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A USABILITY STUDY OF A DATA-DRIVEN HEALTH INFORMATION PORTAL: THE EXTENSIBILITY OF DHIS2

by

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A Proposal for Dissertation

Presented to the faculty of

Towson University

in partial fulfillment

of the requirements for the degree

Doctor of Science in Information Technology

Department of Computer and Information Sciences

Towson University Towson, Maryland 21252

May 2019

TOWSON UNIVERSITY
OFFICE OF GRADUATE STUDIES

DISSERTATION APPROVAL PAGE

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entitled_ A Usability Study of a Data-driven Health Information Portal: The Extensibility of DHIS2

has been approved by the thesis committee as satisfactorily completing the dissertation requirements for the degree_ Doctor of Science in Information Technology

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Abstract

Although technology in healthcare has increased greatly over the past decade, the user experience of the combined available resources unquestionably can be improved especially when using large datasets such as District Health Information Software 2 (DHIS2). Health care has transferred much of its platform to computer based applications such as the institution of electronic health records. However, the end users could increase their health information understanding through a platform that brings the knowledge from medical experts, smart health and wellbeing proven practices, alternative medicine and social media and data-driven material such as DHIS2. Cloud computing and big data have broadened the scope of technical offerings increasing the ultimate experience for the end users (Purkayastha & Braa, 2013). However, the potential of these technologies has not been exploited completely, particularly for health care uses. The use of enhanced visualization could increase the user experiences for healthcare best practices and implementation (Manya, Braa, Øverland, Titlestad, Mumo, & Nzioka, 2012). Employing a new frame work that could be accessed quickly via mobile devices could certainly offer the patients a better experience as they fight against diseases and sustain healthy living (Sanner, Roland, & Braa, 2012). Building on the established DHIS2 data, employing SaaS can offer a single source for patients to research medical diagnosis, smart health and wellbeing, alternative medicine and social media solutions (Garg & Garg, 2015). Through this dissertation, an empirical study has been executed to determine if customizing a User Interface of DHIS2 improves the use of data-driven health information that expands the patients' understanding of their health issues.

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Chapter 1 Introduction

The healthcare community is confronting an almost insurmountable amount of health and healthcare-related content generated from numerous patient care points of contact, highly technical medical instruments, and web-based health communities (Arunasalam, 2013). The contemporary data-driven healthcare areas that are taking shape are genomics-driven big data covering genotyping, gene expression, sequencing data and payer–provider big data including electronic health records, insurance records, pharmacy prescription, patient feedback and responses (Raghupathi & Raghupathi, 2014).

A. Background

Over the past decade, electronic health records (EHR) have been implemented extensively in hospitals and medical facilities giving way to significant clinical knowledge and a deeper understanding of patient disease patterns from such computer-based collections. Using this vast health information data, doctors and patients alike to may be able to more readily diagnosis the issues and determine treatments to remedy their health problems. Utilizing lessons learned from the immense health information data, the end users could increase their healthcare understanding. Expanding on a unified mobile accessible platform, the data-driven health information could offer patients a wealth of knowledge via a mHealth application. Medical professionals have been publishing their expertise in journals that can be used to expand the patient health understanding. In addition, there are many websites that offer smart health and wellbeing proven practices. For example, end users can access information on the Web about alternative medicines to address physical ailments or use social media to blog or crowd source to find remedies and seek healthy solutions. These offerings along with many others could be bundled together to offer a superior distinct healthcare tool.

After decades of implementing computer-based applications in almost every field of study, a by-product taking shape is immense data which is now known as big data (Peters, Havstad, Cushing, Tweedie, Fuentes, & Villanueva-Rosales, 2014). This vast amount of data now collected and accessible via mobile devices and cloud computing technology allow humans to move more deeply into the exploration of the information age. Not harnessed to its fullest, the big data technology now being researched will give way to superior growth of understanding for decision making and everyday life especially in healthcare (Jee & Kim, 2013) . Challenges are apparent in this new technology of big data on cloud computing. Although they cover all ranges, the main areas are data capture, data storage, data analysis, and data visualization (Chen, 2014). Traditional data were mapped and placed in organized relational databases to be searched and presented in software applications for the various end users to perform their daily tasks. Unlike traditional data, data-driven information is readily available on the Internet, from sensors, and even disjointed databases with none of it organized for customary relational database viewing methods (Ma, Wang, Liu, & Ranjan, 2015). The user friendly platform for searching and analyzing this great amount of big data or data-driven information sources is still in the beginning stages.

B. The Study

The overall literature review establishes that the Internet allows for the ability to search the entire world's research. However, this vast data set is lacking a coherent interface to assist the end user. In addition, there are possibly no available data-driven information applications that will assist patients to research and employ their own healthcare software solutions (Miller, Chandler, & Mouttapa, 2015). The gap in the literature exposed by reviewing the healthcare literature has suggested that healthcare can be improved if patients become more involved in their care, addressing illnesses and even postponing possible negative consequences through healthy living (Kumar, Nilsen, Abernethy, Atienza, Patrick, Pavel, Riley, Shar, Spring, & Spruijt-Metz, 2013). In addition, the usability literature points out that the application of user centered design approaches to this data-driven information system platforms can be greatly enhance user acceptance (Wen-ying, Hunt, Beckjord, Moser, & Hesse, 2009). Electronic healthcare research has indicated the need for patients to be responsible for their own healthcare by resolving issues and exploring healthy living techniques. Taking charge of their own needs through the use of user friendly technology can help not only the individual live a more successful lifestyle, but improve society as a whole, where healthcare costs and sickness is lessened as health understanding is improved. In addition, because the studies of data-driven information user experience are still limited, there are significant opportunities to further this field of study (Koliogeorgi, Masouros, Zervakis, Xydis, Becker, Gaydadjiev, & Soudris, 2017).

Therefore, the following research question has been investigated in this dissertation study:

Does the usability of a single data-driven portal, such as DHIS2, impact the users' understanding of health information issues?

C. Implications from the Research

Presently, the process of visualization in data-driven information projects is most often as simple as an image of dots on a map or graphical views. By enhancing the view of big data, the user experience most likely will increase and expand their understanding of health. To present this information, a user interface for an optimal framework has occurred exposing that DHIS2 can offer data-driven health information in the most succinct manner to the end user. Not only has the user been able to access the big data platform from traditional PCs and laptops, but mobile access using smartphones and tablets has been the ultimate end goal. A potential solution is streamlining large sets of data through a single interface that can be accessed from anywhere, allowing the end users to easily obtain healthcare information to better their lifestyle.

Chapter 2 Literature Review

Through the power of cloud computing and data-driven information, the end users now demand more from software applications. This superior technology can be exploited for healthcare uses that allow end users to more easily sift through medical data and find additional medical solutions. Several studies have articulated the benefits of improving visualization of data-driven health information to increase the users' experience as they move toward a better understanding of healing remedies and healthy living guidelines (Zhang, Wolfram, Wang, Hong, & Gillis, 2008). Employing a new framework accessed by mobile devices, patients could harness this knowledge as they combat diseases and achieve healthy living. Fully utilizing the discovery principal available through a mHealth Portal by utilizing a powerful user interface, configuration can occur to offer a unified software mHealth application for patients to research medical diagnosis, healthy living, alternative medicine and social media options.

A. HealthCare Information Sources

Improving HealthCare Solutions

Through numerous patient care points of contact, highly technical medical instruments, health related payment systems and web-based health communities, our society now has access to vast amounts of health and healthcare-related internet based content (Avinash, Liu, & Roehm, 2005). Many health information big data projects have been put in place to utilize the information including genomics-driven big data covering genotyping, gene expression (O'Driscoll, 2013); sequencing data and payer–provider big data including electronic health records (Rind, Wang, Aigner, Miksch, Wongsuphasawat, Plaisant, & Shneiderman, 2011); insurance records, pharmacy prescription, patient feedback and responses, and health and well-being best practices (Stroetmann, 2013). Still, studies have shown that the end users' healthcare needs are not fully met (Harrison & Mort, 1998).

DHIS2 Background

To implement the mHealth Portal solution, the District Health Information Software 2 (DHIS2) backend data source and technology has been utilized. Designed to integrate health information management activities, DHIS2 is an open-source tool best utilized for collecting, validating, analyzing, and presenting aggregate and patient-based statistical data. As a generic tool rather than a pre-configured database application, the DHIS2 offers an open meta-data model and a flexible user interface. This flexibility allows the designer to address the contents of a specific information system without the need for extensive programming. The product is a modular web-based software package built upon Java frameworks. Used in over 40 countries in Africa, Asia, and Latin America, the DHIS2 software is widely adopted. In fact, DHIS2 has been determined as the nation-wide HIS software solution for Kenya, Tanzania, Uganda, Rwanda, Ghana, Liberia, and Bangladesh (Braa & Sahay, 2017).

In expanding uses for big data technology, DHIS2 can be utilized to view an array of healthcare data. As a solution for gathering data, DHIS2 serves as a data collection, recording and compilation tool. From there, DHIS2 can be used to increase data quality. At the point of data entry, a check is made to see if data fall within acceptable range levels of minimum and maximum values for any particular data element. After the data have been collected and verified, DHIS2 can be utilized to create various reports. Health information data can be presented in graphs, maps, reports and health profiles as outputs that DHIS2 can produce. Generally, the reports will be produced, analyzed, and acted upon by health managers (Manya et al., 2012).

For this research project, DHIS2 cloud computing technology has been accessed via Software as a Service (SaaS) model. A managed hosting service provides the DHIS2 software as a service in the cloud. Therefore, instead of crafting the software from scratch, the development team can start using the system immediately. The development team can link in directly to the SaaS data without having to install and maintain the software. Another nicety is that aspects such as backups and security are provided. There also will be available a Web API which provides machine-readable interface to the complete DHIS2 data model. The data can be available by the full list of data elements. The development team then can navigate using the provided URL the various data elements of interest and review the list of data sets. DHIS2 data structures such as data elements, organization units, forms and user roles can be defined completely through the application user interface. In addition, because of the open source development aspect of DHIS2, the development team can expand the offering with additional custom apps. These software apps can live side by side with the core components of DHIS2 and can be integrated into the DHIS2 or presented through a different portal platform (Kariuki, Manders, Richards, Oluoch, Mulonzi, & Kimanga, 2013).

Healthcare Technology

Electronic health records (EHR) have been widely implemented in hospitals and medical facilities allowing patients' access to their records online, opening clinical research areas, and increasing understanding of patients' disease patterns from data-driven health information collections (Ludwick & Doucette, 2009). Access to this healthcare data is greatly expanding the knowledge of patients and medical professionals alike (Murdoch & Detsky, 2013). Clinical improvements are an example where analyzing patient characteristics can identify cost effective treatments. This would occur to help doctors' aid patients (Arunasalam, 2013). Reducing costs by identifying theft minimizing fraud is another area which utilizes big data technology (Bates, Saria, Ohno-Machado, Shah, & Escobar, 2014). Efficiency of processes to help patients locate providers, manage their care, and improve their health is yet another sample of healthcare technology's possible improvements (Neff, 2013). Other areas that are being explored include genomics, bioinformatics (Swan, 2013), pharmacogenomics, dentistry, HIV epidemiology, cardiovascular research (Pah, Rasmussen-Torvik, Goel, Greenland, & Kho, 2015) and much more. Given the technology available and the data being collected, doctors and patients may be more able to diagnose the issues and determine treatments to remedy their health problems (Vaitsis, Nilsson, & Zary, 2014). The medical expertise of various professionals can now be shared through the technology offerings (Philips, Ginnelly, Sculpher, Claxton, Golder, Riemsma, Woolacott, & Glanville, 2004). The collection of all the medical knowledge could help patients with their health needs, especially patients with chronic health issues (Wyber, Vaillancourt, Perry, Mannava, Folaranmi, & Celi, 2015).

In addition to the typical medical advice, patients are seeking alternative medicine to address all of their health needs (Eisenberg, Davis, Ettner, Appel, Wilkey, Van Rompay, & Kessler, 1998). Smart health and well-being best practices can be instituted by patients to address their health concerns outside of basic medicine offerings. While it holds true that most patients are not alone with their health problems, very often they are not able to connect with a community of people who have or had the same issues. Through social media, patients could help each other morally, technically through suggestions for medical care, and specifically through healthy practices like diet and exercise as they share their challenges and needs (Wen-ying et al., 2009). Another avenue of health awareness can be obtained from the mobile access that the user is utilizing to extract the data (Kumar et al., 2013). As the application obtains the patients' geographical location, data presented can be altered based on health care needs in the area (Free, Phillips, Galli, Watson, Felix, Edwards, Patel, & Haines, 2013). For example, virus breakouts can be warned to travelers, detailing the best practices to ward off diseases.

The application of technology in healthcare is increasing overtime (Yao, Tian, Li, Tian, Qian, & Li, 2015). Society's expectations for digital practical applications, health-based professionals are finding usage for technology to replace their paper based systems. Driving down costs, like most other businesses, is the main factor for the adoption of technology in healthcare (Hayhurst, 2015). In health insurance claims, reducing recurrent losses and facilitating enhanced patient care have been a main focus for healthcare technology. Directly streamlining patient related applications such as medical records, patient registration systems, and clinical based applications has greatly increased the efficiency of hospitals and medical practices. Big data applications have to reduce costs in the areas of high-cost patients, readmissions, triage, decompensation, adverse events, and treatment optimization for diseases (Kuiken, 2013). Because of their ease of use, medical professionals also find that software applications assist them in their everyday use through clinical applications, research studies of diseases, and overall trending analysis. To incorporate various health information sources, the following items could be brought together in a single portal to offer superior health analysis.

A. Electronic Medical Records

The United States Government recognizes that technology in healthcare will reduce costs and improve efficiencies. The American Recovery and Reinvestment Act of 2009 states that as of January 1, 2014, all public and private healthcare providers and other eligible professionals (EP) must have adopted and demonstrated “meaningful use” of electronic medical records (EMR) in order to maintain their existing Medicaid and Medicare reimbursement levels (Blumenthal & Tavenner, 2010). However, even with this initiative in place there are very low levels of adoption of electronic health records in U.S. hospitals, suggesting that policymakers face substantial obstacles to health care performance goals that depend on health information technology (Jha, DesRoches, Campbell, Donelan, Rao, Ferris, Shields, Rosenbaum, & Blumenthal, 2009). The Health Information Technology for Economic and Clinical Health Act (HITECH) authorized incentive payments through Medicare and Medicaid to clinicians and hospitals when they use EHRs privately and securely achieving specified improvements in care delivery. HITECH's goal is not adoption alone but “meaningful use” of EHRs, that is, their use by providers to achieve significant improvements in care. Again, technology is the basis of the achievement of advances in health care processes and outcomes.

B. Medical Expertise

Medical professionals utilize software applications to assist their day to day operations in areas such as research of genomics, bioinformatics, pharmacogenomics, HIV epidemiology, chronic disease research and much more (Schmidt, Norman, & Boshuizen, 1990). For example, in the field of genomics, researchers are producing genome-wide data sets on ever-expanding study populations. Because of technology, broad access to these data, stored samples, and EMRs are accelerating society's understanding of the role of genes, environment, and behavior in health and disease. With this information, new knowledge is gained by improving diagnostics, targeting drug development, and exploration into new insights about how to prevent and treat disease (Curtis, Brown, & Platt, 2014). As an interdisciplinary field, bioinformatics is another example of technology in healthcare where methods are developed using software tools for understanding biological data. Bioinformatics combines computer science, statistics, mathematics, and engineering to analyze and interpret biological data. Digital uses are very important in the study of pharmacogenomics which identifies how genes affect a person's response to drugs. In addition, chronic diseases are studied and identified using technology to sort through the vast amount of data points. Patients, as the final end users of the healthcare technology implementations, have various applications that can be used to assist in their healthcare knowledge (Lin, 2015). However, as technology improves, combining all of these areas will assist to offer more sophisticated software usages. Within a unified user interface, having access to the medical expertise information would greatly help patients and doctors diagnosis issues and determine best practices to stay healthy. The big data platform is the best technology available to offer the medical expertise documentation in a unified user interface application.

C. Alternative Medicine

Although medical professionals offer the bulk of society's healthcare understanding, there is a growing acceptance that alternative medicine, smart health and wellbeing advice, social media platforms and mobile device applications are greatly expanding healthcare understanding and best practices. Alternative medicine use and expenditures have been increasing substantially, mainly caused by an increase in the proportion of the population seeking alternative therapies, rather than increased visits per patient (Barnes, Powell-Griner, McFann, & Nahin, 2004). The majority of alternative medicine users appear to be doing so not so much as a result of being dissatisfied with conventional medicine but largely because they find health care alternatives to be more congruent with their own values, beliefs, and philosophical orientations toward health and life (Kelwala, 1998). Patients are looking for many methods to meet their healthcare needs. Similarly, alternative medicine solutions could be researched and analyzed from one healthcare platform application. This would benefit the patient and medical professional alike as they research ways to address the patients' healthcare needs.

D. Smart Health and Wellbeing

The obvious area to increase healthcare is by preventing the issues before they occur. Smart health and wellbeing are the main pillars to prevent health issues such as heart attacks, diabetes and other debilitating diseases. Staying physically fit, maintaining a wholesome diet and continuing healthy living habits will decrease the odds of unplanned doctor visits and extended hospital stays. The issue is that many Americans have lost their understanding of healthy living in the present culture of fast food restaurants and lethargic lifestyles. However, the tide may be turning and many may be in need of understanding how to regain their health to enjoy a longer healthier existence. As the development of computing-oriented healthcare informatics research continues to grow, the integration of different disciplines to advance the healthcare and wellbeing of our society will also be accelerated (Steinbrook, 2008). People reach out to the Internet to gain a better understanding of how to increase their health. An offering of a unified user interface software application that can house all of the available smart health and wellbeing solutions for ease of access would be extremely helpful to the patient and healthy individuals. Combining all of the available medical expertise, alternative medicine technologies and wellbeing guidelines in a single searchable solution could benefit the world as greater health and longevity is sought.

E. Social Media

Social media is a technical platform for end users to engage their thoughts and comments on any range of topics. Very often, social media discussion in Facebook for example may cover ideas of child rearing and places to go on vacation. Through places such as twitter feeds, users may discuss health topics (McNab, 2009). Another method to address the end users' healthcare concerns is through social media software (Heckner, Schworm, & Wolff, 2009). Social media, which bring a new dimension to healthcare, offer a platform for the public, patients, and health professionals to communicate about health issues with the possibility of improving health outcomes (Bello-Orgaz, Jung, & Camacho, 2016). The collaboration between users in social media is a powerful tool as patients can interact to help each other morally through support boards, offer suggestions for medical care, advice for diets and recipes and even specific exercise routines represented by social media, may be changing the communication pattern throughout the

United States especially in healthcare (Karissa McKelvey, 2012). Across the healthcare industry, from institutionalized hospital networks to patient support groups, “new media tools like weblogs, instant messaging platforms, video chat, and social networks are reengineering the way doctors and patients interact” (Hawn, 2009, p. 1). Bringing these documented social media healthcare solutions into a unified user interface solution would assist in addressing patients’ and healthy individuals’ needs (Korda & Itani, 2013).

Dispersed Healthcare Information Sources

As reviewed, patients often have many healthcare solutions available to them. However, they are located at many dispersed sources. There is healthcare technology that can offer them insight into their actual vital signs. Their medical records are stored electronically and can be accessible to review. Medical experts have a plethora of information which is reachable at many different locations on the internet. Alternative medicine may offer healthy solutions to address the patient’s needs. Feeding into the health information sources, smart health and wellbeing regiments are available online. In addition, social media offerings can offer peer support as others are affected with similar diseases. Figure 1 below shows how health understanding is scattered and dispersed throughout various points of access.

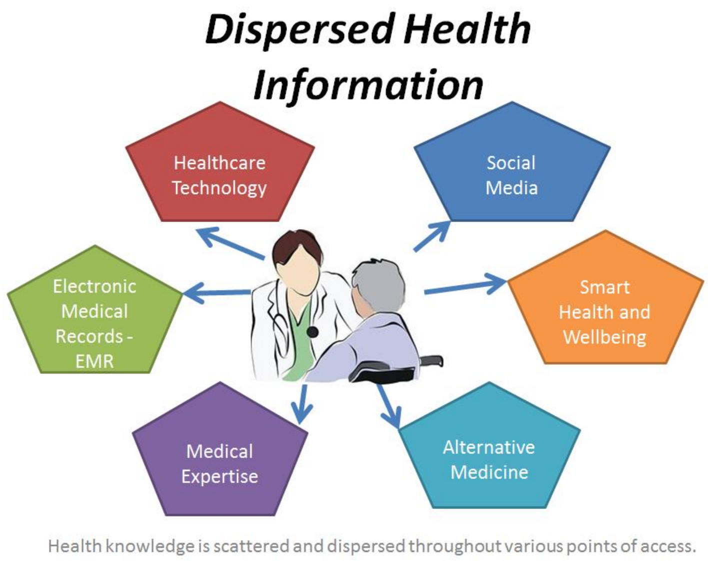


Figure 1. This diagram shows health information is scattered and dispersed throughout various points of access.

