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Examining the Design and Usability of Telemedicine Communications: A Mixed-methods Study

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EXAMINING THE DESIGN AND USABILITY OF TELEMEDICINE PROVIDER COMMUNICATIONS: A MIXED-METHODS STUDY

By

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ABSTRACT

This dissertation describes a mixed-methods study that examines the usability of telemedicine provider interfaces. This study consisted of content analysis, survey, and think aloud methodologies, which afford a multifaceted corpus of data for which to draw inferences and identify design features and functions that negatively impact usability. Usability is a critical component of the user experience with a telemedicine provider interface and can suede or impede the acceptance and adoption of telemedicine. Telemedicine has the potential to increase quality healthcare access and positive health outcomes for individuals who use it, and usability is a key component of technology acceptance and effective use.

Empirical testing of health information technology (HIT) and telemedicine is advocated for as it is the most valuable method of research to understand humans' cognitive processing of information as they interact with technology. In addition, using activity theory and mobile interface theory as a lens in which to understand human activities and interaction with telemedicine provider interfaces, including the telemedicine provider websites and their mobile-responsive websites in this study, is an effective tool for drawing reasonable inferences regarding the usability of telemedicine communications.

Considering the rate at which an unprecedented amount of health information becomes available online and HIT facilitates the delivery of healthcare, usability testing and user-centered, iterative design practices become increasingly essential in order to design effective—and safe—health information and technology that enhance the patient-experience, the affordability and accessibility of healthcare, health literacy and patient empowerment, and positive health

outcomes. Usability testing plays an increasingly important role in characterizing obstacles to achieving these initiatives of the modern patient-centered health paradigm and telemedicine.

The mixed-methods usability testing performed in this study offers a principled approach to usability testing and is ecologically valid because it involves real human subjects. This study fulfills a void in research on the usability of telemedicine communications and reveals usability problems that may not be anticipated by designers of HIT and health information providers. Drawing from the insight gained from this mixed-method study, design features and functions that enhance the usability of health communications are offered. This study draws insight from the human factors, technical communication, and health and medical fields to develop systematic, practical usability testing methods that can be replicated and applied in many fields. The design recommendations resulting from this study will be valuable to programmers; systems analysts; clinicians and nurses; technical communicators; information architects; visual designers; and others in similar roles.

This dissertation is dedicated to first and foremost, my mother who as supported me throughout my scholarship and encouraged my continued education. Additionally, I also dedicate this project to my dissertation committee and especially to Dr. Sonia Stephens in gratitude for her advice, support, and guidance throughout my coursework, exams, and dissertation project.

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LIST OF ABBREVIATIONS

CHI: Consumer Health Informatics

CDS: Clinical Decision Support (system)

CIS: Clinical Information Systems

ED: Emergency Department

eHealth: Electronic Health

FKGL: Flesch-Kincaid Grade Level

HIS: Health Information System

HIT: Health Information Technology

HIT: Human Intelligence Tasks

HCI: Human-computer Interaction

IMeHU: Integrative Model of eHealth Use

IRB: Institutional Review Board

IS: Information System

ISO: International Organization for Standardization

mHealth: Mobile Health

MUA/Ps: Medically Underserved Areas and Populations

NIST: National Institute for Standards and Technology

ONC: Office of the National Coordinator for Health Information Technology

PIMS: Personal Innovativeness Toward Mobile Services

PSSUQ: Post-Study System Usability Questionnaire (PSSUQ)

RWD: Responsive Web Design

SUS: System Usability Scale

TSQ: Telemedicine Satisfaction Questionnaire

TSS: Telehealth Satisfaction Scale

TSUQ: Telemedicine Satisfaction and Usefulness Questionnaire

TIUQ: Telemedicine Interface Usability Questionnaire

TUQ: Telehealth Usability Questionnaire

TWUS: Teladoc Website Usability Survey

UCF: University of Central Florida

WSN-SHHS: Wireless-sensor Networks-based Smart Home Healthcare System

CHAPTER ONE – INTRODUCTION

Telemedicine, or telehealth, is a modern medical delivery system, whereby medical consultation, diagnosis, and treatment is provided via telecommunication (computational technology). Telemedicine is an important component of healthcare today offering many benefits to all stakeholders involved in the healthcare system and encompasses a diverse spectrum of clinical applications (Bashshur & Goldberg, 2014; Bashshur, Reardon & Shannon, 2000). Despite the purported benefits of telemedicine, Direct-to-consumer (DTC) telemedicine has received limited uptake and use by consumers (Ashwood, Mehrotra, Cowling & Uscher-Pines, 2017; Gardner et al., 2015; van Gemert-Pijnen et al., 2001). What contributes to consumers' lack of acceptance and adoption of telemedicine as an alternative healthcare intervention is an important area of research. This study examines the design and usability of DTC telemedicine provider websites because telemedicine communications are a key contributor to consumers' awareness of and ability to use telemedicine. Using a novel, mixed-methods approach to investigating the usability of DTC telemedicine communications, this study used the usability metrics outlined by the International Organization for Standardization (ISO) to gain insight into the effectiveness and efficiency in which users[1] were able to perform tasks using a sample of DTC telemedicine interfaces and evaluate their perceived satisfaction (ISO 9241-11, 2018). The definition of usability and the parameters under which it is evaluated and interpreted in this study will be discussed in more detail later in this dissertation. The insight gained from this research is

[1] Throughout this dissertation, the term, "user," is often used to refer to any patient, consumer, or other stakeholder who interacts with a technological product or interface. I clarify this because different practitioners may use different terms depending on the health situation and discipline. For instance, a healthcare physician might refer to users as, "patients," a website owner might refer to users as, "consumers," and a usability expert or system designer might use the term, "users."

expected to provide design recommendations that will be valuable to programmers; systems analysts; clinicians and nurses; technical communicators; information architects; visual designers; and others in similar roles. This study also contributes a practical and useful application of usability testing methods to interdisciplinary fields, including human-computer interaction (HCI), cognitive science, health informatics, and technical communication. This study has implications for how healthcare information is designed and delivered to individuals who rely on it to make important healthcare decisions. Lastly, the aim of this study was to provide useful insight in the development of usable and useful DTC telemedicine communications that may improve its uptake and appropriate use by patients. The applications and affordances of telemedicine are presented in this chapter followed by a depiction of the inadequate adoption of telemedicine by consumers. The main purpose of this study is discussed in this chapter along with the main research questions. The last part of this chapter outlines the structure of this dissertation.

Telemedicine Definition and DTC Application

Telemedicine is defined by five main characteristics:

1. there is a geographic distance between the provider and the client during the clinical meeting (telediagnosis) or between two or more providers during a consultation (teleconsulting);
2. the use of telecommunication to allow or facilitate the interaction among providers and clients or consultants as well as for data exchange;
3. the existence of an information technology infrastructure and the appropriate staff to maintain it and link units;

4. the development of distinct clinical protocols for diagnoses and treatments via technology;
5. the development of normal patterns of behavior to substitute for the face-to-face contact among clients or consultants and providers. (Bashshur, 1995; de Souza et al., 2017)

To summarize, telemedicine is the practice of healthcare delivery; diagnosis; consultation; treatment; transfer of medical data; and education using interactive audio, video, or data communication (Ashley, 2002). Communication via videoconferencing, telephone, and online platforms are major methods for healthcare to be delivered via telemedicine services. DTC telemedicine is the delivery of healthcare for nonemergency conditions to patients via a live video chat using a Webcam or smartphone, or simply via a telephone call with a physician (Uscher-Pines, Mulcahy, Cowling, Hunter, Burns & Mehrotra, 2016). DTC telemedicine is increasingly becoming an important component of healthcare today. Not only are private insurers now providing reimbursements for telemedicine, similar to a traditional in-office physician visits, but both Medicaid and Medicare recognize telemedicine as a reimbursable healthcare option (Thomas & Capistrant, 2016; National Conference of State Legislators, 2015; Yang, 2016). DTC telemedicine also appeals to more consumers because it typically costs less than traditional in-office visits and affords convenience by eliminating the need to travel to healthcare facilities (Uscher-Pines et al., 2016). Examples of DTC telemedicine providers include: Teladoc, Doctor on Demand, MeMD, and American Well (Amwell®) (Preece, n.d.; Roland, 2015). Telemedicine providers, like other hospitals, healthcare institutions, and pharmaceutical companies, communicate to consumers and patients about their services through their corporate websites (Hwang, McMillan & Guiohk, 2003; Hwang & Christensen, 2007; Tsai & Lancaster, 2012; Wilkes, Bell & Kravitz, 2000). My research focuses on DTC telemedicine communications delivered via the telemedicine providers' websites and mobile-responsive interfaces.

Affordances of Telemedicine

Telemedicine encompasses many clinical applications and offers several benefits, including:

- convenience (Powell, Henstenburg, Cooper, Hollander & Rising, 2017);
- affordability (Uscher-Pines et al., 2016);
- accessibly to individuals who would not seek medical care or for those in remote or rural geographies (Uscher-Pines & Mehrotra, 2014; de Souza et al., 2017);
- remote patient monitoring (Alaiad & Zhou, 2017);
- patient education and increased health literacy (Chiu, 2016; García-Gómez et al., 2014); decision support (Plaisance et al., 2018);
- increased patient self-efficacy and activation (Anderson et al., 1995; Artnak, McGraw & Stanley, 2001; Bandura, 1994; Hibbard, Stockard, Mahoney & Tusler, 2004);
- enhanced medical professional communication to improve clinical decisions and teamwork among healthcare professionals (Brunner, Chuang, Goldzweig, Cain, Sugar & Yano, 2017; Nagler, Schlueter, Johnson, Griffith, Prewitt, Sloane & Adams, 2014);
- therapeutic treatment for mental health and disease management (Celio et al., 2017; Cerdan, Catalan-Matamoros & Berg, 2017; Schneider et al., 2016);

- and the conceptualization of the patient experience using a user-centered design interface (Mirel, Barton & Ackerman, 2008).

To summarize, telemedicine is a convenient healthcare intervention that facilitates patient education, diagnosis, self-care, and the treatment and management of health conditions remotely through technology.

Alternative Healthcare Interventions Using Technology

Telemedicine, along with eHealth and mHealth, are all terms describing alternative healthcare interventions delivered by means of health information technologies (HIT) (Alzougool, Chang & Gray, 2008; Bashshur et al., 2000; Georgsson & Staggers, 2016; van Velsen, Wentzel & van Gemert-Pijnen, 2013). eHealth refers to health services and health information delivered or enhanced through the internet and other technologies (Eysenbach, 2001); similarly, mHealth is any health service or health information delivered or enhanced via smartphone technology (WHO, 2011). These modern health interventions facilitated by technology reside under the large field of consumer health informatics (CHI), which aims to deliver health information and services using technology (Alpay, Verhoef, Xie, Te'eni & Zwetsloot-Schonk, 2009; Brennan & Starren, 2006). For example, eHealth, or online health information, such as health information websites, like Healthline and WebMD, is becoming an increasingly popular delivery method of health information. There are between 10 and twenty thousand health-related websites that exist, and these are often the first port-of-call in consumers search for health information (Fox & Rainie, 2000; Hesse et al., 2005; Pang, Verspoor, Chang & Pearce, 2014). HIT, eHealth, and social media platforms are all increasingly being used by clinicians, consumers, patients, and other stakeholders to access health information, perform health behaviors and manage health and manage health (Fox & Duggan, 2012; Fox & Duggan, 2013; Goldberg et al., 2011). Kasl and Cobb (1966) define health behavior to be any activity an individual performs in which she or he believes to support good health, for the purpose of preventing disease, and/or detecting it in an asymptomatic stage, such as monitor blood glucose levels (Agarwal et al., 2019) and exercise (Albu, Atack & Srivastava, 2015)),

Statistics show that 80% of adults who use the web to access information use it to search for health information (Fox et al., 2003). Often individuals are in search of a diagnosis because they are experiencing a health concern, desire social support and information regarding the experience of others with the same health condition, are searching for health information for someone else, as well as other motivations (Fox et al., 2013). In fact, health information websites have influenced the health decisions of over 21 million individuals (Fox et al., 2000). Yet, other research reveals that only 27% of the individuals searching online for specific health information found what they were searching for (Peute, Knijnenburg, Kremer & Jaspers, 2015b).

