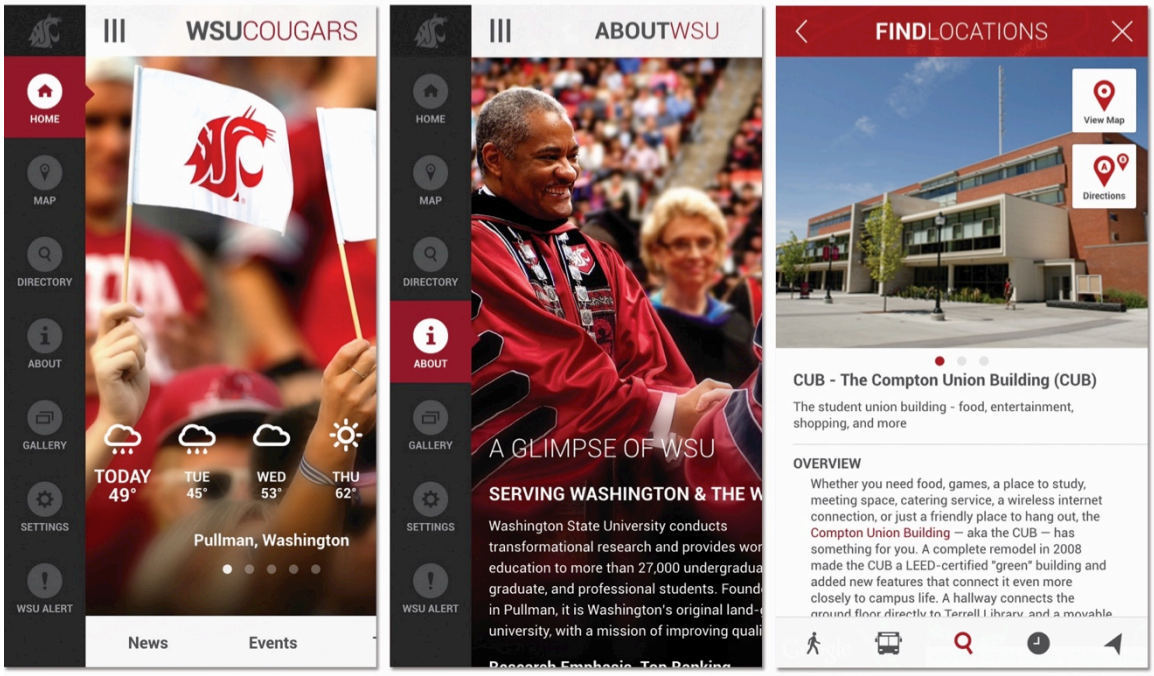

Figure 4.16: Washington State University navigation and visual hierarchy

Michigan State University

The Michigan State app branded as the Spartan App, was one of the most intriguing, and perhaps the one app that would be used on a regular basis. The focus of the app was about getting current students, faculty and staff engaged on and off campus. The app offered deals, food options, event information, nightlife options, transportation, and maps. What made this app so different from the other 29 was the collaboration between MSU and the surrounding East

Lansing community. Businesses were able to contact MSU and advertise opportunities within the college app (Figure 4.17).

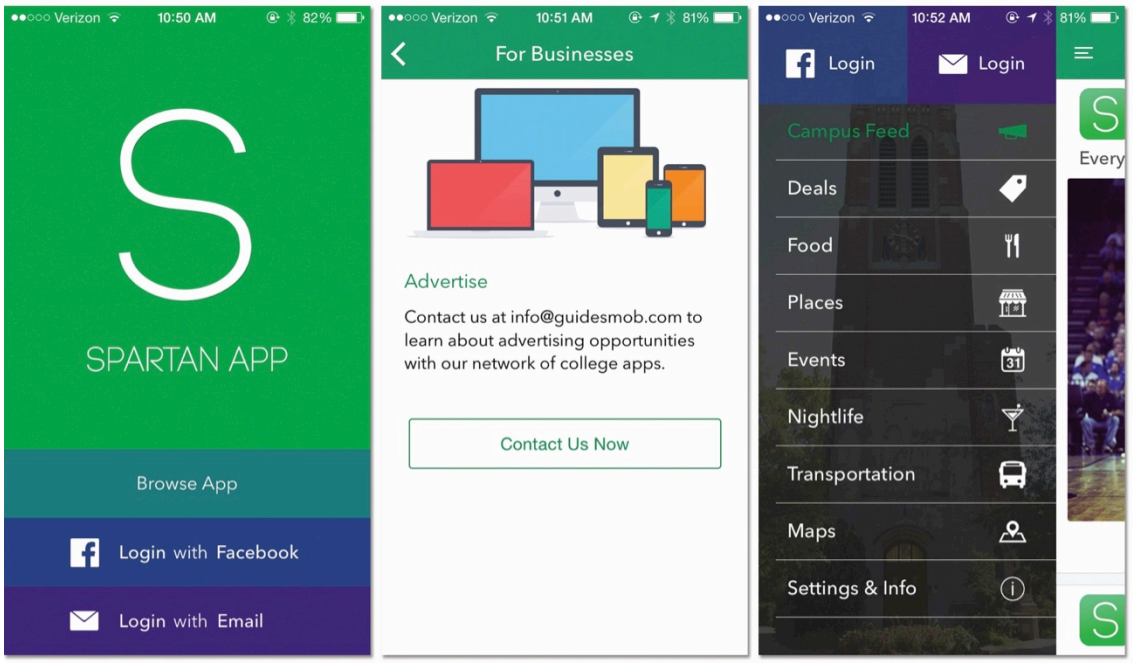

Figure 4.17: Michigan State University app home, advertising, and navigation screens. The navigation screenshot depicts a sliding side menu, where the content is pushed right to reveal the navigation, when the three white line icon is pressed.

