mHealth Literacy: Characterizing People’s Ability to Use Smartphone-based Health-related Applications

BY
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DISSERTATION PROPOSAL
Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Library & Information Science in the Graduate College of the University of Illinois at Urbana-Champaign
February 2015
Champaign, Illinois

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Abstract

In 2013, the world population was 7.1 billion while the number of mobile phone subscribers was 6.8 billion (International Telecommunication Union 2014). The provision of health-related services via mobile technology is called mHealth, abbreviated version for mobile Health (United Nations 2009). The benefits of mHealth services can be achieved by using sensors (on-body sensors and embedded phone sensors), text message, apps (also known as mHealth apps), web-based services, telephone intervention, mobile-phone enabled medical devices, and mobile telemedicine system (Agarwal and Lau 2010; Baker et al. 2014; Free et al. 2011; Krco and Delic 2003; S. Kumar et al. 2013; Lewis and Wyatt 2014; Lunny et al. 2014; Pai, Comstock, and Dolan 2013). Among all these mHealth techniques, in my dissertation, I focus on mHealth apps only.

The US Food and Drug Administration (USFDA), through the industry estimation, reported that, by 2015, 500 million smartphone users worldwide will use at least one mHealth app and by 2018, 50% of the smartphone and tablet users (3.4 billion) will download mHealth apps (USFDA 2014). Currently, in USA, 42% adults use at least one downloaded app; one third of these 42% adults use mHealth apps (Huckvale et al. 2012; Sadasivam et al. 2013). Researchers offered significant insight about how mHealth apps are used by the users for receiving health benefits (Azar et al. 2013; Bender et al. 2013; Bindhim, Freeman, and Trevena 2012; Brewer et al. 2013; Bush et al. 2013; Derbyshire and Dancey 2013; Donker et al. 2013; El-Gayar et al. 2013; Goldbach et al. 2013; Marcano Belisario et al. 2013; Martínez-Pérez, de la Torre-Díez, and López-Coronado 2013; Muessig et al. 2013; Oehler, Smith, and Toney 2010; Pandey et al. 2013; Stephens and Allen 2013; VanWormer et al. 2013; West et al. 2012; Whittaker et al. 2012). Researchers also predicted that, mHealth apps will assist healthcare professionals, outside of the usual healthcare setting, to diagnose patients’ suffering from potentially life-threatening conditions (Mitka 2013).

Considering such incredible potential of mHealth apps, I argue that it is critical to understand whether a user poses necessary literacy skills to use mHealth apps, which requires knowing first what constitutes this literacy. If users do not have such literacy, they would not be able to receive health benefits by using mHealth apps. To the best of my knowledge, this thread of research is still unexplored.

In my dissertation, I propose to investigate the following research question: **what literacy does a user need to receive potential health benefits from using a health-related app on a smartphone?** I coin the term “mHealth Literacy” to refer to all necessary literacy skills a user needs to receive such health benefits.

I believe this research will make a major contribution to the field of health literacy. More than one third of the adult population in USA is suffering from inadequate health literacy problem; they have difficulty with regular health tasks such as following instructions described in the prescription drug label (Mark et al. 2006). With the emergence of newer information technology, the focus of health literacy has been extended from “physical” world to the “cyber” world. For example, in addition to using typical medium (e.g. prescription drug label, leaflet from the caregiver, etc.), people has also started using Internet for accessing health information (Flicker et al. 2004; Jones et al. 2005; Oh et al. 2005a, 2005b; Pagliari et al. 2005). Such extended focus created a new research domain called “eHealth Literacy” (Norman and Skinner 2006b). My dissertation will help to move the field of health literacy even further by integrating mHealth technology in it.
This research will also help the healthcare policy makers. By knowing the current situation of people’s mHealth literacy level, the policy makers may impose certain rules and regulations to the mHealth app-industry to design mHealth apps by adhering to specific guidelines. In this way, the typical users will receive more health benefits from mHealth apps.
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Chapter 1 Introduction

This dissertation proposal consists of three chapters. Chapter 1 offers an introduction to my proposed research question along with its significance and unique contribution. Chapter 2 reports the findings from the scholarly articles published in notable journals and conferences of multiple disciplines (e.g. literacy, health literacy, eHealth literacy, mHealth, community informatics, and community health informatics) that helped to shape my research. Chapter 3 discusses the details of the pilot study I conducted, the research method for my final dissertation (which was designed based on the findings of the pilot study), and the approximate timeline to complete my dissertation.

In this chapter (Chapter 1), I will first introduce my proposed research question along with the definitions of the relevant key concepts. Then I will discuss the significance and unique contribution and novelty of my proposed research. Finally, I will discuss the reasons to choose smartphone-based health-related apps as my research focus.

1.1 Introducing Research Question and Definitions of Key Concepts

In this section, besides introducing the research question, I will also provide working definitions of all the relevant key concepts. As mHealth (the definition is given in section 1.2) is an emerging research area that involves multiple domains such as mobile technology, social sciences, and human-computer interaction, I believe including such definitions is important to clarify my research goal and to remove any confusion associated with the key research concepts.

The research question I am proposing in my dissertation is as follows:

RQ: What literacy does a user need to receive potential health benefits from using a health-related app on a smartphone?

In my dissertation, I coin the term “mHealth Literacy” to refer to all necessary literacy skills a user needs to receive such health benefits. The key concepts associated with this research question are as follows:

a. Smartphone
b. Smartphone app
c. Health-related app or mHealth app
d. User
e. Potential Health Benefit

Below I am providing the definitions of all these key concepts mentioned above.

a. Literacy: Literacy is an evolving area with new information emerging from ever growing research activities. In chapter 2, I will provide the major definitions of literacy provided by the scholars.

b. Smartphone: A smartphone is a type of mobile device that runs a complete operating system and provides advanced capabilities (Phone Scoop 2014).

c. Smartphone app: Smartphone app refers to the application software that can run on a smartphone (Techopedia 2014). These apps are typically available through application distribution platform such as Apple’s ‘App Store’, Google’s ‘Play’, Microsoft’s ‘Windows Phone
There are numerous apps available now-a-days. For instance, Apple app store has 1.2 million apps and iOS users downloaded more than 75 billion copies of these different apps (Apple Press Release 2014). Google play store has 1.3 million apps (AppBrain 2014).

d. Health-related app or mHealth app: Health-related app refers to a specific type of smartphone app that is related to any kind of health management. As these apps are designed to run on mobile devices, they are also called “mHealth apps.” In the rest of my dissertation proposal, I will use these two terms interchangeably.

User: By user, I refer to a person who has access to and uses a mHealth app on his/her smartphone for gaining personal health benefit. Some healthcare professionals (e.g. doctor, nurse, and pharmacist) may utilize these apps for the purpose of patient care, information extraction, and sharing. In my study, healthcare professionals will only be included as users if they use mHealth apps for their personal health management.

Potential Health Benefit: This refers to addressing health-related needs (e.g. monitoring a health condition and health information seeking) which can potentially be beneficial for the users. There are many mHealth apps available that have not been evaluated yet. Also, some mHealth apps might be harmful for the users’ health (e.g. pro-smoking apps). Hence, rather I use the phrase “Potential Health Benefit” as opposed to “Health Benefit.”

1.2 Statement of Significance and Unique Contribution

According to International Telecommunication Union report, in 2013, the world population was 7.1 billion while the number of mobile phone subscribers was 6.8 billion (International Telecommunication Union 2014). The provision of health-related services via mobile communications is called mHealth, short for mobile Health (UnitedNations 2009). mHealth can be exploited to lessen the healthcare cost and to improve healthcare related research and outcomes (Santosh Kumar et al. 2013). In her keynote speech at the mHealth Summit in 2011, Kathleen Sebelius, the US Secretary of Health and Human Services, described mHealth as “the biggest technology breakthrough of our time” (Sebelius 2011). She further mentioned that its use would “address our greatest national challenge.” Steinhubl et al. identified three major forces behind such enthusiasm about mHealth: (a) the expenditure of current healthcare is skyrocketing and some disruptive solutions are urgently needed to address this problem; (b) there exist billions of unique mobile users all over the world creating a great opportunity for bidirectional instantaneous transfer of information; and (c) there is an increased demand for more accurate and individualized medicine that can be provided by mHealth tools (Steinhubl, Muse, and Topol 2013). Although they pointed out several concerns regarding the acceptance and extensive use of mHealth technologies, they provided some examples to show how mHealth technologies can positively transform the current healthcare system. In addition, they emphasized that to achieve this goal, it is necessary to address inefficient practices and challenges faced by consumers and clinicians in the current healthcare system.

mHealth is expanding rapidly in the area of research and practice (Free et al. 2010). Mobile phones can be utilized for healthcare purposes by using sensors (on-body sensors and embedded phone sensors), text message, apps (also known as mHealth apps), web-based services, telephone intervention, and mobile telemedicine system (Agarwal and Lau 2010; Baker et al. 2014; Free et al. 2011; Krco and Delic 2003; S. Kumar et al. 2013; Lewis and Wyatt 2014; Lunny et al. 2014). Mobile phones can also be used as medical devices (Pai et al. 2013). Some examples of mobile-phone enabled medical devices are: blood glucose meter to help diabetic patients to manage their blood glucose level (iBGStar 2014), wireless blood pressure monitor to get the reading of blood pressure
(iHealth 2014a), fitness devices (Fitbit 2014) to track user’s steps, calories burned, and sleep quality, and wireless scale to measure user’s weight, body fat, and body water (iHealth 2014b).

mHealth technologies bring business opportunities to several business organizations such as: mobile network operator to provide “end-to-end mHealth solutions to their customer bases”; pharmaceutical industry to secure supply chain and to battle against counterfeit drugs; and technology industry to design various mobile-phone based medical devices and mHealth apps (MHealthinsights 2013; SNS Telecom 2014).