DTC telemedicine providers promote their healthcare services and capabilities through their websites; therefore, DTC telemedicine websites reside under the umbrella term, eHealth. Potential patients searching the web for health information on a specific health condition or who are seeking treatment may find and use a DTC telemedicine website to access information about their health, services, and treatment options. Because DTC telemedicine websites are the interfaces through which telemedicine providers communicate to patients how to use their service (Norman, 1988; Redish, 2010), it is critical that these websites contain the information that individuals need and understand to be able to make knowledgeable decisions about their health and use telemedicine efficiently and safely (Kushniruk et al., 2010; Middleton et al., 2013). Telemedicine provider websites are often the first medium by which users become aware of and become informed on how to use the service. Given the need to better understand how users interpret and interact with telemedicine communications, this study aims to investigate the usability of telemedicine provider interfaces. Telemedicine's affordances and opportunities to improve and enhance healthcare quality and increase access to healthcare cannot be realized if individuals are not aware of telemedicine, do not conceptualize it to be quality healthcare, or do not understand how to use it.

Health Information Usability Needs

Attention to the usability of health information systems (HIS) is an emerging area of research in health informatics. HCI experts define "usability" to be a quality of efficiency, effectiveness, likability, and safety of a computer system (technology) (Preece, Sharp & Rogers, 2002). Inquiry into usability in the health informatics field has been mostly concerned with the utility, safety, and viability of HIS, such as the accuracy with which a Clinical Decision Support (CDS) system predicts diagnoses (Chaudhrya et al., 2019; Richardson et al., 2017; Sutton et al., 2020). Yet, the usability of eHealth or health information that is delivered online has not received the attention it requires. Given that health information on the web is so highly utilized today, it is critical that health information websites provide accurate information and are able to be used effectively by consumers who rely on the information to make decisions about their health or perform health activities, such as schedule doctor appointments, treatment behaviors, or the dispensing of prescription medication. Self-management activities, such as performing a telemedicine consultation, rely on the use of technologies to facilitate the process. Therefore, it is essential that telemedicine providers design their websites in a way that users are able to locate and understand the salient information they need. HCI design allows users to act on information accordingly in their time of need, which is likely when they are ill and seeking treatment. Telemedicine communications must facilitate timely healthcare during users' "golden window" of treatment opportunity, which is when patients are more likely to need healthcare and motivated to receive it (Cullen et al., 1999). Telemedicine websites serve as a conduit of information that must translate the information users are seeking accurately and in a timely manner (McLaughlin, 1984). Ineffective and insufficient communication from healthcare providers is a barrier to patients receiving quality healthcare (Wilson et al., 1995). Consumer acceptance of and use of telemedicine hinges on the usability of the telemedicine provider communications, which is a quality expressed by the design of the product, as well as subject to the individual user's perception (Alpay et al., 2009; Brennan et al., 2006; Or & Karsh, 2009; Zhang & Waljiac, 2011). Usability has been a focus of product design in many industries (for example, aviation and automobile) and in the HCI field for many years, but has received little attention from the health and medical community until recently (Tang, Johnson, Tindall & Zhang, 2006a; Kushniruk, Triola, Borycki, Stein & Kannry, 2005b; Zhang et al., 2011).

Designing quality, effective HIT is one objective of the patient-centered health paradigm, which focuses on empowering patients to be active participants in their own health and creating and making available health information tools that engage patients, act to increase their health literacy[2], and are used effectively to increase positive health outcomes[3]. Research on the usability of telemedicine is necessitated in order to achieve the quadruple aim of healthcare delivery systems that focus on patient-centered care: reducing healthcare costs and improving the

[2] Health literacy will be explained in greater detail in Chapter Two, but briefly defined, health literacy is, "an individual's ability to read, understand, and use health information to make effective healthcare decisions" (Weiss, p. 4).
[3] Anderson et al., 1995; Brennan, Kuang & Volrathongchai, 2000; García-Gómez et al., 2014; Giguere et al., 2011; Lin, Neafsey, & Strickler, 2009; Morony, McCaffery, Kirkendall, Jansen, & Webster, 2017

patient experience, the physician experience, and the health of populations (Tuckson, Edmunds & Hodgkins, 2017).

In fact, researchers and federal agencies advocate for user-centered design processes, which include usability testing with end-users and iterative design processes in the design and implementation of HIS (Horsky & Ramelson, 2016; Rogers, Patterson, Chapman & Render, 2005; Schumacher & Lowry, 2010). Like other high-consequence industries, such as nuclear power and aviation, the role and impact of usability problems encountered when clinicians and patients use technology are heightened because individuals' lives may be immediately negatively affected. In addition, distinct information is gained from including end-users in the design of HIS and telemedicine that ultimately may increase the efficacy of the system, patient safety, user satisfaction, and health outcomes (Middleton et al., 2013; Patel & Kannampallil, 2014). Improving the usability of telemedicine communications is likely to increase its widespread diffusion.

Challenges to Usability

Given the distinct changes this new healthcare model presents for health education and the traditional approach to delivering and accessing healthcare, both consumers and healthcare providers must be made aware of and be educated on telemedicine practices, affordances, limitations, as well as the tasks required to be able to use these healthcare interventions. If consumers are aware of the affordances (the properties of an object and capabilities of an individual to make use of the object) of telemedicine, such as the convenience, they may be more willing to use it. Likewise, patients and medical providers must also be educated on the proper use of telemedicine technology and understand that this modality of healthcare does not work for health conditions that require urgent care (Padman, Shevchik, Paone, Dolezal & Cervenak, 2010; Whitten, Buis & Love, 2007a).

Usability is a key driver in the ability of users to be informed about telemedicine and be able to effectively perform the tasks necessary to use telemedicine (Zhang et al., 2001). The change for CHI, including telemedicine provider websites, is that usability is entangled with multiple factors. Health literacy is important for patients to be active participants in healthcare and to have positive health outcomes as a result (Dewalt, Berkman, Sheridan, Lohr & Pignone, 2004; Robb & Shellenbarger, 2014; Weiss, 2003). Additionally, in order to make informed healthcare decisions, the information that individuals' access must be reliable, accurate, and usable (Bodie & Dutta, 2008; Raj, Sharma, Singh & Goel, 2016). Other multiple, compounding factors that affect an individual's ability to use health information, include cognitive, physical, social, and affective factors[4]. Kushniruk, Nohr, Jensen, and Borycki (2013) assert, "The usability of health information technology (HIT) has been increasingly recognized as being of critical importance in the design and deployment of systems that are both effective and acceptable to end users" (p. 78). The application of usability studies in the healthcare domain is considered the most challenging given the complex, variable, and range of health situations in which healthcare is delivered through the use of HIT (Kushniruk et al., 2013). Kushniruk et al. (2013) advocate for the usability testing of HIT whereby the context of use is a significant focus in order to make usability testing more relevant to the real-life use of the system by end-users.

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[4] Abbott, 2000; Albers, 2003; Alshamari, 2016; Eysenbach & Köhler, 2002a; Eysenbach, Powell, Kuss & Sa, 2002b; Georgsson et al., 2016; Silberg, Lundberg & Musacchio, 1997; Sillence, Briggs, Harris & Fishwick, 2007; Hibbard & Peters, 2003; Wozney et al., 2016

Usability Testing

Usability testing is a set of practices that aim to assess the degree to which a system is able to effectively and efficiently enable the individuals it was intended for to perform the tasks for which the system was designed (Bastien, 2010; ISO, 2018). Usability testing, such as clinical simulations and observations in-situ better mimic the real-life conditions under which HIT is used and bring to the surface the most serious usability problems (Kushniruk et al., 2005; Kushniruk et al., 2013). Health information design and usability is a requisite area of study in the health and medical field (Kushniruk et al., 2013; Russ et al., 2010) and the rhetoric of health and medicine (Melonçon & Frost, 2015), especially within the context of its complex interaction between numerous stakeholders, institutions, activities, and technologies. Born from the technical communication discipline and complimentary to communication design, Melonçon et al. (2015) maintains that the rhetoric of health and medicine is a capacious space where scholars explore how, "ideas, texts, methods, practices, and technologies work in a variety of healthcare contexts, and more importantly, how that information is designed" (p. 9), and describes the field as the merging of many disciplines, theories, and methods that focus on improving healthcare through, "timely, accessible, accurate, and understandable," (p. 11) health information delivered in different healthcare contexts. Within the context of these complex interactions, individuals must be able to interpret and obtain meaning from HIT, like the telemedicine provider websites analyzed in this study. Several researchers in the health and medical field and from the HCI discipline argue that technology acceptance and adoption ultimately hinges on the usability of the technology or system and users' perception of its usefulness (George, Hamilton & Baker, 2012; Hu, Chau, Sheng & Tam, 1999; Kushniruk, Borycki, Kitson & Kannry, 2019a; Tang et al., 2006a; Zhang et al., 2011).

Additionally, given the rapid increase in which individuals own and use mobile technology, such as smartphones, to access online information and mobile applications (Fox et al., 2012; Taylor & Silver, 2019), it becomes necessary to test the usability of telemedicine websites on these types of devices as a smartphone is one context of use in which users are likely to access telemedicine communications (Geisen & Romano, 2017; Melonçon et al.; 2015). Although responsive web design (RWD) is touted as a solution to dynamically adapt websites accessed on a desktop computer or large screen size for smaller screen sizes and mobile devices, the degradation of usability may still occur (Cazañas & Parra, 2017); therefore, usability testing on smartphones is an essential component of telemedicine interface usability testing (Aiyegbusi, 2020).

This study fills a void in research on the usability of DTC telemedicine communications; specifically, it provides a holistic understanding of the rhetoric in and design of DTC telemedicine communications and their relationship with usability. In so doing, this dissertation reveals usability problems that may not be anticipated by designers of HIT and health information providers, such as displaying labels and buttons that users do not interpret correctly. Drawing from the human factors, technical communication, and health and medical disciplines, this study offers a unique approach to examining the usability of eHealth. Specifically, I used several well-defined, systematic protocols and activities for collecting design, content, and usage data related to end-user interaction with DTC telemedicine interfaces. I used these approaches because they allow researchers to express specific features and properties of the interfaces that contribute to certain levels of usability. Additionally, such a mixed-methods usability study as presented here, can be replicated to examine the usability of other HIT and in other fields.

Problem

In this section, I will provide statistics and other contextual data illustrating the limited uptake and use of DTC telemedicine and argue that poorly designed, inadequate DTC telemedicine communications may be a key element contributing to this problem.

Despite the benefits of telemedicine, consumer and patient acceptance and adoption of telemedicine has been minimal and slow (Bullock, Vehe, Zhang & Correll, 2017; Ly, Labonté, Bourgeault, & Niang, 2017). Research from claims data and enrollment information on California public employee enrollees in the Blue Shield of California health maintenance organization plan determined that in the first 19 months of being offered Teladoc (a DTC telemedicine provider) as a covered benefit, only 3,043 members used Teladoc in comparison to 230,872 members who did not use the free benefit (Uscher-Pines et al., 2016). Teladoc users were not more likely to be located in rural areas and underserved communities (Uscher-Pines et al., 2016). Uscher-Pines et al.'s (2016) study indicates that telemedicine is not increasing access to healthcare within the rural communities who typically experience a shortage of physicians and lack access to healthcare. This situation is concerning given that telemedicine has been identified as a health intervention to help overcome the current and projected short supply of physicians (Bodenheimer & Smith, 2013; Uscher-Pines, Rudin, & Mehrotra, 2017). The Association of American Medical Colleges (2018) 2018 update to the final report on *The Complexities of Physician Supply and Demand: Projections from 2016 to 2030*, estimate that by 2030, the Nation will experience a total physician shortfall of between 42,600 and 121,300 physicians. If telemedicine is not being used by the underserved populations it is projected to service, then it is not fulfilling one of its potential benefits of increasing healthcare access to those who reside in remote geographic locations (Rafiq & Merrell, 2005).

Additionally, there are quality concerns regarding telemedicine. For instance, some telemedicine encounters, such as for acute bronchitis, are associated with more antibiotic prescribing than may be appropriate (Uscher-Pines et al., 2016). A similar quality concern regards the need for physicians to request strep tests when a patient's diagnosis is streptococcal pharyngitis (Uscher-Pines et al., 2016). The quality concerns regarding the healthcare delivered to patients with particular diagnoses indicate that while telemedicine is beneficial for individuals in need of healthcare for many health conditions, there are health contexts where telemedicine may not be suitable. For instance, if a patient feels like she or he might have strep throat, a traditional, in-office physician visit may be more appropriate. Consumers and patients may require more aggressive marketing and education in order to increase the use of telemedicine (Uscher-Pines et al., 2016).