The places section contained information, directions and phone numbers for banks, car shops, cinemas, dentists, dry cleaners, gas stations, grocery stores, fitness, laundry, liquor stores, salons/barbers, storage, tailors, and tanning, many of the everyday necessities of a college student (Figure 4.18). The food section had information about MSU dining, and locations for various types of cuisine including, American, Asian, breakfast, coffee, dessert, Indian, pizza or pasta, Mexican, sandwiches, Mediterranean, and an option that informed the user which restaurants were currently open (Figure 4.19). The transportation services included Capital Area Transportation Authority or public transportation, taxi, and shuttle information. A campus news feed area provided the latest information about athletic events and deals around town. The main

content areas that were notably absent from the MSU app were emergency information and academic related services.

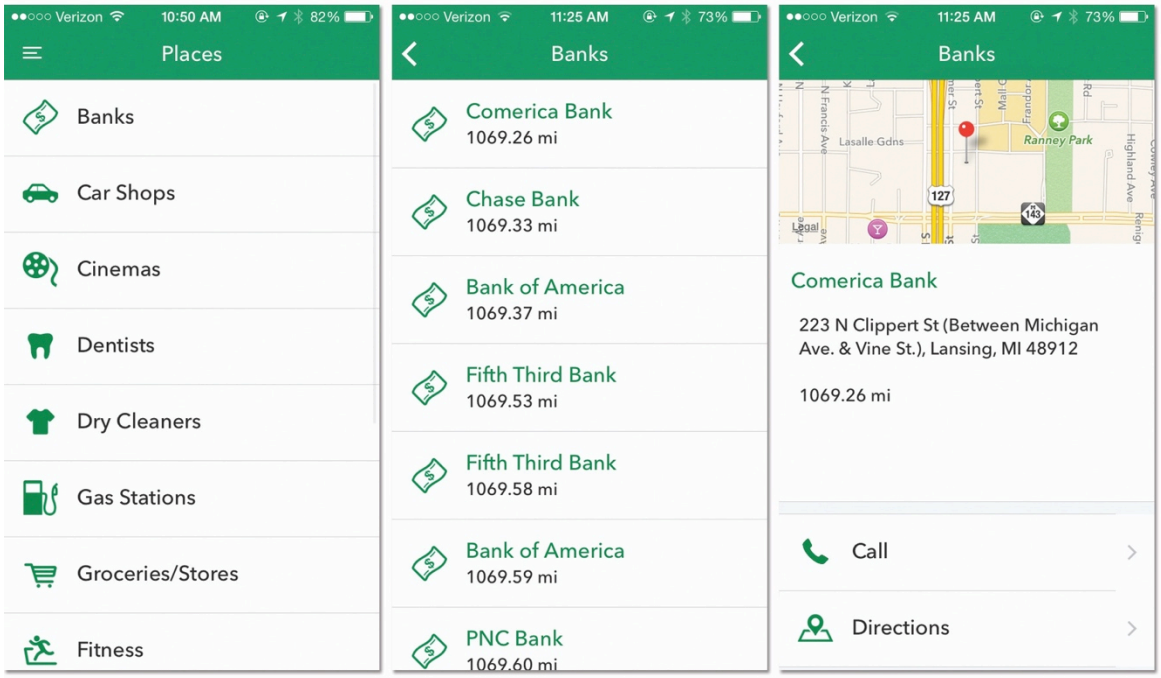

Figure 4.18: Michigan State University places section. These screen shots represent three levels of information within the places section of the app.

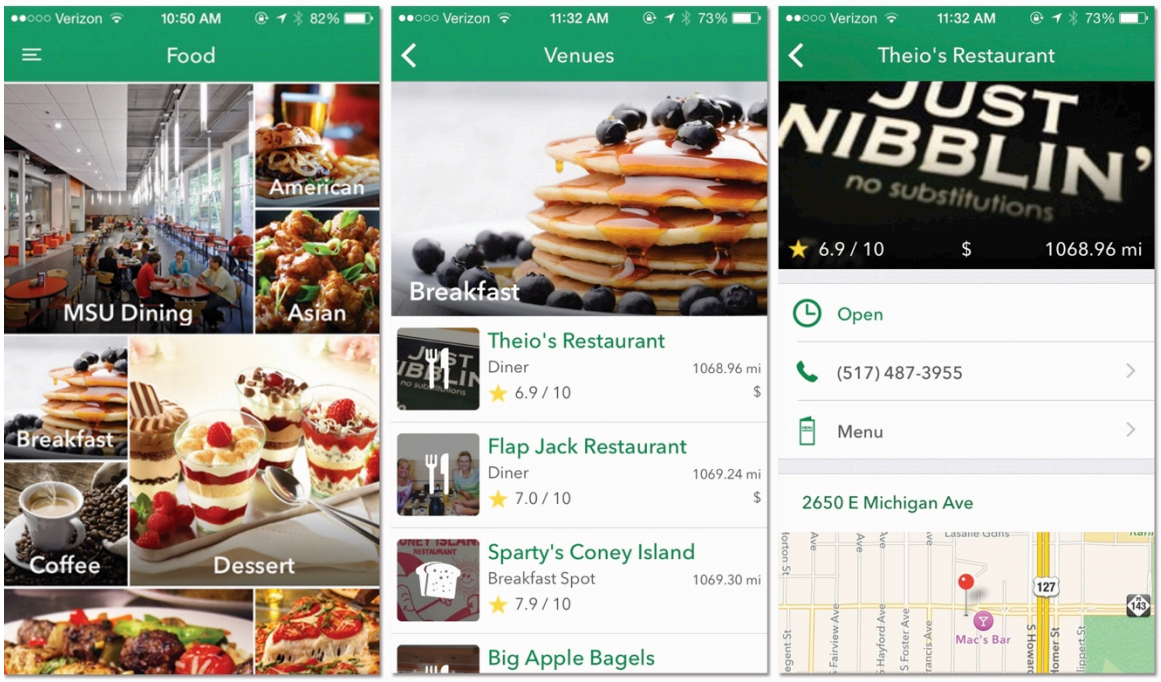

Figure 4.19: Michigan State University food section. These screen shots represent three levels of information within the food section of the app.