B. The Technical Revolution

The large swathes of data being generated through the many computer-based applications continuously can be queried and reachable through cloud computing technology (Rayport & Heyward, 2011). These large datasets have the potential to offer everyone greater knowledge to improve every aspect of their lives, particularly in healthcare.

Cloud Computing

Cloud computing has many implications, but overall it refers to the usage of consuming a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer (Jamal & Deters, 2011). There are many companies that offer cloud computing which encompasses the delivery of hosted services over the Internet (Truong, Dustdar, & Bhattacharya, 2013). To expand the definition, cloud computing is evolving into the utility and consumption of computing resources. This process of computing involves deploying groups of remote servers and software networks that allow centralized data storage and online access to computer services or resources. With these computers sharing resources, superior technological applications are coming to the forefront as computing power is increasing exponentially (Buttell, 2010). At the simplest level, cloud computing refers to accessing servers over the Internet to perform tasks rather than using a local server or computer (Elifoglu, Guzey, & Tasseven, 2014). An example in its most basic form is a user accessing a Gmail account (Park & Ryoo, 2013). However, cloud computing is technically much more powerful than simply accessing email via another platform. In its most powerful form, cloud computing is harnessing the strength of potentially hundreds of servers to produce massive results. The question is with this evolving methodology, can the user experience be enhanced to the fullest to capture the strength of this immense computer technology.

Cloud computing has many uses for a broad range of users. For example, highly skilled bioinformatics users find cloud computing indispensable to solve complex problem sets. Prior to cloud computing, bioinformatics experts would spend immense amounts of time and energy working through a single problem set. Using cloud computing the task is much more efficient. Bioinformatics researchers utilize the Microsoft Azure cloud computing for the ability it offers to scale and analyze outputs and complete tasks in a short amount of time (Shanahan, Owen, & Harrison, 2014).

Data-Driven Sources Overview

At any time, data are being gathered and generated across the Internet (Xia, Yang, Wang, & Vinel, 2012). There is digital data that are emitted from sensors such as mobile phone usage. There are data generated from paper-based forms as processes become almost completely computer based such as Tax Forms (Emani, Cullot, & Nicolle, 2015). There are personal data such as address and contact information found with a quick review across the internet. There are social media data as people go online to post their opinions. The data available via the Internet are almost endless. The issue lies in how to present meaningful results from the data. As defined by Gartner (Gandomi & Haider, 2015), big data are high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making. Taking this data and being able to create progressive decisions based off of the analytical results is the main goal of big data (Demirkan, 2013). The term "big" is applied because traditional data processing cannot be utilized as the data are too large and it are often unstructured which makes it a challenge to organize in customary formatting (Gandomi & Haider, 2015).

Big Data Technology

Utilizing the cloud computing infrastructure offers a platform for the big data to finally begin to be managed and analyzed (Andreolini, Colajanni, Pietri, & Tosi, 2015). As best defined by Hashem et al. (2015, p. 102), "Cloud computing and big data are conjoined. Big data provide users the ability to use commodity computing to process distributed queries across multiple datasets and return resultant sets in a timely manner." Cloud computing provides the underlying engine through the use of Hadoop Distributed

File System (HDFS) (Reyes-Ortiz, Oneto, & Anguita, 2015), a class of distributed data-processing platforms (Feller, Ramakrishnan, & Morin, 2015). Large data sources from the cloud and Web are stored in a distributed fault-tolerant database and processed through a programming model for large datasets with a parallel distributed algorithm in a cluster (Hu, Wen, Chua, & Li, 2014). NoSQL is a type of database that allows for management of large distributed data through a scheme free, easy replication, and simple API. At the programming layer, MapReduce sanctions the processing of large amounts of datasets stored in parallel in the cluster (Darji & Waghela, 2014). From there, views of the data can be compiled and visualized for end users via APIs (Maitrey & Jha, 2015).

Data-Driven Usability

Data-driven information usability was not the focus when big data technology was first established. Not implemented like most technologies with the attention on end user, big data have become a technology more because of an outcome and not just because end users made requirements (Kambatla, Kollias, Kumar, & Grama, 2014). Therefore, the existing data-driven information usability is a view of datasets in graphs and maps. There are no requirements and use cases that can be identified for the creation of big data usability (Kum, Stewart, Rose, & Duncan, 2015). The data is simply there, and usability experts need to now figure out how best to use the overwhelming amount of information (Walji, Kalenderian, Tran, Kookal, Nguyen, Tokede, White, Vaderhobli, Ramoni, & Stark, 2013).

C. The Proposed Portal Experience

The user experience for data-driven health information is in only the beginning stages. Although there are some types of views of big data and limited search availability, the overall user experience can be greatly increased. This limited user experience for data-driven health information is greatly lacking. In addition, there are many areas that can offer more options for the end user (Suchanek & Weikum, 2013). Data visualization is the present most common mean for the industry to access big data technology (Wright, Mathers, & Walton, 2013). Analytics transforms the data into a visual depiction of the data offering map views or other high-level charts and graphs from the data summation. The end-user for these processes is generally upper management or decision makers trying to determine a path forward for their business or government agency (GE, GE, & MINARD, 2014). However, big data has more to offer than simple hints towards future plans. The general public already enjoys data-driven health information searches through Google and other applications to find knowledge to enrich their lives. Elevating these big data offerings could certainly improve the user experience for big data technology. Building on an existing unified user interface framework, the user experience could be increased with only incremental changes. This framework must be available on all devices for the best user experience including desktops, laptops, smart phones and all mobile devices. Ensuring that the interface is simple and yet easy to use is extremely important for the best user experience.

Visualization

Data visualization is defined as the presentation of data in a pictorial or graphical format (Tam & Song, 2016). The objective is to enable decision makers to view data analytics presented visually with the expectation to take the data summation and understand difficult concepts or identify new patterns (Lee, Tong, Shen, Wong, Hagos, & Leung, 2013). Allowing the user to control the views, many companies employ interactive visualization tools to maneuver through the data rapidly customizing charts and graphs to gain more knowledge from the data (Liu, Jiang, & Heer, 2013). Using pictures to understand data has been utilized for centuries, using maps and graphs as early as the 1600s and then pie charts in the early 1800s (Miksch & Aigner, 2014). Superior technology now allows for even more improvement and usage of data visualization (Tatarchuk, Shopf, & DeCoro, 2008). Data Servers now make it possible to process enormous amounts of data at extremely fast speeds (Shvachko, Kuang, Radia, & Chansler, 2010). Data visualization has become a rapidly evolving blend of science and art that feasible because of data analytics (Thorvaldsdóttir, Robinson, & Mesirov, 2013). These computers are processing extensive algorithms to meet the views that the users are requesting (Yang, Zhang, Zhen, & Ji, 2015). With this big data technology there is potential for great opportunity; the next phases of data visualization are researching how to expand the present visual interfaces that are offered of primarily charts, maps and contextual searches (Krämer & Senner, 2015).

Visualization methods have offered increased benefits to many organizations over the past decade beginning with business intelligence and moving to full visual analytics for many subjects (Sagiroglu & Sinanc, 2013). The developing field of visual analytics concentrates on making sense of the big data through integrating human judgement using visual representations and interaction techniques in the analysis process (Keim, Mansmann, Schneidewind, Thomas, & Ziegler, 2008). The Healthcare field is using visual analytics to extract insights from EHR (Wang, Wongsuphasawat, Plaisant, & Shneiderman, 2011), gain knowledge from medical professionals (Zhang et al., 2008), and view how patients are searching for diagnosis on the web (Brownstein, Freifeld, & Madoff, 2009). Building on these applications of visualization and visual analytics, big data technology can move forward in its functionality and uses. Still, big data visualization has much improvement ahead to become a superior user friendly experience (Thomas & Kielman, 2009).

User Experience

Research into big data technology user experiences are only at the very beginning stages (Chan, 2015). In fact, research has found that the user interface in most of the big data projects is an afterthought (Fisher, DeLine, Czerwinski, & Drucker, 2012). The bulk of the data-driven health information projects are centered on setting up the platform, gathering the data and then at some stage a user requests to see the data. Only at that point, the technical team discovers that the data are not as useful for true end user knowledge and have very little view of how the users can actually benefit from the terabytes of data that are available for searching. However, for a truly good user experience of any software application, the end user requirements must be established first, and not only as an addendum.

To improve big data applications, the users need to be contacted and surveyed to determine how they could use an application and what tools would best suit their needs. The issue with the big data platforms is no one, not even the user, truly knows what they want or could even have from this new technology. Modern end users enjoy the benefits of having rich data at their hand through their mobile devices. However, improving the software interface could be done to offer them a better view of the data (Marchionini, 1989). Few applications such as Facebook, Instagram and DHIS2 offer users some satisfaction for probing the vast array of data to meet their needs. Unfortunately, there have been few studies to truly understand how users could utilize big data and how to improve their user experience (Senkowski & Branscum, 2015). A simple incremental improvement to a modern application may offer enhancements that meet the users' needs (Hassenzahl & Tractinsky, 2006). With true user feedback on specific application information, user experience could be improved (Kim & Chang, 2007). Design changes could be implemented with the end user as the central goal (Kopetz, 2011). Thereby, step by step the user experience of big data technology will ultimately improve.

Mobile Technology

To make the most of the user experience, a framework to view the big data technology works best. Currently, users are comfortable with maneuvering through software systems that function with set features available in all screens (Cohen & Oviatt, 2000). For example, many well established applications display buttons along the top and left side for changing the views and acting on the data such as Outlook, Internet Explorer, and Microsoft Word. Having an existing framework will allow the users to transition their existing interface ability to the new big data interface usages (Marchionini & Komlodi, 1998). Not only should the user interface be based on an existing framework, the architecture should be building upon best practices of solid infrastructure conventions (Ghezzi, Balocco, & Rangone, 2015). Maintaining both a framework for the user interface and the technical platform will allow incremental changes that improve the data-driven health information offerings.

Mobile application offerings are the most user friendly technology of the present day. It is hard to walk down the street without seeing people looking at their handheld devices for many of their daily tasks or for simply just socializing (Cifuentes, 2013). Thanks in part to Steve Jobs, the mobile device technology has changed the world forever (Isaacson, 2012). Using a standard framework, software engineers can create software applications called "apps" that can be easily downloaded to a mobile device for almost any purpose. The application is installed on the mobile device, but primarily works off of the wireless network hooking the application up to servers in data centers (Han, Liang, & Zhang, 2015). Now with cloud computing being accessible to anyone for inexpensive monthly fees, applications can fully utilize cloud technology and big data architecture with relative low overhead (Laurila, Gatica-Perez, Aad, Bornet, Do, Dousse, Eberle, & Miettinen, 2012).

Not to be left behind, the healthcare industry has many uses for mobile applications (Strack, Orsini, Fearnow-Kenney, Herget, Milroy, & Wyrick, 2015). In fact, the need is growing so rapidly that there is a new word for mobile health which is entitled mHealth, meaning the practice of medicine and public health supported by mobile devices.

> For the healthcare industry, mobile applications provide a new frontier in offering better care and services to patients, and a more flexible and mobile way of communicating with suppliers and patients. Mobile applications will provide important real time data for patients, physicians, insurers, and suppliers. In addition, it will revolutionize the way information is managed in the healthcare

industry and redefine the doctor – patient communication." (Siau & Shen, 2006) p. 90).

To begin, the mobile device can be used to encourage a patient to exercise and increase their baseline of healthiness (Monroe, Thompson, Bassett Jr, Fitzhugh, & Raynor, 2015). The goal, of course, would be to create an app that could assist users to manage their exercise and weight (Gowin, Cheney, Gwin, & Franklin Wann, 2015). From there, mobile applications give users the information they need when they are moving through their everyday life activities. Mobile users want to be able to get the information they need at their fingertips, and that includes more healthcare knowledge (Miller et al., 2015). Patients are looking for answers for their medical issues such as common infectious diseases, fending off heart disease (Logan, 2013) and even researching mental health issues (Bardram, Frost, Szántó, Faurholt-Jepsen, Vinberg, & Kessing, 2013).

Solutions and Recommendations

Solutions are few to meet this mHealth unified user interface solution. The literature review suggests there is a gap where end users are lost as they try to meet their healthcare needs. The use of Google is one of the most utilized web offerings to answer health related questions. Patients presently utilize the superior information of big data offerings to sort through the vast Internet to try to answer their health concerns. The issue that occurs is easily sorting and categorizing the new information for easy retrieval at another time. Accessing the data-driven health information easily allows the user to transition from simple data information to knowledge. Therefore, the examination continued to increase the user experience of the resulting set offered.

For the purpose of the research project, DHIS 2 sample data has been provided. This includes patient data and aggregated data. Patient data are data relating to a single patient, such as diagnosis, name, age, earlier medical history etc., and is typically based on a single patient-health care worker interaction. For instance, when a patient visits a health care clinic, a variety of details may be recorded, such as the patient's temperature, weight, and various blood tests. Patient based data are important to track longitudinally the progress of a patient over time. Aggregated data are the consolidation of data relating to multiple patients, and therefore cannot be traced back to a specific patient. This data are merely summary data, such as incidences of malaria, TB, or other diseases. The routine data that a health facility deals with is this kind of aggregated statistics, and is used for the generation of routine reports and indicators. Most importantly, aggregated data is used for strategic planning within the health system. Aggregate data cannot provide the type of detailed information which patient level data can but is crucial for planning and guiding the performance of health systems. These data can be collected about a specific health event without necessarily having to identify the patient it involved.

Combing these data into a mHealth Portal allows for better decimation of the data. Summary level views have been combined to allow for quick access of overall views and the ability to dive into more exact information. Inpatient or outpatient visits, a new case of cholera, a maternal death etc. are common use-cases where one would like to collect a lot more detail than just adding to the total count of cases, or visits. These data are often collected in line-listing type of forms, or in more detailed audit forms. It is different from aggregate data in the sense that it contains many details about a specific event, whereas the aggregate data would count how many events of a certain type, e.g. how many outpatient visits with principal diagnosis "malaria", or how many maternal deaths where the deceased did not attend ANC, or how many cholera outbreaks for children under 5 years. In DHIS 2 these data are collected through programs of the type single event without registration.

DHIS2 can be customized to meet the needs of the ever growing user base offering a superior mHealth solution. Easily searchable and retrievable big data offerings can now be accessed routinely. As shown in Figure 2 below, the mHealth Portal utilizing the DHIS2 data-driven health information using SaaS can be very useful for the various healthcare software offerings. A configured application can offer end users the ability to research the various healthcare technology solutions available, view their own medical diagnosis via electronic medical records, evaluate the assessments of medical professionals, review alternative medicine, research healthy living possibilities, and explore social media options.

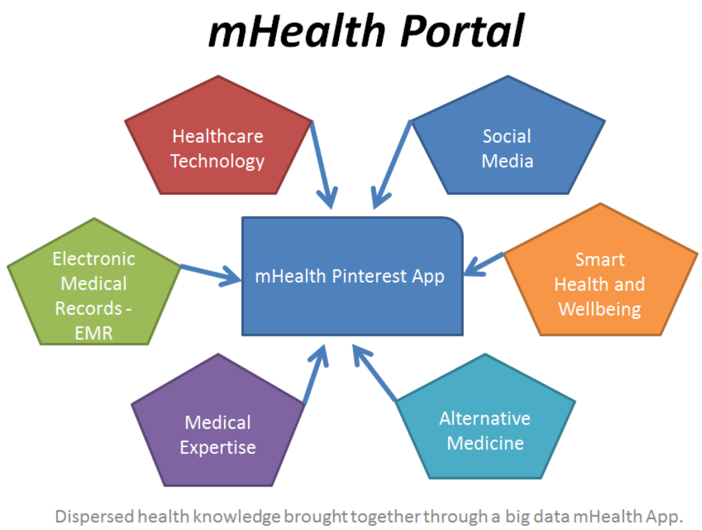


Figure 2. This diagram shows how dispersed health knowledge solutions in various software applications can be brought together through a big data mHealth Portal app.

Although there are many ways to address healthcare needs, one possible solution worthy of study is to implement the popular data-driven health information unified user interface with DHIS2 data to determine if it can be customized to improve the patients' understanding of their healthcare issues. There is very little research performed on the DHIS2 especially in the field of a mHealth Portal. Therefore, it may be that only minor changes to DHIS2 could address the needs of the patients' population. Below, Figure 3 shows a view of the proposed Portal Screenshot. Using a healthcare DHIS2 application as their source of greater knowledge, patients may find their ideas moving them forward in healthcare remedies and smart wellbeing choices.

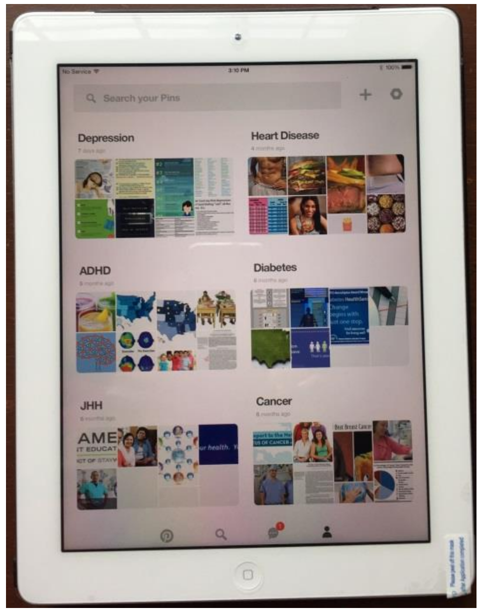


Figure 3. *This image is a view of the proposed Portal Screenshot to address the big data mHealth Portal app solution.*

Chapter 3 Methodology

A. Overall Research Approach

This chapter details the steps to conduct an empirical study of user preferences on specific health related issues, such as malaria, heart disease, depression and/or diabetes. The methodology has been spelled out in detail to define the usability test of the artifact created to answer the research questions to test the hypothesis. The goal is to determine if a mHealth application, building upon a Portal interface, can expand the offerings to the patients and all who seek healthy living through.

B. Usability Theoretical Framework

During this dissertation study, samplings of data-driven health information applications were reviewed and research continued to determine the best usability theoretical framework. After a thorough evaluation, three areas for enhancement to better assist the user were determined: navigation, interaction and visual design. In addition, from a practitioner's perspective the methodology has been defined for a usability design study to address advances for the proposed mHealth Portal.

The first pillar of the usability theoretical framework this study is based on is collecting scientific research through a field study. By examining the methodological implications of a framework, it is proposed that many of the variables that influence usability are generally excluded from normal experimental paradigms. The result is that usability issues are often not obvious in the results of experimental studies. To address this issue, the researcher suggested that more attention be paid to realistic simulation studies and to data from field experiments in order to submit the concept of usability to thorough scientific analysis (Eason, 1984). The second pillar of the framework is to include efficiency, effectiveness, and satisfaction. The reviewed study determined that core constructs for the measurement of usability is defined as efficiency. The product is enabling the tasks to be performed quickly, effectively, and economically. Effectiveness such that accuracy and completeness allows the users to achieve the specified goals and satisfaction which is the degree to which a product is making the user satisfied is also important factors (Coursaris & Kim, 2006). The third pillar of the framework is to keep users involved during the designing process. The user survey collection then provides feedback on the interaction process through items such as: the amount of mental effort required by a user, the degree to which the system conforms to human capabilities, the expected time to complete the interaction, where potential human error may occur, as well as potential misunderstandings or points of confusion to the users. With this information, the designer then can use this evidence to improve the design of the system. Validation of this technique indicates that keeping the users included up front provides accurate predictions of usability attributes and that the technique transfers from the designer to the final product (Koubek, Benysh, Buck, Harvey, & Reynolds, 2003).