In another study, after being offered Teladoc as a free healthcare option, enrollees were sent communications promoting Teladoc as an alternative to Emergency Department (ED) visits for nonurgent medical care; of the 306,027 eligible enrollees with Teladoc coverage, only 2,718 used the telemedicine service with 98 to 99 percent of the Teladoc visits being performed by telephone (Uscher-Pines et al., 2014). During the first 11 months of having access to telemedicine, Uscher-Pines et al. (2014) found that 76 percent of the enrollees used Teladoc only one time; seven percent used Teladoc three or more times. Although the introduction of Teladoc appeared to increase access to healthcare by individuals who were less likely to have used healthcare before, Uscher-Pines et al. (2014) found Teladoc users to be younger, healthier, have fewer chronic conditions, and to be slightly more affluent than users of other healthcare systems. In addition, more than a third of the Teladoc visits were accessed on weekends and holidays, when in-office physicians' consultations are not accessible. Lastly, Uscher-Pines et al.'s (2014) results indicate that only six percent of the telemedicine visits required a follow-up visit, whereas 13 percent of in-office visits and 20 percent of ED visits required a follow-up.

These data provide valuable insight into the use of telemedicine. While evidence of some of telemedicine's benefits of convenience and affordability are indicated, telemedicine is still underrepresented as a healthcare option, and more in-office physician consultations and ED visits are utilized for health conditions that could be managed using telemedicine. Even without impediments, such as reimbursement issues or policy constraints, low utilization rates of telemedicine remain (Grigsby, 2002) suggesting that the marginal use of telemedicine is more deeply rooted in the users' perception of telemedicine (LeRouge, Hevnerb & Collins, 2007). Furthermore, telemedicine appears to serve the younger, affluent population, who may be more technically inclined; yet, the majority of telemedicine use is via telephone. This indicates that telemedicine is not being used by medically underserved areas and populations (MUA/Ps), which it is one of the purported advantages of telemedicine (George et al., 2012).

Inadequate Telemedicine Communications

Technologies produced with poor design and inadequate consideration of the needs of their intended users will be difficult to learn, misused or underutilized, and will ultimately fail to accomplish their objectives (Maguire, 2001b). Thus, usability has been widely recognized as essential to the efficacy of technologies (Shackel, 1991). The usability of health information and health information technology (HIT) is even more critical given the implications on human lives. Design flaws and specific features of HISs and user interfaces have created usability problems that have led to medical errors (Kushniruk, Triola, Stein, Borycki, Kannry, 2004b; Kushniruk et al., 2010). Therefore, poorly designed Direct-To-Consumer (DTC) telemedicine websites that do not contain the information users need may be contributing to the limited uptake and use of DTC telemedicine.

Literature is saturated with instances where poor usability or inadequately designed eHealth have affected users' perception and ability to use the health information. Researchers report consumers' superficial understanding of telemedicine and consequently, marginal use of telemedicine (Welch, Harvey, O'Connell, and McElligott, 2017). In a nationwide survey using SurveyMonkey, Welch et al. (2017) found that out of the 84 percent of the participants who reported to have a primary care provider, only 5.3 percent knew that their primary care provider offers an online video consultation. Fewer still, 3.5 percent, reported to have ever used the telemedicine service to meet with their primary care provider (Welch et al., 2017). Welch et al. 's (2017) data indicate that of the participants who did not have a primary care provider, only 4.6 percent reported to have ever used telemedicine. Like Uscher-Pines et al.'s (2016) study, Welch et al. 's (2017) survey results further demonstrate that telemedicine does not appear to be increasing healthcare access for patients who already have limited access to healthcare.

Consumers and patients who lack knowledge of telemedicine's affordances may be dissuaded from using telemedicine. Improving patients' awareness that telemedicine includes remote communication with healthcare professionals and is a quality healthcare alternative may be accomplished with the delivery of more effective telemedicine communications, including the educational information on telemedicine websites and instructions for how to use the service. Edwards (2016) asserts, "Ongoing education about the telemedicine benefit is key. What does it treat? How can it be accessed? These are simple questions to answer and yet in most cases there is not much effort put towards providing this information." Carefully designed, usable telemedicine communications may contribute to patients being more accepting of a specific telemedicine service. Also, credibility, quality, and a social presence are recognized as important aspects of telemedicine that can be communicated to potential users with improved telemedicine communications (Alaiad et al., 2017; Eysenbach, 2000).

Patients may also avoid using telemedicine and not benefit from telemedicine when lacking knowledge of the health conditions that can be treated with DTC telemedicine. Patients can conveniently connect with a physician, virtually through a video chat, and receive treatment for strep throat, flu, and even rashes and yeast infections (Doctor on Demand, Teladoc). However, if an individual does not know that this type of telemedicine exists, the types of health conditions that can be treated, and that it is affordable, they will not access it. Telemedicine is a potential conduit for delivering healthcare to populations where accessibility is a problem, including rural, minority, and low-education populations (Kaufman et al., 2003). The internet is a mediator of telemedicine provider information, but without useful and usable telemedicine provider websites, patients will not understand what telemedicine is or how they can utilize the service.

Moreover, telemedicine communications must include effective discourse describing the suitable health situations consumers can use telemedicine for, as well as the contexts where a traditional, in-office visit may be required. Telemedicine providers are responsible for providing this type of salient information to individuals in order for them to make informed decisions regarding whether telemedicine is an appropriate form of healthcare in their time of need. Even early adopters of this new healthcare delivery system must have pragmatic and operational knowledge of how to implement a telemedicine service successfully and legally (as it applies to healthcare providers) and, above all, use it safely (as it applies to all healthcare participants).

Insufficient telemedicine provider communications can induce errors and comprise patients' safety.

Major design flaws can cause usability problems that lead to severe consequences, especially in the design of digital EMS systems, web-based medication dispension systems, and other telemedicine services (Bagchi, Melamed, Yeniyurt, Holzemer & Reyes, 2018; Johnson, Johnson & Zhang, 2005; Tang et al., 2006; Weisbord, Soule & Kimmel, 1997). For instance, Johnson et al. (2005) discovered that users were confused by the "save" and "finish" buttons in a HIS and failed to save important patient medical history. Designing and delivering effective, usable healthcare communications might contribute to increasing consumer acceptance of and adoption of telemedicine services—and most importantly, safe use of telemedicine.

Compounding the problem of the inadequate understanding of telemedicine is the low health literacy level most of the population has. Health literacy is defined by Weiss (2003) as, "an individual's ability to read, understand, and use healthcare information to make effective healthcare decisions and follow instructions for treatment" (pg. 4). Health literacy is key to consumers' knowledge of alternative medical interventions, patients' understanding and ability to execute services and treatment, perception of quality, as well as overall individual quality of life (Martínez-Alcalá, Muñoz & Monguet-Fierro, 2013; Melonçon, 2016; Melonçon, 2017). In order to use health information effectively to improve one's health, one must have a suitable level of health literacy. Numerous studies have indicated that more than 50 percent of Americans have intermediate or poor health literacy levels (Bodie & Dutta, 2008; Kutner, Greenberg, Jin, Paulsen & American Institutes for Research, 2006; Norman & Skinner, 2006); this statistic is even greater among racial and ethnic minorities and English as a Second Language (ESL) groups (Kutner et al., 2006). Health information (including telemedicine communications) must be designed to mitigate the affects of poor health literacy and optimize a user's comprehension of the information, and as a result, improve the usability and user experience (Guard et al., 1996; Lin et al., 2009; Monkman & Kushniruk, 2013b; Morony et al., 2017).

Despite the increasing availability of online health information and other HIT, the quality and usability of many of these alternative healthcare interventions have been found to be poor (Berland et al., 2001; Bernhardt, Lariscy, Parrott, Silk & Felter, 2002; Eysenbach & Köhler, 2002). The majority of online health information has been found to be insufficient, misleading, inaccurate, and difficult to read (Eysenbach, 2008; Eysenbach, Powell, Kuss, & Sa, 2002; Raj, Sharma, Singh & Goel, 2016; Smart & Burling, 2000). Furthermore, disparities exist in the ability of consumers to find, access, and use online health information (Abbott, 2000; Eysenbach, Powell, et al., 2002; Georgsson & Staggers, 2016; Silberg, Lundberg & Musacchio, 1997; Sillence et al., 2007; Wozney, et al., 2016). The results from previous studies demonstrate that despite the abundance of online health information, there are impediments to consumers finding reliable and trustworthy health information that can be used effectively to help them achieve their goals for use (Birru & Steinman, 2004a; Hibbard et al., 2003). Without sufficient health communications that elaborate on the quality of telemedicine and how to access a telemedicine service, consumers may not make the decision to use telemedicine; thus, they will not be able to use it to achieve a health-related goal.

Consumers and patients often retrieve health information "just in time," which is at the time they need it the most and are most likely to act on the information (Eysenbach, 2005). If individuals do not find the information they are seeking immediately once landing upon a health information website, they often reject the website, leave, and do not benefit from the health information (Sillence, Briggs, Fishwick & Harris, 2006). Similarly, telemedicine provider websites must communicate to users that telemedicine is a quality healthcare alternative, as well as inform on how to perform a telemedicine consultation using their service. Designers of telemedicine provider interfaces must account for the real-life context the user is in when accessing the telemedicine communications and their ability to use the instructions for performing a virtual doctor visit effectively. Real-life situations that involve HIT require users, who may be under stress, to integrate complex information and involve strenuous problem solving (Kushniruk et al., 2019a; Mirel, 2004). HIT is one of the most significant growth areas for usability and UX researchers given that many health systems fail because designers and developers do not account for the real-life health contexts and use by end-users (Kushniruk et al., 2019a; Mirel, 2004; O'Connor et al., 2016). Along with a user's ability to understand and use HIT effectively, users' acceptance and adoption of a new technology hinges on her or his perception of the affordances of the technology and the similarity with her or his past experiences with technology (Bagchi et al., 2018; George et al., 2012). Even though telemedicine may provide benefits and increase healthcare access, if users are not aware of it, do not understand its affordances, or are able to use it due to their limited health literacy, then telemedicine will have limited uptake and adoption by those it is touted to help the most.

Significance of Study

Empirical research is necessary to the understanding of how users interact with DTC telemedicine websites because it allows researchers to be able to identify usability problems that may shape users' perspective, understanding, and use of telemedicine. Empirical evidence is necessary to bring to surface usability problems that representative users encounter as they interact with a technology, and this data also helps explain users' motives and reasoning for performing certain actions and tasks during their interaction with a technology. Considering the benefits of telemedicine and the limited use by consumers, it is necessary to examine variables that may hinder widespread consumer adoption of telemedicine. Moreover, individuals who may benefit the most from telemedicine, such as those in remote areas where medical providers are a limited resource or low-income, uninsured patients, are likely more vulnerable to experiencing usability problems when interacting with telemedicine communications; thus, understanding how the rhetoric in and design of telemedicine provider communications affects usability is essential. Such insight can inform the design and delivery of more effective and useful telemedicine communications that may increase the use of telemedicine.

More than ever, scholars and healthcare practitioners are recognizing the need to perform usability testing with real-life, target end-users in order to evaluate the usability of HIT and be able to design HIT that is going to be used appropriately, effectively, and safely by all stakeholders (Eysenbach, 2008; Johnson et al., 2005; Kaufman et al., 2003; Kinzie, Cohn, Julian & Knaus, 2002; Kushniruk & Patel, 2004a; Kushniruk et al., 2013; Wolpin et al., 2015; Zhang et al., 2011). This project examines the design and usability of telemedicine communications in order to understand how users interact with them and become informed by them. This project also focuses on accessing if users can successfully perform a telemedicine consultation from the discourse included in the telemedicine communications. The overall objective of this research is to identify the rhetoric in and design elements of telemedicine provider communications that contribute to poor usability. In addressing such factors, the results of this empirical research can provide important insights into the barriers of productive participation in DTC telemedicine that may be assuaged by more effective and usability telemedicine communications.

Purpose

This dissertation examines the design and usability of telemedicine interfaces, which include the telemedicine provider websites and mobile phone interfaces. Insufficient telemedicine communications and usability problems are probable root causes of the limited consumer awareness and use of telemedicine. The careful design of and the inclusion of rhetorical content and health information on telemedicine interfaces may increase their efficacy to improve consumer awareness of, knowledge of, and use of telemedicine services. In this section, I discuss the purpose of my study of DTC telemedicine communications. I provide an explanation of why I choose to study DTC telemedicine communications in order to understand how telemedicine communications influence individuals' knowledge of telemedicine and their use of telemedicine as these are barriers to telemedicine acceptance and adoption. I also provide examples in the literature that emphasize the need to study the usability of telemedicine communications.