The app was very well designed and the interface allowed for easy navigation and use of the app. A side menu housed the main navigation and a tabbed menu was used on various pages to provide further navigation options. The information architecture pattern was a nested doll, where the user was able to move forward and back through the content and click the side menu icon to access the other sections whenever desirable. Labels and icons were descriptive, well designed, and consistent throughout the app and did a great job of informing the user what content to expect. The use of photos as a design component, as is evident in the food and deals sections was sensually and visually appealing. Brand colors of green, white, and grey, high contrast color schemes, and the use of shape created a powerful visual hierarchy and an app that had great consistency and unity.

CHAPTER 5

DISCUSSION

Summary

The general conclusion from both the quantitative and qualitative analysis was that none of the apps excelled in all five UX categories, indicating that it may in fact be difficult to be exemplary in all five of the categories and comply with the best practices of the *Mobile application user experience framework* (Figure 2.1). The top six apps seemed to focus on two or three of the UX categories rather than all five, resulting in stronger user experiences overall. The highest ranked six apps portrayed how the various UX categories and best practices interact with and rely on each other to create a successful user experience. The in-depth analysis revealed that it was very difficult to look at the first three levels of an app once and effectively evaluate the user experience best practices. In fact, on further analysis of the top six ranked apps, where 30 minutes to an hour was spent going through the app and writing an evaluation of the UX best practices, different ratings might have been obtained. While the top six apps could have flip-flopped positions, the researcher believed that these six apps were far better in most of the UX categories than the other 24 apps.

Visual Design with User Interface and Navigation Design

The UX categories of visual appeal and user interface and navigation design were the two that had the most impact on one another. An interface that was designed well had strong visual appeal and those apps that were visually appealing tended to have effective navigation that enhanced the visual design and user interface. The apps that integrated these two categories most effectively were the University of Arizona, Washington State University, and Michigan State

University. The other three apps, University of New Hampshire, University of Florida, and Ohio State University, while effective apps took users to either mobile websites or desktop websites within the mobile app framework, but this hybrid approach to app design detracted from the overall design and appeal of the site and often led to confusion about navigation.

Content and Services Offered with Interaction Design and Information Architecture

Content and services offered and interaction design and information architecture were the other two UX categories that were closely related. The content and services offered were indicative of whether the app encouraged repeated use. It was the use of information architecture patterns that determined the organization of the content or services offered within the app. The app that offered the best content, a strong information architecture, encouraged repeated use, and enabled interaction with mobile device features most effectively was the University of Arizona. The University of New Hampshire offered a variety of unique content and was successful in targeting a variety of university audiences. The University of Florida allowed users to filter content and customize the home screen of the app. Michigan State did a great job of connecting students to the East Lansing community through its content, but failed to integrate more campus related features within the app. Washington State University's content was not very conducive to repeated use, but was more informational for prospective students. All six applications would have benefited from better organization of the services offered, perhaps by alphabetizing the service options on the home page or in the main navigation menu. Another option would have been to group the services into content categories, though this may have been difficult to achieve. University of New Hampshire had the best organization of content by offering sections such as academics, campus services, and discover UNH, which each had further options within.

Functional and Technical Specifications

This UX category had the least variance among all 30 apps and was therefore not critiqued to the same extent as the other four categories. The mere fact that this category had so many *yes/no* questions, made it less intriguing, as each feature was either present or absent from the apps. Aside from the privacy policy best practice, all other functional and technical specifications were predominately present in nearly all of the mobile applications. The University of Florida, Ohio State University, and Washington State University did not provide users access to their privacy policy, while the University of Arizona was slow to load pages, which affected the user experience significantly. Overall the top six apps performed well in the best practices associated with the UX category of functional and technical specifications.

The Impact of Application Source on Best Practices

After the quantitative and qualitative analysis were performed, the evaluator determined whether the apps were (1) custom apps designed at the universities, "write it yourself options" or (2) white label apps, "free, out of the box options" (Dixon, 2012). During the content analysis portion of this study notations were made about what development option each university had chosen for their app. If the university used a white label app, the vendor was determined where possible. Table 5.1 summarized whether the app was a custom or white label and the developer or vendor respectively for each university application.

Table 5.1: App Type and Developer or Vendor

University	Custom	White Label	Developer/Vendor
University of New Hampshire	X		UNH Mobile
University of Arizona		X	Modo Labs
Ohio State University	X		Unknown
University of Florida	X		UF Information Tech
Washington State University	X		WSU Mobile App Team
Michigan State	X	X	Guidesmob & Graphic Designer AnMaree
Colorado State University		X	Ellucian
North Carolina State	X		NC State Students and Staff
Oregon State		X	Guidebook
University of Kentucky		X	Blackboard
University of Hawaii	-	-	Unknown
University of Nebraska		X	Blackboard
Auburn University	X		AU Information Tech
Florida A&M		X	Blackboard
Virginia Tech	X		Unknown
University of Missouri	X		Mizzou Information Tech
Iowa State University	X		College of Engineering & Information Tech
University of Tennessee		X	Blackboard
Clemson University	X		Unknown
University of Minnesota		X	Guidebook
Texas A&M		X	Blackboard
University of Nevada		X	DUBLabs
University of Idaho		X	Ellucian
Oklahoma State	X		OSU Students & Office of Communications
University of Wisconsin	X		UW Communications & Information Tech
University of Georgia	X		UGA Students & Information Tech
University of Alaska		X	Blackboard
Utah State University	X		Unknown
University of Maryland		X	EX Axess
Louisiana State University		X	Blackboard