Healthcare professionals are using mHealth technology to achieve their “need for better communication and information resources at the point of care” (Ventola 2014). Healthcare professionals are mainly engaging into five types of activities in mHealth domain: administration (information and time management), health record maintenance and access, communications and consulting, reference and information gathering, and medical education and training (Ventola 2014).

Patient caregivers are using mHealth technology for three major purposes: (a) information storage: to enter and update patients’ medical information; (b) medication and patient management: to get the reminder about medication and prescription renewal; and (c) educational: to get the educational information to know how to handle an emergency situation (Scher 2012).

People use text messages to improve their health. Significant research attention has been given to text message-based systems to address several health issues such as heart disease, HIV, malaria, smoking, diabetes, preventive healthcare, self-management, fitness, and obesity. (Franklin et al. 2008; Free et al. 2011; Githinji et al. 2013; Lester et al. 2010; Moonen and Cohen 2011; Patrick et al. 2009; Zurovac et al. 2011; Žurovac, Talisuna, and Snow 2012). Text message can be used as a reminder to the users to increase their adherence of medication (Quilici et al. 2013) or as a communicating medium with users in a weekly manner to know how they are doing (Lester et al. 2010).

Among all these aspects of mHealth (sensors, text messages, apps, web-based services, telephone intervention, mobile telemedicine system, and mobile-phone enabled medical devices), I focus on mHealth apps only in my dissertation. The purpose of mHealth apps is “to improve health outcomes, deliver health care services, or enable health research” (Powell, Landman, and Bates 2014). Extensive research has been performed in this domain where researchers showed that people are using mHealth apps for their health and disease management such as fitness, obesity, mental Health, diabetes, drug reference, smoking, HIV/STD, infectious disease, heart health, cancer, asthma, and dermatology, etc. (Azar et al. 2013; Bindhim et al. 2012; Brewer et al. 2013; Bush et al. 2013; El-Gayar et al. 2013; Goldbach et al. 2013; Marcano Belisario et al. 2013; Muessig et al. 2013; Oehler et al. 2010; Pandey et al. 2013; VanWormer et al. 2013; West et al. 2012). Some extensive literature reviews related to mHealth apps were also performed for specific health issues (Bender et al. 2013; Derbyshire and Dancey 2013; Donker et al. 2013; Marcano Belisario et al. 2013; Martínez-Pérez et al. 2013; Stephens and Allen 2013; Whittaker et al. 2012).

In these aforementioned research articles, researchers offered significant insight about how mHealth apps are used by the users for receiving health benefits. However, I argue that, we also need to know whether a user poses necessary literacy skills to use these systems, which demands to know first what constitutes this literacy. The reason of my argument is that irrespective of the design effectiveness of the mHealth apps and soundness and efficiency in their design and
development processes, if users do not have necessary literacy skills, they would not be able to receive health benefits by using these mHealth apps. To the best of my knowledge, no research focused on understanding this necessary literacy skill or offered a definition of what users need to know to use these systems effectively. My dissertation seizes this opportunity.

1.3 Reason to Choose mHealth Apps

My proposed study will focus on the use of mHealth apps for the following reason:

It is estimated that, by the end of 2014, 1.76 billion people all over the world will own and use smartphones (eMarketer 2014). mHealth apps are becoming pervasive among smartphone users. In US alone, 42% adults use at least one downloaded app; one third of these 42% adults use mHealth apps (Huckvale et al. 2012; Sadasivam et al. 2013). The UK Department of Health has suggested that, mHealth apps should be prescribed as part of long term care (Huckvale et al. 2012; Sadasivam et al. 2013). Currently more than 100,000 mHealth apps, in diversified healthcare categories, are available on the app stores (MIT Technology Review 2014). The US Food and Drug Administration (USFDA), through the industry estimation, reported that, by 2015, 500 million smartphone users worldwide will use at least one mHealth app and by 2018, 50% of the smartphone and tablet users (3.4 billion) will download mHealth apps (USFDA 2014). Researchers predict that, mHealth apps will help doctors, outside of the usual healthcare setting, to diagnose patients suffering from potentially life-threatening conditions (Mitka 2013). Considering such tremendous potential of these mHealth apps, I argue that it is very important to know what literacy a user should have to use mHealth apps to receive potential health benefits.

In summary, in this chapter, I have first introduced the research question of my dissertation. I have offered definitions of the key concepts related to this research question. Then, I have discussed the significance and uniqueness of my research. And finally, I have described my rational for choosing smartphone-based mHealth apps in my research.
Chapter 2  Related Work

The research question that I am addressing in my dissertation is:

**RQ: What literacy does a user need to receive potential health benefits from using a health-related app on a smartphone?**

Several research disciplines guided me to shape my research question and in this chapter, I will review the literature from these relevant disciplines.

My study deeply relies on and contributes to two threads of scholarship: Health Literacy and eHealth Literacy. Since these two threads of scholarship are rooted from “Literacy” domain, I will first summarize relevant research literatures on Literacy (section 2.1). In section 2.2 and 2.3, I will summarize the scholarly works of Health Literacy and eHealth Literacy respectively.

My research question also relies on and contributes to mHealth domain. In section 2.4, I will discuss how my study fits in this domain.

Two other research disciplines (community informatics and community healthcare informatics) also shaped my research question that will be discussed in the final section (section 2.5) of this chapter.

2.1  Literacy

Literacy is an active research area for the last few decades, where researchers defined literacy in several ways as well as described different aspects of literacy along with different categorizations. In this section, I will provide some prominent definitions of literacy and will discuss both the literacy aspects and literacy categories relevant to my study succinctly.

In 1958, UNESCO defined literacy as: “A literate person is one who can, with understanding, both read and write a short, simple statement on his or her everyday life” (Carr-Hill 2008). In 1966, UNESCO and UNDP jointly formed “Experimental World Literacy Programme” and introduced the concept of ‘Functional Literacy’, which was defined in the following way: “A person is functionally literate who can engage in all those activities in which literacy is required for effective functioning of his (her) group and community and also for enabling him (her) to continue to use reading, writing and calculation for his (her) own and the community’s development [and vice versa]” (Carr-Hill 2008).

2.1.1  Different Aspects of Literacy

In 2003, Williams identified 11 theses of literacy (Williams 2003). She performed an extensive review of the peer-reviewed articles published in the Journal of Literacy Research and the Journal of Adolescent and Adult Literacy, and all the published books for 20 years (1993-2003) on literacy research. For each thesis, she provided comprehensive references that expressed the thesis. Table 1 shows the list of these 11 theses:
Literacy is a technical skill

Literacy is conceptual

Literacy is historical

Literacy is social

Literacy is intertwined with power

There is a literacy divide between school and home

Bridging different literacies is desirable

Literacy theory is in crisis

Literacy problems suggest that democracy is threatened

Literacy theory is cultural hegemony

The digital format integrates literate forms of communications with non-literate forms

<table>
<thead>
<tr>
<th>Literacy Definitions</th>
<th>Reference</th>
</tr>
</thead>
</table>
| “Literacy is defined as a particular capacity and mode of behavior: the ability to understand and employ printed information in daily activities, at home, at work and in the community - to achieve one's goals and to develop one's knowledge and potential.” | (OECD and Statistics Canada 2000)
OECD = Organisation for Economic Co-operation and Development |
| “Literacy is the ability to decode and comprehend written language at a rudimentary level--that is, the ability to say written words corresponding to ordinary oral discourse and to understand them.” | (Carl F. Kaestle 1991) |
| There are two types of literacy: literacy in the schools, reading achievement; and literacy outside the schools, functional literacy. | |
| “Literacy as adaptation, [a] metaphor . . . to capture concepts of literacy that emphasize its survival or pragmatic value.” | (Scribner 1994) |

Table 1: Eleven theses of literacy, from Table 2 of (Williams 2003)

To get a comprehensive idea about how mHealth literacy is related to the traditional literacy, I have used these 11 theses as a starting point. To identify the relevant literacy theses and literacy types for my dissertation, I also conducted an interview-based pilot study with three avid, regular, and skilled mHealth app users. The pilot study is discussed in detail in section 3.2. The findings of the pilot study revealed that the first three aspects of literacy (see table 1) closely match with my research question. Hence, these three aspects are discussed in more detail below:

**Literacy is a technical skill:** By referring to earlier research articles concerning literacy, Williams showed that literacy is nothing but a technical skill and that skill can be measured through a standard test across a huge population (Williams 2003). Williams referred to the following literacy definitions to show that literacy is a technical skill.