In my review of the literature on this topic, I located only one study that directly examined the content in telemedicine communications and users' understanding of it; however, this study examined telemedicine leaflets (Kayyali et al., 2017). Following a content analysis of telemedicine leaflets and interviews with potential telemedicine users, the researchers found many disparities between the information that potential telemedicine users needed and what was actually presented in the telemedicine leaflets (Kayyali et al., 2017). For instance, Kayyali et al. (2017) found that many of the telemedicine communications failed to address the key information that users needed and wanted, such as step-by-step guidance of how to use the telemedicine service. Insufficient telemedicine communications may contribute negatively to consumers' adoption and participation in telemedicine services (Kayyali et al., 2017). The rhetoric in and design of telemedicine communications should be carefully considered as a potential strategy to enhance telemedicine uptake and use by consumers.

DTC telemedicine communications must also contain quality indicators so that individuals perceive telemedicine to be a healthcare option similar to that of traditional healthcare and are more willing to use it. A patient's perception of quality and trust in a healthcare service is mediated by many constructs (Alrubaiee, 2011; LeRouge et al., 2007). Healthcare quality is a composite of socio-technical attributes, whereby some indicators of quality are physical, such as the facilities and equipment used (Alrubaiee, 2011; LeRouge et al., 2007). Other quality indicators are intangible, such as the level of empathy the physician expresses, personalized attention, and interpersonal warmth, which may emanate from face-to-face contact (Alrubaiee, 2011; LeRouge et al., 2007). These socio-technical aspects of healthcare engender patient trust and satisfaction and motivate patients to use a healthcare service (Alrubaiee, 2011; LeRouge et al., 2007). Likewise, the lack of any one of these socio-technical aspects of healthcare delivery, such as the face-to-face contact with the physician, has been observed to be a barrier to patients' adoption of telemedicine; patients' perceive telemedicine to be of less value (Alaiad et al., 2017; Bagchi et al, 2018; Huang et al., 2016; O'Connor et al., 2016). Understanding patients' perception of telemedicine is, thus, crucial for patients' perceptions of telemedicine prior to use contribute significantly to their willingness to accept and adopt telemedicine services (Choi, Wilson, Sirrianni, Marinucci & Hegel, 2014; Cranen, Veld, Ijzerman & Vollenbroek-Hutten, 2011; Huang, Lu, Alizadeh, & Mostaghimi, 2016).

An individual's knowledge of telemedicine and how to use a telemedicine service is obtained from the individual's initial access of and interaction with a telemedicine provider communication. Discourse cannot be separated from one's context of use and this has considerable influence on a user's interaction with and interpretation of information (Bernhardt, 2004; Nardi, 1996). Essentially, telemedicine provider interfaces are the tools users interact with during the activity of performing a virtual physician visit. Bødker (1991) argues that all human activity is bound to a goal, which is aimed at solving problems or directed toward another object. Individuals use telemedicine communications in a particular context of use (when they are ill and seeking healthcare) to perform the tasks necessary to access a virtual physician visit. Hervás and Bravo (2011) call attention to the pervasive amount of information that individuals must manage and analyze on a daily basis and that individuals use this information to make decisions and to perform actions. Provided by the sophisticated technology available today, effectively designed and intelligent user interfaces may help provide users, "with the right information at the right time, in an appropriate manner and through the most suitable device for each situation" (Hervás & Bravo, 2011, p. 40).

Individuals' information needs are dependent upon their context of use. If individuals are experiencing a health situation where they have a need to access a telemedicine communication, they are likely anxious, stressed, or experiencing cognitive deficits, which will affect their ability to use health information they encounter and access. Within this context, telemedicine communications must quickly and effectively exhibit to users that it is a quality healthcare delivery method and support users' information needs in terms of how to use the service (Hervás et al., 2011). For instance, Sillence et al. (2007) analyzed users' interaction with and perception of health information websites and found that poor navigation, too much text and complex information, and too many pop-ups were reasons for users to rapidly reject a website; and therefore, not use it. These content and design flaws contributed to poor usability and resulted in the users not trusting or using the health information provider (Sillence et al., 2007). Freeman &

Spyridakis (2004) reported similar findings when examining factors that affect users' perception of online health information websites. Users' perception of credibility is based on quick judgements regarding the design and layout of the information, rather than on the actual quality of the health information provided (Freeman et al., 2004). These and other studies suggest that the design of a website carries more weight than all other factors in terms of its influence over users' first impressions of a website and in their decision to leave the website and unwillingness to use the healthcare service (Allen, Currie, Bakken, Patel, and Cimino, 2006; Freeman et al., 2004; Sillence, Briggs, Fishwick & Harris, 2004).

This prior research indicates that more qualitative usability research is needed to elucidate on the human factors and design aspects that affect the usability of DTC telemedicine interfaces and that may contribute to the limited uptake and use of telemedicine (Kushniruk et al., 2019a; Kuziemsky et al., 2013). Such research is essential as major catastrophic problems in the design and usability of HIT are often only discovered when performing usability testing with end-users of the technology (Breakey et al., 2013; Johnson et al., 2005; Kushniruk et al., 2004). Additionally, prior usability testing research has revealed several design flaws result in usability problems. Usability problems that have been associated with flaws in the design of a HIT include: poor navigation; poor aesthetics; complex and busy layout, lack of understanding of terminology, lack of status visibility; and inadequate error messages—all of which hinder how effectively individuals can locate, access, and use needed information' ability to [5].

The usability of telemedicine communications and eHealth is critical because, if effective, they can lead to positive health outcomes. Ineffective or poorly designed telemedicine

[5] Allen et al., 2006; Corrao, Robinson, Swiernik & Naeim, 2010; Damman, Hendriks, Rademakers, Delnoij & Groenewegen, 2009; Johnson et al., 2005; Kushniruk et al., 2019a; Kushniruk, Monkman, Kitson & Borycki, 2019b

communications, however, can create performance-related errors, miscommunication, or require high cognitive effort for users, and be detrimental to individual's lives (Lin, Vicente, Doyle, 2001). Patients are the primary consumers of telemedicine communications, and thus, designing information in ways that support their information needs, on whatever device they use, must be the primary focus of telemedicine communications.

Research Questions

This section offers a brief summary of my research questions and the mixed-methods study I performed in order to answer these questions. The primary aim of this study drove the combination of qualitative and quantitative research methods used and developed. Specifically, I performed a mixed-methods study of DTC telemedicine communications. In my study, I analyzed the rhetoric in, design of and usability of existing DTC telemedicine provider interfaces in order to discover the type of content and information they provide and whether individuals are able to use them effectively to achieve specific goals.

Evidence that telemedicine is being minimally used as an alternative health intervention (Bullock, et al., 2017; Ekeland, Bowes & Flottorp, 2010; Ly et al., 2017; Martínez-Alcalá et al., 2013; Uscher-Pines et al., 2014) and understanding that individuals access online health information and use it to make decisions about their health and perform healthcare activities (Eysenbach, 2005; Eysenbach & Diepgen, 1998) indicates a gap in research on how telemedicine providers are communicating to consumers about their telemedicine service. Without sufficient telemedicine communications delivered by telemedicine providers via their corporate website, consumers may not make the decision to use telemedicine or be able to use the information to achieve a health-related goal.

My study addresses this gap in research on the usability of telemedicine provider communications and contributes to the knowledge on how users interact with telemedicine provider interfaces in different contexts with the following research questions:

1. What rhetorical content, information, and design strategies are currently used in telemedicine interfaces?
2. When described a particular health-related scenario, in what context of use are potential telemedicine users most likely to access a specific telemedicine communication? Put another way, where might a potential telemedicine user be when accessing the telemedicine provider website, and where might a potential telemedicine user be when accessing the telemedicine provider mobile interface?
3. How effective and usable are telemedicine interfaces and communications from the consumer perspective? Are users able to find and comprehend the information they need to perform certain actions and activities?
4. How likely are potential telemedicine users to access and use a telemedicine service following their interaction with and engagement with the telemedicine providers' communications?
5. Are potential telemedicine users able to perform a telemedicine consultation following their interaction with the telemedicine provider communication or interface? Which telemedicine provider communication is most effective at mediating users' activities to reach the goal of performing a telemedicine consultation?

In order to answer these research questions, I used a combination of data and insight attained from performing mixed-methods consisting of three parts. Performing mixed-methods afforded a multifaceted understanding of the usability of telemedicine communications with increasing degrees of reliability, fidelity, and validity (Figure 1) (Kushniruk, Patel, Cimino & Barrows, 1996; Kushniruk et al., 2013).

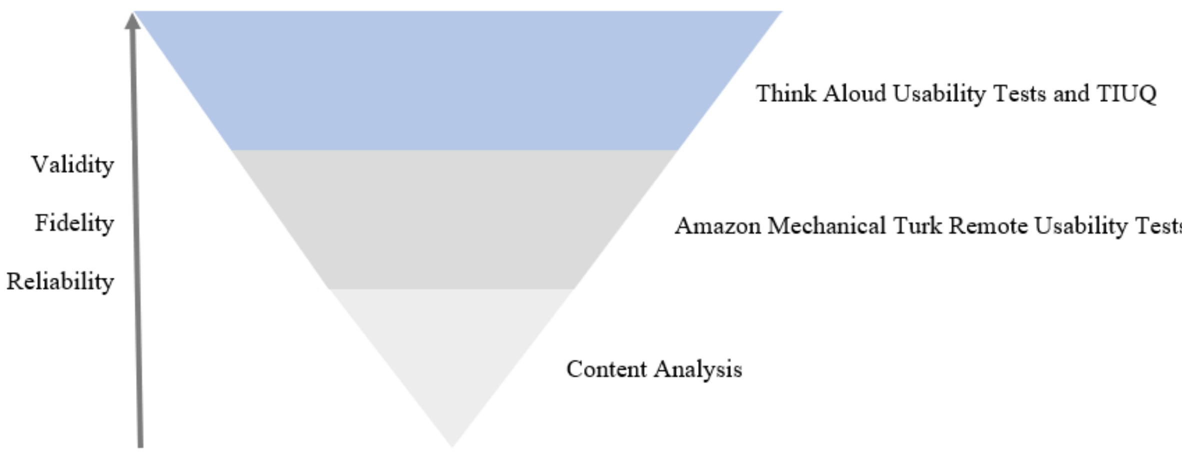

Figure 1: Mixed-methods Study: Each Part Affords an Increase in Reliability, Fidelity, and Validity

I selected three telemedicine provider interfaces as the sample of telemedicine communications to examine for this study: Teladoc, KADAN Institute, and Carie Health. The first part of my research involved doing a systematic content analysis examining the content and information provided on telemedicine providers' websites and their corresponding mobile-responsible sites. The second and third parts of my study were comprised of a series of usability tests using survey and think aloud methodology. One usability data set was conducted remotely via Amazon Mechanical Turk using a survey consisting of questions asking participants to locate specific information and perform various tasks and respond with yes or no or a description of the process. The survey results offered subjective user-feedback from a large, heterogenous population sample and quantitative data measuring task completion. The think aloud usability tests were conducted in-person using undergraduate student subjects and video-recorded to obtain rich qualitative data. During the think aloud usability tests, participants were asked to complete a testing protocol that had them interact with telemedicine provider websites and locate specific information while describing their thought process aloud. Subjects were video-recorded to capture their actions and verbal reports. The video recordings were coded according to a principled coding scheme and other inferred themes that emerged identifying usability problems (Kushniruk et al., 2004, Kushniruk et al., 2019a). Each participant completed a Telemedicine Interface Usability Questionnaire (TIUQ) adapted from the System Usability Scale (SUS) (Brooke, 1986), the Post-Study System Usability Questionnaire (PSSUQ) (Lewis, 1992), and the Telehealth Usability Questionnaire (TUQ) (Parmanto, Lewis, Graham & Bertolet, 2016) following their usability test in order to obtain their subjective evaluation of their experience using the telemedicine provider interface. These three data sets offered me a multifaceted understanding of the usability of telemedicine communications from which I was able to draw insight and contribute both theoretical and practical implications. This study has theoretical implications because I use activity theory and mobile interface theory to analyze the healthcare activity of individuals' interacting with telemedicine provider websites in various contexts. Mobile interface theory is innovatively employed to conceptualize individuals' interaction with their mobile device and thus further develops this theoretical framework. By carefully constructing my study and detailing the methods I used, this study has implications for both researchers and industry professionals. Both the academic and industry communities are able to replicate and execute the methods used in this study, or even one part, and evaluate any HIT in other contexts, to gain user feedback. It is my hope that researchers replicate this study's methods and continue to develop rigorous ways to perform empirical research. Industry professionals can implement usability testing, such as the remote usability testing performed in this study, and the useful user insight can be directly fed back into the design of more usable HIT.