Fifteen of the 30 universities developed their own custom apps, while fourteen, used various vendors' white label apps. Only one application, the University of Hawaii, provided no indication of how it was developed. The University of New Hampshire, Ohio State University, University of Florida, and Washington State University all developed custom mobile applications with a development team in-house at the university. Michigan State University used a white label app from a company called Guidesmob, but customized the app with the help of a graphic designer. The University of Arizona used a custom white label app called Kurogo, which is an open-source program created by Modo Labs (2015). The University of Arizona no doubt customized their white label app to conform to university brand standards and was able to take a pre-designed application framework and develop an app that was both visually appealing, had a strong user interface, and great content. While the University of Arizona was the only land-grant university evaluated in this study to use the Kurogo app framework, other universities across the nation using the same software, include Boston College, Colgate, Dartmouth, Harvard, College of William & Mary, Georgetown, Indiana State, and New York University. The mix of custom and white label apps among the 30 ranked schools provides no indication as to which method is better. Planning and execution of UX best practices supersede the type of app development any one university chose.

Limitations

There were four principal limitations in this study. The first limitation involves the exploratory nature of the study itself. No previous research could be located that explored how universities approach mobile communication and the development of mobile applications. Thus, this study was the first of its kind, and the criteria to evaluate the university apps was drawn from best practices associated with mobile websites and general mobile applications, as opposed to

university mobile applications. Based on the research, 49 reasonable best practices were chosen as criteria to evaluate the 30 applications, but there could be additional variables or best practices to consider when evaluating university mobile applications. In particular, certain definitions of the variables, such as walkthroughs, could be clarified and redefined. The topics explored in the study are in their infancy with regard to measurer research methodology.

The second limitation deals with the sample size of the study. A sample size of 30 universities was very small-scale and limited the reliability and validity of the study, particularly the quantitative results. However, as a mixed-methods study that incorporated quantitative content and qualitative descriptive analyses, evaluating 30 applications was deemed reasonable. However, increasing the sample size would no doubt increase the statistical power of the study. A more in-depth quantitative analysis might have been possible with a larger sample size and might have provided more insight into the relationships between individual best practices and UX categories.

Third, the validity of the study also was potentially limited by the use of one coder for the content analysis. The use of one coder could have led to bias, based on the evaluator's preconceived perceptions and opinions of what a good app should look like and how it should work. Adding a second coder could improve the validity and reliability of the findings if the study is replicated in the future.

Using only land-grant universities was a fourth limitation of this study. While it was reasonable to use 30 of the 115 land-grant schools in light of Colorado State's role as Colorado's only land-grant university, using different samples of the more than 3,000 colleges and universities in the United States could have produced different patterns and conclusions. Despite the use of only land-grant universities, this study can be used a guide for not only other land-

grant schools, but for other aspiring universities as well. Evaluating non land-grant universities in a similar fashion would only add power, validity, and reliability to the overarching concepts of university mobile applications, best practices, and user experience design.

Future Research

More research needs to be done with mobile applications in general as well as about mobile applications and their role in university communications with students and other constituents.

Validating best practices measures

Specifically for universities, a re-evaluation of the best practice criteria and application of the same study to a larger sampling of universities would be highly beneficial to substantiate the results and provide further insight into university mobile applications and user experience best practices. Performing studies on each of the user experience levels and or categories would provide universities with a greater understanding of each UX category by itself and how the five interact and relate to one another to create the overall user experience of a mobile application. In particular, it would be valuable to develop an empirically testable set of measures that could be reliably combined into effective indices for each of the five dimensions or user experience design categories investigated in this study. Achieving reliability would involve creating a set of interval-level measures (scaled items) for which a Cronbach Alpha statistic could be created.

Understanding mobile app strategies

Looking back at the Mobile Application User Experience Workflow presented in Chapter 2 (Figure 2.1), the user experience strategy level was excluded from this particular study because of the difficulty of verifying the strategy behind the observable content. Garrett (2011) noted that, “The foundation of successful user experience is a clearly articulated strategy” (p. 35). As

this study was concerned with user experience design and therefore the four levels of scope, structure, skeleton, and surface, there was no definitive way to determine what the university mobile app strategy was, nor user needs or expectations. Therefore, it would be of great advantage to perform a variety of studies that address university goals as well as user needs, desires, and interests.

Qualitative and quantitative investigations involving university officials and app developers could be used to determine not only the strategy of the university with regard to app development, but also to corroborate the conclusions found in this study. Whether the research is focus groups, surveys, questionnaires, or in-depth interviews, all universities would benefit from knowing what strategies are currently employed and considered effective, as well as how developers see the future of mobile in the university environment.

Investigating user response

Beyond strategy involving research with professionals, at the opposite end of the mobile application user experience workflow is the user. Performing quantitative and qualitative studies to determine what students, faculty, staff, visitors, alumni, donors, and any other university audiences want from a mobile application could help determine the future of mobile communication at universities. Usability testing would be another approach for getting feedback about how well a university or group of universities is doing from a user experience perspective, such research can assist in determining where a developer needs to go next. In fact, research has already begun that investigates the users' perspective of university mobile applications. Gupta, Gop, and Kyei-Blankson (2014), published a study in October that evaluated the usage patterns and student expectations of two popular university owned mobile applications. "The study

highlights the gaps where universities fail to reach out to its students, hence delaying their engagement or use of the apps" (Gupta, Gop & Kyei-Blankson, 2014, p. 742).