The final and pinnacle pillar of the framework is to focus on ***navigability***, ***interactivity***, and ***customization.*** Empirical evidence and design guidelines discussed through this research work to address advances in health information systems aimed at promoting preventive health behaviors**.** The team provides a theoretical framework for designing Motivational Technologies through three aspects of modern media interfaces of ***navigability***, ***interactivity, and customization*** which can be used to enhance individuals' intrinsic motivation for preventive health, based on self-determination theory (Sundar, Bellur, & Jia, 2012). The final pillar of the framework is utilizing navigation, interaction and visual design aspects of mobile UI. For a detailed usability study review, the team iteratively tested three successive versions of a specific user interface with different groups of adults to best determine changes needed to address the software usability requirements. Breaking the results into three aspects, the team determined the design enhancements could focus on navigation, interaction and visual design. Specific examples are as follows:

1. Navigation: use the home screen menu as safe point of return;
2. Interaction: use the back button as a safeguard;
3. Visual Design: provide generous spacing between items.

With the implemented improvements, the users were better able to successfully utilize the software reviewed in the study (Barros, 2014). Building on the pillars mentioned above, this dissertation study conducted a field study to collect information directly from the end users and have the survey instrument include navigation, interaction and visual design. Using this focus, the best usability theoretical framework for the purpose of gathering the paramount feedback from the end users can be ensured.

The survey has been expanded to include a defined set of usability criteria questions. Initially created by John Brooke in 1986, the System Usability Scale (SUS) has become an industry standard for measuring usability (Brooke, 1996). This set of questions provides a “quick and dirty” defined set of criteria that usability can be defined and then easily categorized against other similar software products. It is a reliable tool consisting of a 10 item questionnaire with five response options for respondents. The end users reviewed each item and confirm their answer from “Strongly agree” to “Strongly disagree". Although this tool can be used to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications, for this usability test the apps on tablets were reviewed.

C. Experimental Procedures

IRB

Keeping in line with expected practices of research studies, the Institutional Review Board (IRB) permission was sought to approve the proposed experiment. The details of the application are documented in Appendix A-1, A-2 and A-3. Upon approval, the IRB committee supplied the Exemption Number as displayed in Appendix A-4.

Application Research and Development

There certainly are many solutions to providing superior healthcare options for patients and for others in the medical field. In fact, as technology grows constantly, there will always be improvements and new applications to employ. However, the proposed mHealth Portal customization platform does seem to offer some mechanism for searching healthcare solutions. To determine if the mHealth Portal framework was a possible solution, a nurse practitioner was consulted regularly to determine if any process improvements could be made in the healthcare materials disseminated to patients.

To meet the best practices of software engineering, the mHealth Portal application was developed and documented. The details to the application are reviewed in the Application Development section. Initial customization was all that was required to build a solution to address the research question experience. However, full development and detailed customization can continue to occur to expand the mHealth application to meet the new requirements of the patient population.

Survey Creation and Review

Trying to better understand if the proposed mHealth Portal customization would meet the users' needs, a descriptive study was designed to review the user preferences of the mHealth Portal. The proposed experiment was a within-subject design consisting of tasks across three different aspects (Navigation, Interaction and Visualization), totaling 6 tasks. The proposed instrument was the mHealth Portal application tool as shown in Appendix C-9. The details of the application creation are described in the application development of the mHealth Application section below. The different tasks and different types of user experience, therefore, constituted the independent variables. After the completion of each task, participants were presented user satisfaction and preference questionnaires. These satisfaction and preference items constituted the dependent variables. The details to the surveys are defined in The Experiment section.

Application Development of mHealth App

Requirements of mHealth App

The requirements of the mHealth App were not provided to the user population. However, to meet the best approach software engineering solution, general requirements have been assembled. The details to the requirements are in the Appendix D-1.

Hardware and Software Environment of mHealth App

This hardware and software environment of the mHealth App is built around the Hadoop Big Data Platform. The details to the Hardware and Software Environment are in the Appendix D-2.

Configuration of mHealth App

Because the baseline of the mHealth App is on solid Portal framework, the bulk of the technical changes occurred in configuration. The Portal framework developers believe in a community effort; therefore they have made their code available as an open source application that has APIs that can be expanded for various uses. The documentation for their product and downloading of the base code is available at their website

To begin the project creation, the user setup was one of the most important pieces to the mHealth Portal User tool. Because the mHealth Portal app is configured around healthcare content, the user is essential to the process. When creating a user in the mHealth Portal, the first steps are the questions of the Profile creation. These selections are then used to offer search ideas for the users as they use the tool to discover solutions to the healthcare issues. For this project, a generic user was created and named healthypatient2020@gmail.com. The next selection was the user profile that created the basis for all searching. The following were the items selected.

- Medical Terminology
- Medical Technology
- Medical Illustration
- Healthy Eating
- Healthy Snacks
- Health and Fitness
- Health
- Healthy Breakfasts
- Health Desserts
- Healthy Drinks / Foods
- Fitness
- Healthy Living
- Inspiration Quotes
- Healthy Recipes
- Nutrition

As the user logs on, the selection of search items available were based on the topics that had been entered in the Profile creation. In addition, the topics also cause the searches to offer certain selections. The following are the topics that were created for the HealthyPatient2020 user.

- ADHD
- Medical Technology
- Cancer Awareness
- Diabetes
- Healthy Living
- Health and Fitness
- Fitness

When the user entered the app, the selection of views was customized by a board search or by pre-defined Boards. In addition, the themes to the boards also caused the searches to offer certain selections. The following are the boards that were created for the HealthyPatient2020 user.

- ADHD
- Cancer
- Diabetes
- Heart Disease
- Flu
- Depression
- Johns Hopkins Medical Facility

The configuration was core to the mHealth Portal creation with the User being the central step. The tablet was configured to use the HealthyPatient2020 established session to perform the tasks outlined in the Methodology section. With the created user, the idea of the greater user experience big data app was explored.

The data or content that was displayed to the HealthyPatient2020 was core to the data-driven health information setting. Initially, to control the user view for the survey selection, the customized mHealth Portal app had Boards created for the purposed of this survey. Content was added to the Boards through the framework concept of association where useful data is tagged as worthy of further review. The Meta data is associated with the Board and User so that future viewing is possible. Although any topic can have the focus, the boards as defined above were selected as the topics for this mHealth initial configuration creation. Content was loaded and presented to the user to reflect relevant items that were reviewed in the DHIS2 data set. The details to the Configuration are in the Appendix D-3.

Development of mHealth App

The Development for the mHealth Portal is in the early stages. Because the baseline of Framework offered a good beginning solution for research study, not a lot of additional development was required. However, expansion of the API is easily performed with the open source code available. The details to the various development opportunities are reviewed in the Appendix D-4.

The Experiment

As a first step, a methodological survey of DHIS2 accessible data related to healthcare with a focus on user experience or improving UX was executed. From the information gathered through the literature review, the decision occurred to create a descriptive study based on the mHealth Portal application. Allowing the application to stand alone and not be compared, provided users the freedom to analyze the product and determine if any avenues of the application should be updated to better suit the user interface. For the full study, the same tasks across three different aspects of navigation, interaction and visualization totaling 12 tasks are used. The same configured tool is the web-based mHealth Portal platform presented on a single tablet and used to analyze usage for malaria as presented by the DHIS2 data and supplemental information. For the study, the variables were defined as where the tools used were the independent variables and user satisfaction and preference items were the dependent variables.

Full Study

The full study was executed using participants from a college setting. Participants for the full study were recruited from local college classes. The challenge of gathering participants can be difficult. Therefore, utilizing college students who were available and agreeable was the decided approach for this study. College students were accessible in person to review the tablet and document their findings. They were all inquisitive to learn the methods of the mHealth Portal which made them much more available for the study. Other studies could utilize various different groups, but do to the readily available participants, the college students were deemed to be the best candidates for this study. Again, all participants were voluntarily recruited with no offer of compensation. These participants agreed to have data collected from a college computer lab location at a convenient time. Each survey lasted approximately 15 minutes and the data were collected over a three month period generally during the afternoon. A total of 43 participants were interviewed and all results are presented in the dissertation.

To extend the data collected for this experiment, additional participants were recruited for a larger full study. The additional study was carried out using participants recruited during a standing community event. Random participants were requested during each session. Participants for the pilot study were recruited via open advertising from a standing local community organization. All participants were voluntarily recruited with no offer of compensation via advertisements placed on bulletins and word of mouth.

These participants agreed to have data collected from the comfort of their homes at a convenient time. Each survey lasted approximately 15 minutes and the data were collected over a two week period typically after dinner times. A total of 15 participants were interviewed and results were collected.

Survey Collection Process

In each data collection, the purpose of the usability study was explained and informed consent was collected. The participant was asked a series of questions starting with a pre-test followed by the User Satisfaction questionnaire. The pre-test survey was given to collect a baseline of the user's experience with technology. The information gathered covered variables such as gender, age range, technical experience, web searching experience, and healthcare researching experience. The participants were given some time to familiarize themselves with the functions of the tablet and become comfortable with its operations.

To being the descriptive study, each participant was asked to interact with the mHealth Portal on the tablet. A set of three tasks defined in each survey were laid out for the participant to walk through each website. The tasks asked the user to find the following: the definition of malaria, symptoms of malaria, malaria prevention, malaria treatment and a review of DHIS2 malaria data. At the end of the tasks, the users were asked to complete the survey related to their experiences with the mHealth Portal. The questions pertained to the tasks and focused on navigation, interaction, visualization, healthcare information provided and portal experience. Users rated their experiences on a scale of one to five with five being the highest user experience. Data were collected using pen and paper and then transcribed into a excel spreadsheet. At the end of each study, the users were asked to describe their experience with the mHealth Portal. The users were asked System Usability questions related to their overall preference with the interaction with the mHealth Portal. In addition, 2 open ended questions were asked to allow the users to offer feedback of how the application could be improved. The final question asked the users if they thought a mHealth Portal type application could be used to assist them to answer their healthcare needs.

The full field study was conducted through interviews to review the Portal and collect user feedback. The focus of their healthcare issue was still determined to be malaria. Interviews were conducted on days that work best for the interviewees. The order in which the interviewees were selected was dependent on the availability of the participants in that whoever was free and available for interview. The interviews were carried out through the afternoon from approximately 12:00 am to 5:00 pm. Each interview lasted approximately 15 minutes. Every effort was made to erase and or remove any personally identifying characteristics of the users from the data collected to protect and preserve their privacy. Since the identity of the users is not the focus but rather their experiences, it was more useful to collect the users' experience data only. In addition, the user experience data was not shared with any project members as it would not be relevant to their work.

The full field study was conducted using 58 total college students and community persons as participants. The participants for this study were recruited by advertising through classrooms and billboards in common areas across the Computer and Information Sciences Department at Towson University. Each participant was met at a computer lab by the research team. These computer labs were accessed mainly for the quiet space available. The purpose of the usability study was explained. The users were informed of their rights including the right to refuse to answer any question they deem uncomfortable or unwilling and also the right to terminate the study at any time without any repercussions to their current position in the community. After these explanations the participant was asked to sign the consent form. Upon signing, background information about the participants was collected through a series of questions regarding their experiences with the comparable healthcare applications.

Each participant was asked a series of questions starting with a pre-test followed by the user satisfaction questionnaire. The information was gathered by the interviewer as the individual reviews the mHealth Portal on the tablet. The last portion to the survey was the comment section where the participants provided their personal feedback of the applications. These instruments can be found in Appendix B-1 through B-6 with the views in Appendix C-1 through C-5. The pre-test survey will be given prior to the Survey to understand the participants' experience with technology and their general baseline for a profile setup. Appendix B-1 shows the pre-test. These interviewees experiences, including aspects of the tool they found easy or hard to use or navigate, were collected and written down using pen and paper and then transcribed into a word document.

The study took place at computer lab with each test lasting no more than ten minutes. Participants were supplied with a standard tablet to view the mHealth Portal website. The researchers were present during the sessions so that one could take notes and the other could engage the participant. Each session was organized in the following parts: 1) introduction; 2) teaching and training vertical and horizontal swipes; 3) tasks; 4) user satisfaction questionnaire; and 5) debriefing. Sessions were devised with tasks according to the defined research questions to assess the usability of each interface. Sessions were completely confidential with no other personal information gathered. To ensure complete privacy, not photos or videos were captured during the meeting. Results from the test were analyzed for statistical validity and any inferences from the research to continue further refining of the development framework to improve user experience for data-driven health information initiatives.

A set of tasks defined in each survey as shown Appendix B-2 through B-5 were laid out for the participant to walk through each site. From there, a survey was given to a group in the community to review the mHealth Portal healthcare site with questions on user satisfaction; 5 questions pertaining to the navigation, 5 questions about interaction, and 5 questions about visualization and the 10 questions referring to the System Usability Scale. The questions pertained to the changes and focuses of navigation, interaction and visualization. The answers had a scale of one to five with five being the highest user experience. The responses were collected using a 5-point Likert scale.

The following are the steps the participants performed as they worked through the survey and application interaction. The details to the survey were handed to them on a sheet of paper. In addition, the tablet was supplied to them to work through the steps they were given in the survey. Below are the outline of the steps and the comparative pictures between the two types of screens. All of the artifacts used in this section are pointed to in the appendix.

1. The participant entered the room for the survey, welcomed and seated.
2. The participant was given the Consent Form to sign as seen on Appendix A-1.

3. If the participant agreed to continue with the survey, the paper survey and tablet were handed to them.
4. The participant completed the Pre-Test that is identified in Appendix B-1.
5. The participant completed the User Steps using the details in Navigation, Interaction, and Visualization Appendix B-2.
6. The participant then completed navigation, interaction, and visualization survey through the Likert scale as shown in Appendix B-3.
7. The participant then completed System Usability Scale Likert scale as shown in Appendix B-4.
8. The participant then completed the Comment Section as shown in Appendix B-5.
9. The participant handed the papers to the researcher and completed the survey.

D. Data Analysis

This study was built on quantitative data collection methods. The quantitative metrics that were used helped determined the individuals' like and dislikes for the software application. A series of statistics gathered at each of the sessions helped to effectively understand the users' preferences as reviewed in the results. These statistics proved to be extremely critical as comparison between the selected sites. Through validating, verifying, and recording the findings, the data found was effectively analyzed. With the information collected, a conclusion of what software application was more desirable to the end users was determined. A series of tasks as defined in the User Satisfaction and Preferences Survey Section was performed simple tasks for each component of the test plan. The results were compared and metric results were viewed to determine the best conclusion from the research. The IBM SPSS product was used to present the results in a statistical acceptable view.

The quantitative data collected were analyzed after the full study was completed. Using the IBM SPSS product, the data were entered for building various statistical analyses. Statistical models were reviewed beginning with the mean, assessing the fit of a model including the sums of squares and variances. Using the data, the standard error, confidence interval and standard deviation were gathered and scrutinized. The statistical models such as T-Test, Mann-Whitney test and Pearson's correlation coefficient were carried out. The goal was to use the statistical models to determine the null hypothesis significance. Other analysis to review effect size and meta-analysis was also performed. Finally, ANOVA testing was performed to analyze the differences among group means and their associated procedures.

Compiling all of this information, the team was able to build graphs and charts to assist in analyzing the data collected. From there the team was able to determine conclusions from the results.

Chapter 4 Reporting Results

This chapter details the results found during the full empirical study of user preferences on specific health related issues. The results are defined in detail in relation to the research questions to exam the hypotheses. The focus was to determine if a mHealth application utilizing the Portal framework technology can expand the offerings to the user community who seek healthy living in conjunction with the DHIS2 data.

A. Hypothesis Review

The purpose of this experiment was to determine if a mHealth Portal User Interface combining DHIS2 data could increase the users' experience. Specifically, this experiment was established to determine if an application using an established framework could offer a superior platform for a DHIS2 interface thereby increasing the knowledge gained for the End User.

The following research questions were investigated in this study.

- Does the usability of a single data-driven portal, such as DHIS2, impact the users' understanding of health information issues?

The independent variable or the cause for this study was the customization creating the mHealth Portal and the tasks presented for the user experience. The dependent variables were the user satisfaction. The variable was being tested through a Usability study with a user experience questionnaire in a standard five-level Likert scale. The exact questions and rating scale can be reviewed in Appendix B-2 through B-5. The main hypothesis was that the mHealth Portal would improve the use of data-driven health information increasing the users' usability. The survey specifics covered health care topics, but could be replaced with other topics such as financial information, government offerings and many other areas of expertise. Through this section, Full Study data was reviewed and presented for dissemination.

B. Full Study Data Collection

The timeframe for the full study occurred over the Fall Semester of 2018. Various Computer Science classes at Towson University were approached to request participants for the study. Students that volunteered were sent a link to a website where they could select Tuesday and Wednesday afternoon slots lasting 30 minutes beginning at 12:00 until 4:00. They then responded via the website with the timeframe they preferred and their contact information. In addition, a community group was requested for their input. To contact them, meetings were established and the data were collected in their homes.

The volunteer students were a representation of the population of college students in the Computer Science Department and a sampling of the local community. First, 64% of the participants were male. The age range was 18-25 for 60% of them. When asked of their technical capability, 62% of them responded with “above average” or greater. Describing their internet usage in terms of hours per day, 86% of them stated it was 4-6 hours or greater. That is to say the group utilized for this study was often male in the age range of 18-25 and highly technical with great usage of the internet.

C. Results

The full study results showed that the mHealth Portal was well received by the end users. Out of 58 participations interviewed, 51 (or 88%) stated they had a very high confidence level in using the mHealth Portal App. Given navigation, interaction and visualization Likert scale questions totaling 870, the users selected 4 and 5 options 800 times or 92% of the time. Along with very detailed comments, the users were very satisfied with the results of the user experience. They did offer input for improvement in the area of to include visual clarity of some images and keyboard usage. Some participants did note that their confidence could be improved if they could be assured that the views displayed were from medical experts. Again, they stated if the healthcare content was from trusted sources, they would then select mHealth Portal to view DHIS2 data for the simple user interface.

The descriptive survey covered steps to review the questions related to healthcare topic, specifically was malaria. After the user interfaces was utilized, the participants were asked the questions presented in a Likert scale. These categories covered navigation, interaction, visualization, and system usability topics. The selection of 5 being the highest and 1 being the lowest, the below table displays the mean scores. The exact output can be viewed in the Appendix F – 1 through F – 7.

To review the data results, the first approach taken was to derive the mean, median, standard deviation, minimum, maximum and range for the user preferences of only the navigation, interaction, visualization items. The output is listed below in Table 1. The lowest mean found was 4.09 and the highest was 4.81. All but one median value was 5. The minimum values were either 1 or 2 and 5 was the maximum value for all questions. The range was found to be evenly dispersed 3 or 4. The standard deviation was the most telling result. With .58 being the lowest standard deviation and 1.06 being the highest, the extreme values depict a trend with the results. The lower standard deviation values show that there was a smaller range of results from the highest value of 5. The higher standard deviation values than show that there was a larger result range from the highest value of 5. This seems to show that for the lower the standard deviation the more the users liked the mHealth Portal app. The higher the Standard Deviation the more the users disliked the items presented in the mHealth Portal App. The results show that most all standard deviation was low. This implies that the bulk of the users choose high satisfaction for the results. The lowest standard deviation at .58 shows that the users liked the ability to navigate around the tablet. The value of .61 standard deviation demonstrates the users liked the navigation around the grid view and the interaction wording. The highest standard deviation value of 1.06 symbolize that the users had a difficult time viewing the DHIS2 Map data. This issue was related to the fact that the image was not as clear as could be possible. The next highest standard deviation at 1.01 shows that the users did not like or did not often interact with the keyboard so therefore did not have a preference or could not evaluate the request. The Table 1 view depicts the mean, median, standard deviation, minimum, maximum and range for the user preferences of the navigation, interaction, and visualization items.