<table>
<thead>
<tr>
<th>Literacy Definitions</th>
<th>Reference</th>
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</thead>
</table>
| “Literacy is defined as a particular capacity and mode of behavior: the ability to understand and employ printed information in daily activities, at home, at work and in the community - to achieve one's goals and to develop one's knowledge and potential.” | (OECD and Statistics Canada 2000)
OECD = Organisation for Economic Co-operation and Development |
| “Literacy is the ability to decode and comprehend written language at a rudimentary level--that is, the ability to say written words corresponding to ordinary oral discourse and to understand them.” | (Carl F. Kaestle 1991) |
| There are two types of literacy: literacy in the schools, reading achievement; and literacy outside the schools, functional literacy. | |
| “Literacy as adaptation, [a] metaphor . . . to capture concepts of literacy that emphasize its survival or pragmatic value.” | (Scribner 1994) |

Table 2: Literacy is a technical skill (Williams 2003)

**Literacy is conceptual:** To show that literacy is conceptual, Williams referred to 10 intellectual capabilities (Table 3) mentioned in an NRC report (National Research Council Committee on
Information Technology Literacy 1999). These ten capabilities were categorized as foundational concepts.

<table>
<thead>
<tr>
<th>#</th>
<th>Intellectual Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Engage in sustained reasoning</td>
</tr>
<tr>
<td>2.</td>
<td>Manage complexity</td>
</tr>
<tr>
<td>3.</td>
<td>Test a solution</td>
</tr>
<tr>
<td>4.</td>
<td>Manage problems in faulty solutions</td>
</tr>
<tr>
<td>5.</td>
<td>Organize and navigate information structures and evaluate information</td>
</tr>
<tr>
<td>6.</td>
<td>Collaborate</td>
</tr>
<tr>
<td>7.</td>
<td>Communicate to other audiences</td>
</tr>
<tr>
<td>8.</td>
<td>Expect the unexpected</td>
</tr>
<tr>
<td>9.</td>
<td>Anticipate changing technologies</td>
</tr>
<tr>
<td>10.</td>
<td>Think about information technology abstractly</td>
</tr>
</tbody>
</table>

Table 3: 10 Intellectual Capabilities. Table 1 of (Williams 2003)

Williams also provided the following literacy definitions (Table 4) from earlier scholars to show that literacy is not a “context-free, value-neutral set of skills.”

<table>
<thead>
<tr>
<th>Literacy Definitions</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being literate “has always referred to having mastery over the processes by means of which culturally significant information is coded.”</td>
<td>(de Castell and Luke 1994)</td>
</tr>
<tr>
<td>“Reading does not consist merely of decoding the written word or language; rather, it is preceded by and intertwined with knowledge of the world. Language and reality are dynamically interconnected.”</td>
<td>(Freire and Macedo 1987)</td>
</tr>
</tbody>
</table>

Table 4: Literacy is conceptual (Williams 2003)

**Literacy is historical:** Williams mentioned that, “Literacy researchers have made the broader observation that culture changes; thus, literacy is historical” (Williams 2003). By referring to the example from de Castell & Luke (de Castell and Luke 1994), Williams also showed that “definition of literacy changes over human history.” Table 5 shows how literacy definitions have been evolved over time in American education (de Castell and Luke 1994).

<table>
<thead>
<tr>
<th>Types of Literacy</th>
<th>Time Frame</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical literacy</td>
<td>19th Century</td>
<td>“Being able to read Greek and Latin, to practice rhetoric, make an analysis of key texts (notably the Bible), and to be familiar with a defined literature. This was the literacy of a</td>
</tr>
</tbody>
</table>
2.1.2 Types of Literacy Relevant to my Study

Researchers proposed various types of literacy to date. Since the concept of mHealth literacy evolved from eHealth literacy, I explored the results reported by Norman and Skinner, who determined the literacy skills needed to become eHealth literate (Norman and Skinner 2006b). Based on my findings from the pilot study and the results from Norman and Skinner, I have identified eight literacy types relevant to my research. These literacy types include: Traditional Literacy, Health Literacy, Information Literacy, Computer Literacy, Scientific Literacy, Media Literacy, App literacy, and Graph Literacy. Of these literacy types, traditional literacy was discussed in Section 2.1 (the word “literacy” was used to refer to traditional literacy) and App literacy is a new term coined by my interviewees (hence will be discussed in the pilot study section, Section 3.2). Health literacy is the most relevant literacy type to my study and deserves a more elaborate discussion (Section 2.2). The remaining five literacy types are discussed below:

**Computer literacy**: Computer literacy was defined in several ways. Williams provided a comprehensive definition of computer literacy after synthesizing the relevant scholarly work from several disciplines including computer science, education, and literacy studies (Williams 2003, 2012). Table 6 summarizes the eight points that are required to become computer literate. In my dissertation, I will use this definition for its comprehensiveness.

1. Having contemporary skills (e.g., browsing or text editing)
2. Knowing foundational concepts (e.g., networks)
3. Possessing intellectual capabilities (e.g., evaluating sources)
4. Understanding computer literacy as an aspect of life in an information society
5. Being familiar with at least the basics of computer programming
6. Practicing computer literacy that is tailored to individual needs, interests, and goals
7. Being part of the community of people who can use IT, which means knowing
   (a) how to keep learning,
   (b) who or where to go for new concepts and skills (including software help features and online sources), and
   (c) how to solve problems with others in that community
8. Not assuming that someone with computer literacy is better than someone who isn’t computer literate

Table 6: Computer Literacy. Borrowed from Williams (Williams 2012) p. 14

Among these eight points, few might be irrelevant for my study. For instance, to be mHealth literate, perhaps, it is not required to know any computer programming. I will be certain about this after finishing my final study.

**Information literacy**: Information literacy was first introduced in 1974 by Paul Zurkowski where he described it as: “People trained in the application of information resources to their work can be
called information literates. They have learned techniques and skills for utilizing the wide range of
information tools as well as primary sources in molding information solutions to their problems”
(Zurkowski 1974). In 1989, the American Library Association described information literacy as:
“Ultimately, information literate people are those who have learned how to learn. They know how
to learn because they know how knowledge is organized, how to find information, and how to use
information in such a way that others can learn from them. They are people prepared for lifelong
learning, because they can always find the information needed for any task or decision at hand”
person knows what potential resources to consult to find information on a specific topic, can
develop appropriate search strategies, and can filter results to extract relevant knowledge”
(Norman and Skinner 2006b).

Scientific literacy: The term “Scientific Literacy” was first introduced in 1958 by Paul deHard Hurd
(Holbrook and Rannikmae 2009). In 1996, the National Research Council (NRC) defined Scientific
Literacy as: “Scientific literacy is the knowledge and understanding of scientific concepts and
processes required for personal decision making, participation in civic and cultural affairs, and
economic productivity. It also includes specific types of abilities. In the National Science Education
Standards, the content standards define scientific literacy” (NRC 1996). Holbrook and Rannikmae
identified two major points of view of scientific literacy among scholars: “a) those that advocate a
central role for the knowledge of science; and b) those who see scientific literacy referring to a
society usefulness” (Holbrook and Rannikmae 2009).

Media literacy: In the National Leadership Conference on Media Literacy held on December 1992,
25 representative leaders of Media Literacy met and agreed upon the following definition of media
literacy: “It is the ability of a citizen to access, analyze, and produce information for specific
outcomes” (Aufderheide 1993). Norman and Skinner described media literacy as “a skill that
enables people to place information in a social and political context and to consider issues such as
the marketplace, audience relations, and how media forms in themselves shape the message that
gets conveyed” (Norman and Skinner 2006b). Arke and Primackb introduced a measurement scale
to measure a person’s media literacy level and showed that “media literacy scale was significantly
correlated with a composite critical thinking measure” (Arke and Primack 2009).

Graph Literacy: Graph Literacy is defined as “the ability to understand graphically presented
information” (Galesic and Garcia-Retamero 2011). Although graphs (e.g. pie chart, bar chart, line
plots) became ubiquitous and are now available in newspapers, magazines, television, and Internet,
many people experience difficulty to comprehend even the simplest forms of graph (Galesic and
Garcia-Retamero 2011). To assess the ability of an eighth-grade student to interpret the general
graphs, Mevarech and Kramarsk designed a 36-item “Graph Interpretation Test” (Kramarski and
Mevarech 2003). In addition, Galesic and Garcia-Retamero developed a 13-item graph literacy scale
for the healthcare domain (Galesic and Garcia-Retamero 2011).

2.2 Health Literacy
As I mentioned earlier, one of the focal points of my dissertation is health literacy. In this section, I
will discuss the major definitions of health literacy, the prevalence of limited health literacy among
patients, the major tools currently used to measure health literacy, and how health literacy
influenced the design of my final study.
2.2.1 Definitions of Health Literacy

The definition of health literacy evolved over time. Table 7 summarizes the major definitions of Health Literacy available from existing literature.

<table>
<thead>
<tr>
<th>Health Literacy Definitions</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Health literacy is the degree to which individuals can obtain, process, and understand basic health information and services needed to make appropriate health decisions.”</td>
<td>The Institute of Medicine and Healthy People 2010 (a national health promotion and disease prevention initiative which was started in 2000 and was led by the U.S. Department of Health and Human Services) (Anon 2000; Institute of Medicine 2004; Ratzan and Parker 2000)</td>
</tr>
<tr>
<td>Health literacy refers to a set of skills to function efficiently in the healthcare environment.</td>
<td>(Berkman et al. 2011) (Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs 1999; Baker 2006)</td>
</tr>
<tr>
<td>Health literacy should include three types of human capabilities: (a) Print literacy: capability to read and comprehend documents and to locate and understand information in those documents; (b) Numeracy: capability to utilize numeric information for tasks, such as understanding food labels, measuring blood glucose levels, and following the medication regimens appropriately, etc. and (c) Oral literacy: ability to speak and listen effectively.</td>
<td>(Raynor 2012)</td>
</tr>
<tr>
<td>Three aspects need to be considered to be health literate: (a) The ability not only to read but also to comprehend health information, (b) The broader capability to involve with the healthcare process, and (c) The elimination of redundant complexity and barriers to patient understanding and engagement.</td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Definitions of Health Literacy

Health literacy became a global issue. According to the 2003 National Adult Assessment of Literacy (NAAL), 36% of US adults (ages 16 and older) had either basic or below basic health literacy (Mark et al. 2006). NAAL adopted the definition of Health literacy provided by the Institute of Medicine and Healthy People 2010. Outside US, the situation is also similar. For instance, one third of the older people in UK find it difficult to read and comprehend the basic health related written information (Bostock and Steptoe 2012).