Mobile communication research is in its infancy, but no doubt has a bright future as more and more people purchase multiple types of devices. Universities can use this research to evaluate how well their own apps conform to UX best practices and the leading land-grant university mobile applications. Those that wish to further the research in the field of mobile communication in universities can build upon this study as a framework for future investigations surrounding user experience and university mobile applications.

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APPENDIX 1A

VISUAL DESIGN CODE SHEET

UNIVERSITY_____

BEST PRACTICE	SCORING	NOTES
A - Contrast *App uses high contrast color schemes (mix of neutral and bright colors)*	☐ YES ☐ NO	
AX - Unity & Consistency *Colors, typography, space, and layout are designed consistently and create a sense of unity throughout the app*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
A - Typography *Fonts and text elements are simple and readable; No more than 2 fonts are used throughout the app*	☐ YES ☐ NO	
AX - Visual Hierarchy *App creates a sense of visual hierarchy and flow (i.e. elements are arranged according to emphasis in the layout – through the use of different font sizes, colors, spacing elements, and content sections)*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	

BEST PRACTICE	SCORING	NOTES
AX - Brand Identity *The brand of the university is consistent throughout the app with the use of university colors, logos, and/or brand identifiers (i.e. slogans)*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
A - Texture & Shape *App uses texture and/or shape to enhance detail and make empty space more appealing*	☐ YES ☐ NO	
AX - Aesthetics *The overall design of images, colors, fonts, and other elements are visually and sensually pleasing; design enhances user engagement and interest*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
AX - Color *Color is used to give prominence to content items, demonstrate how items are connected, and helps structure content (i.e. separates content)*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	

APPENDIX 1B

INTERFACE AND NAVIGATION DESIGN CODE SHEET

UNIVERSITY_____

BEST PRACTICE	SCORING	NOTES
B - Horizontal Scrolling *App avoids horizontal scrolling*	☐ YES ☐ NO	
B - Graphics/Text *Graphics and text are not distorted, blurred or pixelated*	☐ YES ☐ NO	
B - Orientation *App supports landscape and portrait orientation and is capable of rapid transition between orientations*	☐ YES ☐ NO	
B - Screen Space *Design is for a single window or full screen. Main task is front and center*	☐ YES ☐ NO	
BX - Consistent Interface Design *The interface of the app is consistent – when app directs users to webpages they are mobile friendly and fit with the app interface design*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	

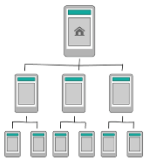
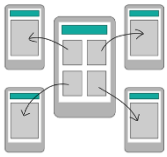
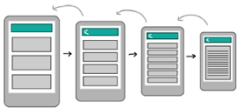
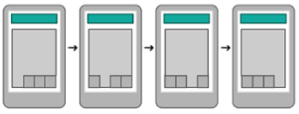
BEST PRACTICE	SCORING	NOTES
B – Button Size *App uses appropriately sized buttons and touch targets (i.e. buttons are easy to click and react appropriately to touches)*	☐ YES ☐ NO	
BX - Navigation *Buttons and format of navigation are consistent; navigation communicates the relationship between navigation elements and the pages or content they are linked to*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
B - Back Button Navigation *App supports/uses standard back button navigation*	☐ YES ☐ NO	
B - Labels & Icons *Labels and Icons are descriptive, clear, concise, and consistent (inform the user about what content will be provided when clicked)*	☐ YES ☐ NO	
B - Page Titles *App provides descriptive yet concise page titles that clue the user into the content of the page*	☐ YES ☐ NO	
Navigation Styles *Which navigation format(s) is/are used? Select all that apply*	☐ EXPANDING MENU: *A menu icon (generally a series of lines) is contained in the header. Tapping the icon shows a list of main menu items.* ☐ SIDE MENU: *You will often press an icon with a series of lines or slide the screen over, this then expands or slides open the menu, showing a list of menu options vertically down the side of the screen. This can have categories as well as being scrollable.* ☐ TABBED MENU: *A persistent toolbar, displayed in either the header or footer of an app, allows user to quickly switch between sections.* ☐ HUB & SPOKE: *A centralized home screen allows the user to select a menu option. This will navigate the user to this section, which can have its own internal navigational pattern. The user may return to the home screen by activating a back link.*	

APPENDIX 1C

INTERACTION DESIGN AND INFORMATION ARCHITECTURE CODE SHEET

UNIVERSITY_____

BEST PRACTICE	SCORING	NOTES
C - Gestures *App employs gestures that are consistent with the operating systems standards*	☐ YES ☐ NO	
C - Walkthroughs *Overlay instructions or coach marks are provided upon initial launch to show users how to use different features of the app when deemed necessary*	☐ YES ☐ NO	
C - Error Messages *App provides helpful error messages when a task does not go as planned (i.e. messages when login fails)*	☐ YES ☐ NO	
C - Input *Default values are displayed for input and appropriate keyboard is available when entering data (i.e. numbers are available when asking for a phone number)*	☐ YES ☐ NO	
CX - Repeated Use *App encourages repeated use through interaction with features of the app*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	

BEST PRACTICE	SCORING	NOTES
CX - Device Features *App enables interaction with mobile device features (camera, location functions, and other apps available on the device)*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
C - Notifications *App notifies user when it is leaving the app to access other phone features and/or apps*	☐ YES ☐ NO	
CX - Architecture Pattern *App utilizes a consistent architecture pattern that is shallow not deep in nature (i.e. hierarchy, hub & spoke, tabbed view, nested doll)*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
Identify which of the following information architecture patterns the app uses	☐ HIERARCHY: Standard index and series of sub pages  ☐ HUB & SPOKE: Central index/hub users navigate out to "spokes" and back to "hub"  ☐ NESTED DOLL: Linear pattern – leads to more detailed info. Perception of moving forward & back  ☐ TABBED VIEW: Group of sections linked together through a toolbar or menu 	