This mixed-methods study represents a novel integration of methods from the fields of HCI, cognitive science, and health and medicine that contribute to the improvement and development of rigorous, yet pragmatic scientific research for the assessment of the usability of health and medical communications and user interfaces and can be replicated in future usability studies (Kushniruk, Patel & Cimino, 1997).

The primary goal of this research is to develop a clearer understanding of the rhetorical content and design attributes that may lead to more effective, usable telemedicine communications. Telemedicine, eHealth, and other HIT are important healthcare delivery mechanism and sources of health information for individuals today given the availability of sophisticated information technology; thus, efforts to increase the usability of health information delivered through these methods are vital to arming individuals with the knowledge and skills they need to be active participants in their health, share in the clinical decision-making process, and improve their health (Brennan et al., 2006; Fox et al., 2000)—one of the key goals of patient-centered care (Stewart, Brown, Weston, McWhinney, McWilliam, Freeman, 1995; Institute of Medicine, 2001; Wolpin et la., 2015). How individuals respond to communications is largely determined by the design of the information in a communication and the usability of the interface. Without a clear understanding of how individuals use the information delivered by telemedicine providers, it is unknown the implications insufficient telemedicine communications have on the awareness and uptake of DTC telemedicine.

This study identifies significant usability problems and provides design recommendations to HIT designers and health information providers that will improve the effectiveness and usability of telemedicine. Achieving this objective will likely augment the use of telemedicine. Additionally, this study offers a novel and pragmatic approach to usability testing by employing mixed-methods and data analysis using a video-coding software and a principled coding scheme along with thematic analysis. My methods and approach to usability testing and findings contribute to and can be applied in the human factors, technical communication, and health and medicine fields.

Organization

In this dissertation, I discuss health information communication technology and usability from a human factors perspective in order to express the relevancy to DTC telemedicine communications. I explain my research methods, results, and conclusions drawn from the empirical data. Chapter One is an introduction to my research topic and questions. Chapter Two is a review of the literature on the usability of telemedicine, eHealth, and other HIT. In Chapter Three, I describe how I employ activity theory and mobile interface theory as my theoretical frameworks. In Chapter Four, I elucidate on my mixed-methods research consisting of content analysis, think aloud usability testing, and survey methodologies. In Chapter Five, I present the results of my data analysis and usability problems discovered. In Chapter Six, I discuss the usability of the telemedicine interfaces study as it pertains to my research questions. Finally, Chapter Seven is a conclusion where I provide specific recommendations for health information providers and practitioners and future research needed. This organization allows readers to understand the healthcare context where more usability telemedicine communications are needed and how this motivated my research questions. This structure also supports readers' understanding of how the theories used in this study, activity theory and mobile interface theory, guided the design of this study and the methods used, and prepares readers to be able to conceptualize how I applied activity theory and mobile interface theory to gain insight into users' complex interactions with telemedicine communications. Lastly, the organization of this dissertation allowed me to end by offering practical guidance for the design and delivery of usable health information and other technology that users interact with.

CHAPTER TWO – LITERATURE REVIEW

Although current knowledge of telemedicine stems from its rapid increase in popularity, telemedicine has a deep and rich history. In this section, I will first describe the four main types of telemedicine and provide a brief history of telemedicine. Considering the various types of telemedicine, there is a breadth and depth of literature regarding specific types of telemedicine, such as remote home monitoring (Agnisarman, 2017; Alaiad et al., 2017) and health information websites (Raj et al., 2016; van den Haak & van Hooijdonk, 2010), and mobile health applications (García-Gómez et al., 2014; Schneider et al., 2016), as well as more focused studies on patients' perceptions of telemedicine (Bullock et al., 2017; George et al., 2012; Jaber, Ghani & Herman, 2014), health literacy (Morony et al., 2017; Norman et al., 2006), and the usability of telemedicine and health communications (St.Amant, 2017b; Wozney et al., 2016). Thus, only a few studies on the usability of telemedicine and eHealth will be discussed as these are most relevant and related to the focus of my research. Lastly, major barriers to individuals' acceptance of telemedicine and use will be discussed followed by a comprehensive description of the critical factors that impact the usability of health information, specifically focusing on contextual and individual determinants of telemedicine and eHealth usability. Although it is difficult to broadly review telemedicine because of the diverse modes of delivery and unique implementation settings, the literature discussed in the next section will provide an overview of the types of studies performed regarding telemedicine and describe the current healthcare landscape. The literature presented also demonstrates the gap in research on the usability of telemedicine provider websites, which is evidence supporting the need to investigate the usability telemedicine provider communications.

Types of Telemedicine

Telemedicine is the practice of healthcare delivery, diagnosis, consultation, treatment, transfer of medical data, and education using interactive audio, video, or data communication (Ashley, 2002). According to the American Telemedicine Association, there are about 200 telemedicine networks in the United States (U.S.) and nearly half of all U.S. hospitals use some form of telemedicine. The extent and variation to which telemedicine is being employed across the U.S. raises the question: What are the different types of telemedicine?

Telemedicine encompasses a wide range of methods of providing and delivering health and medical services through the use of computational technology, including: diagnosis, consultation, treatment, education, care management, and self-management. As a part of the patient-centered care paradigm, the World Health Organization explains that telemedicine and HIT are continuously evolving to adapt to the changing needs of patients and contexts of use, but the focus is always to meet the needs of patients and to improve health outcomes (2010). There are four main types of telemedicine—or mechanisms of health care delivery—depending on the mode of health information and data storage, transport, and use, as well participating users. The four telemedicine types are: Synchronous, Asynchronous, Remote Patient Monitoring, and Mobile Health (Harlow, 2016; Northeast Telehealth Resource Center). Regardless of the type of telemedicine, the four main objectives of telemedicine are: one, to use information communication technology (ICT); two, to provide clinical support; three, to overcome geographical barriers by connecting to users remotely; and four, to improve health outcomes (WHO, 2010).

Synchronous telemedicine is live, real-time, two-way interaction between two physicians or a physician and a patient via audiovisual technologies. DTC telemedicine is typically delivered to patients synchronously. Patients register online or call into a live call center and provide simple medical history and request a virtual consultation (Uscher-Pines et al., 2014). Within a few minutes, a doctor calls the patient or they perform a live video consultation with the patient, in real-time (Uscher-Pines et al., 2014). Synchronous telemedicine providers include, Teladoc and Doctor On Demand (Lake, 2018; Roland, 2015; Siwicki, 2017). This synchronous approach to telemedicine is the type of telemedicine that will be the focus of the research presented in this dissertation.

Asynchronous telemedicine is when the acquisition and storing of clinical information, such as medical data, images, sounds, and video, is then transmitted via a secure electronic communications system (maintaining Health Insurance Portability and Accountably Act (HIPAA) compliance) to a common access site or to a physician with specialty expertise for review. Following the physician's' review of the patient's medical data, the patient receives the physicians' diagnosis and treatment directions via the secure electronic communications system (Armstrong, Sanders, Farbstein, Wu, Lin, Liu & Nesbitt, 2010; Hwang, Lappan, Sperling & Meyerle, 2014). Asynchronous telemedicine is also termed, "store-and-forward," and is the most frequently used form of telemedicine in the U.S. Department of Defense for teledermatology consultations for active duty military members who are serving in remote geographic locations (Hwang, Lappan, Sperling & Meyerle, 2014).

Remote Patient Monitoring is the use of wireless networks and electronic communication technologies to collect and transmit patient personal health and medical data from one location to a medical provider location for use in monitoring the patient's condition, care of the patient, and related support (Alaiad et al., 2017; Jasemian & Nielsen, 2005). This type of service allows a provider to continue to track healthcare data for a patient once released to her or his home or a care facility, thereby, reducing readmission rates, lowering healthcare costs, and enhancing patient safety and comfort (Alaiad et al., 2017; Jasemian et al., 2005). For example, wireless-sensor networks (WSN)-based smart home healthcare systems (SHHS) are wireless networking and sensor technologies that are integrated into patients' existing electronic infrastructure in their homes (Alaiad et al., 2017). These sensors are small, require low-power, and are smart medical devises that record and transmit patient medical data to an off-site medical provider for remote patient monitoring and/or real-time communication (Alaiad et al., 2017). The American Telemedicine Association reports that worldwide millions of patients use the remote home monitoring type of telemedicine to monitor their vital signs outside of the hospital.

Mobile Health or *mHealth*, similar to eHealth, is the delivery of healthcare or health and medical information/education that is supported by mobile communication devices such as cell phones, tablet computers, and personal digital assistants (PDAs) (García-Gómez et al., 2014; Schneider et al., 2016). Applications can range from targeted text messages that promote healthy behavior to wide-scale alerts about disease outbreaks, to name just a few examples (Garg et al., 2016; Kannisto, Koivunen & Välimäki, 2014). This type of telemedicine includes continuous glucose monitoring systems, mobile disease self-management apps for Smartphones, and online symptom checkers (Chiu, 2016; Coughlin, 2017; García-Gómez et al., 2014).

Given the affordances of ICT today, there is a wide range of opportunities for telemedicine and methods for consumers to access healthcare. For the study presented here, I decided to focus on synchronous telemedicine because it is widely available to consumers, offers several benefits, and from my professional experience in the health and medical industry managing corporate websites, website design and delivering usable health information is not a top priority despite it being a marketing strategy to promote health products. This inspired me to inquire about how telemedicine providers are promoting their service online and designing their corporate websites.

History of Telemedicine

Many of telemedicine's early projects have been initiated and funded by the U.S. government. The Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) project, active from 1973 to 1977, was a telemedicine service devised to provide medical care to remote populations (Freiburger, Holcomb & Piper, 2007). Few know that telemedicine has been used for nearly 40 years; the term, *telemedicine*, was first mentioned in literature in 1950, but its first application has not been established (Zundel, 1996). Much of telemedicine's early administration was through the U.S. government (Institute of Medicine (U.S.) Committee on Evaluating Clinical Applications of Telemedicine, 1996; Mahar, Rosencrance & Rassmussen, 2018; Zundel, 1996).

The American Indian population has been a focus of telemedicine projects because of this group's sparse and remote distribution across the U.S., low-socioeconomic status, and digital divide that impedes their ability to obtain timely and relevant healthcare access and information (Dick, Manson, Hansen, Huggins & Trullinger, 2007). Federal funding often neglects local health priorities, such as the creation of multimedia health education that is more impactful to the local community. To remedy this issue, the American Indian and Alaska Native Programs (AIANP), at the University of Colorado at Denver Health Sciences Center, implemented a Native Telehealth Outreach and Technical Assistance Program (NTOTAP), in 2003. The

NTOTAP was designed to not only provide technical training to local community health professionals, but also increase the community's access to healthcare resources and promote its sustainability. Although the initial NTOTAP took place for only 18 months, Dick et al. (2007) argue that the NTOTAP was a unique opportunity for Native American locals to use their own creativity and expertise to develop appropriate and culturally relevant health education materials to increase the health literacy of the local population—those who would most need it. Furthermore, this telemedicine initiative also encouraged the rise in the availability of technology in remote geographic locations as the local health advocates now had the technical expertise to create multimedia health resources. Because telemedicine is intended to provide remote delivery of healthcare via telecommunications, studies that showcase the viability of this delivery method in meeting the health needs of those in remote populations is valuable.

The history of telemedicine is punctuated with examples of use by the U.S. Government. Telemedicine has been highly used by the U.S. Department of Defense (DOD) to deliver sophisticated healthcare services to military members who are deployed to remote and austere environments locally and overseas (Hwang, Lappan, Sperling & Meyerle, 2014). Telemedicine offers active duty military members point-of-care healthcare through technology and communication systems allowing the solider to receive healthcare services faster and to avoid medical evacuation. The "store and forward" process has been used for referring physicians to transmit digital images and clinical history electronically via a secured email transport system to a common access point for specialist physicians to access and to respond with diagnoses and treatment plans to be delivered to the solider at her or his point of care (Hwang et al., 2014).

The benefits of telemedicine are demonstrated by several examples of early utilization to deliver healthcare services and education to individuals and communities in remote environments and in geographic locations where sophisticated healthcare resources are scarce. Moreover, telemedicine has not only been used to deliver healthcare at a distance, but also to provide health services to individuals using more meaningful, relevant methods that will help them most and in their time of need. Provisioning more meaningful health communications to target audiences is visible in Dick et al.'s (2007) technical training of Native American health advocates in order to help them develop multimedia health education materials that are pertinent to the Native American population, such as the video providing preventive and descriptive information on Hepatitis C or the interactive CD-ROM for elementary school students focusing on the effects of alcohol and other drugs on the body (Dick et al., 2007). Other benefits of telemedicine are evident in the U.S. DOD's deployment of telemedicine that delivers nearly immediate specialty healthcare to active duty military personnel at their remote point-of-care location, allowing them to avoid medical evacuation and delayed access to healthcare (Hwang et al., 2014).