2.2.2 Tools for Measuring Health Literacy

A significant number of research has been conducted to design measuring tools to identify people with low health literacy (Raynor 2012). Below is a short description of some of these tools:

**REALM (Rapid Estimate of Adult Literacy in Medicine)**: In 1991, Davis and colleagues designed a quick screening tool for the physicians to measure the reading levels of the patients (Davis et al. 1991). This tool offered a form consisting of 125 pre-selected words selected from typical direction and education materials prepared for patients (e.g. eye, dose, rectal, fatigue, pelvic, Syphilis,
Emergency, Medication, and Inflammatory). In 1993, Davis and colleagues redesigned the initial REALM tool by keeping only 66 words instead of the originally proposed 125 (Davis et al. 1993). To complete a test using RELAM, it took around three to five minutes for 125-item REALM and one to two minutes for the 66-item REALM. REALM works in the following way: the words are first ordered based on associated difficulty of readings and complexity based on the number of syllables. For example, the easy words (e.g. single-syllable words such as fat, flu) are placed first followed by the difficult words (e.g. multi-syllable words such as allergic, osteoporosis). The patients are instructed to read the word loudly as many as they can. The administer keeps the record of the patient’s pronouncing capability. Standard dictionary pronunciation is the gold standard for evaluating the correctness of the pronunciation. If the patient successfully pronounces a word, a score is added. If the patient finds it difficult to read a word, he is instructed to skip it and move on to the next word. At the end of the reading session, the total score is summed up. The minimum score can be zero while the maximum can be 66 (for 66-word REALM). The score is then transformed into one of the four grade-level literacy levels to estimate the health literacy score of the patient: 0–18 (<=3rd grade), 19–44 (4th to 6th grade), 45–60 (7th to 8th grade) and 61–66 (>=9th grade). To evaluate the efficacy of the 125-word REALM, Davis and colleagues tested this tool on 207 adults recruited from six public and private primary care clinics. The results were compared with two standardized reading tests namely “Peabody Individual Achievement Test-Revised (PIAT-R) (Markwardt 1989)” and “the Slosson Oral Reading Test (SORT-R) (Slosson and Nicholson 1990).” The researchers showed that 125-item REALM correlated highly with the above mentioned two standardized tests. And for evaluating the 66-item REALM, the researchers recruited 203 patients from four university hospital clinics. They compared the results with three standardized reading tests: PIAT-R, SORT-R, and the Wide Range Achievement Test-Revised (WRAT-R) (Jastak and Wilkinson 1984). The results indicated that 66-item REALM correlated well with all these three standard tests.

**Different Forms of REALM:** In 2003, Bass et al. reduced the 66 items to eight items and named it REALM-R (Rapid Estimate of Adult Literacy in Medicine – Revised) (Bass 3rd, Wilson, and Griffith 2003). The selected eight words are: ‘osteoporosis’, ‘allergic’, ‘jaundice’, ‘anemia’, ‘fatigue’, ‘directed’, ‘colitis’, and ‘constipation’. The administration time was reduced to less than a minute. The researchers performed the testing with 157 patients and showed that their tool correlated with WRAT-R. Arozullah et al. tried to make this version even more shorter (Arozullah et al. 2007). They named it REALM-SF (REALM-Short Form), which contains only seven items (‘Behavior’, ‘Exercise’, ‘Menopause’, ‘Rectal’, ‘Antibiotics’, ‘Anemia’, and ‘Jaundice’). Like REALM, the final score of REALM-SF is mapped into four grading levels in the following way: 0 (<=3rd grade), 1-3 (4th to 6th grade), 4-6 (7th to 8th grade) and 7 (>=9th grade). The researchers recruited 1336, 164, and 50 patients for model development, validation, and field testing respectively. REALM-SF and REALM highly correlated mainly in the development and the validation stage. On the contrary, REALM-SF and Wide Range Achievement Test scores highly correlated in field testing validation.

**TOFHLA (Test of Functional Health Literacy in Adults):** Parker et al. first designed this instrument to assess patient’s functional health literacy (Parker et al. 1995). This assessment tool consisted of 67 items; 50 items to assess reading comprehension skill, and the remaining 17 items were for testing numerical ability. It required up to 22 minutes to administer. By performing an extensive user-study among 256 English- and 249 Spanish-speaking patients, Parker et al. showed that TOFHLA is a valid and reliable instrument to measure a patient’s ability to read health-related materials.
Different Forms of TOFHLA: In 1999, Baker et al. proposed an abbreviated version of TOFHLA and named it as S-TOFHLA (Short Test of Functional Health Literacy in Adults) (Baker et al. 1999). S-TOFHLA consisted of four numerical items instead of 17 and two prose passages instead of three. The maximum time for administration was also reduced from 22 minutes to 12 minutes. After evaluating through a group of 211 patients, Baker et al. showed that S-TOFHLA is well correlated with REALM (0.8).

2.3 eHealth literacy

After observing the increasing involvement of World Wide Web and other technology-based applications in public health and healthcare environment, in 2006, Norman and Skinner first introduced the concept of “eHealth Literacy” (Norman and Skinner 2006b). They defined eHealth literacy as “the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem.” They also proposed an eHealth literacy model called “Lily model” (Norman and Skinner 2006b). In an additional article published in the same year, Norman and Skinner proposed eHEALS (eHealth Literacy Scale), an 8-item measure of eHealth literacy, to assess consumers’ combined knowledge, comfort, and perceived skills at finding, evaluating, and applying eHealth information pertaining to their health problems (Norman and Skinner 2006a). In this section, I will review the work of Norman and Skinner to demonstrate how the eHealth Literacy model evolved and how eHEALS (eHealth Literacy Scale) was designed to measure the degree of eHealth Literacy of a patient. In addition, this section will throw some light on other scholars’ works related to eHealth Literacy.

2.3.1 Lily Model

To define eHealth Literacy, Norman and Skinner argued that a person requires six different literacy skills to be eHealth Literate. These six skills are: traditional literacy, information literacy, media literacy, health literacy, computer literacy, and scientific literacy. To illustrate the relationship among these skills and how these are connected to the core concept of “eHealth Literacy”, they proposed a model called “Lily Model” (Figure 1). According to them, “using the metaphor of a lily, the petals (literacies) feed the pistil (eHealth literacy), and yet the pistil overlaps the petals, tying them together.”

Figure 1: eHealth Literacy Lily Model. From Figure 1 of Norman and Skinner, 2006 (Norman and Skinner 2006b)
Norman and Skinner categorized these six skills into two types: **analytic** (traditional, media, information) and **context-specific** (computer, scientific, health). Irrespective of context, analytic skills are applicable for a wide range of information source. According to Norman and Skinner, doing shopping or researching a term paper is an example of analytic skills. On the contrary, context-specific skills largely depend on a particular situation. A skill to fix a computer problem is an example of context-specific skill.

### 2.3.2 eHEALS: the eHealth Literacy Scale

Although Lily model proposed the required skill set to be eHealth Literate, a big question was still unanswered: how to assess a user’s capacity for engaging in eHealth (Norman and Skinner 2006a). To answer this question, Norman and Skinner designed eHEALS, an 8-item measure of eHealth Literacy scale. They psychometrically evaluated the properties of eHEALS through a six-month long user study among 664 participants. The participants were recruited from 14 secondary schools from a large city in Canada. Table 7 shows the final eight questions selected for eHEALS.

<table>
<thead>
<tr>
<th>Question #</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I know how to find helpful health resources on the Internet</td>
</tr>
<tr>
<td>2</td>
<td>I know how to use the Internet to answer my health questions</td>
</tr>
<tr>
<td>3</td>
<td>I know what health resources are available on the Internet</td>
</tr>
<tr>
<td>4</td>
<td>I know where to find helpful health resources on the Internet</td>
</tr>
<tr>
<td>5</td>
<td>I know how to use the health information I find on the Internet to help me</td>
</tr>
<tr>
<td>6</td>
<td>I have the skills I need to evaluate the health resources I find on the Internet</td>
</tr>
<tr>
<td>7</td>
<td>I can tell high quality from low quality health resources on the Internet</td>
</tr>
<tr>
<td>8</td>
<td>I feel confident in using information from the Internet to make health decisions</td>
</tr>
</tbody>
</table>

Table 8: Questions in eHEALS. From Table 1 of Norman and Skinner (Norman and Skinner 2006a)

### 2.3.3 eHealth Literacy and Web 2.0

Since the field of eHealth is dynamic and gradually evolving over time, Norman argued that the context of eHealth literacy should also evolve in the same way (Norman 2011). When the Lily model was first introduced in 2006, the first generation of web gained prominence and web 2.0 and social media were in a very preliminary stage. In his latest paper, Norman revisited Lily model and identified some problems and opportunities for eHealth literacy as an evolving concept. After considering the critiques from other researchers (Chan and Kaufman 2011; Stellefson et al. 2011; van der Vaart et al. 2011; Xie 2011), Norman described that the following skills should be considered for measuring eHealth literacy in web 2.0 domain: confidence to clearly express oneself in online social media; skill to synthesize professional and non-professional advice; ability to navigate through information using mobile devices; and capability to filter relevant and trustworthy information from web (Norman 2011).