APPENDIX 1D

CONTENT AND SERVICES OFFERED CODE SHEET

UNIVERSITY_____

BEST PRACTICE	SCORING	NOTES
D - Target Audiences *Which of the following audiences does the app target? Select all that apply.*	Current Students ☐ Yes ☐ No Prospective Students ☐ Yes ☐ No Faculty/Staff ☐ Yes ☐ No Campus Visitors ☐ Yes ☐ No Donors ☐ Yes ☐ No Alumni ☐ Yes ☐ No	
DX - Organization *Content and services offered are organized efficiently for easy navigation (i.e. by target audience)*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
DX – Succinct Copy *Copy is reflective of the main points that are ideal for quick information consumption. Additional info is deferred to secondary screens*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
D - University Logo/Name *The university name and/or logo appear on the landing page or main page of the app*	☐ YES ☐ NO	

BEST PRACTICE	SCORING	NOTES
DX - Multimedia *Images and video are used appropriately to supplement content and provide a good user experience*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
D - Sharing Content *App has easy access to social media platforms and the ability to share content to these platforms*	☐ YES ☐ NO	
D - Up-to-Date Content *Content is updated with current and accurate information*	☐ YES ☐ NO	
DX - Services Offered *App offers services that are appropriate for a university mobile app environment; services offered are usable and enhance the user experience*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
Which services are available on the mobile application? *(Taken from Al-Khalifa, 2014; Marshall, 2012; and Hayes & Walker, 2013)*	☐ Academic Programs ☐ Admission Information ☐ Alumni ☐ Athletics ☐ Bookstore ☐ Bus/Shuttle Information ☐ Campus Map ☐ Campus Tour ☐ Class Schedule ☐ Contact ☐ Course Catalog ☐ Dining Info ☐ Directory of people/staff ☐ Emergency ☐ Events ☐ Grades ☐ Library ☐ Multimedia ☐ Social media ☐	

APPENDIX 1E

FUNCTIONAL AND TECHNICAL SPECIFICATIONS CODE SHEET

UNIVERSITY_____

BEST PRACTICE	SCORING	NOTES
E - Load time & Speed Load time & speed of app is acceptable for the purpose of the app and does not alter the user experience by being uncontrollable	☐ YES ☐ NO	
EX - Trustworthy *App provides user with a sense of security and is transparent (informs users about what personal information is required, who it will be shared with, and why)*	☐ 1 Strongly Disagree ☐ 2 Disagree ☐ 3 Neutral ☐ 4 Agree ☐ 5 Strongly Agree	
E - Privacy Policy *App provides a clearly visible link to the privacy policy and/or terms and conditions*	☐ YES ☐ NO	
E - Interruptions *App has the capability to accept an incoming call while running*	☐ YES ☐ NO	
E - Continuation *App has the capability to resume tasks from the same place or a logical restarting point*	☐ YES ☐ NO	

BEST PRACTICE	SCORING	NOTES
E - Click-to-Call *App provides phone numbers that can be clicked and prompt the user to make a call*	☐ YES ☐ NO	
E - Opt-In Consent *App obtains opt-in consent prior to accessing location data and/or geo-tagging with photos and videos; provides an option to opt-out*	☐ YES ☐ NO	
E - User Feedback *App provides users with a means to contact the organization with questions and/or provide feedback about the app*	☐ YES ☐ NO	
E - Function Progress *App provides visual indication of activity (i.e. prompt for user input, splash screens, progress bars, "please wait" text, etc.)*	☐ YES ☐ NO	
E - Login Security *App asks users to login appropriately (i.e. when accessing personal info). Logins are not overused*	☐ YES ☐ NO	

APPENDIX 2A

RANKINGS FOR VISUAL DESIGN

UNIVERSITY	A CONTRAST	AX UNITY & CONSISTENCY	A TYPOGRAPHY	AX VISUAL HIERARCHY	AX BRAND IDENTITY	A TEXTURE & SHAPE	AX AESTHETICS	AX COLOR	**A TOTAL**
University of Florida	1	5	1	5	5	1	5	5	**8**
Ohio State University	1	5	1	5	5	1	5	5	**8**
University of Arizona	1	5	1	5	5	1	4	5	**7**
Washington State University	1	5	0	5	5	1	5	5	**7**
University of New Hampshire	1	5	1	5	4	1	5	5	**7**
Michigan State	1	3	1	4	4	1	5	5	**5**
Florida A&M	1	1	1	1	2	1	2	3	**3**
Texas A&M	1	1	1	2	2	1	2	2	**3**
University of Kentucky	1	3	1	4	4	1	4	4	**3**
University of Hawaii	1	5	1	4	2	0	2	4	**3**
University of Missouri	1	3	1	3	3	1	2	3	**3**
Iowa State University	1	3	1	4	2	1	3	4	**3**
University of Tennessee	1	1	1	2	2	1	2	2	**3**
Colorado State University	1	2	1	2	5	0	1	2	**3**
University of Maryland	1	2	1	3	2	1	1	4	**3**
Oregon State	1	4	1	4	4	0	4	3	**2**
Oklahoma State	1	2	1	3	2	0	1	2	**2**
Virginia Tech	0	2	1	3	3	1	2	2	**2**
North Carolina State	1	4	1	3	3	0	3	4	**2**
University of Nebraska	1	2	1	3	3	0	1	2	**2**
Clemson University	1	2	0	4	2	0	2	4	**2**
University of Minnesota	1	3	0	3	4	1	3	4	**2**
University of Nevada	0	4	0	4	4	1	4	4	**1**
University of Alaska	0	2	0	2	2	1	2	2	**1**
University of Idaho	0	4	0	3	4	1	3	4	**1**
Auburn University	1	2	0	2	2	0	2	3	**1**
Utah State University	0	1	0	1	2	1	2	2	**1**
University of Georgia	0	1	0	1	3	0	1	2	**0**
Louisiana State University	0	1	0	2	3	0	1	3	**0**
University of Wisconsin	0	3	0	2	3	0	1	1	**0**