Early deployment of telemedicine using the "store and forward" process or less mature forms of electronic communication comprise the history of telemedicine. Modern approaches using more sophisticated technology, such as mobile health applications (Agarwal et al., 2019; García-Gómez, 2014; Jasemian et al., 2005) and SMS messaging (Garg et al., 2016), are customary in today's society and more heavily researched. Yet, few studies have been replicated or repeated making evidence the need for rigorous research on telemedicine.

Current Telemedicine Usability Research

Although telemedicine is still in its infancy, it is gaining in popularity due to the rise in healthcare costs, the increasing number of patients, and the lack of physicians—both primary and specialty—to service these patients. That said, there is still a dearth of research or studies on the usability of telemedicine. Telemedicine usability research began in the mid-1990s to early 2000s, with a focus on patient safety, as researchers recognized the need to characterize barriers to the productive and safe use of HIS (Kaufman et al., 2003; Kushniruk et al., 2004b). More recently, usability studies center on the quality of online health information and users' comprehension level (Eysenbach, 2005; Sillence et al, 2007).

A factor confounding this situation is there are so many variations of telemedicine, circumstances under which telemedicine is implemented, and stakeholders involved, it is a problematic and nuanced subject to undergo extensive scrutiny within the confines of one study. Although there is a mass of literature on users' access and use of eHealth, to my knowledge, there is no study that addresses the specific DTC telemedicine interfaces and communications that this research seeks to examine. This situation is problematic because DTC telemedicine websites are likely the only method telemedicine providers use to communicate to individuals about their service, and users may access these websites on a number of devices. Thus, it is essential that telemedicine provider websites be designed for usability in many contexts. In this section, I will describe some current research studies on various types of telemedicine and end with a specific focus on the available research on DTC telemedicine. As noted, many telemedicine studies are pilot studies, case studies, or based on ethnographic research, for instance interview and survey data, which indicates the gap in empirical research on how users interact with telemedicine communications. My research seeks to address this gap by performing mixed-methods to examine the rhetorical content in and design of DTC telemedicine websites and relate it to the usability problems I observed users encounter during their interactions with telemedicine provider websites.

Both qualitative and quantitative methods have been used to study the use and usability of telemedicine. Telemedicine is used to educate lay individuals and other healthcare professionals, as well as to deliver sophisticated healthcare to those who would otherwise not have access to healthcare or have limited access to the specific medicine expertise needed, such as dermatology and immunology. For instance, de Souza et al. (2017) performed semi-structured interviews of physicians at a high technology hospital that leveraged telemedicine to educate physicians at a unit hospital situated in a remote geographical location to improve their delivery of healthcare to their patients. Although the affordances of the telemedicine system mirrored many mediated telemedicine benefits, such as increased access to medical expertise for the remote and rural settings and cost savings, despite these benefits, de Souza et al. (2017) reported that the telemedicine system was minimally used. One of the main utilization barriers was lack of acceptance of telemedicine by the remote unit professionals (de Souza et al., 2017).

Alaiad, et al. (2017) added to the research on remote monitoring telemedicine systems with their study of a wireless-sensor networks (WSN)-based smart home healthcare system (SHHS). The combined WSN-SHHS is a home-based telemedicine system that monitors patients and transfers medical data to medical providers through the integration of small, low-power, medical sensors into patients' existing home electronic infrastructure. Alaiad, et al. (2017) performed a mixed-methods study of patients' adoption of WSN-SHHS to determine the unique characteristics of the telemedicine system that facilitate and prevent patient adoption. To triangulate data and acquire greater validity, Alaiad et al. (2017) used interview and survey methodologies to gain quantitive data to understand patients' perception of the home monitoring system. Alaiad et al. (2017) discovered that the human-quality of the telemedicine system was more important to patients than its performance. Patients' desired the interpersonal contact with a physician that the telemedicine system was unable to emulate. Patients appeared to experience an emotion of human detachment by the lack of physical touch, and “they did not see that anything technological will replace that” (Alaiad et al., 2017). Alaiad et al. (2017) recommended that telemedicine systems be designed in such a way as to not only support patients’ self-care, but also enhance the social presence of physicians through the communication system. This situation demonstrates that context of use is a significant factor to consider when designing not only telemedicine systems, but the communications and messages that promote the service. Designing and delivering telemedicine communications that call attention to the social aspect and emotional support that the telemedicine service offers may facilitate consumers’ intention to use the telemedicine service and encourage consumers to use it.

Walsh et al. (2017) performed a content analysis of online educational and promotional resources used to motivate consumers to use MyHR, an Electronic Health Record (EHR), which would enable patients to better manage their own health. Walsh et al. (2017) attributed barriers to user adoption and utilization of EHRs were, in part, due to poor usability and sought to analyze the existing content and resources available to consumers according to several themes, including: readability, currency (timeliness), information source (credibility), target audience, and presentation style. Walsh et al. (2017) found that most of the online information was text-based and lacked interactive content, was written at readability grade levels too difficult for the average consumer, and may lack in essential information for certain target audiences that would encourage the use of MyHR. Walsh et al. (2017) recognizes the that online educational and promotional information is a significant marketing tool used to motivate consumers and increase the uptake of EHRs. Similarly, DTC telemedicine provider websites are tools used to motivate consumers and promote DTC telemedicine. Performing content analyses is one method to examine how existing healthcare companies are communicating to consumers about their products online.

Georgsson et al. (2016) used a standardized approach to assess the usability of an mHealth diabetes management system with usability measuring instruments, such as the SUS and task performance measurements. The qualities of usability defined by the ISO 9241-11 (2018) were used to assess performance efficiency and user satisfaction against relevant user characteristics, such as demographics, gender, and age. To gain objective, quantitative data, Georgsson et al. (2016) measured subjects' effectiveness (total number of errors), efficiency of task completion (time to complete), and satisfaction (SUS)—these data, Georgsson et al. (2016) argue, can be used to provide design benchmarks for the development of decision aids for chronic disease (Georgsson et al., 2016).

Although males, younger individuals, and individuals who had more technical expertise performed slightly better and had higher satisfaction scores, nearly one-third of the participants rated the mHealth system to have poor usability (Georgsson, et al., 2016). It is evident that individual characteristics influence how one interacts with a telemedicine system (Georgsson, et al., 2016). Other scholars have implemented the SUS or a modified version to appraise the usability of telemedicine (Richardson et al., 2017; Kandemir & Bağ, 2018; Wozney et al., 2016).

In addition, a myriad of telemedicine studies that employ user-centered design processes or perform usability testing with real end-users stress the value of end-user involvement in the design of telemedicine and HIT (Gerdes, Smaradottir & Fensli, 2014; Kinzie et al., 2002; Plaisance et al., 2018; Taylor, Sullivan, Mullen & Johnson, 2011; Yen & Bakken, 2009). Often, more severe usability problems are able to be discovered that would not have been identified without collaborating with end-users (Allen et al., 2009; Peute et al., 2015b; Yen et al., 2009).

The insight gained from real end-user feedback suggests that there is a gap between designers' conceptual model of a telemedicine system and users' conceptual model of how the system should work. Kinzie et al. (2002) concur, "Design experts are often experienced technology users and can frequently overlook problems that more novice technology users will have with a Web site" (p. 326). A conceptual model, or mental model, is a user's understanding of how she or he intends to perform a task or solve a problem during an activity (Peute, de Keizer & Jaspers, 2015a). An individual's mental model includes the internal, personalized, and contextual understanding of how an user interface is designed to be used (Peute et al., 2015a).

Similarly, other researchers have endeavored to develop standard, principled methods for evaluating the usability of HIT, but they emphasize that both objective and subjective user metrics must be measured when evaluating usability (Kushniruk et al., 2019a; Peute et al., 2015b; Zhang et al., 2011). Kushniruk et al. (2019) developed a protocol and video-coding scheme for identifying usability problems encountered during the live interaction between a human subject and the HIT. Peute et al. (2015b) designed a comprehensive, practical framework for evaluating the usability of health information websites consisting of user-centered design practices, iterative design, and usability inspection methods. Zhang et al. (2011) also employed user-centered design practices in their development of the TURF, a replicable usability framework that emphasizes the usefulness, usability, and satisfaction of HIT that enables intended users to accomplish the goals they have set out to achieve by using the HIT.

Hinchliffe and Mummery (2008) used a combination of qualitative and quantitative methods when implementing a user-centered design process to design and develop a health information website. Quantitative data, such as the time subjects required to complete pre-established tasks and qualitative data attained from think aloud usability testing was used to identify common usability problems (Hinchliffe et al., 2008). Hinchliffe et al. (2008) discovered that subjects encountered many of the same usability issues evidenced in other studies as they interacted with the website, including navigation difficulties, misunderstanding of terminology, and unclear instructions (Freeman et al., 2004; Monkman et al., 2013b; Sillence et al., 2007).

Other qualitative studies focus on understanding patients' perceptions of virtual physician visits, that is, how they were able to use the telemedicine technology and how they perceived the quality of healthcare they received. Powell et al., (2017) performed semi-structured interviews with patients following a video consultation with their primary care provider and found that the majority of patients were satisfied with the telemedicine visit and recognized its convenience, yet some subjects had technical challenges with visit codes and passwords and some had concerns regarding whether the physician could perform an adequate physical examination virtually.

Like Powell et al. (2017), Gardner et al. (2015) sought to understand patients' perceptions of physician visits using a video-based virtual consultation. Gardner et al. (2015) performed a phone survey of a random sample of patients at an outpatient institution and discovered that thirty-eight percent of respondents were very likely to accept a virtual physician visit, and those who were familiar with this type of telemedicine were more likely to find it to be of similar quality to a traditional in-office visit. Gardner et al. (2015) discovered that the primary factor influencing whether patients would use the telemedicine service was their comfort level with the technology. In fact, patients with low technical expertise even experienced anxiety by just the thought of having to set-up a virtual physician visit. Gardner et al. (2015) explain, "If the technology is not understood or if someone is not technologically facile, the thought of having to set-up a call could cause some anxiety" (p. 284). Overall, most patients still desired to consult with their physician in the traditional manner, in-office, despite the convenience and cost-savings of telemedicine (Gardner et al., 2015).

Agnisarman et al. (2017) also studied virtual physician consultations, but focused more on the usability of the telemedicine platforms (technology) specifically designed to deliver the video-based, virtual physician visits to patients in their homes. In order to foster acceptance and adoption of telemedicine services, it is important for patients to have a positive attitude towards telemedicine systems. Usability of a technology is a key driver of users' subjective attitude when using a system (Agnisarman et al., 2017). Thus, Agnisarman, et al. (2017) sought to situate the telemedicine system in a real-word, context of use to understand the context-specific aspects that affect patients' ability to use the system successfully. A detailed analysis of the features in the four telemedicine platforms: Doxy.me, Ploycom, Vidyo, and VSee, was performed, as well as retrospective think aloud usability studies of human subjects. Agnisarman et al. (2017) found that there were significant cognitive and technical barriers to the usability of the telemedicine systems that varied with each system. For instance, the email invitation that initiated the virtual doctor visit that the Vidyo platform sent to patients included several links and required patients to download a plug-in (Agnisarman et al., 2017). The complexity of the email and number of steps required to initial the virtual doctor visit confused participants and made the check-in process difficult (Agnisarman et al., 2017 Likewise, during the video chat session, the VSee had multiple windows available (contact list, patient view, and chat box), which seemingly confused subjects and increased their frustration (Agnisarman et al., 2017). Control buttons, such as the audio and video buttons, disappeared after a few minutes of inactivity in the Polycom platform, which impacted the ease of use of the platform (Agnisarman et al., 2017).

Such work indicates the design of telemedicine systems significantly impacts the usability and ultimately consumers' acceptance of and use of telemedicine services. As Agnisarman et al. (2017) conclude that understanding individuals' contextual determinants of usability is critical in order to design and deliver telemedicine services that achieve user satisfaction and are accepted by consumers.