Table 1

User Preferences of the Navigation, Interaction, and Visualization Items

Category	Mean	Median	Standard Deviation	Minimum	Maximum	Range
Navigation Tablet	4.74	5.00	.58	2	5	3
Navigation Grid	4.64	5.00	.61	2	5	3
Navigation Information	4.78	5.00	.56	2	5	3
Navigation Main Screen	4.60	5.00	.75	1	5	4
Navigation Search Screen	4.72	5.00	.70	2	5	3
Interaction Tablet	4.64	5.00	.69	2	5	3
Interaction Wording	4.81	5.00	.61	1	5	4
Interaction Back	4.50	5.00	.82	1	5	4
Interaction Scroll	4.72	5.00	.81	1	5	4
Interaction Keyboard	4.43	5.00	1.01	1	5	4
Visualization Layout	4.50	5.00	.80	2	5	3
Visualization Spacing	4.53	5.00	.86	1	5	4
Visualization Icons	4.53	5.00	.84	1	5	4
Visualization Images	4.50	5.00	.96	1	5	4
Visualization Map	4.09	4.00	1.06	1	5	4

Note. Data collected from Usability Study

The next descriptive statistics chart reviewed below in Table 2 has the mean, median, standard deviation, minimum, maximum and range for the system usability user preferences. The details are displayed similar to the results for the navigation, interaction, and visualization items; however, the System Usability Scale (SUS) has differently stated questions creating different results. Scoring SUS cannot just assume that the correct answers should all be high 5 range and low 1 range. In fact, the opposite is true for all even questions. For all odd questions, the answers should be close to 5. These types of questions keep users very involved as they cannot simply circle all 5 answers to easily complete the questionnaire. The must read each question and often come to the answer that 1 is the best response. During this survey, very often users did not understand the questions for the SUS and became confused with the correct responses. For this reason, the SUS results are viewed separately.

To score the SUS results, the odd items a result must subtract one from the user response. For even-numbered items the researcher must subtract the user responses from 5. This scales all values from 0 to 4 (with four being the most positive response). The researcher should then add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40.

In reference to interpreting SUS scores, the information must be reviewed carefully. Despite the wide usage of SUS, there has been little guidance on interpreting SUS scores, acceptable modifications to the items and information on reliability and validity. Many researchers have used SUS during usability evaluations. Many researchers have reviewed the existing research on SUS and analyzed data from many users across various different evaluations. The data show that SUS is a reliable and valid measure of perceived usability. It performs as well or better than commercial questionnaires and home-grown internal questionnaires. That said the exact questionnaire was not used in this survey as the questions did not seem as a perfect fit. Because question wording was changed, the SUS results were not compared against industry standards.

With the idea in mine, even results should be close to 5 and odd answers should be close to 1. Given that there was confusion, the data generally showed these results. As shown in Table 2, the standard deviation indicated high numbers for odd questions and low values for even questions. This indicated that most users understood the request and answered generally around the desired patterns of odd questions being low and even questions being high. The median values also reflect this pattern with generally odd questions being high and even questions being low. The only deviation from this pattern was question 6. This correct response was high even though generally even questions should be low in SUS results. For this reason, each question results was reviewed in its' own basis and generally related to SUS results.

The highlighted items to note are the usability confidence. The results showed that the standard deviation was the lowest at .49. This indicated that most users selected either 4 or 5 for this response. For the question about complexity of the system, the users generally selected 2 and often 1. This result showed that most users did not think the system was very complex. Users also thought that low effort or support would be needed for the users to use the system with the results of median value 1.5. Users defined that it would not be very difficult to learn and use the system. The results of median value 2. Finally, usability consistency was rated high with a value of 5.

Table 2

Range for the System Usability User Preferences

Category	Mean	Median	Standard Deviation	Minimum	Maximum	Range
Usability System	3.98	4	0.93	1	5	4
Usability Complexity	2.32	2	1.56	1	5	4
Usability Usage	4.6	5	0.88	1	5	4
Usability Support	2	1.5	1.34	1	5	4
Usability Functions	4.34	5	0.81	2	5	3
Usability Consistency	4.69	5	0.68	2	5	3
Usability Learn People	4.31	4	0.78	2	5	3
Usability Cumbersome	2.44	2	1.57	1	5	4
Usability Confidence	4.84	5	0.49	2	5	3
Usability Learn User	2.33	2	1.49	1	5	4

Note. Data collected from Usability Study

The graph below represents the simple scatter plot means of standard deviation by Items. The results from the entire survey are displayed to show the results from the navigation, interaction, and visualization in conjunction with the SUS results. After understanding that the SUS results should have at least 4 results in the high standard deviation, the graph displays usability cumbersome, usability complexity, usability learning for users, and usability support showing high standard deviation. These details show that the correct opposite responses were found for these SUS values. In addition, the rest of the findings are closely located around the 4 and 5 result range. This again shows that for the navigation, interaction, and visualization questions, the users supplied high responses.

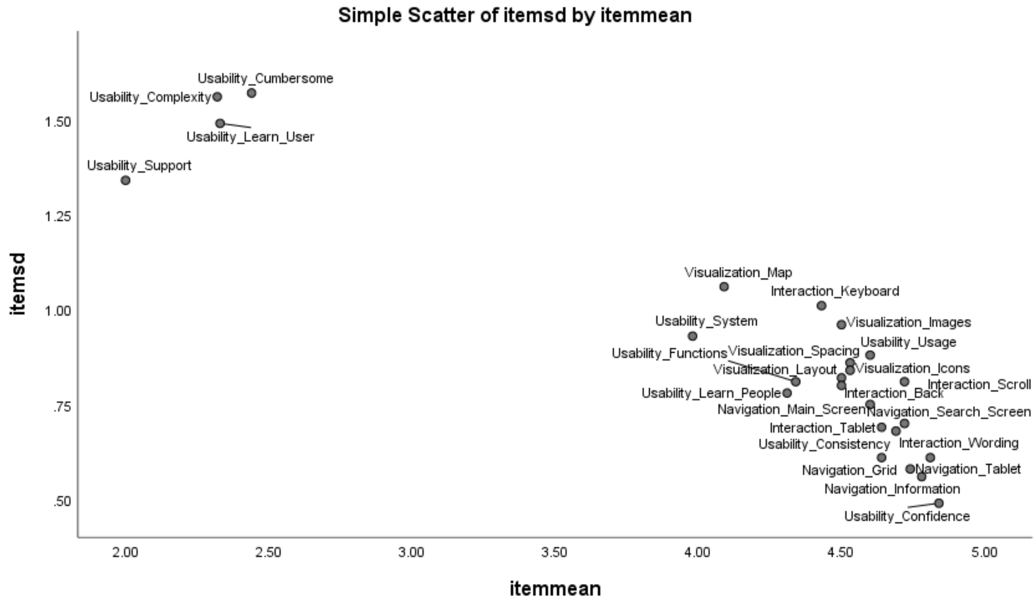


Figure 4. A graphical representation the Simple Scatter Plot Means of Standard Deviation by Items.

The graph below represents the simple scatter plot means of standard deviation by items with the items usability cumbersome, usability complexity, usability learning for users, and usability support showing high standard deviation removed from view. By removing these outlying results, we can capture items that standout in the grouping. In Figure 5, the standard deviation results for navigation, interaction, and visualization all are generally around 4 and 5. Below are the items categorized by high and low satisfaction responses:

- High Satisfaction
  - Usability Confidence

  - Navigation Information
  - Tablet Usage
  - Interaction Wording
  - Navigation Grid
  - Usability Consistency
  - Navigation Search Screen
- Low Satisfaction
  - Visualization Map Clarity
  - Usability System Question (supposed to be opposite)
  - Interaction Keyboard
  - Usability Learning Question (confusing for some users)
  - Visualization Images Clarity

Using this view, we can see that visualization on the map was a low mean with a high standard deviation. This falls in line with the responses that say the image was a bit blurry and should have been more in focus. The next outlier was for the usability system question and again this most likely has a high standard deviation with a low mean because the SUS question was confusing to some users causing them to select questions that did not fall in line with the correct response. The interaction on the keyboard was also rated low because it was not used very often. In contrast, usability confidence, navigation information and tablet usage had the highest scores; the users were the most satisfied with these mHealth Portal aspects. Users spoke positively about the grid usage and usability consistency as they maneuvered through the product. That their scoring fell generally around 4 and 5 indicated that the users were highly satisfied with the mHealth Portal.

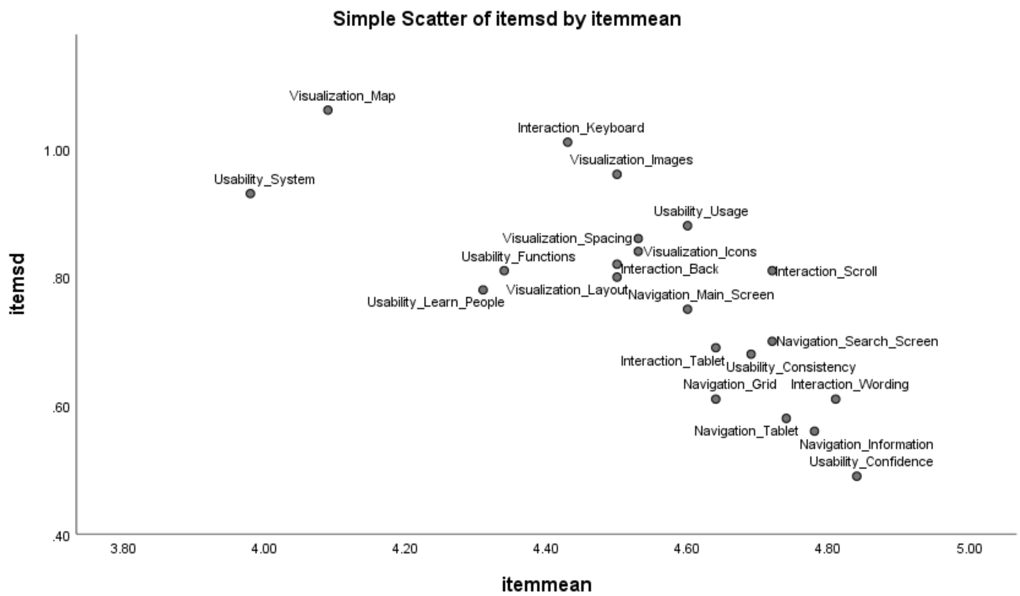


Figure 5. A graphical representation the Simple Scatter Plot Means of Standard Deviation by Items with the items Usability Cumbersome, Usability Complexity, Usability Learning for Users, and Usability Support showing high Standard Deviation removed from view.

The results were put through extensive analysis with standard deviation in association with the various demographics. The goal was to determine if there were any findings that would show heterogeneity in the results. After various SPSS chart analysis, there was no significance displayed among any of the demographic results taken. That is, gender, age, and technical usage did not influence the results. Additional research would need to occur to delve deeper into this result finding.

Regarding the hypothesis, the results showed that end users found that the mHealth Portal provide high user satisfaction. The full study indicated that 92% of users referred mHealth Portal customization to meet the need of a Portal for Healthcare information as shown in Table 3. Based on the findings, the user experience in mHealth

Portal for a DHIS2 data-driven health information App was very helpful to gain knowledge from the combined healthcare information. The chart in Figure 6 displays that the participants preferred the mHealth Portal Application significantly more than the other websites. This is a visual display of their affirmation with respect to the hypothesis noting for almost all response 5 was the response. In addition, 4 was the next highest rating.

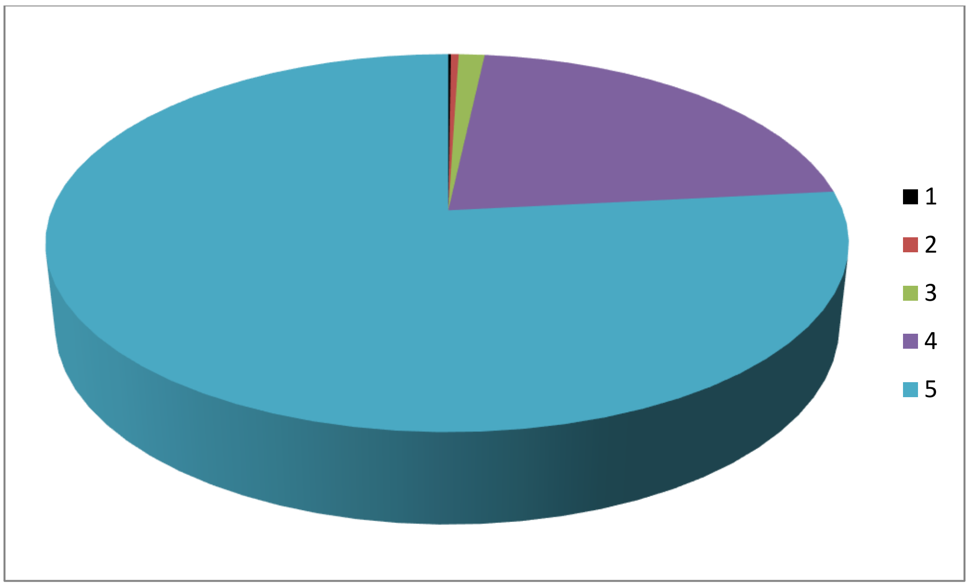


Figure 6. This graph displays the total answers 1 – 5 for Navigation, Interaction, and Visualization of Users Satisfaction with the mHealth Portal App.

The details percentages are defined in Table 3 which validate that 4 and 5 are the most highly selected options.

Table 3

Amount of System Usability User Preferences

Items Selected	Percentage
Amount of 1	0.11%
Amount of 2	0.34%
Amount of 3	1.15%
Amount of 4	20.23%
Amount of 5	71.72%
Total Amount of 4 and 5	91.95%

Note. Data collected from Usability Study

D. Summary

The purpose of this study was to determine if mHealth Portal could offer a superior data-driven health information user experience platform of the DHIS2 data. The finding showed that 88% stated they had a very high confidence level in using the mHealth Portal App. Given navigation, interaction and visualization, 92% of the time the users preferred the mHealth Portal app showing high satisfaction of the product. In addition, there was no bias found in regards to gender, age, technical ability or proficiency with searching. Finally, for the categories of navigation, interaction, and visualization, the users had very encouraging comments to say about the mHealth Portal. Most users stated comments such as “I think that the mHealth portal could definitely help address my healthcare needs. The layout of the interface is very intuitive and I found it to be fairly simple and easy to navigate.” And “I was satisfied with the information given; you were easily able to find the information you need.” The mHealth Portal was found to offer a good user experience, as stated by the participants.

This study shows the User Interface of mHealth Portal has a high acceptance response by the users who viewed it. The choice of mHealth Portal may most likely be the optimal method as users would like to find information presented to them with ease. As they worked through the survey, users seemed to find the experience illuminating as they found the information they needed quickly in the mHealth Portal. By configuring the mHealth Portal to offer the health content they need, the users were happy to find the material easily in a succinct user friendly platform.

Chapter 5 Analysis and Conclusion

This dissertation reports the empirical research that investigated user preferences to determine if a mHealth application utilizing the mHealth Portal technology can expand the offerings to the user community in relation to health topics. The research is original and informative because the findings point out that a mHealth Portal could offer an enhanced big data application leading the users to increased knowledge. The findings of this research are only the first step to help researchers evaluate DHIS2 data-driven health information usability and how a mHealth Portal can create a highly satisfied user experience.

A. Discussion Analysis

Although big data research has been growing over the past decade, the review of the user experience has been lacking. This aim of this study was to answer the research question: “Does the usability of a single date-driven portal, such as DHIS2, impact the users understanding of heal information issues?” It was hypothesized that crafting a mHealth Portal could improve the use of Healthcare DHIS2 data-driven health information expanding the patients’ knowledge concerning their health issues. Based on our findings, this hypothesis should be accepted.

To address the hypothesis, the team created a study creating a Healthcare focused mHealth Portal to understand the user experiences. The study supplied users with steps to address a healthcare need, in this case malaria. As the users worked through the process of finding information regarding Malaria, the study was working to address the idea that their healthcare knowledge was improved. The ability to find the information not only more quickly and concisely, but also presented with similar information that expounded upon malaria issues thereby helped users find more knowledge and a healthier lifestyle. Previously, big data analytics has only been utilized to present graphs or high-level data output. However, the study sought to determine if changing how data-driven health information is presented to the end user in a better user experience improve the users' awareness.

The results of the study found that 92% of the users were highly satisfied with the updated healthcare focused mHealth Portal app. As described in the participants' comments, they found the mHealth Portal app as "it was very useful and it can help people get more knowledge about topics like these diseases", "with this application I can find information on health topics very easily", "The information was easily navigable. Someone could learn all they need to know on the topic", and "It can help people understand about health issues especially when everything like symptoms and preventions are all listed on the same page" The details of the comments in Appendix F-7. The mHealth Portal app offered the ability to present data-driven health information in a single point of entry offering a Portal view of healthcare information. From a user experience presentation only, the study did validate that altering the view of the big data information could greatly enhance the users' knowledge gained. That said, when some users felt that the information was not a highly regarded medical resource, they did not feel that mHealth Portal could be established as a source for medical information. They brought their bias to the study and thought that the mHealth Portal could not point toward valid medical sources. Technically speaking all that mHealth Portal offers is a data-driven health information interface, so that any underlying information can be established as viable medical data information if setup for that purpose. This further proves that more research in the field of a mHealth platform should be moved forward.

For the usability study was a total of conducted using 58 total college students and community persons as participants. The first set of the 48 participants was gathered from the Computer and Information Sciences Department at Towson University. These students are highly technical and have much experience in computer usage. When selecting the technical skill set, they all chose “above average”. Out of only the college students, the group selected 4 or 5s also 92% of the time. This was the same outcome as the full group. The question then is whether their highly capable technical skills gave them more education and a better understanding of how to use devices such as the tablet. Did they select high satisfaction and the ease of use for the Portal because they have greater knowledge than the normal users? That said, these highly savvy users could have thought the program was not beneficial based on their experiences with other software. Instead, based on their usage, they found that the mHealth Portal had a sound interface and interesting information to offer. The final 15 participants were gathered from a local community setting. They covered an age range from 26 – 85 with the bulk of them being in their 40s. Their technical skills varied, and some participants rarely used the internet. Again, with this group, the results were also very high for the selection of 4 and 5s. However, they selected the high satisfaction results for only 90% of the outcome. This seems to state, that the more technical skills did have a slight bent toward more readily accepting the interface for the mHealth Portal. The community users greatly selected the 4 and 5 results, but less often.

B. Interpretation of the Findings

The findings of this study extend the knowledge that was reviewed in Chapter 2. Many big data methods and techniques have been researched and studied to further knowledge in the fields of business, government, social media and marketing. Still the Usability in the area of data-driven health information is lacking and much in depth exploration needs to occur in many avenues. Specifically in the area of Healthcare, the literature reviewed many areas of study that fully utilized the offerings of big data. After a thorough review, there was not a single study that worked to incorporate all the data offered from Medical devises on a single platform that includes expertise from medical professionals, smart health and wellbeing proven practices, alternative medicine solutions and social media offerings in the goal to increase the end user's healthcare understanding. Studies of mHealth Portal were also reviewed for their research gathered; however known focused on the usability of the software and its ability of configuration to advance the health care knowledge. The main finding through this study, as stated by the participants, a mHealth Portal was found to offer a highly satisfied user experience to understand the DHIS2 data.

The only finding that was contrary to selecting mHealth Portal in the study was the underlying question as to whether the material presented was in fact medically sound. The users wondered if they could rely on information presented by mHealth Portal for healthcare information. Knowing that the mHealth Portal is an interface to present data-driven health information, it is with confidence that the knowledge presented could truly be viable medical information. In fact, hospitals or medical facilities could create their own mHealth portals with reviewed healthcare content that they could ensure is presented to their patient population.

C. Lessons Learned

During this study, we have learned a number of lessons the first of which is the importance of the gift of knowledge. As each participant worked through the survey tasks collection steps, a general enlightenment occurred where the users began to understand how they were actually important in the process of searching for data. This is to say, that they realized that their opinions matter as they performed searches and utilized software. Very often, the user felt like they might have done something wrong or selected the incorrect option. However, as they were repeatedly reassured that they were correct and in fact the user experience of the software should be improved to make it easier to view what they would like, each user felt more confident to truly review the information and demand the outcome to reflect what they would like to see. The experience throughout this study revealed the importance of proper survey design and strategy. The questions were categorized based on the user experience main features. Also, in design of the survey questions, we not only used our domain knowledge but also benefited from reviewing similar surveys and consulting medical professionals. These efforts aimed at ensuring use of a terminology that is familiar to the respondents and keeping the questions at a reasonable number without sacrificing domain coverage. That said, we were satisfied with the survey results.

In spite of the usefulness and all the pros of everyday users being able to find medical information online, there are also related dangers. The available content online should of course not be replacing a professional medical doctor, but simply be available to enhance the knowledge base and understanding. This aspect also reflects in the experiments. Even though the usability results are high in mHealth Portal, there were some users who doubted the information found was medically accurate and reliable data. To address this concern, a set of mHealth Portal Boards could be supplied specifically from the local hospital medical team to provide the exact content for the users. Using the mHealth Portal platform allows for configuration of the User Interface and the content base is completely transferable to be as accurate as needed. This would alleviate the concerns of medical accuracy.