APPENDIX 2B

RANKINGS FOR INTERFACE AND NAVIGATION DESIGN

UNIVERSITY	B HORIZONTAL SCROLLING	B GRAPHICS/ TEXT	B ORIENTATION	B SCREEN SPACE	BX CONSISTENT INTERFACE	B BUTTON SIZE	BX NAVIGATION	B BACK BUTTON	B LABELS & ICONS	B PAGE TITLES	**B TOTALS**
University of Arizona	1	1	1	1	5	1	5	1	1	1	**10**
University of New Hampshire	1	1	1	1	5	1	5	1	1	1	**10**
Michigan State	1	1	0	1	5	1	5	1	1	1	**9**
Washington State University	1	1	0	1	5	1	5	1	1	1	**9**
Colorado State University	1	1	1	1	4	1	5	1	1	1	**9**
Oregon State	1	1	0	1	5	1	5	1	0	1	**8**
North Carolina State	1	1	0	1	2	1	5	1	1	1	**8**
University of Florida	1	1	0	1	5	0	5	1	1	1	**8**
Auburn University	1	1	1	1	1	1	3	1	1	1	**8**
Oklahoma State	1	1	0	1	1	1	4	1	1	1	**7**
Ohio State University	0	1	0	0	5	1	5	1	1	1	**7**
Virginia Tech	1	0	0	1	2	1	4	1	1	1	**6**
Texas A&M	1	1	0	1	1	1	4	1	1	0	**6**
University of Kentucky	0	1	0	1	3	1	4	1	1	1	**6**
University of Alaska	1	1	0	1	1	1	4	1	1	0	**6**
University of Idaho	0	0	1	0	2	1	5	1	1	1	**6**
University of Missouri	1	0	0	1	1	1	3	1	1	1	**6**
University of Nebraska	1	1	0	1	1	0	3	1	1	1	**6**
Iowa State University	0	1	0	0	3	1	5	1	1	1	**6**
University of Maryland	1	1	0	1	1	1	4	1	0	1	**6**
University of Nevada	0	0	0	1	4	1	4	1	1	1	**5**
University of Hawaii	0	0	0	0	4	1	5	1	1	1	**5**
University of Tennessee	1	1	0	1	1	0	3	1	1	0	**5**
Utah State University	1	1	0	1	2	1	4	0	0	1	**5**
Clemson University	0	1	0	0	1	1	4	1	1	1	**5**
University of Minnesota	0	1	0	0	3	1	4	1	1	1	**5**
Florida A&M	0	1	0	0	1	1	4	1	1	0	**4**
University of Georgia	0	0	0	0	1	1	4	1	1	1	**4**
Louisiana State University	0	1	0	0	1	0	2	1	1	0	**3**
University of Wisconsin	0	1	0	0	1	0	2	0	1	1	**3**

APPENDIX 2C

RANKINGS FOR INTERACTION DESIGN AND INFORMATION ARCHITECTURE

UNIVERSITY	C GESTURES	C WALKTHROUGHS	C ERROR MESSAGES	C INPUT	CX REPEATED USE	CX DEVICE FEATURES	C NOTIFICATIONS	CX ARCHITECTURE PATTERNS	**C TOTALS**
Ohio State University	1	1	1	1	5	5	1	2	**7**
University of New Hampshire	1	1	1	1	5	5	1	3	**7**
Oregon State	1	1	1	1	5	2	1	1	**6**
Michigan State	1	0	1	1	5	5	1	3	**6**
North Carolina State	1	0	1	1	3	5	1	2	**5**
University of Arizona	1	0	1	1	5	5	0	4	**5**
Washington State University	1	0	1	1	2	2	1	5	**5**
University of Wisconsin	1	0	1	1	4	5	1	2	**5**
Clemson University	1	1	1	1	2	4	1	2	**5**
University of Minnesota	1	1	1	1	3	2	1	4	**5**
Florida A&M	1	0	1	1	2	3	1	4	**4**
University of Kentucky	1	0	1	1	2	2	1	3	**4**
University of Hawaii	1	0	1	1	2	2	1	4	**4**
University of Nebraska	1	0	1	1	2	4	1	3	**4**
University of Florida	1	0	1	1	5	2	0	4	**4**
Auburn University	1	0	1	1	3	4	1	3	**4**
Colorado State University	1	1	1	0	1	5	0	4	**4**
Virginia Tech	1	0	1	1	2	3	0	4	**3**
Texas A&M	1	0	1	1	2	4	0	3	**3**
University of Georgia	1	0	1	1	2	2	0	2	**3**
University of Nevada	1	0	1	0	4	4	1	3	**3**
University of Idaho	1	0	1	1	3	2	0	3	**3**
University of Missouri	1	0	1	0	4	4	1	4	**3**
Louisiana State University	1	0	1	1	1	4	0	3	**3**
Iowa State University	1	0	1	1	1	2	0	3	**3**
University of Tennessee	1	0	1	1	2	1	0	3	**3**
Utah State University	1	0	1	1	1	4	0	3	**3**
Oklahoma State	1	0	0	1	1	2	0	3	**2**
University of Alaska	1	0	0	1	2	4	0	3	**2**
University of Maryland	1	0	0	0	1	1	0	3	**1**