Hickson et al. (2015) studied the effectiveness of eVisits (electronic office visits) as an alternative healthcare delivery method by reviewing current literature that reported on the utilization of eVisits. Hickson et al. (2015) conclusions were consistent with other studies: eVisits are more efficient and can increase healthcare access. That said, Hickson et al. (2015) pinpointed several barriers to implementation stemming from human factors, such as the inability of physicians and patients to use telemedicine technology effectively and low health literacy causing patients to inaccurately discern when an eVisit is appropriate to use. Security and confidentiality were other concerns raised regarding the acceptance and adoption of eVisits. The researchers assert that because telemedicine has a limited capability to treat certain health conditions, patients must be provided guidance and information that answers pertinent questions in order to reduce ambiguity (Hickson et al., 2015). These studies suggest that telemedicine communications are lacking in key information that support users' understanding of when and how to perform a virtual physician visit.

Summary of Literature Review on Telemedicine Usability

Health informatics researchers are aware that usability is a critical factor affecting physicians and patients' acceptance, use, and adoption of telemedicine and other HIT. In addition, usability impacts the effectiveness of telemedicine as an alternative healthcare intervention (Kushniruk & Patel, 2005). Usability studies, including the studies just described, range from those on eHealth and other HIT, such as electronic health records and online patient portals (Monkman et al., 2013b; Sandefer, Westra, Khairat, Pieczkiewicz & Speedie, 2015; Sarkar et al., 2010) to studies that focus on the usability of mHealth applications and online self-care or disease management programs (de Korte et al., 2018; Lin et al., 2009; Schnall et al., 2016). This research concentrates on various aspects of usability often quantified as categories or themes, such as content quality and comprehensibility, aesthetic design, credibility, and navigation (Britto et al., 2009; Peute, Spithoven, Bakker & Jaspers, 2008; Sun, Zhang, Gwizdka & Trace, 2019; Usman, Ashraf & Ghazali, 2017). There is widespread agreement that more research is needed on the usability of telemedicine given the context-sensitive and subjective nature of usability.

A review of the literature on telemedicine usability makes it evident that there is a gap in knowledge on how telemedicine providers communicate about their service to target end-users, and how users interpret and gain meaning from telemedicine provider communications in different contexts. My research fulfils this gap in knowledge. Additionally, the literature on telemedicine usability informed the design of my study and the methods I implemented; for instance, I selected and adapted methods used in other studies to be able to better collect the data I needed in order to answer my research questions. For instance, I performed a content analysis to understand the rhetorical messages and content that exists in current telemedicine communications (Walsh et al., 2017). I performed think aloud usability testing, like several other researchers (Kushniruk et al., 2019a; Peute et al., 2015b) to understand how users interact with telemedicine communications, and the retrospective questionnaire I implemented allowed me to collect subjective user-feedback (Kushniruk et al., 2004a; Zhang, Babu, Jindal, Williams & Gimbel, 2019). Also, the understanding that context of use is a significant factor in determining how individuals will access, interpret, and use health information informed the design of my study by performing usability testing on different devices to simulate various contexts of use. Employing mixed-methods enabled me to comprehensively examine the usability of the telemedicine provider websites and triangulate data (Hinchliffe et al., 2008).

Although there have been studies on the specific type of telemedicine this dissertation calls attention to—virtual physician visits—these studies only examine the usability of the telemedicine technology or the platforms used to facilitate the virtual physician interaction and healthcare service. There does not appear to be an examination of the telemedicine provider communications that are intended to motivate users to use the service and to explain to users how to perform a virtual physician consultation in my review of the literature. This gap in research and knowledge on how the usability of telemedicine communications impacts users' interaction with them and subsequent ability to use telemedicine is one that my study fulfils. The design and delivery of effective telemedicine information accessible on telemedicine websites may help increase consumers' and healthcare professionals' understanding of telemedicine and impression that telemedicine is a beneficial and quality healthcare system, and ultimately increase the adoption of DTC telemedicine by a widespread consumer audience.

Barriers to Telemedicine Implementation

As previously described, usability is a key force in the widespread awareness of and adoption of telemedicine. In this section, I will briefly discuss other barriers to the implementation and use of telemedicine. Research suggests several individual and contextual determinants that influence telemedicine implementation and medical provider and patient use, which can be classified under five major categories: technical, acceptance, financial, organizational, and legal (Broens et al., 2007). Although each major barrier involves different health contexts and health participants, in this section, I primarily focus on the acceptance barrier as this is most relevant to the current research. I first briefly touch on each major category (technical, financial, organizational, and legal) and then offer a detailed explanation of the various reasons why individuals may not be accepting of telemedicine as an alternative healthcare intervention. In the next section, I will focus specifically on usability aspects. It is important to understand what hinders the practical use of telemedicine in order to create solutions.

Technical Barriers

There are several challenges to implementing telemedicine given its dependence on the accessibility of technology, internet service, and having the proper technological infrastructures. The lack of a robust information technology infrastructure can impede the implementation of telemedicine at hospitals (Broens et al., 2007; Ly, Labonté, Bourgeault & Niang, 2017; Peddle, 2007). Patients' access to technology, knowledge of how to use telemedicine technology, as well as technical difficulties, such as internet service availability, all influence their use telemedicine (Agnisarman et al., 2017; Broens et al.'s, 2007; Peddle, 2007). In fact, Broens et al.'s (2007) qualitative literature study of telemedicine research found technical difficulties to be a chief complaint hindering the implementation and use of telemedicine. Artnak et al. (2001) contend that one means to increasing access to quality healthcare in rural communities is to invest in HIT and technology infrastructures by redesigning healthcare delivery services to include telemedicine.

Financial Barriers

Although the costs of telemedicine have been predominantly purported to be a benefit, this affordance mostly relates to patient costs for a telemedicine consultation. For instance, DTC telemedicine visits have been known to be less costly for patients than ED visits (Sipek, 2014; Uscher-Pines & Mehrotra, 2014; Uscher-Pines, Mulcahy, Cowling, Hunter, Burns & Mehrotra, 2016). Due to the rising costs of healthcare and the desire to decrease unnecessary medical claims, many employers are offering a telemedicine service as a part of their group medical plan or as a separate employee benefit product (Sipek, 2014; Uscher-Pines & Mehrotra, 2014). Caldwell, Srebotnjak, Wang, and Hsia (2013) report that, out of 76.6 million ED visits, the median charge for an ED outpatient condition, was $1,233, and all diagnoses had an interquartile range of greater than $800. That said, financial challenges can also be a barrier to a successful telemedicine implementation and sustainability. Besides the costs for the technology to faciliate a telemedicine service, implementing telemedicine requires other monetary investments in the operation, maintenance, and training of physicians to use the technology (Broens et al., 2007; Ly, Labonté, Bourgeault & Niang, 2017). Internet connection and service costs may be higher, as well, in order to ensure it is reliable (Jasemian et al., 2005). In order for telemedicine to be sustainable, it must be utilized, which relates to medical provider and patient acceptance and adoption of telemedicine. Lastly, there are considerable costs associated with implementing a healthcare system or interface that must be subsequently redesigned or modified because of low utilization caused by poor usability (Johnson et al., 2005).

Organizational Barriers

As a fairly new modern healthcare delivery system, there have been no standard hospital protocols or procedures developed to ensure quality and uniform practice across healthcare providers (Broens et al., 2007; Peddle, 2007). For instance, the cooperation between medical (clinicians, nurses) and non-medical staff (technology partners, administrators) that is needed to operate and administer telemedicine is not clear outlined by healthcare providers' policies (Broens et al., 2007). Additionally, at the organizational level, a lack of human resources to carry out telemedicine services is also a barrier and contradicts on of the affordances of telemedicine being to help with the increasingly short supply of physicians (Ly et al., 2017; Peddle, 2007). Medical staff being poorly informed about telemedicine procedures that oppose existing healthcare delivery methods is a major organizational obstacle that influences telemedicine implementation and uptake. Other HIT, such as patient-centered information systems implemented in healthcare facilities, represent the patient-centered health paradigm by empowering patients with health information that supports their active participation in their health (Brennan, Kuang & Volrathongchai, 2000). However, Brennan et al. (2000) describe the many organizational challenges to their utilization and effectiveness, such as the ability to have integration of data from multiple healthcare providers' computerized systems. Brennan et al. (2000) argue that healthcare providers' competing interests, lack of common language structures, and non-secured communication channels are among the challenges of implementing HIT for patient use at healthcare facilities, such as clinics and hospitals.

Legal Barriers

Corresponding with the lack of universal policy on how to execute telemedicine, there also exists disparate legal guidelines. As with any wide-scale social realization, telemedicine is difficult to deploy without any suitable legislation and policy. Lack of standard guidelines for the practice of telemedicine or a framework for telemedicine implementation is a major challenge to its success (Brous, 2016; Broens et al., 2007; Chaet, Clearfield, Sabin & Skimming, 2017).

Telemedicine practices and frameworks are still being developed and determined by regulatory agencies and are continuously changing (Brous, 2016). In addition, Broens et al. (2007) contend that many of these frameworks are inappropriate for all unique aspects of telemedicine implementations. There is uncertainty concerning what credentials a physician must have in order to practice healthcare across state lines (Ashley, 2002). In addition, healthcare professionals have a concern about protecting their patients' privacy of health information and remaining compliant with HIPAA, also a notable acceptance barrier (Ashley, 2002; Peddle, 2007). The need for informed consent and a secure information transfer mechanism also exists (Broens et al., 2007). In addition, interoperability between systems is a concern (Broens et al., 2007).

Acceptance Barriers

Acceptance of telemedicine, by both medical providers and patients, is key to the successful implementation and use of telemedicine. Broens et al. (2007) identified attitude and usability to be two influencers on telemedicine acceptance and use by medical providers and patients: knowledge of telemedicine and ethical concerns. For instance, physicians' have voiced concern over whether they have the competence to respond to patients' health questions on a website and whether they are adequately adhering to the Health Insurance Portability and Accountability Act (HIPAA) and respecting patients' privacy and confidentiality (Brous, 2016; Chaet et al., 2017; Hickson et al., 2015; Kaplan & Litewka, 2008; Ly et al., 2017).

Patients require the delivery of accurate and relevant information in order to be able to make knowledgeable healthcare decisions, as well as be motivated to use telemedicine (Broens et al., 2007). Broens et al. (2007) and Bullock et al. (2017) contend that patients must have a familiarity with telemedicine in order to be motivated to use it, which can be augmented by involving potential users early in the development of telemedicine systems (Agnisarman et al., 2017; Goldberg et al., 2011). Carefully designed telemedicine provider communications will also act to motivate individuals to use telemedicine (Kayyali et al., 2017; Uscher-Pines et al., 2016). For instance, Kayyali et al. (2017) found in a discourse analysis of telemedicine providers' leaflets, which are the communications used to inform consumers about the telemedicine service, that the telemedicine service was described differently among a sample of leaflets with little consistency in what telemedicine was or how to use it. For instance, one leaflet described telemedicine to be a device that patients use to transfer their vital signs to a monitoring center that would identify abnormal readings and communicate with them via a telephone call (Kayyali et al., 2017). Whereas, another leaflet only explained the health conditions for which the telemedicine service could be used for rather than describe the service itself (Kayyali et al., 2017). Kayyali et al. (2017) assert that telemedicine communications appear to be too vague and do not effectively instruct consumers how to perform a telemedicine consultation.

Technical expertise and age were also found to influence the acceptance of telemedicine (Broens et al., 2007; Lin et al., 2009). Technical expertise has consequences to the usability of a telemedicine system or service. Usability issues, such as complex initiation downloads, poor information quality, and poor interface quality are likely more frequently experienced by those with low technical expertise and can lead to low levels of user satisfaction, which affects patient acceptance and adoption of telemedicine (Agnisarman et al., 2017).

Religious and cultural factors impact patients' use of telemedicine (Ly et al., 2017; St.Amant, 2017a; St.Amant, 2017b). St.Amant (2017a) articulates, “No technology is culture-free” (p. 114). Health and medical contexts vary from one culture to the other, as such, HIT must be designed to be operated and perform successfully in these diverse cultural contexts.

User perception of usefulness has also been identified as a significant factor in user uptake of new technology and systems (Davis, 1989). Davis (1989) points out that flexibility in a system may not always meets users' needs for ease of use, especially for novice users. For instance, adding more components, features, and functions to a system in order to offer value to a user may actually be confusing to users. Thus, flexibility impairs ease of use of a system (Davis, 1989). A system that is complex may be too difficult for beginners to use (Britto et al., 2009; Kinzie et al., 2002). Users are more willing to use and accept an IT if they perceived it to be useful, even if it was not easy to use and/or if they did not perceive it to be easy to use to (Davis, 1989). Kirwan, Duncan, Vandelanotte, and Mummery (2012) discovered similar evidence that users are more likely to use and adopt a health application if they perceive it to support their ability to improve their health. For instance, users were more likely to use a smartphone application than the online version to enter their physical activity data because they perceived it to be more convenient and efficient (Kirwan et al., 2012).