D. Limitations and Potential Threats to Validity

Although the findings for this study noted that the participants were highly satisfied with the mHealth portal to review the data-driven health information results, further research should be conducted to explore the idea in greater depth. There is a question of bias in relation to the survey process. All surveys were conducted in the order of navigation, interaction and visualization in the mHealth Portal. To eliminate bias, a random order effect should be utilized where navigation, interaction and visualization are presented in different orders. This will help address the affect that users have of the learning curve of the survey and general attention span of the process. The question can be asked if rearranging the order would have the same outcome in the System Usability Scale. Therefore, for a follow on study, the large candidate group will be broken down into four categories where the order allows for each of the navigation, interaction and visualization and System Usability Scale will be rotated randomly. From there, the new process will end with a different order for ending working through the categories. This will allow for the various orders to be analyzed in the results.

There are several forms of bias that must be addressed. The first is towards the U.S. in that the selected websites are mostly used in the U.S. For further research this should be taken into consideration as results may be different when considering users from the U.S. and users from other parts of the world. In addition, bias towards mHealth Portal is present as users who have experience with the specific health care issues have a different experience with the results. For further study, the research should also analyze the effect of various different healthcare topics to validate the results.

The participants group is also a limitation that could be improved upon. The majority of the group was college students from the computer science field. Expanding the study to first include other non-technical fields could expand the knowledge gathered from the study. In addition, the college study sample is primarily from the same age group. Reaching other various age groups could help gather additional feedback that could help improve the reach of the mHealth Portal. The various age groups could have significant resulting effect on the satisfaction level. Their ideas may bring more information to improve the usability of the application. In addition, non-US based participants could be studied. This would help gather information about users from various countries and greatly enhance the impact of the findings.

E. Recommendations

For future studies, building upon the determined strengths and weaknesses of this current study, key changes could occur to further investigate the mHealth Portal. First, a much larger sample size would greatly increase the understanding of the study. The full study utilized highly technical, generally younger participants. Expanding the group for age, technical skills and geographical influence may alter that outcome. In addition, changing the participants may change the bias found and increase other lessons learned. Because this study focused on malaria as the healthcare initiative, it may be useful to present another study with other focuses such as diabetes, cancer, or heart disease. This may show that a configured mHealth Portal may still offer various offerings, but the other websites may not have the same capability. Further research would expand the understanding if only the Malaria focus caused the result of participants favoring mHealth Portal. There are many aspects that could be furthered study from this research and basic idea; increasing the group size, altering the healthcare focus and expanding the usage of the mHealth Portal are only a few.

F. Implications

The potential impact for positive social change at the individual, family, organizational, and societal/policy levels are almost quite limitless. Although the purpose of this study was a limited scope to determine if mHealth Portal could offer a superior big data experience. The implications of implementing a mHealth Portal with the technical backbone of a platform would most certainly create positive social change.

The internet can be a very overwhelming experience with vast content and unorganized material. Users may log onto the internet and peruse information for hours only to forget much of the details reviewed and often not be able to relocate the helpful content when desired. In addition, there is more information in the internet of things that are not being used to its fullest. Detailed data points are being collected and stored offering great insight to a wealth of knowledge, but the information is not available in an organized useful interface. The idea is that all of this information could be brought together in a single portal to better support various avenues of interest. For example, government policy, history related details, financial ideas, and many other focuses could all be different portal functions.

Healthcare or medical information could certainly benefit from a single search portal. Patients today with health issues can be loss in the vastness of piling medical information before them. With a specialized mHealth Portal, they could be directed to the best information to help their specific needs. Hospitals or medical facilities could offer subsets of the mHealth platform for their patients. The vision of the hospital use case for the mHealth platform could be revolutionary. First, instead of the present practice of sending patients home with piles of documentation, hospitals' could allow access for users with specific diagnostics to the hospitals' approved material to support the patients' needs. In addition, the hospital could have another area where they allow access to patient care details such as specific notes from their doctors, their own electronic medical records, and personalized homecare practices and procedures. From there, the patient could then explore within the mHealth Platform views of other patients input such as their feelings with similar medical issues, healthy food ideas, and support groups. This healthcare related information could all be offered from a single source to allow for a valid source of medical information. With this great source of data-driven health information at the patients' fingertips, their own knowledge of their healthcare will expand greatly.

Expanding on the implications of the mHealth Portal, incorporating a global vision of the software could grow the reach of the health information availability. With the base idea of bringing various data driven content in a single platform, the mHealth Portal could bring additional resources to users in countries around the world. Building on the case of malaria, as the DHIS2 data is collected in countries within Africa, the data could then be presented to these users. With the malaria data findings presented, the resources of how to address the disease, prevention and access to community outreach programs could all be available in the mHealth Portal to the users in the African countries. They could use this information to grow their health knowledge and as a community more effectively understand how to become a healthier society. This same idea can be presented around the world in every continent to better assist every community as they ward off diseases.

G. Conclusion

In 1843, Ada Lovelace's "notes," contains a revolutionary narrative of the potential of programming a machine to go beyond simple number-crunching to "computing" (Fuegi & Francis, 2003). She envisioned a machine that could be reprogrammed to do an unlimited array of tasks. She took this idea one step farther and noted that the computer operation could alter the relation not just between numbers but between any symbols that are logically related. This insight would become the core concept of the digital age. Any piece of content data or information such as music, text, pictures, numbers, symbols, sounds, or video could be expressed in digital form and be manipulated by machines. She fundamentally foresaw the big data area which we now live and breathe. But like Ada, shouldn’t we also be visionaries that foresee how this technology can offer more. We can also envision a new better way of big data usability where we can gain greater knowledge from the information as it is presented before us. This can be in the area of healthcare with medical focus or expanded to more areas of interest such as finance or global initiatives. And all of this would be accessible through a single portal. This research is a small step forward to prove that users agree that they would like to user a mHealth Portal. There is much more to do, but with the goal of a grander healthier society, the work is worth the effort.

Further research is needed to understand the outcomes of improvements in data-driven health information usability software usage. This research offers a first step in understanding how incremental changes to an interface can offer greater satisfaction to patients and health seekers. As found through the research study, the vast majority of users preferred the mHealth Portal. Beginning with the mHealth Portal application, small changes could be implemented to make the vast amount of data useful to all. Decisions could be made more rapidly once the patient has full access to the insight the data can foretell. The goal is increase the knowledge gained from large datasets and for that to occur the application needs to offer a superior DHIS2 user experience; an interface that is easy to maneuver; the ability to effortlessly retrieve personal saved points of interest; present DHIS2 big data for viewing in an straightforward sorted view; include the option for Social Media blending of ideas, customizable for various fields of interest, and all from within a Portal for single sign on accessing. Through this study, the results show that the ability of a Portal design to increase knowledge gathered from DHIS2 data-driven health information was desirable. The participants in the study found that they could increase their healthcare knowledge through a platform that had access to medical experts, smart health and wellbeing proven practices, alternative medicine, and social media. This new mHealth framework could be quickly accessed via mobile devices could offering patients a better experience as they fight against diseases and sustain healthy living. Through this dissertation, an empirical study was executed and found that customizing mHealth Portal could improve the use of DHIS2 data-driven health information expanding the patients' knowledge concerning their healthcare issues.

The user experience of viewing data-driven health information can be greatly improved gaining superior knowledge from the vast array of information readily available (Raghupathi & Raghupathi, 2014). With the expansion of electronic medical records and much of the medical industry digitized, boundless information is at the patient's finger tips. From this immense data, a platform that brings the expertise from medical professionals, smart health and wellbeing proven practices, alternative medicine and social media could increase the end user's healthcare understanding. With a technological breakthrough in cloud computing and big data, mHealth software applications can offer substantially more information to the end users. This innovative technology can be utilized for healthcare uses to more easily identify medical related information discovering greater medical solutions. Cultivating healthcare big data visualization could intensify the user experience gaining a better understanding of healing remedies and healthy living guidelines leading toward longevity. This original framework could be accessed using mobile devise such as tablets in assisting patients to attain healthy living. This research study may prove that employing the discovery principals available through a mHealth Portal utilizing the DHIS2 data-driven health information through SaaS can offer patients the ability to research their own medical diagnosis, healthy living, alternative medicine and social media options.

Related Publications

Shipley, N. and Chakraborty, J. March 2016. Big data and cloud computing accessibility initiatives for the elderly: a practitioner's perspective. *Cambridge Workshop on Universal Access and Assistive Technology CWUAAT*, 51-55.

Shipley, N. and Chakraborty, J. March 2017. Big Data and mHealth: increasing the usability of healthcare through the customization of mHealth Portal – literary review. *Next-Generation Mobile and Pervasive Healthcare Solutions*, 46-66.

Shipley, N. and Chakraborty, J. March 2018. Using mHealth Portal to improve the big data user experience - a comparative analysis in healthcare. *6th World Conference on Information Systems and Technologies*: Naples, Italy, 949-960.

Appendices

Appendix A-1: IRB – Consent Form

INFORMED CONSENT FORM

PRINCIPAL INVESTIGATOR: Nancy Shipley

Purpose of the Study:

The purpose of this study is to determine if customizing MHealth Portal will improve the use of Healthcare Big Data expanding the patients' knowledge concerning their health issues. To that effect, the user experiences with the existing health gathering process will be compared against the usage from within the MHealth Portal platform.

Eligibility Criteria:
You are eligible to participate in this study if you have the ability to view health data on websites AND are 18 years or older.

Procedures:
Each participant will be met at a local community setting by Nancy Shipley, the sole data collector. The purpose of the usability study will be explained. The user will then be informed of their rights including the right to refuse to answer any question they deem uncomfortable or unwilling and also the right to terminate the study at any time without any repercussions. After these explanations the participant will be asked to sign the consent form. Upon signing, the subject will be asked a series of questions regarding their experiences with the websites. These interviewees experiences, including aspects of the tool they found easy or hard to use or navigate, will be collected and written down using pen and paper and then transcribed into a word document. These answers will be written down as quickly as possible and would also include facial expressions for analysis using the Grounded Theory Method (GTM). Interviews will be conducted on day that is best for the interviewee and then more the following days as permitted. The order in which the interviewees will show up will be dependent on the availability of the participants (whoever would be free will be available for interview). The interviews will be carried out through the afternoon from approximately 12:00 am to 5:00 pm. Each interview is expected to last approximately 15 minutes. Every effort will be made to erase and or remove any personally identifying characteristics of the user from the data collected to protect and preserve their privacy. Since the identity of the user is not the focus but rather their experiences, it would be much more useful to collect the users' experience data only. In addition, the user experience data would not be shared with any project member as it would not be relevant to their work.
The entire study should take no more than 1hour.

Risks/Discomfort:
There are no known risks associated with participation in the study. Should the interview become distressing to you, it will be terminated immediately.

Benefits:
It is hoped that the results of this study will help to identify factors that can make the mobile health tool more usable for future studies.

Alternatives to Participation:
Participation in this study is voluntary. You are free to withdraw, decline or discontinue participation at any time.

Cost Compensation:
Participation in this study will involve no costs or payments to you.

Confidentiality:
All information collected during the study period will be kept strictly confidential. Every effort will be made to remove any personally identifiable information from the interviews. You will be identified through identification numbers. No publications or reports from this project will include identifying information on any participant. If you agree to join this study, please sign your name below.

_____ I have read and understood the information on this form.

_____ I have had the information on this form explained to me.

____ ____________________

Subject's Signature Date

____ ____________________

Witness to Consent Procedures Date

____ ____________________

Principal Investigator Date

If you have any questions regarding this study please contact Dr. Joyram Chakraborty at the Department of Computer and Information Science at (301) 704-2109 or the Institutional Review Board Chairperson, Office of University Research Services, 8000 York Road, Towson University, Towson, Maryland 21252; phone (410) 704-2236.

THIS PROJECT HAS BEEN REVIEWED BY THE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN PARTICIPANTS AT TOWSON UNIVERSITY

Appendix A-2: IRB – Exempt Research Cover Letter

Dear Participant,

My name is Nancy Shipley and I am a doctoral student in the Department of Computer Science at Towson University. As part of the research for my dissertation, I will be conducting a survey to determine whether or not an improvement to a software application will increase healthcare awareness. Participation in this study is voluntary. If you choose to participate in my project, you will be asked to complete a short survey. It is not necessary to answer every question, and you may discontinue your participation in the project at any time. Your decision whether or not to participate in the project or to withdraw from the project at any time will in no way affect your status. I have been given permission to conduct my study at this community center and if you participate no one else will know how you respond.

If you do choose to participate in the study, your participation will be completely anonymous. Neither anyone reading the results of the survey nor I will be able to identify you. Please do not put your name or any other identifying marks on the survey form.

If you have any questions about the project, you may contact me, my faculty advisor, Dr. Joyram Chakraborty at, or the Chairperson of Towson University's Institutional Review Board for the Protection of Human Participants, Dr. Debi Gartland. A copy of the results of the survey, reported in aggregate form, will be available to you upon completion of my project, if you would like to see it. Copies will be forwarded to the community center, where you may pick them up.

Thank you for your time.

Sincerely,

Nancy Shipley
Doctoral Student

THIS PROJECT HAS BEEN REVIEWED BY THE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN PARTICIPANTS AT TOWSON UNIVERSITY.

Appendix A-3: IRB – Exemption Number

TOWSON UNIVERSITY

EXEMPTION NUMBER: 16-X118

Office of Sponsored Programs & Research

Towson University
8000 York Road
Towson, MD 21252-0001

t. 410 704-2236
f. 410 704-4494
www.towson.edu/ospr

To: Nancy Shipley
From: Institutional Review Board for the Protection of Human Subjects Debi Gartland,Chair
Date: Tuesday, June 07, 2016
RE: Application for Approval of Research Involving the Use of Human Participants

Thank you for submitting an application for approval of the research titled,

Big Data on Loud Computing: Increasing Usability of Healthcare through the Customization of Pinterest

to the Institutional Review Board for the Protection of Human Participants (IRB) at Towson University.

Your research is exempt from general Human Participants requirements according to 45 CFR 46.101(b)(2). No further review of this project is required from year to year provided it does not deviate from the submitted research design.

If you substantially change your research project or your survey instrument, please notify the Board immediately.

We wish you every success in your research project.

CC: J. Chakraborty
File

Appendix B-1: Pre-Test

Pre-Test

Circle Value:

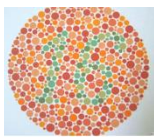
1. Identify your Gender.

   Male Female

2. Identify your age from the ranges listed below.

   18-23 24-29 30-35 36-40 41-45 46-50 51-+

3. Select the number you see in the image below.

   16 10 36 46

4. Classify your knowledge of computers.

   None Some Moderate Above Average Technical

5. How many hours per day do you use the Internet?

   None 0-1 2-4 4-6 6-8 8-10 More

6. How many days per month do you use the Internet to research healthcare information?

   None 0-1 2-4 4-6 6-8 8-10 More

Appendix B-2: User Steps

Malaria presented through the mHealth Portal

Instructions:
On the tablet, open the mHealth Portal App by tapping the P Icon.
Then tap the grey person icon and select Malaria.

Review Topics:

- Medical Expertise: What is Malaria? How did I get it?
    1. Select the "Malaria Definition" box and tap on the icon Mosquito.
    2. Tap Read It to find the Malaria Definition.

- Medical Advice: What are the symptoms of Malaria?
    1. Select the "Malaria Symptoms" box and tap on the icon Symptoms.
    2. Tap Visit to find the Malaria Symptoms.

- Smart Health and Wellbeing: Is there anything I can do to avoid Malaria?
    1. Select the "Malaria Prevention" box and tap on the icon.
    2. Tap Read It to find the Malaria Prevention.

- Medical Advice: What should I do if I get Malaria?
    1. Select the "Malaria Treatment" box and tap on the icon.
    2. Tap Read It to find the Malaria Treatment.

- Global View: If I travel to Sierra Leone, how many cases of Malaria are reported?
    1. Select the "Malaria Cases" box and tap on the icon.
    2. Tap Visit to find the map showing the Malaria Cases.

Review the mHealth Portal App for additional Malaria information.

Appendix B-3: User Experience Survey

<u>Rate your User Experience:</u>
1 – 5 (where 1 is Low Rating and 5 is High Rating) - Circle Value:
Navigation:
How easy was it to navigate the mHealth Portal app using a tablet?
1 2 3 4 5

How easy was it to navigate through grid of the mHealth Portal app?
1 2 3 4 5

How easy was it to find the information in the mHealth Portal app?
1 2 3 4 5

How easy was it to find the main screen in the mHealth Portal app?
1 2 3 4 5

How easy was it to find the search screen in the mHealth Portal app?
1 2 3 4 5

Interaction:
How easy was it to interact with the mHealth Portal app using a tablet?
1 2 3 4 5

How useful was the wording of the mHealth Portal app?
1 2 3 4 5

How easy was it to move back through the mHealth Portal app?
1 2 3 4 5

How easy was it to use the scroll action in the mHealth Portal app?
1 2 3 4 5

How useful was the keyboard interaction of the mHealth Portal app?
1 2 3 4 5

Visualization:
How useful was the layout of the mHealth Portal app?
1 2 3 4 5

How useful was the spacing in the mHealth Portal app?
1 2 3 4 5

How useful were the icons on the mHealth Portal app?
1 2 3 4 5

How useful were the interactive images on the mHealth Portal app?

1 2 3 4 5

How useful was the Malaria data information from the Africa map in the mHealth Portal app?

1 2 3 4 5

Appendix B-4: System Usability Scale Survey

Rate your User Experience using the System Usability Scale:
1 – 5 (where 1 is Low Rating and 5 is High Rating) - Circle Value:

How frequently would you like to use this system?
1 2 3 4 5

How unnecessarily complex did you find the system?
1 2 3 4 5

How easy to use did you find system?
1 2 3 4 5

How much technical support would you need to be able to use this system?
1 2 3 4 5

How well integrated did you find the various functions in this system?
1 2 3 4 5

How satisfied are you with the consistency in this system?
1 2 3 4 5

How quickly do you imagine that most people would learn to use this system?
1 2 3 4 5

How cumbersome did you find the system?
1 2 3 4 5

How confident are you with using the system?
1 2 3 4 5

How much did you need to learn before you could get going with this system?
1 2 3 4 5

Appendix B-5: Survey Comments
Comments:

Were you satisfied with the information provided to expand your health knowledge? If not, do you have suggestions for improvement?

____

____

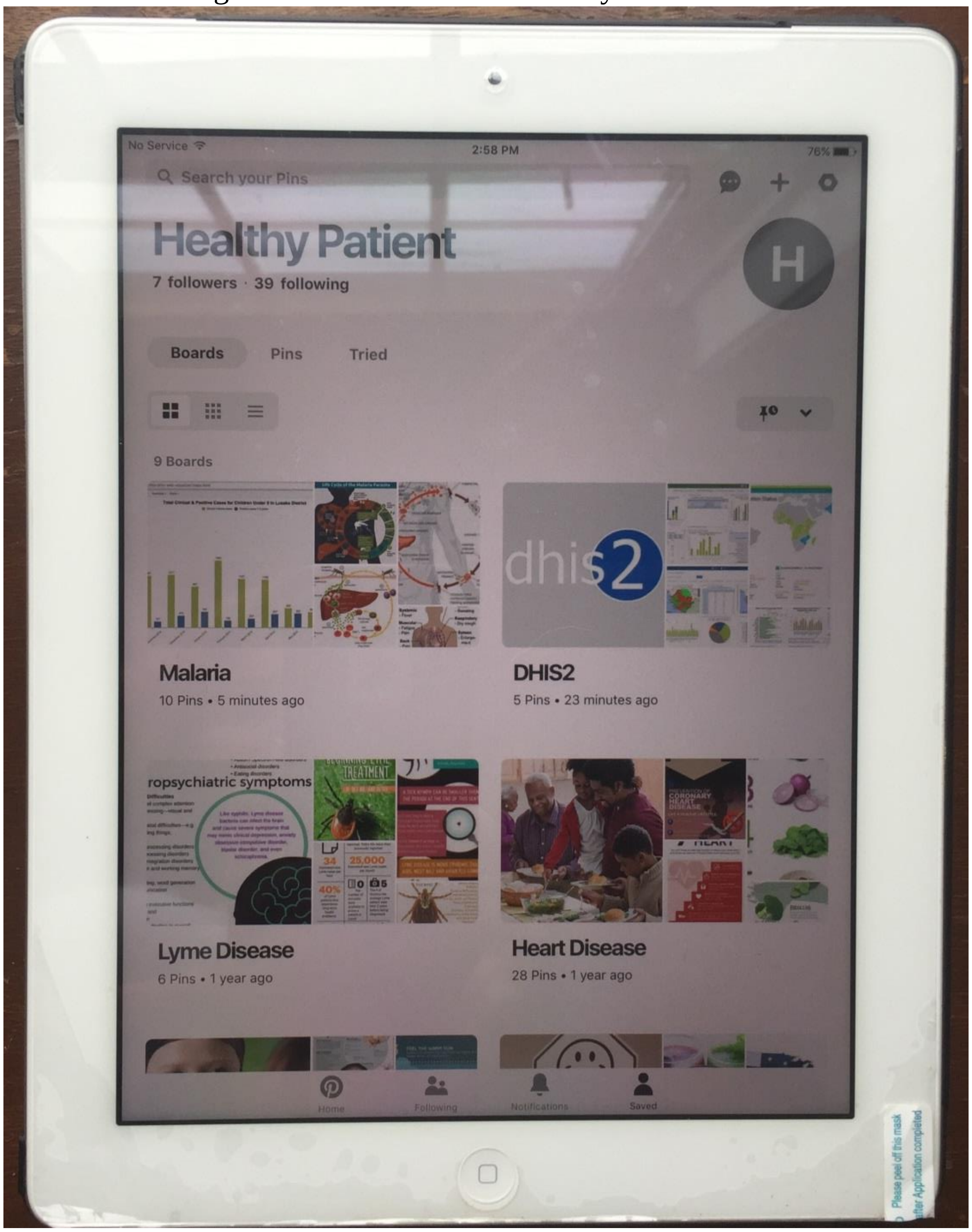
Could this consolidate mHealth Portal help address your healthcare needs? If not, do you have suggestions for improvement?