### 2.3.4 Studies using eHEALS

van der Vaart et al. conducted two studies to measure the actual eHealth literacy among patients with Rheumatic Diseases (van der Vaart et al. 2013). Another goal of these two studies was to identify the problems that patients encounter when using the Internet in relation to their diseases. In the two studies, the patients had to answer the questions they were asked about their current disease-related Internet use. The eHealth literacy of the patients was observed during performance tests. The results of these studies indicate that many patients did not have enough skill to properly
use Health 1.0 (information websites) and Health 2.0 (interactive applications such as peer support forums, online consults, and insight into electronic medical records).

Since older adults typically do not have much computer literacy (Victoria Rideout et al. 2005) and it is very daunting for them to function well in the eHealth era, in 2011, Xie performed a study on 146 older adults aged 56 to 91 to examine the effects of a theory-driven eHealth literacy intervention for older adults (Xie 2011). The intervention comprised of two-weeks of learning by the older adults to use SeniorHealth.gov website to access reliable health information. The results of the study revealed that: (a) the intervention significantly improved knowledge, skills, and eHealth literacy efficacy from pre- to post-intervention; (b) the participants received the intervention in a positive manner and (c) the intervention led to positive changes in their own healthcare.

eHEALS was available only in English and no validation data was available. Considering that, van der Vaart et al. translated eHEALS into Dutch language and then performed a study in two populations to evaluate its validity (van der Vaart et al. 2011). The first population of the study consisted of patients with rheumatic diseases (n=189) and the second population consisted of regular Dutch people (n=88). The results showed that the internal consistency of eHEALS was high, which made it sufficiently reliable. However, the results also indicated that further study is required to be certain about the validity of the eHEALS instrument, since the relationship with Internet use was not very strong and expected relations with age, education, and performance were insignificant.

Rather than focusing on studies of older adults’ Internet use, as many researchers did, Choi and DiNitto concentrated on low-income disabled and homebound older adults (Choi and DiNitto 2013). Face-to-face interviews or telephone surveys were conducted on 980 such vulnerable older adults who used to live in central Texas. They divided these people in two categories based on their age (78% were age 60 or older and 22% under age 60). The researchers compared, among the individuals aged 60 or older as opposed to their younger counterpart, the Internet usage patterns, the main causes of their discontinued Internet use, the degree of eHealth literacy, and their approach about computer/Internet use. The researchers applied two methods in their research: eHEALS to measure their degree of eHealth literacy and the ATC/IQ (Attitudes Toward Computer/Internet Questionnaire) to measure their attitude towards Internet/computer use. The Internet use was very low among these people. Among people age 60 years and older, only 17% of subjects used the Internet and 16% among them discontinued later. Among people under-60 age group, 34% of them used Internet and 35% among them discontinued later.

The researchers reasoned that either lack of exposure to computer/Internet or high cost to obtain computers or poor medical conditions, disabilities, and associated pain prevented them to use Internet and computer, which resulted in low usage.

2.4 mHealth and mHealth literacy

Since mobile and smartphones have become an integral part of people's lives and millions of people are using mobile phone-based healthcare applications (or app in short) on a regular basis for maintaining a healthy lifestyle, I argue that it is time to extend the focus of health literacy even further than eHealth and include mHealth technology. My research question is founded on this argument. I have coined a new term “mHealth Literacy” to represent the literacy a user needs to receive potential health benefits from using a health-related app on a smartphone.
To maintain a healthy life, people typically receive help from formal caregivers such as doctors and nurses and informal caregivers such as family members and friends. Hence, the necessity of smartphone-based healthcare apps might not be evident. In my dissertation, I am not suggesting that mHealth apps will demolish or even reduce the necessity of formal and informal caregivers; rather I am arguing that these apps will act as a complementary source of service. For instance, as I mentioned earlier, researchers foresee that, mHealth apps will be useful for doctors to diagnose patients who are suffering from possible life-threatening health issues (Mitka 2013). Mitka also argued that healthcare apps will help patients to manage their health and it will provide useful information whenever and wherever they need it.

A significant research has been performed in mHealth domain where researchers showed that people are using mHealth apps for their health and disease management (Azar et al. 2013; Bindhim et al. 2012; Brewer et al. 2013; Bush et al. 2013; El-Gayar et al. 2013; Goldbach et al. 2013; Marcano Belisario et al. 2013; Muessig et al. 2013; Oehler et al. 2010; Pandey et al. 2013; VanWormer et al. 2013; West et al. 2012). I have found 172 relevant research articles from eight major databases (e.g. PubMed, ACM Digital Library, Ebsco, IEEE Xplore, Science Direct, Web of Science, PsycINFO, and Scopus) that focus on mHealth apps or technology. A meta-analysis of these 172 articles is a part of my Research Methodology and is currently underway. The report of the meta-analysis will be available in my final dissertation.

2.5 Community Informatics and Community Health Informatics

In this section, I will discuss some classic basic definitions provided by the scholars of community informatics and community health informatics and how my study is relevant with these two areas. Community Informatics was defined in several ways. Some prominent definitions are provided below:

<table>
<thead>
<tr>
<th>Community Informatics Definitions</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Community informatics is a multidisciplinary field for the investigation and development of the social and cultural factors shaping the development and diffusion of new ICTs and its effects upon community development, regeneration and sustainability.”</td>
<td>(Keeble and Loader 2001)</td>
</tr>
<tr>
<td>“Community informatics can be defined as a strategy or discipline that focuses on the use of information and communication technologies by territorial communities.”</td>
<td>(O’Neil 2002)</td>
</tr>
<tr>
<td>“Community Informatics (CI) – enabling communities with Information and Communications Technologies (ICT) – is a very new development in the academic world, but in reality a very old one in the daily life of communities.”</td>
<td>(Gurstein 2004)</td>
</tr>
<tr>
<td>“Community informatics is an emerging field focusing primarily on the interaction between local communities and information technologies and a more particular focus within social informatics.”</td>
<td>(Williams and Durrance 2009)</td>
</tr>
<tr>
<td>“Community informatics aligns with the evolutionary paradigm in studies of how people make sense of and operate in an environment that includes ICTs.”</td>
<td>(Veinot and Williams 2012)</td>
</tr>
</tbody>
</table>
“Community informatics (CI) is one field that has attended to local community, specifically, local community in the digital age, as it adopts information technology or adapts to a technologically transformed society.”

(Williams et al. 2013)

Table 9: Definitions of Community Informatics

Veinot and Williams mentioned that, treatment of ICTs within community informatics is largely empirical, rather than conceptual (Veinot and Williams 2012). In my study, I am also treating ICTs, more specifically smart-phone based healthcare apps, in an empirical manner. Two parts of my research methodology (pilot study and empirical study), which will be discussed in chapter 3 in more detail, follow empirical research methodology. However, unlike Community Informatics, I am not concentrating on a specific “local and geographical community.” Rather, the participants of my study may come from any geographical community. The recruitment process and the sampling method are described in section 3.3.1.

Community Health Informatics is a relatively new research area that integrates “community informatics” and “healthcare” domains. According to Veinot, “Community health informatics aims to improve the reach and impact of health information among marginalized groups, particularly those that experience health disparities” (Veinot 2014). My study also aims to improve the reach and impact of mHealth information among people; however, rather than focusing on marginalized groups, my focus is on general people irrespective of whether they experience health disparities.
Chapter 3 Research Design

The research question that my dissertation will address is reiterated here:

RQ: What literacy does a user need to receive potential health benefits from using a health-related app on a smartphone?

In this chapter, I will discuss in detail the research methodology that I will utilize to address my research question. The research methodology has three parts: meta-analysis, pilot study, and empirical study. In the meta-analysis section, I will describe my rational for selecting this particular methodology, the search technique and the inclusion and exclusion criteria to use for collecting and selecting relevant research articles for meta-analysis, and finally the article’s coding scheme.

In the pilot study section, I will discuss first why I have chosen this technique followed by the details of the user recruitment process, the demographics of the users, the interview questions, and the results and analysis of the pilot study I conducted.

The experience I gathered from the pilot study helped me to design my final empirical study, which I will discuss in section 3.1. More specifically, I will describe the sampling and user recruitment procedure, the details of the interview process, and post-fieldwork analysis technique that I will follow for conducting the empirical study.

Finally, I will provide the approximate timeline to complete my dissertation.

3.1 Meta-Analysis

Since eHealth and mHealth domains have several overlapping features, to understand what literacy a mHealth app user needs to receive potential health benefits, I started exploring the research methodology used in eHealth Literacy domain (Norman and Skinner 2006b). Rather than conducting any empirical study, Norman and Skinner performed a comprehensive literature review to identify these literacy skills that a person should possess to be considered as eHealth literate. Inspired by their technique, I will also perform an extensive meta-analysis to identify the literacy skills a user should have to be considered as mHealth literate.