APPENDIX 2D

RANKINGS FOR CONTENT AND SERVICES OFFERED

UNIVERSITY	D CURRENT	D PROSPECTIVE	D FACULTY	D VISITORS	D DONORS	D ALUMNI	DX ORGANIZATION	DX SUCCINCT COPY	D LOGO/NAME	DX MULTIMEDIA	D SHARING CONTENT	D UP TO DATE CONTENT	DX SERVICES	**D TOTALS**
University of New Hampshire	1	1	1	1	1	1	5	5	1	5	1	1	4	**12**
University of Arizona	1	1	0	0	0	1	5	5	1	5	1	1	5	**10**
Washington State University	1	0	1	1	0	0	4	4	1	5	0	1	3	**6**
University of Wisconsin	1	0	1	0	1	1	2	3	1	2	0	1	3	**6**
University of Florida	1	0	0	0	0	0	2	5	1	3	1	1	5	**6**
Ohio State University	1	0	0	1	0	0	3	5	1	4	1	1	3	**6**
Oregon State	0	1	0	1	0	0	2	4	1	4	1	1	3	**5**
Michigan State	1	0	1	1	0	0	3	4	0	4	1	1	2	**5**
North Carolina State	1	0	1	0	0	0	4	4	1	3	1	1	3	**5**
Utah State University	1	0	1	0	1	1	1	2	1	2	0	0	4	**5**
University of Minnesota	0	1	0	1	0	0	4	4	1	2	1	1	3	**5**
Oklahoma State	1	0	0	0	0	1	3	2	1	2	0	1	1	**4**
Virginia Tech	1	0	1	0	0	0	4	3	1	2	0	1	3	**4**
University of Kentucky	1	0	0	0	0	1	3	4	1	4	0	1	2	**4**
University of Georgia	1	0	1	0	0	0	2	2	1	2	0	1	3	**4**
University of Nevada	1	0	0	1	0	0	3	4	0	4	0	1	3	**4**
University of Hawaii	0	1	0	1	0	0	5	2	0	4	0	1	3	**4**
University of Alaska	1	1	0	0	0	0	2	2	1	4	0	1	2	**4**
University of Idaho	1	0	1	0	0	0	4	2	1	1	0	1	4	**4**
University of Nebraska	1	0	0	0	0	0	2	3	1	3	1	1	2	**4**
Colorado State University	1	0	0	0	0	0	1	3	1	1	1	1	3	**4**
Florida A&M	1	0	0	0	0	0	2	2	1	3	0	1	2	**3**
Louisiana State University	1	0	0	0	0	0	1	1	1	3	1	0	2	**3**
Auburn University	1	0	0	0	0	0	2	4	0	1	1	1	3	**3**
University of Tennessee	1	0	1	0	0	0	2	3	1	2	0	0	2	**3**
Clemson University	1	0	1	0	0	0	4	2	0	2	0	1	4	**3**
Texas A&M	1	0	0	0	0	0	2	3	1	4	0	0	2	**2**
University of Missouri	1	0	0	0	0	0	2	4	0	4	0	1	3	**2**
Iowa State University	0	0	0	0	0	0	3	3	0	2	0	1	3	**1**
University of Maryland	0	0	0	0	0	0	1	1	1	1	0	0	2	**1**

APPENDIX 2E

RANKINGS FOR FUNCTIONAL AND TECHNICAL SPECIFICATIONS

UNIVERSITY	E LOAD & SPEED	EX TRUSTWORTHY	E PRIVACY POLICY	E INTERRUPTION	E CONTINUATION	E CLICK TO CALL	E OPT IN CONSENT	E USER FEEDBACK	E FUNCTION PROGRESS	E LOGIN SECURITY	**E TOTALS**
University of Florida	1	5	0	1	1	1	1	1	1	1	**9**
Iowa State University	1	3	1	1	1	1	1	1	1	1	**9**
Ohio State University	1	5	0	1	1	1	1	1	1	1	**9**
Colorado State University	1	5	1	1	1	1	0	1	1	1	**9**
Florida A&M	1	4	0	1	1	1	1	1	1	1	**8**
Michigan State	1	3	1	1	1	1	0	1	1	1	**8**
North Carolina State	1	4	0	1	1	1	1	1	1	1	**8**
University of Kentucky	1	3	0	1	1	1	1	1	1	1	**8**
University of Georgia	1	3	0	1	1	1	1	1	1	1	**8**
University of Nevada	1	4	0	1	1	1	1	1	1	1	**8**
University of Missouri	1	3	0	1	1	1	1	1	1	1	**8**
University of Tennessee	1	3	1	1	1	1	1	1	1	0	**8**
University of New Hampshire	1	4	1	1	1	1	0	1	1	1	**8**
Virginia Tech	1	4	0	1	1	1	1	0	1	1	**7**
Texas A&M	0	4	0	1	1	1	1	1	1	1	**7**
Washington State University	1	3	0	1	1	1	0	1	1	1	**7**
University of Hawaii	1	2	0	1	1	1	1	0	1	1	**7**
University of Idaho	1	5	0	1	1	0	1	1	0	1	**7**
Louisiana State University	0	4	0	1	1	1	1	1	1	1	**7**
University of Nebraska	0	4	0	1	1	1	1	1	1	1	**7**
Auburn University	1	4	0	1	1	1	1	0	1	1	**7**
Clemson University	1	3	0	1	1	1	0	1	1	1	**7**
University of Arizona	0	3	0	1	1	1	0	1	1	1	**6**
University of Alaska	0	2	0	1	1	1	1	1	0	1	**6**
University of Wisconsin	0	4	0	1	1	1	1	1	0	1	**6**
University of Maryland	0	1	0	1	1	1	1	0	1	1	**6**
Oregon State	1	4	0	1	1	0	0	0	1	1	**5**
Oklahoma State	1	2	0	1	1	1	0	0	0	1	**5**
University of Minnesota	1	2	0	1	1	0	0	0	1	1	**5**