____

____

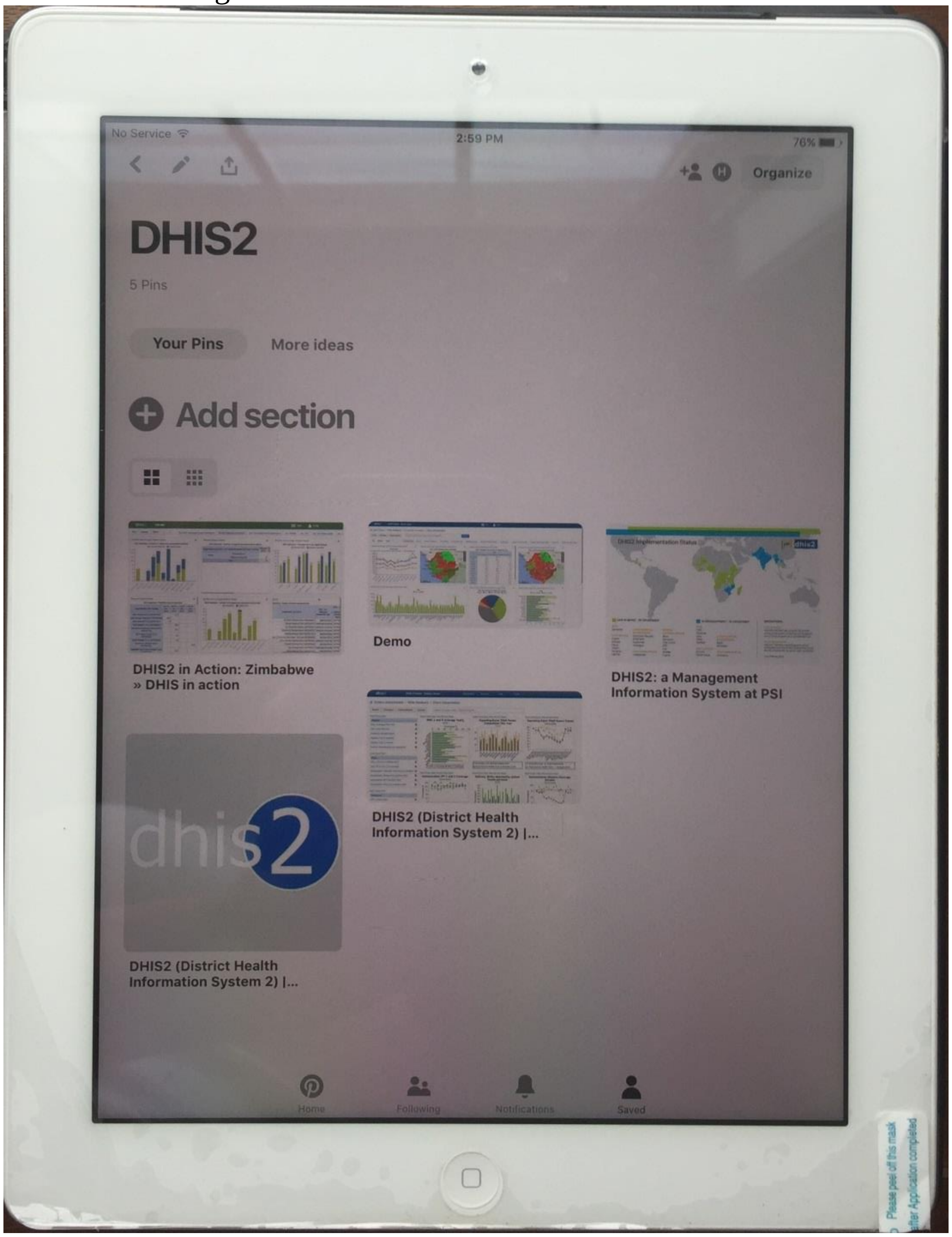
Appendix C-1: Screen Shots – Healthy Patient Home View

The following is a screen shot of the Healthy Patient Home View.



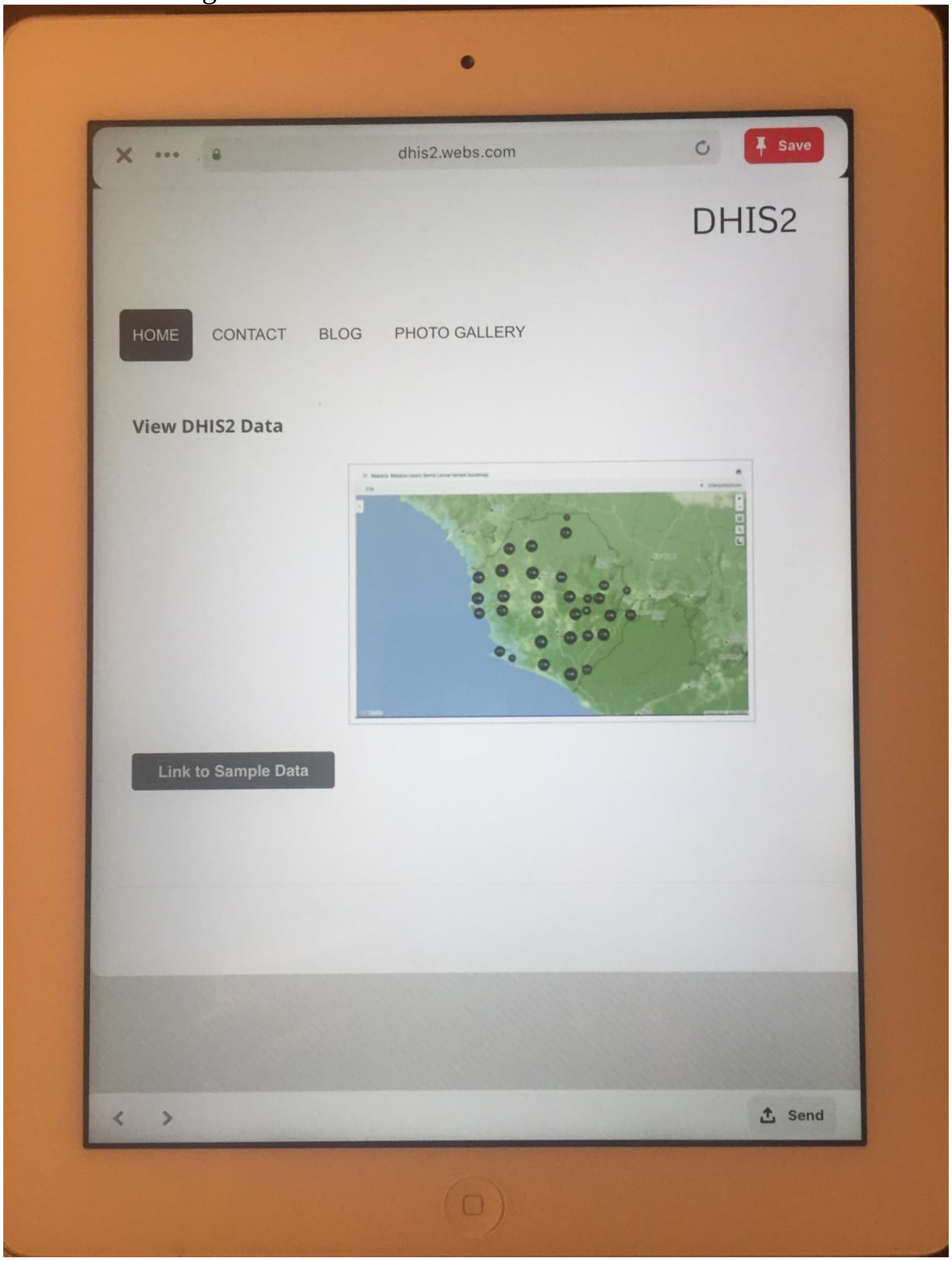
Appendix C-2: Screen Shots – DHIS2 Overview View

The following is a screen shot of the DHIS2 Overview View.



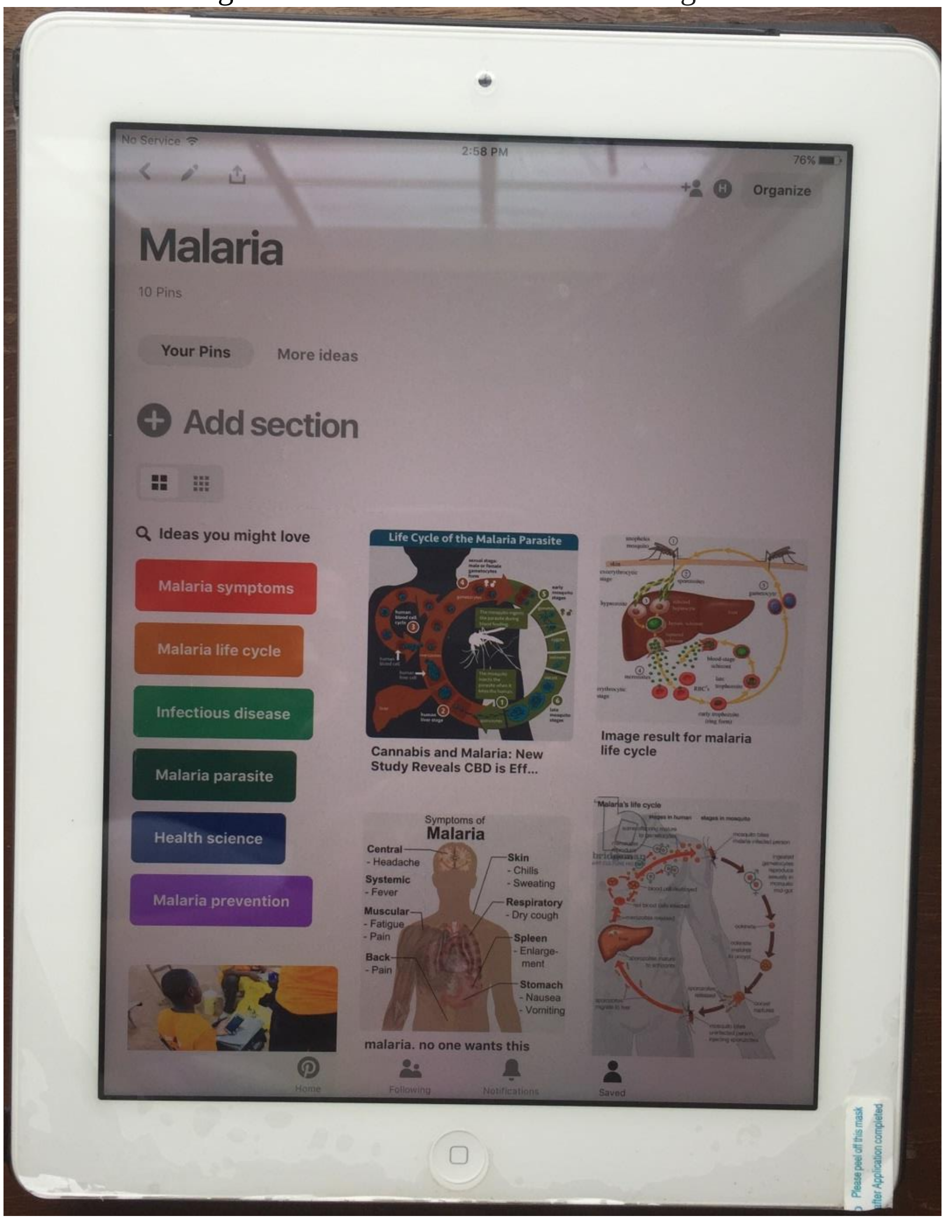
Appendix C-3: Screen Shots – DHIS2 Data View

The following is a screen shot of the DHIS2 Data View.



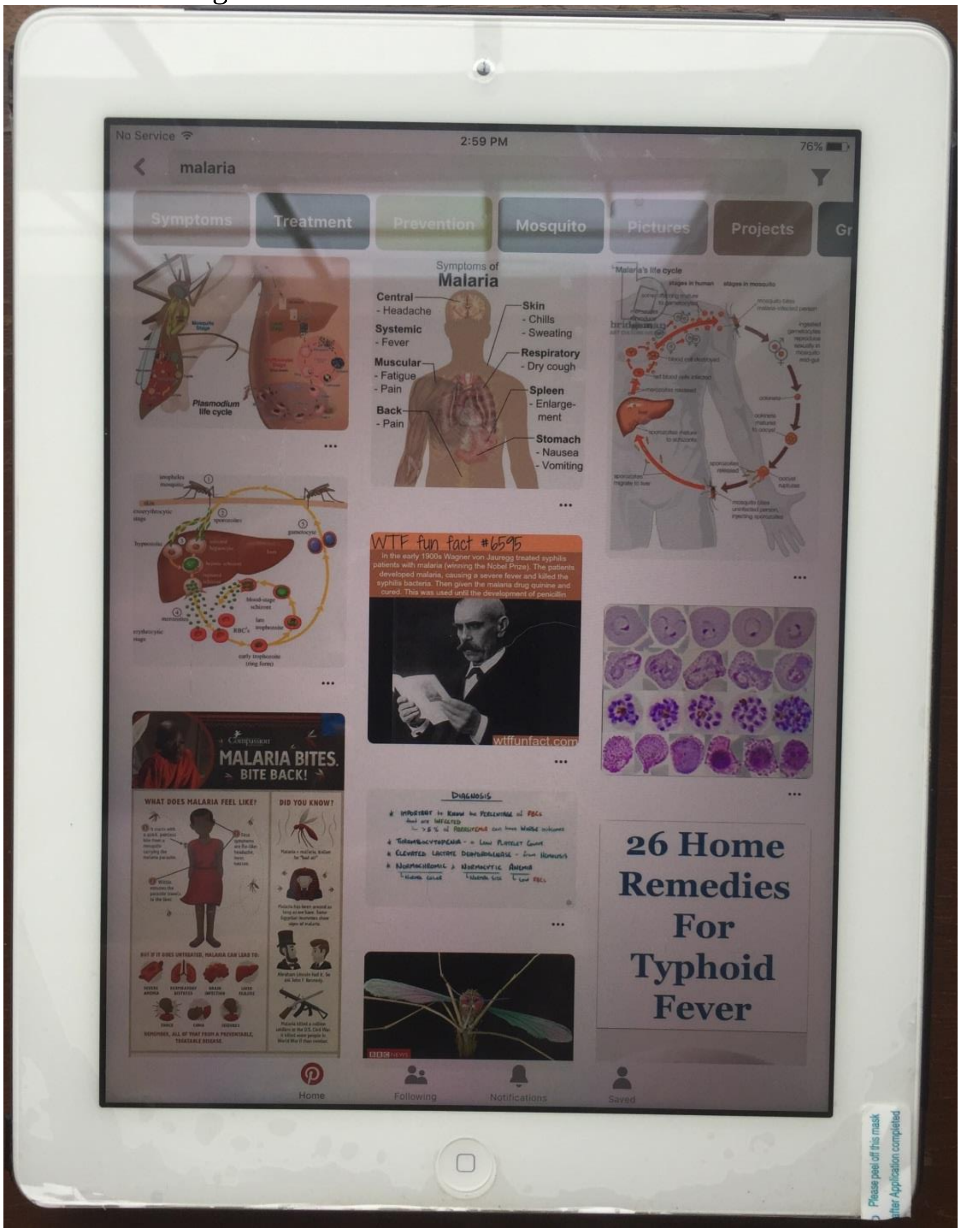
Appendix C-4: Screen Shots – Malaria Diagnosis View

The following is a screen shot of the Malaria Diagnosis View.



Appendix C-5: Screen Shots – Malaria Search View

The following is a screen shot of the Malaria Search View.



Appendix D-1: mHealth App Requirements

1. View Health Search Requirement

The system shall offer a patient the ability to view specific health details such as healthcare technology solutions, Electronic Medical Records, Medical Expertise, Alternative Medicine, Smart Health and Wellbeing, and Social Media Health topics from within the health search app via a tablet.

2. View Healthcare Technology Details Requirement

The system shall offer a patient the ability to view specific healthcare technology details.

3. View Electronic Medical Records Details Requirement

The system shall offer a patient the ability to view specific Electronic Medical Records details.

4. View Medical Expertise Details Requirement

The system shall offer a patient the ability to view specific Medical Expertise details.

5. View Alternative Medicine Details Requirement

The system shall offer a patient the ability to view specific Alternative Medicine details.

6. View Smart Health and Wellbeing Details Requirement

The system shall offer a patient the ability to view specific Smart Health and Wellbeing details.

7. View Social Media Health Details Requirement

The system shall offer a patient the ability to view specific Social Media Health details.

Appendix D-2: mHealth Hardware and Software Environment

Although the hardware requirements can expand to a much larger physical set, the below is the minimum requirements to have a working Hadoop Big Data solution.

Minimum Hardware Specs

	Medium	**High End**
CPU	8 physical cores	12 physical cores
Memory	16 GB	48 GB
Disk	4 disks x 1TB = 4 TB	12 disks x 3TB = 36 TB
Network	1 GB Ethernet	10 GB Ethernet or Infiniband

Minimum Software Specs

Software	Version
Apache Accumulo	1.5.1
Apache ActiveMQ	5.8.0
Cloudera Apache Flume	CDH4.6.0 (flume---ng---1.4.0+96)
Cloudera Apache Hadoop	CDH4.6.0 (hadoop---2.0.0+1554)
Cloudera Apache Hive	CDH4.6.0 (hive---0.10.0+237)
Cloudera Apache Pig	pig---0.11.0+42---1.cdh4.6.0
Cloudera Apache Zookeeper	CDH4.6.0 (zookeeper---3.4.5+25)
Cometd	2.4
Ganglia	3.17
Google Earth Enterprise	5
HBSS Analytic Tool	1.0.0

Java	7u72
JBOSS	7.1.1
Jetty	9.2.3---20140905
Jzmq	2.1.0
Kafka	0.7.2
PostGres-- 9.2	9.2.4
Puppet	2.7.21---1
RHEL	6.5
SIMP	4.0.4---2
Storm	0.9.0.1
ZeroMQ	2.1.7---1

Appendix D-3: mHealth Configuration

mHealth Portal User Setup Documentation:

Developers Docs Tools Apps Healthy

Overview
API
Getting started
Users
Boards
Pins
SDKs
Overview
iOS
Android
Javascript
Add-ons
Getting started
Save button
Follow button
Pin widget
Board widget
Profile widget
Rich Pins
Getting started
Article Pins
Movie Pins
Place Pins
Product Pins
Recipe Pins
Reference
Get help

Users

You can use the API to fetch profile info, boards, suggested boards, likes and Pins, as well as search boards and Pins for authenticated users. You can also create, fetch and delete followers and following relationships for authenticated users.