A recent research article from our Community Informatics Research Lab, which was published in First Monday, also shaped my meta-analysis technique (Williams et al. 2013). In that paper, we identified 563 items (journal articles, book chapters, and conference presentations) after exploring 14,410 peer-reviewed journal articles and 914 edited books and conference proceedings. These 563 items covered eight disciplines and 22 years of research (1990-2011) and discussed about empirical research on a specific local and organic community and their usage of Information technology. I will follow the same meta-analysis technique in my dissertation.

3.1.1 Search Technique, Inclusion and Exclusion Criteria

I have already completed the first step of this meta-analysis process; i.e. collection and selection of all relevant research articles. After exploring relevant meta-analysis papers in healthcare domain (Fanning, Mullen, and McAuley 2012; Lustria et al. 2013; Mosa, Yoo, and Sheets 2012), I have finalized the following eight major databases to search for research articles: PubMed, ACM Digital
Total Records identified through database searching (n = 2613)
PubMed (428)
Scopus (1169)
Web of Science (505)
IEEE Xplore (169)
PsycINFO (71)
Ebsco (184)
Science Direct (51)
ACM Digital Library (36)

Duplicate articles (n = 620)
No author information available (n = 63)

Title and Abstract Screened (n = 1930)

Removed based on title and/or abstract (n = 1728)

Articles potentially appropriate for systematic review (n = 202)

Removed if the primary users of the healthcare apps are not either patients or primary caregivers (n = 30)

Articles included for final systematic review (n = 172)

Figure 2: Summary of the article selection process for the systematic review process

Library, Ebsco, IEEE Xplore, Science Direct, Web of Science, PsycINFO, and Scopus. I have used the following search string to all of these databases to collect the relevant articles:
(((mobile phone OR cell phone OR smart phone) AND (health OR healthcare) AND (apps OR app OR applications OR application))

This keyword-based search resulted in a list of 2613 research articles. To identify the articles that will help me to address my research question, I have incorporated some inclusion and exclusion criteria. An article is eligible to be included in the final list for review if that article conforms to the following characteristics:

- The article must be written in English-language.
- The article must be officially published in a peer-reviewed venue (e.g. journal, conference proceedings, and book chapters). The publication can be either online or print.
- The article must be a research article, which asks a specific research question, and follows a defined methodology to answer that question. Any article (e.g. news, comments, letter to editor, columns by specialists, etc.) that does not fit this criterion will be excluded.
- No restriction was imposed on the field of studies.
- The article focused on mHealth apps only. Any article discussing other mHealth aspects was excluded from further analysis.
- The mHealth apps were targeted to persons who use any mHealth app on their smartphones for receiving personal health benefits. If healthcare professionals (e.g. doctor, nurse, and pharmacist) mentioned in any article used the mHealth apps for their personal benefits rather than professional use, those studies were also included.

Figure 2 summarizes the steps I followed to finalize all the articles for the meta-analysis process. After collecting all the research articles (n= 2613) from the eight major databases, I imported these articles to EndNote (Thomson Reuters 2014). EndNote facilitated to identify all the duplicate articles (n = 620) and all articles without author information (n = 63). The remaining 1930 articles were selected for the next-round of reviews. In this stage, I examined the titles and abstracts of all the articles for further screening, and found that 1728 articles did not meet the inclusion criteria listed above. Further screening helped me to identify 30 articles that were discussing mHealth apps from healthcare professionals’ point of view. Hence, these 30 articles were discarded from the final collection that resulted in 172 articles for coding.

3.1.2 Article Coding

Based on the findings of the pilot study that I conducted, I have identified five literacy skills (e.g. Traditional Literacy, Health Literacy, Information Literacy, App Literacy, and Graph Literacy) and prepared the coding dictionary shown in Table 10. The pilot study and the five literacy skills are discussed in detail in section 3.2.

In my article coding, I will use the similar approach Williams et al. followed (Williams et al. 2013). More specifically, I will search for specific texts from all these 172 articles to map the text to specific literacy skills using the basic coding dictionary. I anticipate that I may discover additional literacy skills when I will complete the coding process for all of the collected articles.

<table>
<thead>
<tr>
<th>Code</th>
<th>Concept</th>
<th>Text to search for</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL</td>
<td>Traditional Literacy</td>
<td>Any text describing people’s skill to understand “English text” and/or numbers (arithmetic) to use mHealth apps.</td>
</tr>
<tr>
<td>HL</td>
<td>Health Literacy</td>
<td>Any text describing people’s skill to understand the purpose of their health needs and/or to know different health related</td>
</tr>
</tbody>
</table>
acronyms.

<table>
<thead>
<tr>
<th>IL</th>
<th>Information Literacy</th>
<th>Any text describing people’s skill to find the appropriate mHealth apps from the app store and/or to follow the app instructions properly.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>App Literacy</td>
<td>Any text describing people’s skill to run the mHealth app in a proper way (e.g. download and install the app and understand whether app requires any initial setup requirement)</td>
</tr>
<tr>
<td>GL</td>
<td>Graph Literacy</td>
<td>Any text describing people’s skill to understand the graphically presented information available on the mHealth app.</td>
</tr>
</tbody>
</table>

Table 10: Basic coding dictionary for identifying the literacy skill

3.2 Pilot Study

Although Norman and Skinner did not conduct an empirical study to identify the skill set a person should have to be considered as eHealth literate, as a trained Community Informatics Researcher, I realize the importance and necessity of conducting empirical study in addition to the text-based meta-analysis technique. I believe that the empirical study will help not only to verify the findings of the meta-analysis but also augment the results. However, without the precedence of any such empirical study, per my advisor’s (Professor Kate Williams) suggestion, I have conducted a pilot study first. This pilot study enabled me to finalize my interview questionnaire, sampling method, data collection, and analysis procedures of my proposed empirical study. In this section, I will discuss the pilot study that I conducted.

3.2.1 Participants of the Pilot Study

Upon receiving the IRB (Institutional Review Board) approval from the University of Illinois, during August 2014, I conducted interviews with three avid, regular, and skilled mHealth app users. Appendix D contains the IRB approval letter.

<table>
<thead>
<tr>
<th>Interviewee # 1</th>
<th>Interviewee # 2</th>
<th>Interviewee # 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>Male</td>
</tr>
<tr>
<td>Age</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>Age</td>
<td>28</td>
<td>35</td>
</tr>
<tr>
<td>Education</td>
<td>MBA (Finance)</td>
<td>MS (Divinity)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td>MS (Electrical Engineering)</td>
</tr>
<tr>
<td>Profession</td>
<td>Senior Assistant Vice President and Head of Project Management of a reputed bank in Bangladesh</td>
<td>Software Engineer</td>
</tr>
<tr>
<td>Profession</td>
<td></td>
<td>Senior Principal Design Engineer</td>
</tr>
<tr>
<td>Current Location</td>
<td>Bangladesh</td>
<td>USA</td>
</tr>
<tr>
<td>Current Location</td>
<td></td>
<td>USA</td>
</tr>
</tbody>
</table>

Table 11: Demographics of the three interviewees

To recruit the users, I posted a recruitment message in my Facebook profile. Some of my Facebook friends also shared the same message to their Facebook profiles, which helped to reach more people. Six people responded to the recruitment message. I interviewed three of the interested Facebook friends based on their availability to participate in the study. The other users agreed to participate in the study in future, if needed. Appendix A contains a sample recruitment flyer (a generic social media/email message). Table 11 shows the demographics of the three interviewees.
3.2.2 Measures Used in the Pilot Study

All the three interviews were conducted via phone. Before starting an interview, I took the verbal consent from the interviewee. Appendix B contains the consent form while Appendix C contains the questionnaire I used during the interviews. The interview consisted of 15 questions that included questions on user demographics, experience with the apps, comments and suggestions on mHealth literacy, and recommendations on improving the mHealth apps. However, I used the questionnaire as a guide for the interview session and always welcomed tangents during the interview process. In addition, the questions evolved based on the experience of the previous interview(s).

3.2.3 Results and Analysis of the Pilot Study

I have performed a qualitative analysis of all the interviews. Table 12 summarizes the usage of mHealth apps by the three interviewees.

<table>
<thead>
<tr>
<th></th>
<th>Interviewee # 1</th>
<th>Interviewee # 2</th>
<th>Interviewee # 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the smartphone OS</td>
<td>Android</td>
<td>iOS</td>
<td>iOS</td>
</tr>
<tr>
<td>Duration of smartphone used</td>
<td>5 years</td>
<td>5 years</td>
<td>4-5 years</td>
</tr>
<tr>
<td>App name</td>
<td>Nike Running</td>
<td>MyFitnessPal</td>
<td>Instant Heart Rate</td>
</tr>
<tr>
<td>App purpose</td>
<td>Tracks the user’s running history and pattern</td>
<td>Calorie counting and weight management</td>
<td>Measures the heart rate instantly</td>
</tr>
<tr>
<td>Duration of the current mHealth app use</td>
<td>9 months</td>
<td>1 year</td>
<td>3-4 months</td>
</tr>
<tr>
<td>Frequency of use</td>
<td>Everyday</td>
<td>Sometimes, every day. Sometimes, twice a week.</td>
<td>5-6 times per week</td>
</tr>
</tbody>
</table>

Table 12: Usage of the mHealth apps by the interviewees

The interviewees shared their opinions on how to receive health benefits from a mHealth app. I have mapped their opinions to different aspects of literacy reported by Williams (Williams 2003) in the following way:

**Literacy is a technical skill:** The interviewees pointed out that a mHealth user should have similar skills mentioned in the survey report by OECD and Statistics Canada (OECD and Statistics Canada 2000). According to interviewee # 3, “A person should know how to get the reviews (of the app) and how to parse the review.” – this statement is closely related to prose literacy mentioned in the OECD report. According to interviewee # 1, “The summary report of the jogging is given every month, both in numeric and graph format. The user should interpret and understand the summary report.” – the summary report mentioned here indicates to quantitative literacy (arithmetic) as categorized in the OECD report.