User object

Attribute	Type	Description
id	string	The unique string of numbers and letters that identifies the user on Pinterest.
username	string	The user's Pinterest username.
first_name	string	The user's first name.
last_name	string	The user's last name.
bio	string	The text in the user's "About you" section in their profile.
created_at	string in ISO 8601 format	The date the user created their account.
counts	map<string,i32>	The user's stats, including how many Pins, follows, boards and likes they have.
image	map<string,image>	The user's profile image. The response returns the image's URL, width and height.

MHealth Portal Board Setup Documentation:

Developers Docs Tools Apps Healthy

Overview
API
Getting started
Users
Boards
Pins
SDKs
Overview
iOS
Android
Javascript
Add-ons
Getting started
Save button
Follow button
Pin widget
Board widget
Profile widget
Rich Pins
Getting started
Article Pins
Movie Pins
Place Pins
Product Pins
Recipe Pins
Reference
Get help

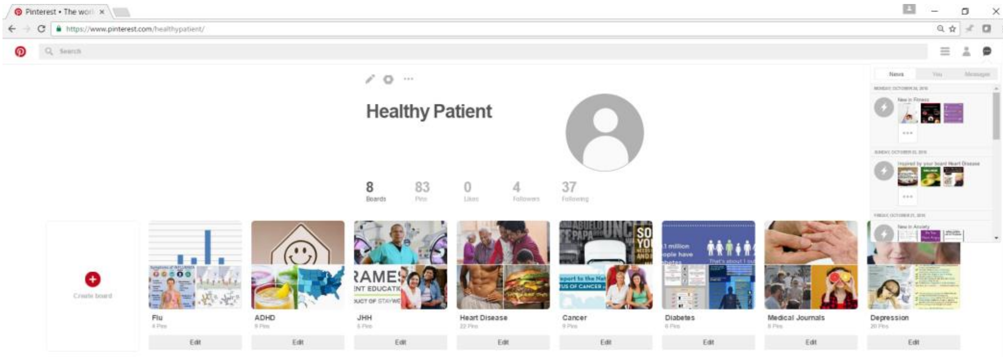
Boards

You can use the API to create, edit and delete boards for authenticated users. You can also fetch boards and Pins on a board for any user.

Board object

Attribute	Type	Description
id	string	The unique string of numbers and letters that identifies the board on Pinterest.
name	string	The name of the board.
url	string	The link to the board.
description	string	The user-entered description of the board.
creator	map<string,string>	The first and last name, ID and profile URL of the user who created the board.
created_at	string in ISO 8601 format	The date the user created the board.
counts	map<string,i32>	The board's stats, including how many Pins, followers, user's following and collaborators it has.
image	map<string,image>	The user's profile image. The response returns the image's URL, width and height.

HealthyPatient2020 User Setup:


Healthy Patient
8 Boards
83 Pins
0 Likes
4 Followers
37 Following
Flu
ADHD
JHH
Heart Disease
Cancer
Diabetes
Medical Journals
Depression
Edit

Appendix D-4: mHealth Development

Reusable Objects:
Object Definitions Below:

Open Graph

Class	Description	Required
og:image	The URL for a high-resolution image related to the article. You can add up to 6 og: image tags.	Optional
og:see_also	A URL pointing to other related articles from the same domain. You can add up to 6 og:see also tags.	Optional
og:referenced	The canonical URL for a referenced item in the article. The referenced page doesn't need to be on the same domain as the original article. For example, you might reference a page where a product can be purchased or a page that further describes a place.	Optional
article:modified_time	The date the article was last modified. The time should be in ISO 8601 date format.	Optional
article:section	The article section name. All formatting, line breaks and HTML tags will be removed.	Optional
article:tag	The article tags or keywords. All formatting, line breaks and HTML tags will be removed.	Optional
og:rating	An aggregated rating for something mentioned in the article (e.g., 4.5).	Optional
og:rating_scale	The maximum value (integer) of the ratings scale (e.g., 5). Required if og:rating is provided.	Optional (Required if og:rating is used)
og:rating_count	The total number of ratings (integer) (e.g., 113).	Optional

Schema.org

Property	Description	Status
image	The URL for a high-resolution image related to the article. You can add up to 6 images.	Optional
author	The article author. All formatting, line breaks and HTML tags will be removed.	Optional
articleSection	The article section name. All formatting, line breaks and HTML tags will be removed.	Optional
keywords	The article tags or keywords. All formatting, line breaks and HTML tags will be removed.	Optional
wordCount	A number of words (integer) in the text of the article.	Optional
aggregateRating	An aggregated rating for something mentioned in the article. For more information, see Schema.org's aggregateRating article.	Optional
relatedItem	A URL pointing to other related articles from the same domain.	Optional
referencedItem	The canonical URL for a referenced item in the article. The referenced page does not need to be on the same domain as the original article. For example, you might reference a page where a product can be purchased or a page that further describes a place.	Optional

Movie Pins

Schema.org

Property	Description	Status
image	The URL for a high-resolution image related to the article. You can add up to 6 images.	Optional
duration	The length of the movie in ISO 8601 duration format.	Optional
genre	The genre of the movie.	Optional

relatedItem	A URL pointing to other related movies from the same domain.	Optional

Methods Below:

Convenience methods

There are two categories of methods in the SDK, authentication and users, boards, and Pins.

Authentication

Method	**Parameters**	**Description**
PDK.login	scope (required): The scopes that you want to request from the user. Possible values include one or more of read_public,write_public, read_relationships, and write_relationships.	Directs the user to your authentication pop-up window. Call this method from a user-click to avoid a "pop-up blocked" message.
PDK.getSession		Returns the user's access token and scope.
PDK.logout		Clears the current cookies and session. This will require the user to log in again.
PDK.setSession	session (required): A callback to a PDK.getSession.	If you already have session data stored, you can call this instead of PDK.login so your user's don't have to reauthenticate.

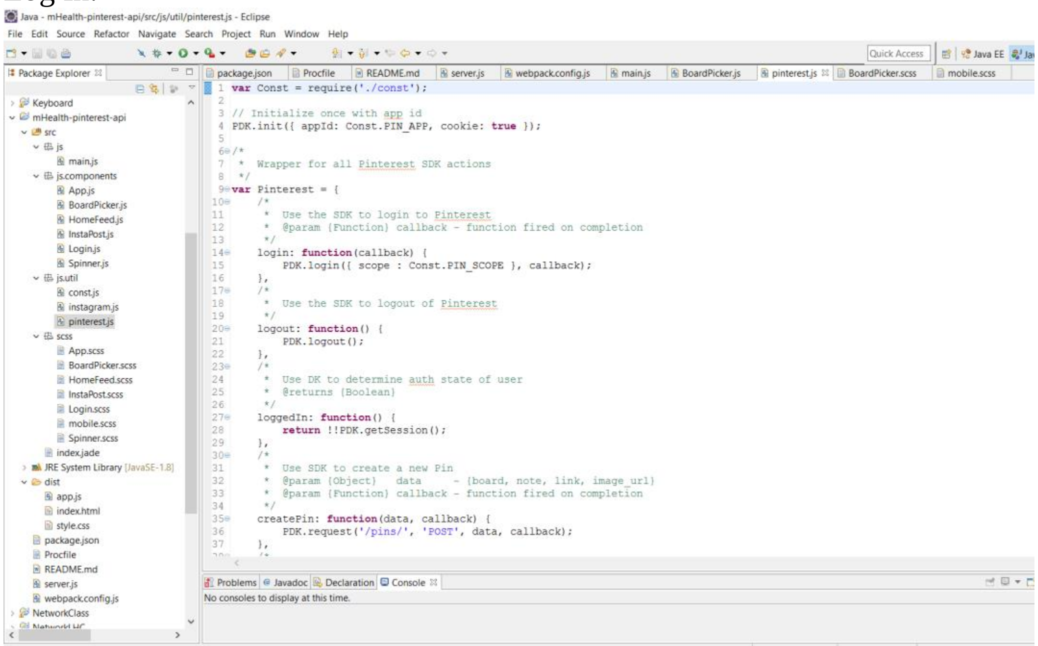
Users, Boards and Pins

Method	Parameters	Description
PDK.pin	image_url (required): The link to the image that you want to Pin. note (optional): The Pin's description. link (optional): The URL the Pin will link to when you click through.	Use PDK.pin to replicate the Pinning action from a Pin It button. Since this method brings your user to a Pin Create form, the user does not have to be authenticated.
PDK.me	fields (optional)	Use PDK.me to quickly return information about an authorized user's profile, boards and Pins. PDK.me: The default response returns the first and last name, id and url of the authenticated user. PDK.me('boards': The default response returns a list of the authenticated user's public boards, including the url, privacy, id and name. PDK.me('pins': The default response returns the id, link, url and description of each of the authenticated user's Pins.
PDK.request		You can use PDK.request for all API endpoints not covered

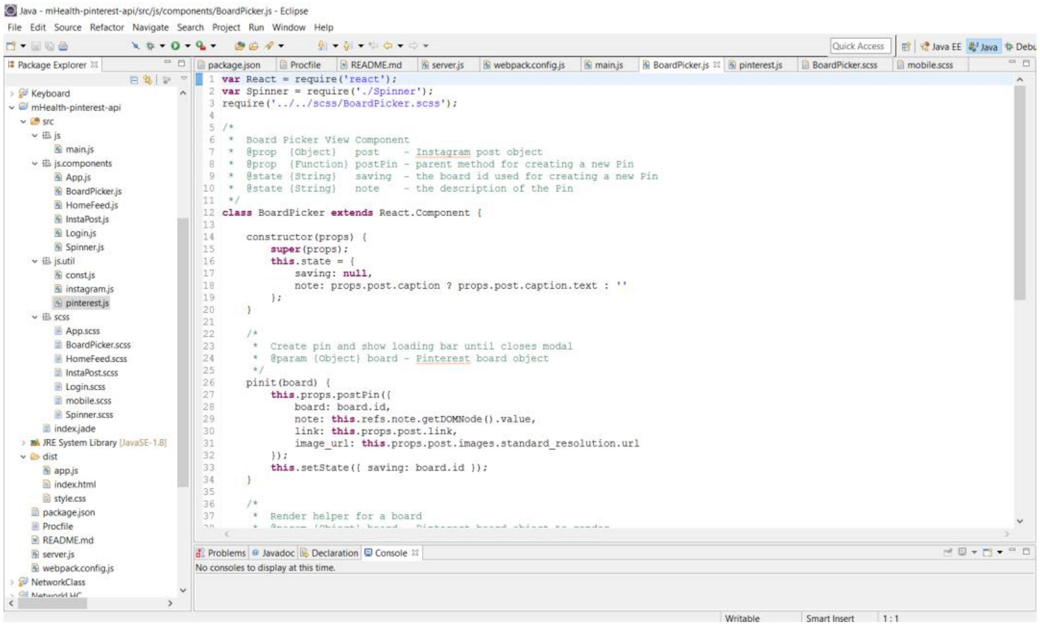
		by other convenience methods. See users, boards and Pins for a list of all available endpoints. All PDK.request calls require an authenticated user.

Code Below:

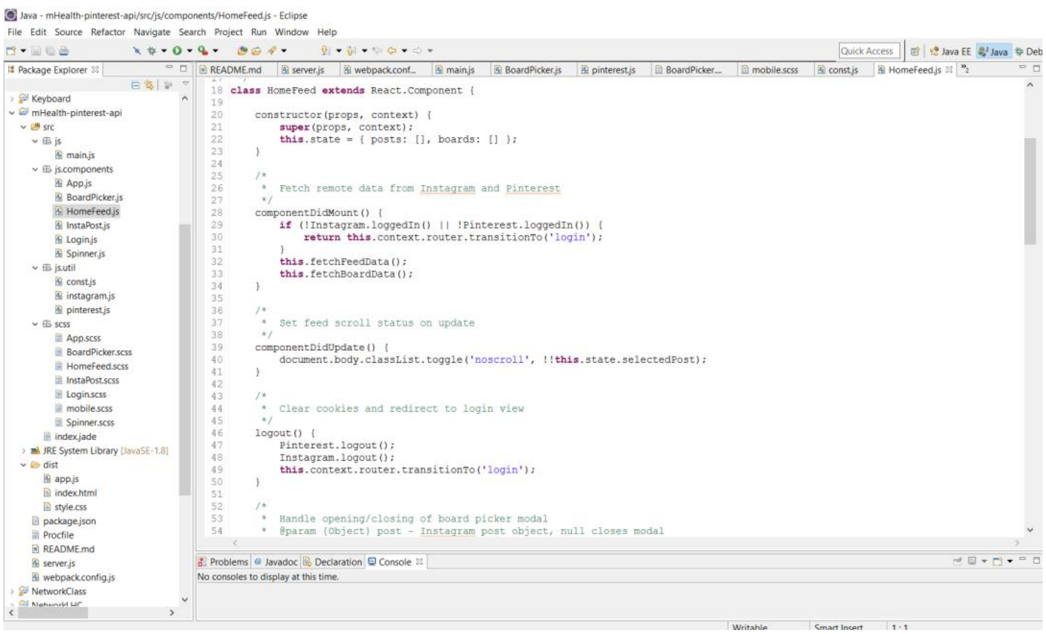
Log In:



Select Board:



Home Feed:



Appendix F-1: Survey Results – Pre-Tests

The below data is the results collected from the Pre-test.

Table 4

Results of Pre-test

ID	Gender	Age	Image	Experience	Internet	Research
1	Male	26-35	16	Above Average	More	2-4
2	Male	18-25	16	Moderate	4-6	2-4
3	Male	26-35	16	Moderate	0-1	0-1
4	Male	18-25	16	Above Average	4-6	None
5	Male	18-25	16	Above Average	6-8	0-1
6	Female	18-25	16	Technical	8-10	2-4
7	Male	18-25	16	Above Average	6-8	0-1
8	Female	36-45	16	Technical	6-8	4-6
9	Female	18-25	16	Above Average	4-6	0-1
10	Female	18-25	16	Above Average	6-8	None
11	Female	18-25	16	Moderate	4-6	None
12	Male	26-35	16	Technical	8-10	0-1
13	Male	18-25	16	Moderate	8-10	2-4
14	Female	18-25	16	Moderate	4-6	4-6
15	Male	18-25	16	Above Average	8-10	0-1
16	Female	18-25	16	Moderate	6-8	0-1
17	Female	18-25	16	Moderate	6-8	2-4
18	Male	36-45	16	Technical	More	More
19	Male	18-25	16	Above Average	4-6	0-1
20	Male	18-25	16	Moderate	8-10	More
21	Male	18-25	16	Above Average	4-6	0-1
22	Male	18-25	16	Some	8-10	0-1
23	Female	18-25	16	Above Average	8-10	2-4
24	Male	18-25	16	Moderate	More	None
25	Male	18-25	16	Above Average	6-8	2-4
26	Male	18-25	16	Moderate	6-8	2-4
27	Male	18-25	16	Above Average	2-4	0-1
28	Male	18-25	16	Above Average	More	0-1
29	Female	26-35	16	Above Average	6-8	2-4
30	Female	18-25	16	Above Average	8-10	0-1
31	Male	18-25	16	Above Average	8-10	2-4
32	Male	18-25	16	Above Average	4-6	2-4
33	Female	36-45	16	Technical	4-6	0-1
34	Male	18-25	16	Above Average	4-6	2-4
35	Female	18-25	16	Above Average	6-8	More
36	Male	18-25	16	Above Average	4-6	2-4

37	Male	18-25	16	Above Average	More	None
38	Female	18-25	16	Above Average	6-8	6-8
39	Male	26-35	16	Moderate	More	None
40	Female	18-25	16	Moderate	4-6	4-6
41	Male	18-25	16	Moderate	6-8	2-4
42	Male	26-35	16	Technical	8-10	0-1
43	Male	18-25	16	Above Average	4-6	None
44	Male	76-85	16	Some	None	None
45	Female	76-85	16	None	None	None
46	Female	56-65	16	Some	0-1	0-1
47	Male	46-55	16	Moderate	4-6	0-1
48	Male	46-55	16	Moderate	4-6	None
49	Male	26-35	16	Technical	8-10	2-4
50	Male	26-35	16	Technical	More	2-4
51	Male	56-65	16	Above Average	More	None
52	Male	26-35	16	Technical	8-10	None
53	Female	56-65	16	Above Average	0-1	2-4
54	Male	36-45	16	Above Average	8-10	0-1
55	Female	46-55	16	Above Average	More	More
56	Female	18-25	16	Moderate	6-8	More
57	Female	56-65	16	Some	0-1	2-4
58	Male	56-65		Moderate	2-4	2-4

Note. Data collected from Usability Study

Appendix F-2: Survey Results – Navigation

The below data is the results collected from the Navigation Use Case.

Table 5

Results of Navigation Use Case

ID	Navigation Tablet	Navigation Grid	Navigation Information	Navigation Main Screen	Navigation Search Screen
1	5	5	5	5	5
2	5	5	5	5	5
3	5	5	5	5	5
4	5	5	4	4	5
5	5	4	5	5	5
6	5	5	5	5	5
7	5	4	5	5	4
8	4	4	5	5	5
9	4	4	3	5	2
10	5	5	5	4	5
11	5	5	5	5	5
12	5	5	5	5	5
13	5	5	5	5	5
14	5	5	5	5	5
15	5	5	5	5	5
16	4	5	5	5	5
17	5	5	5	5	5
18	5	4	5	5	5
19	5	5	4	4	4
20	5	5	4	4	5
21	4	5	5	4	5
22	5	5	5	5	5
23	5	4	5	3	5
24	5	4	5	5	5
25	5	5	5	5	5
26	5	5	5	4	4
27	4	4	5	4	4
28	4	4	5	5	5
29	4	5	5	5	5
30	2	2	2	1	2
31	5	5	5	4	5
32	5	5	5	5	5
33	5	5	5	5	5
34	5	4	4	5	3
35	5	5	5	5	5

36	5	5	5	5	5
37	5	5	5	4	4
38	5	5	5	5	5
39	4	4	5	4	5
40	5	4	4	4	5
41	5	4	5	3	5
42	4	5	5	5	5
43	5	4	5	5	5
44	5	5	4	5	5
45	5	5	5	5	5
46	4	4	4	4	4
47	5	4	5	4	5
48	5	5	5	5	5
49	5	5	5	5	5
50	3	3	4	3	3
51	5	5	5	5	5
52	5	5	5	5	5
53	5	5	5	5	5
54	5	5	5	5	5
55	5	5	5	5	5
56	5	5	5	5	5
57	5	5	5	5	5
58	5	5	5	5	5

Note. Data collected from Usability Study

Appendix F-3: Survey Results – Interaction

The below data is the results collected from the Interaction Use Case.

Table 6

Results of Interaction Use Case

ID	Interaction Tablet	Interaction Wording	Interaction Back	Interaction Scroll	Interaction Keyboard
1	5	5	5	5	5
2	4	5	5	5	5
3	5	5	5	5	5
4	5	5	5	5	4
5	5	5	5	5	3
6	5	5	5	5	5
7	5	5	2	5	4
8	5	4	4	4	4
9	4	5	4	5	5
10	4	5	4	5	4
11	5	5	5	5	5
12	5	5	5	5	5
13	5	5	5	5	5
14	5	5	5	5	5
15	5	4	5	4	4
16	4	5	5	5	4
17	5	4	4	5	5
18	4	5	4	5	5
19	4	5	4	5	5
20	5	4	5	5	5
21	5	5	3	5	4
22	5	5	5	5	5
23	5	5	3	5	3
24	4	5	4	3	5
25	5	5	4	2	3
26	4	4	3	5	5
27	3	5	5	5	5
28	5	5	5	5	4
29	5	5	5	5	5
30	2	1	1	1	1
31	5	4	5	5	4
32	5	5	5	5	5
33	4	5	5	4	5
34	5	5	4	5	4

35	5	5	5	5	5
36	4	5	5	5	5
37	5	5	5	5	5
38	5	5	5	5	5
39	4	5	5	5	5
40	5	5	4	5	5
41	2	5	4	2	4
42	5	4	5	5	5
43	5	5	5	5	5
44	5	5	4	5	4
45	5	5	5	5	1
46	4	5	4	5	4
47	4	5	4	4	3
48	5	5	5	5	1
49	5	5	5	5	5
50	5	5	5	5	5
51	5	5	5	5	5
52	5	5	5	5	5
53	5	5	4	5	5
54	5	5	5	5	5
55	5	5	5	5	5
56	5	5	4	5	5
57	5	5	5	5	5
58	5	5	5	5	5

Note. Data collected from Usability Study

Appendix F-4: Survey Results – Visualization

The below data is the results collected from the Visualization Use Case.