**Literacy is conceptual:** In my pilot study, to answer one of the questions, interviewer # 3 responded that, it was not enough to read the reviews but “it was also important to internalize the reviews after reading”. –this quote supports the statement made by Freire and Macedo (Freire and Macedo 1987) because the user needs to understand some basic concepts of mobile (e.g. mobile phone, app store, app, OS) and health.
Literacy is historical: I observed that new concepts have been emerged for the mHealth arena. Earlier, mHealth primarily focused on text message based systems. However, currently it incorporates app based system, which introduces new concepts such as smart phone, app store, app reviews, OS, etc.

The interviewees also expressed their views about different types of literacy skills that a mHealth app user should have to receive health benefits. Here are some literacy skills mentioned by the interviewees:

Traditional Literacy: All three interviews mentioned that, the following two aspects of traditional literacy are vital for a mHealth app user:
- Prose literacy: Understanding the English text since the description and reviews of most of the mHealth apps are written in English.
- Quantitative literacy: Understanding the numbers (arithmetic) as the results provided by the apps are shown in a numerical format.

Health Literacy: According to the interviewees, a mHealth user should be health literate. It is a prerequisite for the user to know the health needs to use the appropriate app for his/her health. According to the interviewees:
- “The first skill needs to know the main purpose of his health that means what he wants to achieve”. – Interviewee # 1
- “A person should have a clear idea of his health purpose. - Interviewee # 1

A person should also be aware of the different health acronym and basic assumption an app makes related to health. Below are some quotes from the interviewees in this regard:
- “A person should also know the health acronym such as BMI relevant to his health.” – Interviewee # 3
- “It is easy and straightforward only if you understand the assumption the app is made. One basic assumption of the app is that a person needs 2000 calorie per day.” – Interviewee # 2

Information Literacy: There are numerous apps available in the app store. After identifying the health need, a person should know how to find an appropriate app from the app store. Here are some quotes of the interviewees about information seeking skill.
- “After determining his health purpose, the user should find few apps and then decide which one he should use. He should choose an app which is more convenient for him.” – Interviewee # 1
- “A person has heard about an app. Now he needs to know where the app can be found. If he knows the app store then he needs to know where that app is. App store has categories for health. A person should know how to find the right app from that category.” – Interviewee # 3

Also, the interviewees reported that having skill to follow the app instructions (e.g. how to calibrate GPS at the very first time for a jogging app) is very important. Moreover, since people are exposed to massive amounts of correct as well as incorrect information, according to interviewee # 2, a person should have the skill to differentiate between these two types of information.

App Literacy: After locating the right app in the app store, a person should know whether that app really works to serve his purpose. Hence the user should be able to download and install this app in his smart phone by himself. Also, it is important to know if there is any issue of the app such as not giving the correct result, stopping the app without informing the user, etc. Besides knowing these
issues, it is also important to know whether these issues are fixable, how to fix these, whether the app should be abandoned and whether the user should switch to a new app, etc. The user also needs to understand whether the app requires any initial setup (e.g. calibration of the GPS, create user name/password, find the appropriate category for inputting the food). This skill is termed as “App Literacy” by interviewee #3. Some related quotes from the interviewees are as follows:

“An app might have several features...Some apps have only one screen with three or four icons. Some apps have several tabs to embed more information.... Every person might not have the skill (to use the features)... For some sophisticated app, the user should have skill to use it. I prefer to say this skill as app literacy rather than computer literacy” – Interviewee #3

**Graph Literacy:** Since most health apps provide the data in a graphical format, according to all of the interviewees, understanding the graphical format is imperative for a mHealth app user. Here are some representative quotes from the interviewees:

- The user needs to interpret the summary, which is shown graphically, by his own. – Interviewee #1
- “.... Interpreting the graphical format is another skill a user should have” – Interviewee #3

### 3.3 Empirical Study

The experience that I gathered from the pilot study clearly pointed out that a mHealth app user requires some specific literacy skills to receive potential health benefits from using a mHealth app on a smartphone. However, one major limitation of the pilot study was that all of the three interviewees were male, well-educated (all of them have Masters level degree), and avid mHealth app users. As I mentioned earlier, by 2015, 500 million smartphone users worldwide will use at least one mHealth app, and by 2018, 50% of the smartphone and tablet users (3.4 billion) will download mHealth apps (USFDA 2014). These statistics indicate that mHealth app use is becoming popular among people from different race, age group, culture, and educational background. Although the results I found from the pilot study provided an idea about the literacy skills a mHealth user should have, the results are not comprehensive. Hence, I argue that, a more elaborate study with more diversified users is needed to answer my research question. The final empirical study will serve that purpose. In this section, I will discuss how I will conduct this empirical study.

#### 3.3.1 IRB Approval, Sampling, and User Recruitment

I will apply for another IRB approval for my final empirical study. This IRB application will contain similar content of the IRB that I had applied for my pilot study along with the modified interview questions. The next step will be to recruit a diversified group of users, where I will use stratified sampling method (som 1995). The strata will be formed based on age (under 50 and over 50), gender (male/female), formal education (less than high school/more than high school), country of origin (US/non US), and language (English as a first language/English as a second language). I will recruit around 20 users for the interview. I will post the recruitment flyer to the Internet mediums (e.g. social media, website, email lists, and listserv) and to the local organizations (e.g. public library, church, and mosque) to recruit the diversified users. I will use the same flyer for recruitment that I used for my pilot study (Appendix A).

#### 3.3.2 Interview

Interviews will be performed either face-to-face or via phone or skype depending on the preference and geographic location of the interviewee. Interviews are expected to last around 30 to 40
minutes, with one interview per participant. Interviews will be audio-recorded with the permission of the interviewee. I will also take notes while conducting the interview.

In case of a face-to-face interview, I will collect the participant’s written consent. In case of a telephone or skype interview, the participants will provide recorded oral consent before the interviews begin. I will use the same consent form I used for my pilot study (Appendix B).

The audio recording will be done using my laptop audio recorder and my cell phone audio recorder. As I am currently living in Memphis, TN, I will use a quite study room in the Memphis Public Library for any face-to-face interview. In case of a telephone or skype interview, I will use my home office. I will also take notes on paper during the interview whenever necessary, also with interviewee’s permission.

The same day of the interview, I will move the audio file to my personal hard drive as well as to a university server, both of which are password protected. I will also save the filed-notes in a locker at my home office.

To ensure the anonymity and privacy, the names of the participants in the filed note will be referred to by first-names followed by last initials. In my dissertation, all individual information will be anonymized (e.g. user 1, user 2 and so on) or reported only in a summarized fashion, to ensure one more layer of anonymity and to keep all individual identities private.

3.3.3 Updated Interview Questions
After reevaluating each question of the pilot study, I have selected 13 interview questions for my final study. I believe answers to these questions from the participants would help me to gain deeper understanding about mHealth Literacy. Below I will discuss these interview questions along with the rational for selecting them.

<table>
<thead>
<tr>
<th>Question #</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Please state your full name, age, ethnicity, the highest educational degree you have achieved, and your current profession.</td>
</tr>
<tr>
<td>2</td>
<td>For how long have you been using smart phone?</td>
</tr>
<tr>
<td>3</td>
<td>What healthcare app(s) are you currently using? For how long have you been using this app(s)? How frequently are you using this app(s)?</td>
</tr>
<tr>
<td>4</td>
<td>How did you learn to use this app?</td>
</tr>
<tr>
<td>5</td>
<td>Please share your experience of installing this app. Did you do it by yourself?</td>
</tr>
</tbody>
</table>

Table 13: Interview questions to know interviewee’s background and mobile competency level

<table>
<thead>
<tr>
<th>Question #</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Did you receive any health related benefit from using this app? If yes, what are those benefits and how does the app help you to receive that?</td>
</tr>
<tr>
<td>7</td>
<td>What literacy skills a person should have to get potential health benefits from a health app? Why do you think they should have these literacy skills?</td>
</tr>
</tbody>
</table>

Table 14: Interview questions to know interviewee’s perspective on health-benefits and mHealth literacy

Question 1 to 5 will be asked (Table 13) to know about the interviewee’s demographic information and background, his/her familiarity and usage of the mHealth apps, and his/her competency level
to use a mHealth app. Answers to these questions will shed light on whether mHealth literacy is dependent on these factors.

Since people may get health-benefits in dissimilar ways by using mHealth apps, the answer to question 6 (Table 14) will help me to understand the correlation, if there is any, between mHealth literacy and health-benefits using mHealth apps. Question 7 (Table 14) is an open-ended question aiming to understand the interviewee’s perspective on major literacy skills a user need to use mHealth apps to receive potential health benefits.

<table>
<thead>
<tr>
<th>Question #</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Do you think a user must know “English language” to use a health app? Please explain your answer.</td>
</tr>
<tr>
<td>9</td>
<td>Do you think a user must understand numbers to use a health app? Please explain your answer.</td>
</tr>
<tr>
<td>10</td>
<td>What kind of health information do you think a person should be aware of to use a health app? Please explain your answer.</td>
</tr>
<tr>
<td>11</td>
<td>What kind of app-related information do you think a person should be aware of to use a health app? Please explain your answer.</td>
</tr>
<tr>
<td>12</td>
<td>Do you think a person must know how to download, install, and use a health app by himself/herself?</td>
</tr>
<tr>
<td>13</td>
<td>Do you think a person must understand the graphically presented information to use the health app properly?</td>
</tr>
</tbody>
</table>

Table 15: Optional Interview questions

Although the answer of the question 7 should provide participants’ perspective on using mHealth apps, some literacy types identified in my pilot study (Section 3.2.3) might be absent from their given answers. To ensure that any literacy type found in the pilot study is not missed unknowingly or unintentionally, I will ask questions 8 to 13 (Table 15). Question 8 and 9 cover traditional literacy; question 10 covers health literacy; question 11 covers information literacy; question 12 covers app literacy; and question 13 covers graph literacy. These questions are optional in a sense that if any literacy type is already mentioned by the interviewee to answer to question 7, the question on that particular literacy will not be asked anymore.

All these updated interview questions are compiled in Appendix E. I believe these questions are not intrusive and important for gaining understanding about interviewees’ literacy levels in different dimensions. However, if any interviewee should feel uneasy about any question or about the study, he/she will be able to skip a question and/or end his/her participation at any time. I will remind the interviewee of this voluntary nature of participation at the onset of the interview.

### 3.3.4 Post-fieldwork Analysis

In parallel to the interview sessions in Spring 2015, I will also transcribe the audio files and input the hand written notes. When all the transcriptions and field-notes are completed, I will begin the intensive data analysis process. I will first systematically review all the data to identify what kind of literacy the users have mentioned to use mHealth apps to get health benefits. I will use the same coding dictionary I described in the meta-analysis section (Table 9).
### 3.4 Timeline of the Final Dissertation

I am planning to finish my dissertation by Summer 2015. Table 16 shows the expected timeline I am proposing to finish my dissertation.

<table>
<thead>
<tr>
<th>Dissertation Item</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRB Approval</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Meta-Analysis</td>
<td>Ongoing</td>
</tr>
<tr>
<td>User Study (Recruitment, Interview, and Transcription)</td>
<td>February 2015 – April 2015</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>May 2015</td>
</tr>
<tr>
<td>Dissertation Writing and Dissertation Presentation</td>
<td>Summer 2015</td>
</tr>
</tbody>
</table>

Table 16: Dissertation Timeline
References


USFDA. 2014. “Mobile Medical Applications.”


Williams, Kate. 2003. "Literacy and Computer Literacy: Analyzing the NRC’s ‘Being Fluent with Information Technology.’" *Journal of Literacy and Technology* 3(1).


Appendix A: Recruitment Flyer for the Pilot Study

Hello, I am a researcher from the University of Illinois at Urbana Champaign in the US. I am investigating mobile phone-based healthcare applications (or app for short): **What literacy does a user need to receive health benefits from using a health-related app on a smartphone?**

Do you use any mobile health apps such as calorie count or food intake, step count, blood pressure monitor, diabetes control, running tracker, and weight management, etc.? If yes, please reply so that I can interview you briefly.

Thank you.

Shameem Ahmed
ahmed9@illinois.edu

217-979-9901
Appendix B: Consent Form for the Pilot Study

In accord with rules about informed consent, this document explains what research we are doing, informs you of your rights, and asks for your voluntary consent to participate. The research is led by Dr. Kate Williams and Shameem Ahmed of Graduate School of Library and Information Science department at the University of Illinois at Urbana Champaign in the US.

In this study, we investigate the characteristics of the users of mobile phone-based healthcare applications (or app in short) to answer the following research question: what is mHealth Literacy? In other words, what does a person need to know in order to get health benefits from using a health-related app on a mobile phone? By participating in this research, you are helping to create a better understanding of how people are currently using mobile phone based health apps.

Participation will involve a face-to-face or phone/skype interview of approximately one hour in length. During this interview, you will be asked some questions and your answers will be audio recorded with your permission. There are no risks involved in participating in this research other than those involved in ordinary everyday life. Participation is entirely voluntary and you may skip any questions you do not wish to answer with no negative consequences. You can also stop participating in the research.

The materials from this research may be used for research presentations and publications. Your identity, participation, and answers will all be kept confidential by the research team, safeguarding your privacy.

If you have any questions regarding the research, please ask. You can also email or call the lead researchers collect at any time (Shameem Ahmed and Kate Williams, katewill@illinois.edu or 217-244-9128). If you have any questions about your rights as a participant in this study or any concerns or complaints, please contact the University of Illinois Institutional Review Board at 217-333-2670 (collect calls will be accepted if you identify yourself as a research participant) or via email at irb@illinois.edu. A copy of this document will be given to you.

☐ I understand the above and voluntarily agree to participate in this research.

☐ I consent to the audio recording of this interview.

Yes ☐ No ☐

Signature: ________________________________________________________________

Printed name: ______________________________________________________________

Email or phone number: _____________________________________________________

Date: ____________________________________________________________________
Appendix C: Interview Questions for the Pilot Study

Thank you for taking the time to participate in this research. I want to begin by, once again, verifying your permission to audio-record this interview. You are free to (a) discontinue participation in this study at any time (b) request that the audio recorder be turned off at any time and (c) pass on any question that you do not want to answer. Do you consent to this interview?

If yes, continue:

1. Tell me about the model and OS of your current smart phone.
2. For how long have you been using your current smart phone?
3. Did you use any other smart phone before?
   If yes, the follow-up questions:
   a. What was the model and OS of that phone?
   b. For how long have you used that smart phone?
4. What healthcare app are you currently using in your smart phone? What is the goal of this app?
5. For how long have you been using this app? How frequently are you using this app?
6. How did you get the information of this app at the very first time?
7. Did you install this app by yourself?
   If yes, the follow-up questions:
   a. Please share your experience of finding and installing this app.
   b. How hard was that?
   c. Are you more comfortable now to install a new healthcare app?
8. Did you pay for this app?
   If yes, the follow-up questions:
   a. How much did you pay?
   b. How did you pay?
   If no, the follow-up questions:
   a. Do you know how to buy a health app from the app store?
9. Please share your experience of using this app.
   Follow-up questions:
   a. Are you satisfied with this app?
   b. What features do you typically use and like?
   c. What features you don’t like?
10. Using your own words, how easy or difficult it was to understand all the features and/or to interpret all the data provided by the app?
11. Do you think that the app helped you to get any health benefit? If yes, how?
12. Using your own words, what does a person need to know to get health benefits from a health app?
13. What do you consider a high quality app versus a low quality app?
   Follow-up questions:
   a. Have you ever seen an app you thought was inadequate?
   b. If yes, name of the app and why was it inadequate?
14. Do you usually share your data with others (e.g. doctor, family member, friend, social media, etc.)?
   If yes, the follow-up questions:
a. To whom you usually share the data?
b. Why and how (e.g. via email, Bluetooth, simple copy-paste, etc.) do you share this data?
15. May I know your age and educational background?
Appendix D: IRB Approval for the Pilot Study

August 1, 2014

Kathleen Williams
GSLIS
LIS 131
501 E. Daniel St.
Champaign, IL 61820
M/C 493

RE: mHealth Literacy: A Dissertation Pilot Study to Characterize the People’s Ability to Use Mobile Phone-based Healthcare Applications
IRB Protocol Number: 15055

EXPIRATION DATE: 07/31/2017

Dear Dr. Williams:

Thank you for submitting the completed IRB application form for your project entitled mHealth Literacy: A Dissertation Pilot Study to Characterize the People’s Ability to Use Mobile Phone-based Healthcare Applications. Your project was assigned Institutional Review Board (IRB) Protocol Number 15055 and reviewed. It has been determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(2).

This determination of exemption only applies to the research study as submitted. Please note that additional modifications to your project need to be submitted to the IRB for review and exemption determination or approval before the modifications are initiated.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me or the IRB Office, or visit our website at http://www.irb.illinois.edu.

Sincerely,

Rebecca Van Tine, MS
Assistant Human Subjects Research Specialist, Institutional Review Board

c: Shameem Ahmed
Appendix E: Interview Questions for the Final Empirical Study

Thank you for taking the time to participate in this research. I want to begin by, once again, verifying your permission to audio-record this interview. You are free to (a) discontinue participation in this study at any time (b) request that the audio recorder be turned off at any time and (c) pass on any question that you do not want to answer. Do you consent to this interview?

If yes, continue:

1. Please state your full name, age, ethnicity, the highest educational degree you have achieved, and your current profession.
2. For how long have you been using smart phone?
3. What healthcare app(s) are you currently using? For how long have you been using this app(s)? How frequently are you using this app(s)?
4. How did you learn to use this app?
5. Please share your experience of installing this app. Did you do it by yourself?
6. Did you receive any health related benefit from using this app? If yes, what are those benefits and how does the app help you to receive that?
7. What literacy skills a person should have to get potential health benefits from a health app? Why do you think they should have these literacy skills?

Optional Questions:

8. Do you think a user must know “English language” to use a health app? Please explain your answer.
9. Do you think a user must understand numbers to use a health app? Please explain your answer.
10. What kind of health information do you think a person should be aware of to use a health app? Please explain your answer.
11. What kind of app-related information do you think a person should be aware of to use a health app? Please explain your answer.
12. Do you think a person must know how to download, install, and use a health app by himself/herself?
13. Do you think a person must understand the graphically presented information to use the health app properly?