Table 7

Results of Visualization Use Case

ID	Visualization Layout	Visualization Spacing	Visualization Icons	Visualization Images	Visualization Map
1	5	5	5	4	4
2	5	4	4	5	4
3	5	5	5	5	3
4	4	5	4	4	3
5	3	5	5	5	2
6	5	5	5	5	5
7	4	4	5	5	4
8	5	5	5	4	5
9	2	4	4	5	1
10	4	3	5	5	2
11	5	5	5	5	4
12	5	4	5	5	5
13	4	5	5	5	5
14	5	5	5	5	4
15	5	5	5	5	3
16	4	4	5	5	4
17	5	5	5	5	5
18	5	5	5	5	5
19	5	5	5	5	5
20	5	4	5	5	4
21	5	5	4	4	5
22	4	4	5	4	5
23	5	5	4	4	3
24	4	5	4	5	2
25	4	4	5	5	5
26	5	4	5	5	3
27	4	4	3	3	4
28	4	4	4	5	3
29	4	4	4	4	5
30	2	1	1	1	2
31	5	5	4	5	5
32	5	5	5	5	5
33	5	5	3	5	5
34	4	5	5	4	4
35	5	5	5	5	5

36	5	5	5	5	5
37	4	5	5	4	5
38	5	5	5	5	5
39	5	4	5	5	3
40	4	5	5	4	3
41	5	5	3	1	4
42	4	5	4	4	5
43	5	5	5	4	4
44	5	5	5	5	5
45	5	5	4	5	5
46	5	5	5	5	4
47	5	5	5	4	4
48	5	5	5	5	4
49	2	2	3	2	4
50	3	2	2	2	2
51	5	5	5	5	5
52	5	5	5	5	5
53	5	5	4	5	4
54	5	5	5	5	5
55	5	5	5	5	5
56	4	3	5	5	3
57	5	5	5	5	5
58	5	5	5	5	5

Note. Data collected from Usability Study

Appendix F-5: Survey Results – System Usability Scale – Part 1

The below data is the results collected from the System Usability Scale Use Case.

Table 8

Results of System Usability Scale Use Case Part 1

ID	Usability System	Usability Complexity	Usability Usage	Usability Support	Usability Functions
1	3	1	5	1	5
2	4	5	5	4	4
3	5	1	5	1	5
4	4	2	5	2	5
5	3	2	5	2	3
6	5	5	5	2	5
7	5	1	5	1	4
8	4	1	4	4	4
9	4	2	4	2	4
10	4		1	2	3
11	3	1	5	1	5
12	4	1	5	4	5
13	2	4	5	1	5
14	5	5	5	2	5
15	3	1	5	1	4
16	4	1	4	2	5
17	5	1	5	1	5
18	5	4	5	1	5
19	4	1	5	1	4
20	3	2	5	2	4
21	4	2	4	1	4
22	5	1	5	1	5
23	5	1	5	1	4
24	3	1	4	2	4
25	4	1	5	1	5
26	4	1	4	1	4
27	3	3	5	1	4
28	2	1	5	1	5
29	4	1	5	1	4
30	4	2	1	2	4
31	5	2	5	2	5
32	4	1	5	2	5
33	5	4	5	1	3

34	4	2	4	2	4
35	5	1	5	1	5
36	4	1	5	1	5
37	4	2	4	1	4
38	3	1	5	1	5
39	4	2	4	2	4
40	4	3	4	3	3
41	3	1	4	2	3
42	2	2	5	1	4
43	4	1	5	1	5
44	4	5	5	4	5
45	5	5	5	3	5
46	4	3	4	2	4
47	4	2	2	1	2
48	4	1	5	1	5
49	1	3	5	1	2
50	3	1	5	3	3
51	5	5	5	5	5
52	5	5	5	5	5
53	4	5	5	5	5
54	5	5	5	5	5
55	5	5	5	5	5
56	4	3	5	1	4
57	5	1	5	1	5
58	5	5	5	5	5

Note. Data collected from Usability Study

Appendix F-6: Survey Results – System Usability Scale – Part 2

The below data is the results collected from the System Usability Scale Use Case.

Table 9

Results of System Usability Scale Use Case Part 2

ID	Usability Consistency	Usability Learn People	Usability Cumbersome	Usability Confidence	Usability Learn User
1	5	4	3	5	1
2	5	5	4	5	4
3	5	5	5	5	1
4	5	4	1	5	1
5	5	4	2	5	1
6	5	4	1	5	3
7	5	5	1	5	1
8	4	4	4	5	4
9	4	5	2	4	2
10	4	4	1	5	1
11	5	5	1	5	1
12	5	4	1	5	1
13	5	4	1	5	1
14	5	4	1	5	2
15	5	5	2	5	1
16	5	4	1	5	2
17	5	4	1	5	1
18	5	4		5	1
19	5	4	1	5	1
20	5	4	3	5	2
21	5	4	1	4	2
22	5	5	1	5	2
23	4	4	3	5	1
24	4	4	1	5	1
25	5	5	1	5	1
26	5	4	3	5	2
27	2	5	4	4	2
28	5	5	4	5	4
29	4	5	1	5	2
30	5	5	2	5	3
31	5	4	5	5	5
32	5	4	1	5	1
33	5	2	4	5	4

34	5	4	3	4	2
35	5	5	4	5	1
36	5	5	1	5	1
37	4	4	1	5	3
38	5	5	5	5	1
39	4	4	2	4	4
40	5	5	3	5	1
41	3	4	2	5	3
42	4	4	2	5	1
43	5	2	1	5	2
44	5	5	5	5	4
45	5	5	1	5	5
46	4	4	2	4	2
47	2	2	2	2	2
48	5	5	1	5	2
49	5	3	4	5	2
50	5	5	1	5	1
51	5	5	5	5	5
52	5	5	5	5	5
53	5	4	5	5	5
54	5	5	5	5	5
55	5	5	5	5	5
56	5	3	1	5	1
57	5	5	1	5	5
58	5	5	5	5	5

Note. Data collected from Usability Study

Appendix F-7: Survey Results – Comments

The below data is the results collected from the Comments Use Case.

Table 10

Results of Comments

ID	Comments Improvements Knowledge	Comments mHealth Portal
1	Yes, I was satisfied.	Yes
2	I was satisfied with the information given. All was good except for the small hic-up with the back button on the bottom.	I would say that the mHealth Portal can help address my healthcare needs
3	Yes, with this application I can find information on health topics very easily	Yes, I would use this application to address my needs
4	I was satisfied with the information provided. It was concise and easy to get to.	I think that the mHealth portal could definitely help address my healthcare needs. The layout of the interface is very intuitive and I found it to be fairly simple and easy to navigate. I do have one suggestion for improvement, however. When the user clicks on one of the main categorized in the malaria main menu, "malaria prevention" for example, they are presented with a new screen that who's and image of two pill bottles. When you click on the image, it takes you to the treatment and prevention article, but I think it would be helpful to have some sort of label on the image.
5	I am very satisfied	Yes, I suggest considerations the older audience when working with interfaces.
6	I think more things should be put on. For me study tools would be very helpful. Maybe home remedies for sicknesses, or neither connect doctors around me	It would need more healthcare issues like colds, this more common things
7	The information was very easy to find, concise and visually appealing. But perhaps would be a bit too wordy for	I think the portal was almost perfect. But I would suggest adding a button to return to the

	some individuals	home screen quicker because it can become tiring to hit the back button twice every time I needed to go back to the home screen.
8	Yes, but need more time to read contents	Yes, it does address my healthcare needs
9	I really liked how the different categories were saved as folders where I could click to find more information about a specific topic regarding malaria	Yes, treatments, prevention etc., are provided. You can also use the search tool to find any additional information.
10	Yes	It is a great tool that leads to many different links instead of having the information on the site
11	I was satisfied with the information given; you were easily able to find the information you need.	It could address healthcare needs to a certain extent, maybe just give to give you a base overview.
12	I was satisfied as it provided detail through illustrations and text information.	Yes, It reminds me of a more user friendly version of WebMD
13	The information provided was to have a basic knowledge about a certain disease.	It does, because it provides with the necessary info to get started.
14	The information provided was well written and I learned a lot. I was satisfied.	Yes, Because it has different questions in front of the users face and the portal is appealing and user friendly.
15	Everything was easily laid out so it wasn't hard to find anything	It can help people understand about health issues especially when everything like symptoms and preventions are all listed on the same page.
16	Yes	Yes
17	Yes, I suggest the words should ease to read so non-English speakers can understand	Yes
18	Yes, satisfied	Yes it does
19	Yes, I learned things about malaria that I've never know before.	Yes, unless the healthcare need is too advanced, such as brain problem.
20	Yes, it was very useful and it can help people get more knowledge about topics like these diseases.	Yes it can help people find out what might be bothering with them if they have a sickness. It's like your own mini doctor
21	Yes, the information provided was insightful.	Yes, if I ever needed to find information, I would be comfortable using this.
22	Yes, I was satisfied.	Yes, it would help

23	It was easy to use, and very straight forward so no suggestions	It is a very useful idea. I'd image you would have to put a lot more diseases however.
24	I was satisfied for the most part except for the map. Also a for back main subset option instead of pressing back 3 or 4 times.	It could help consolidate my health care needs of ADHD
25	Yes	Yes
26	Yes, I would suggest more visuals	Yes
27	I was satisfied. The links were in depth and useful.	Absolutely a search page that could lead me to arrangements similar to the one presented would be very appealing.
28	Yes	Yes, this can help a lot because it helps me to gather information about healthcare.
29	Yes	Yes
30	Yes	Yes
31	Yes, I was satisfied with the information provided.	Yes I believe it could help tremendously
32	Yes	Yes
33	Yes	Yes
34	Yes, I felt it was a lot of good information.	I feel like some of the information could be slimed down so the bigger points are more noteworthy.
35	I think it was very helpful and the information was well organized.	Yes, if I was looking for private info, if I needed real treatment I wouldn’t go on the internet
36	The information was easily navigable. Someone could learn all they need to know on the topic.	It would be useful in identifying if on has a certain disease and where / how to treat it.
37	I was satisfied	No suggestions
38	Application was very easy to use and navigate.	Yes, it could help; it had easily accessible and useful information.
39	Yes, could use more pictures for empty space for pictures	Yes, could add some more diseases
40	Yes, but I wish there was a lot more info on treatments	Yes, it’s easier for people to understand what malaria is
41	Make the application more friendly for children	Not none, but definitely those who are unaware of the usual diseases
42	Yes, provide a brief synopsis for each sub menu before the info graphics	Yes, it provides quick and thorough information about malaria in a way that’s simple to understand

43	Yes, the information was easy to locate and the app was easy to use	Sure, it seems like a quick way to get medical information
44	Yes, very good	Yes, very good
45	Yes, all good	Yes, all good
46	Yes	Yes
47	Yes	All on one screen
48	Very satisfied - user friendly	Yes because it is very easy to navigate
49	It was hard to tell if the data was current or authoritative. It is more convenient to search google	If the data was guaranteed accurate and updated it would be useful
50	Yes, I was satisfied with the information	Yes
51	Yes	Yes
52	Yes	Yes
53	very easy to understand and interesting since my Dad had malaria	Yes, informing patients is so important
54	n/a	n/a
55	Excellent information and very easy to navigate	Yes, it was so easy to find information!
56	Yes	Yes
57	Very satisfied, easy access to the information I was searching	Yes, I feel it would be very helpful to healthcare providers as well as patients I appreciated how clean the information was to look at without a lot of unnecessary information
58	That was excellent and if you would put person history and have it for any use health wise	Yes, it works. The more secure the better that way the use could be great for people in emergency rooms, critical care, instead of waiting for a love one to explain or permissions for treat/

Note. Data collected from Usability Study

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Curriculum Vitae

[redacted]

QUALIFICATION PROFILE

Security Clearance Beginning in 2012 - Active Top Secret - SCI

SOFTWARE ENGINEERING: *Projects, related skills and practicum include:*

Management Experience:

- Effectively utilized strengths of teams up to 20 members to disperse workload productively.
- Consistently stayed within budget as large as $2 million while meeting goals of project.
- Primary customer interface for sales, technical, and operations departments.

Process Design:

- Documented business and technical requirements for software applications.
- Created design diagrams incorporating Visio and Rational technologies.
- Implemented software designs based on SOA methodology standards.

Development:

- Developed in languages including Java, C#, ASP.Net, ASP, VB.NET and Python.
- Generated database code written in TSQL using SQL Server, Sybase, Oracle & MySQL.
- Performed data analytics in Big Data environment using Hadoop, MapReduce and Accumulo.
- Built Infrastructure as Code using Pivotal Cloud Foundry as IaaS to efficiently create AWS Platform.
- Created structures in XML and WML.
- Produced websites using HTML, Front Page, ASP.Net, Flash, PHP, Apache and Python.
- Crafted WISE, InstallShield, SMS, ManageSoft, Altiris, and Puppet software installation packages.

Education:

Doctor of Computer Science Degree in Information Technology, May 2019
Towson University, Towson, Maryland

Masters of Science Degree in Finance, 1996
Loyola University, Baltimore, Maryland

Bachelors of Science Degree in Business Admin.; Concentration in Economics, 1994
Towson University, Towson, Maryland

Certificates:

CompTIA - Security+
Project Management Professional - PMP
Microsoft Certified Professional - MCP

Publications:

Shipley, N. and Chakraborty, J. March 2016. Big Data and Cloud Computing Accessibility Initiatives for the Elderly: A Practitioners Perspective. Cambridge Workshop on Universal Access and Assistive Technology CWUAAT, 51-55.

Shipley, N. and Chakraborty, J. March 2017. Big Data and mHealth: Increasing the Usability of Healthcare through the Customization of Pinterest – Literary Review. Next-Generation Mobile and Pervasive Healthcare Solutions, 46-66.

Shipley, N. and Chakraborty, J. March 2018. Using Pinterest to Improve the Big Data User Experience - A Comparative Analysis in Healthcare. 6th World Conference on Information Systems and Technologies, 949-960.

Professional Associations:

PMI, Maryvale Technology Committee, Missions Chairperson, My Sister's Circle Mentoring Program

PROFESSIONAL EXPERIENCE – Government Contract Work

Edgesource Corp – Alexandria, VA 4/2018 - Present

Product Manager / Lead Platform Engineer

- Product Manager of Cloud Infrastructure Project using Pivotal Cloud Foundry on AWS for AFRL.
- Attended AWS Training including Architecting on AWS, Advanced Architecting on C2S, Developing on C2S, and DevOps Engineering on AWS.
- Created AWS EC2 Instances and S3 buckets using Cloud formation scripts.
- Attended Dojo Pivotal Training to engineer a platform using PCF tools and Agile methodology.
- Utilized Open Source automatically creating AWS Infrastructure with an operational network.
- Using terraform scripts successfully created a Platform on AWS generating Infrastructure as Code.
- Onboarded Application teams to the AWS components serving as PaaS - Platform as a Service.
- Configured Concourse as the CI/CD - Continuous Integration / Continuous Delivery tool as the Configuration Management process.
- Setup PCF Ops Manager as the PCF deployment manager displaying the Bosh director for the IaaS and the Production tiles available to the application teams.

Federated IT / CIO Federal – Ft. Meade, Maryland 10/2013 – 5/2015 & 5/2017 – 4/2018

Lead Senior Software Developer

- Software development of CATS system working with INSCOM for DLA DISA.
- Led team to provide project direction and mentored less experienced developers.
- Created C# .Net projects to address ongoing requirement enhancements to system.
- Generated SQL updates to correct production issues.
- Created database designs to increase longevity of database.
- Performed migration from Windows 2003 Servers to Windows 2008.
- Developed web services to send data to remote agencies.
- Created process to transition data from SQL Server to Oracle database.
- Developed in Java to implement connection to Database and query data.
- Led team through Agile software development cycle.
- Updated C# code linked with SharePoint to meet customer requirements.

Zapata Technology – Aberdeen Proving Ground, Maryland 5/2015 – 5/2017

Senior Software Engineer

- Performed Java development on TCRI system in support of I2WD for DCGS-A customer.
- Collected various data source elements and mapped them to Accumulo table specifications.
- Created and updated data dictionary for the project.
- Developed data models in Java to define ingestion methods using Storm Topologies.
- Extended components in Niagara Files to consume data.
- Configured ActiveMQ to acquire various external data providers.
- Created custom Niagara Files components to meet project requirements.
- Configured Hadoop to implement data into Accumulo tables.
- Updated MapReduce jobs where needed to ensure data was viewable for Visualization tools.
- Installed software releases on Linux servers in Hadoop Cloud Computing Platform.
- Constructed Stealth to view data as spatial Visualization tool.
- Placed updated code in Git Repository.
- Configured Ozone Widget Framework to view Big Data ingested.
- Developed java code on AWS to update Accumulo database.
- Crafted documentation for project such as PDR and SEMP.
- Configured workflow engine using the Red Hat JBoss BPM Suite.

Lockheed Martin – Aberdeen Proving Ground, Maryland 12/2012 – 10/2013

Project Lead / Senior Software Engineer

- Supported INSCOM Futures under G2 to assist in developing Army Cloud project.
- Worked with PM DCGS-A to ensure System Engineering outputs met requirements.
- Organized hand-off of SE documentation from INSCOM CM to DCGS-A CM.
- Software development in Java delivering Ozone Widgets on Cloud solution for INSCOM.
- Managed system engineer team to deliver DODAF artifacts and engineering documentation.
- Performed Systems engineering task creating OV-1 and OV-5 reflecting DCGS-A Operations.
- For each component, included DCGS-A capability, create SV-1, SV-4 and SV-6 views.
- Led Test Team to draft software test definitions.
- Drafted proposals and engaged in contract teams.

Booz Allen Hamilton – Aberdeen Proving Ground, Maryland 12/2011 – 12/2012

Associate / Senior Software Engineer

- System Engineer employing Cloud Computing on Linux for RDECOM for Tactical fielding solutions.
- Worked closely with PM DCGS-A to develop requirements for CM documentation deliverables.
- Managed Configuration Management team to ensure successful software deployments for DCGS-A.
- Implemented and administered Trac system to house DCGS-A Edgenode Defect Reports.
- Configured Source Control via Subversion to manage code.
- Performed Assessment on research development lab to ensure the software releases meet CMMI standards.
- Created Process Improvement Plan for I2WD with the goal of successful release deployments.
- Developed test automation scripts using Python to assist Test team in validation.

PROFESSIONAL EXPERIENCE – Commercial Work

JOHNS HOPKINS HOSPITAL – JHMCIS, Baltimore, Maryland 4/2008 – 12/2011

Project Lead / Senior Software Developer

- Team Lead implementing unique medical record ID project for patients at all Johns Hopkins Hospitals.
- Developed tool in Visual Basic to connect to external software interfaces.
- Replaced existing Mainframe application with new vendor solution using ASP.Net.
- Created Reports in SQL to define patient reports.
- Managed Project to success balancing PMP core items of Costs, Quality, and Time Constraints.
- Setup SharePoint site to manage project initiatives.

MANAGESOFT CORP – Software Management, Boston, Massachusetts 12/2004 – 4/2008

Senior Software Engineer

- Served as Technical Lead for customers to engineer product solutions.
- Provided architecture solutions for customers regarding their Software Distribution system.
- Implemented technical solution onsite and web training for customers.
- Created a Customer Forum website using PHP and MySQL.
- Created Install Packages in WISE and InstallShield.

ATSG – Advanced Technologies Support Group, Owings Mills, Maryland 8/2004 – 12/2004

Team Lead / Senior Software Developer

- Software developer for BlackBerry applications based in WML using C#.
- Led team to create websites in Flash and JAVA.
- Created Management Reports using Reporting Services.

THOMSON PROMETRIC – Testing Solutions, Baltimore, Maryland 10/2000 – 8/2004

Project Lead / Senior Software Developer

- Severed as team lead creating an administration system responsible for processing candidates' tests.
- Software Developer coding in Visual Basic creating Administration System on SQL Server Database.
- Created Reports using TSQL to view candidate data.
- Developed Data Center code in C# to ensure data mapped to scores.

ETC - Electronic Technologies Corporation, Street, Maryland 1/1997 – 10/2000

Software Engineer

- Developer in VB for a refrigeration food health and quality data maintenance application.
- Engineered Program Logic Controllers to collect control point data from across grocery store.
- Led project to transfer paper accounting system to software based system.