Given the considerable impact that acceptance, usefulness, and user perception can have on telemedicine adoption and utilization, the usability of telemedicine communications are the primary foci of my research.

Usability of Health Information

Along with different modes of telemedicine, there is an abundance of research on eHealth and mHealth usage and usability; often these studies focus on only one aspect of usability, such as frequency of use and intention to use (Fox & Duggan, 2013; Rains, 2007; Sillence, et al., 2007), readability (Berland, et al., 2001), quality (Impicciatore, Pandolfini, Casella & Bonati, 1997; Eysenbach, 2000), and health information search behaviors (Pang, et al., 2014; Pang, et al., 2016). That said, there are several critical factors that affect the usability of health information and ultimately the ability to use telemedicine services. These include social, cognitive, physical, and cultural factors, as well as an individuals' unique health situation, context of use, and health information needs (Albers, 2003, Carliner, 2000; Goldberg et al., 2011; Pang et al., 2016; St.Amant, 2017). Social cognitive theory suggests that human behavior is influenced by one's individual experiences, environment, and the behaviors of others (Bandura, 2001). Likewise, according to the integrative model of eHealth use (IMeHU), an individuals' underlying socio-cognitive-technical structure mediate one's health literacy, perceived ability to use health information, motivation to perform health behaviors, and resultant health outcomes (Bodie et al., 2008). In the next sections, I will define usability and other terminology used to express how individuals interact with, experience, and use health information and then I will discuss the usability of health information in terms of environmental/contextual and individual/subjective determinants. Although many of the individual and contextual factors that impact usability are beyond the scope of my study, they are important to be aware of in the application and interpretation of usability testing with representative users. Usability is a function of the user interface and individual user characteristics (Kaufman et al., 2003). Empirical research that seeks to investigate the dimensions of competency and barriers to efficient, effective, and satisfactory use by individuals must do so with an understanding of the key mediators of usability.

Albers (2003) classifies the multidimensional needs of users as knowledge, detail, and cognitive dimensions and that user goals and information needs change and vary within varying circumstances. Norman (1988) argues that individuals form mental models of how to behave and perform actions in the world, which is the integration of previous experience and knowledge, cultural conventions, as well as how they interpret the things in which they interact with.

Designing usable information requires one to explore these multidimensions of individuals as they integrate and comprehend information (Albers, 2003). The human factors involved in HCI have been a recent area of focus in the health and medical field given that the interface to HIS is primarily responsible for communicating information to the user (Kushniruk, Borycki, Kuwata & Ho, 2008).

Designing usable health information is compounded by the complexity of the information, as well as individuals' unique health situations and goals for use of the health information. Usability implications include demographic and subjective attributes, but usability is also shaped by the design of health information. Hsu et al. (2014) describe these usability determinants to be "self-regulating," such that there is a bidirectional and interdependent association between and among behaviors, environments, and personal experiences that affect one's health literacy, successful performance of health behaviors, and ultimately, health outcomes (Dewalt et al., 2004). In addition, healthcare decisions are complicated by the fact that health information is complex and often require a rapid response, which involve the intertwined cognitive processes of problem solving and decision making (Kushniruk, 2001; Klein, Orasanu, Calderwood & Zsambok, 1993). Researchers argue that individuals progress through a series of heuristic and analytical cognitive processes when making decisions, which is termed the *cognitive continuum* (Hammond, 1998). The cognitive continuum is affected by numerous factors, among these, include the amount of information presented, previous knowledge and experience, the task required, and the conditions under which the activities take place (Kushniruk, 2001; Hammond, 1998; Lesgold et al., 1988). The variables that influence one's ability to make healthcare decisions are similar, if not identical, to those that affect the usability of HIT, such as patient record systems and clinical decision support tools (Kushniruk, 2001).

However, these cognitive studies of medical problem solving and decision making have mostly been focused on medical experts and clinicians, not on patients use of HIT (Kastner, Lottridge, Marquez, Newton & Straus, 2010; Kuipers, Moskowitz & Kassierer, 1988; Kushniruk, 2001; Patel, Kushniruk, Yang & Yale, 2000). The extent to which the usability of HIT, like telemedicine communications, affects patients' cognitive continuum of problem solving and decision making provides motivation for this research because the design of health information on telemedicine websites is likely to affect the healthcare decisions of patients as they interact with the telemedicine communications (Kushniruk, 2001). It is important to review the literature on the usability of health information and summarize the current knowledge concerning design features, functions, and rhetorical aspects of health information that increase usability.

DTC telemedicine providers promote their healthcare services and capabilities through their websites online. These websites are health information websites that are considered eHealth. To my knowledge, there is no research that directly focuses on DTC telemedicine interfaces and the implications on usability; therefore, much of the literature review regards any HIT or health informatics platforms, including general health information websites (Eysenbach et al., 1998; Eysenbach et al., 2002a; Eyenbach et al., 2002b; Eysenbach, 2008; Kinzie et al., 2002; Pang et al., 2016; Raj et al., 2016), electronic health records (Monkman, Griffith & Kushniruk, 2015c; Sandefer et al., 2015; Tang, Ash, Bates, Overhage & Sands, 2006), mHealth (Brown, Yen, Rojas & Schnall, 2013; Klasnja & Pratt, 2011; Schnall et al., 2016), and other eHealth technology interventions (van Gemert-Pijnen et al., 2001; Wozney et al., 2016). The multicomponent and personalized nature of these alternative health interventions and the rapid change in technology, healthcare policies, and healthcare circumstances require context-sensitive and tailored studies on usability (Tuckson et al., 2017). Research on the usability of telemedicine communications by end-users—the potential patients—must inform telemedicine technology design, implementation, practices, and policies in order to increase the acceptance and adoption of telemedicine.

Usability

Usability is defined by the ISO, as the extent to which a product can be used by target users to achieve specific goals with effectiveness, efficiency, and satisfaction in their context of use (ISO, 2018; Yen & Bakken, 2012). Put another way, usability is the ability of a product or application to be understood, learned, used, and aesthetically pleasing to the user within a specific context of use (Yen et al., 2012). Zhang et al. (2011) describe usability as, "how useful, usable, and satisfying a system is for the intended users to accomplish goals" (p. 1056), and refer to "usefulness" as how well a system supports the ability of the users to accomplish their goals for use. The requirements for health information usability are complex, multifaceted, and dynamic, and require an approach to understanding the user's information needs and context of use in order to design for usability and deliver health information that is able to be used effectively by individuals to achieve health-related goals.

Designing for usability involves a deep understanding of the target user and their context of use, which involves the integration of multiple cognitive, behavioral, social, and cultural factors (Albers, 2003; Alshamari, 2016; Hibbard et al., 2003). One of the major barriers to designing and delivering effective online health information is the mismatch between a designer's conceptual model and a user's conceptual model (Carroll & McKendree, 1986; Zhang, & Waljiac, 2011, Kushniruk, 2001). Individuals use several criteria to evaluate eHealth when making the decision to use the information, including the overall look and feel of the website, display of information, and authorship (Eysenbach et al., 2002a; Eysenbach et al., 2002b; Sillence et al., 2006; Weymann, Härter & Dirmaier, 2015). The concept of satisfaction is often determined by the subjective perception of the user (Eysenbach, 2005). For instance, attractiveness is a valence dimension of a website—a purely subjective emotional impression of like or dislike—however, it does impact whether a user chooses to use a website or product (Schrepp, Hinderks & Thomaschewski, 2014).

As an attribute of usability, "use quality," is considered a significant contributor to the successful implementation of telemedicine and must be assessed at the patient-encounter level and context of use (DeLone & McLean, 2003; LeRouge et al., 2007). LeRouge et al. (2007) define, "use quality," to be the effectiveness of the telemedicine encounter and it emphasizes the socio-technical attributes of a telemedicine encounter that affect usability, including the ease of use of the technology, the communication of health information, the integration of traditional healthcare with telemedicine delivery methods, the context of use, and user satisfaction. The ease of use of the telemedicine provider service, the communication of critical healthcare information, the quality of the technology used, and user satisfaction are interdependent and the determination of success is situated within the context of use and varies with individual users (DeLone et al., LeRouge et al., 2007).

Usability entails accessibility and usefulness and must address a full range of human experiences and health contexts (Goldberg et al., 2011). Usability cannot be detached from users' individual and subjective experiences nor context of use. Goldberg et al. (2011) remark, "If usability and accessibility in the consumer context are not taken into account, then there is no way that the final products will meet the usability and accessibility goals for the broadest range of people with the widest range of capabilities" (p. S189). A wide range of consumer HIS have been abandoned because of usability problems and the system's failure to support users' ability to identify, understand, and apply health information to improve their health (Monkman & Kushniruk, 2015a).

Although many usability determinants are outside the scope of my study and difficult to control for, even in a controlled environment, these are critical factors that must be understood when performing usability inspection methods, such as the think aloud usability tests I perform in the current research (Cheng & Mustafa, 2014; Fernandez, Insfran & Abrahão, 2011). Therefore, the major individual and contextual factors that influence the usability of health information will be discussed next.

Context of Use

The context in which one accesses and interacts with health information impacts one's ability to use the information effectively. Context of use includes the integration of several characteristics regarding the environment which the user is expected to interact with a product or information and the specific tasks in which the user expects to perform while using the product or information (Maguire, 2001a). Understanding the context of use in which telemedicine communications are used is crucial to being able to design and deliver health information that individuals are able to use in their time of need. Although the think aloud usability tests were performed in a controlled environment, in real-life situations, there are many contextual factors and distractors that influence one's ability to use telemedicine successfully and the conditions in which a user does access and use health information are important to understand.

Because eHealth and other HIT are so commonly used today, context of use, from a human factors perspective, is imperative to health information providers. The design and delivery of effective, usable telemedicine, HIT, and eHealth have been a focal point, most recently, in the human factors and ergonomics fields as health information and healthcare providers gain an awareness of the complex nature of health and the entwined factors influencing usability (Lin, Vicente, & Doyle, 2001; Young & Patterson, 2012). Yet, attending to patients' context of use is an often overlooked element of usability when designing and delivering health information (de Korte, et al., 2018; Klaassen, van Beijnum & Hermens, 2016). Knowledge of how individuals' access and use health information and the relationship between health information usage and health outcomes is still in its infancy (Agree, King, Castro, Wiley & Borzekowski, 2015; van Gemert-Pijnen et al., 2001). Kushniruk et al. (2013) articulate:

> The human factors approach is distinctly design driven and aims to optimize performance, safety and users' sense of well-being associated with their use of a system through the application of user-centered systems design and evaluation. On a healthcare system level, the socio-technical perspective maintains that the HIS integrates the human, social, organizational and technological dimensions and in so doing contributes to an essential body of knowledge of existing healthcare systems and contributes to their continuous evolution. The design, implementation, and evaluation of safe, effective, efficient and easy to adopt HIT, therefore requires proper consideration of human and organizational factors. (p. 84)

Healthcare takes place in many different locations and involves many different stakeholders. The information required to deliver effective, safe healthcare must be present and easily accessible in these contexts (Nøhr, Borycki, Kushniruk & Kuziemsky, 2015). The context of use of a HIS affects users' needs and the information required for them to manage their health effectively, and this, consequently, affects the usefulness of the system and user satisfaction—all of which impact consumer adoption of HIT (Monkman & Kushniruk, 2015b; Nøhr et al., 2015). Participation in eHealth and telemedicine is largely determined by one's context of use.

Contextual factors, such as efficacy, time to learn, environment, personal experiences, health status, and more, have all been cited as factors affecting individuals use of telemedicine (Campbell, Harris & Hodge, 2001; Chou, Hunt, Hesse, Beckjord & Moser, 2009). Context of use includes the geographical or physical location a user is in when accessing HIT (St.Amant, 2017); the time the user has to engage with the health information (Freeman et al., 2004); the motivation level of the user (Damman, Hendriks, Rademakers, Delnoij & Groenewegen, 2009; Sillence et al., 2007; Sun et al., 2019); the emotional state of the user (Alaiad et al., 2017); the social presence of other stakeholders (Goldberg, et al., 2011; van Gemert-Pijnen et al., 2001); as well as the cultural attitudes and beliefs of the individual (Birru et al., 2004a; St.Amant, 2017). Usability cannot be detached from context of use. These usability determinants will be addressed next and must be accounted for when evaluating the usability of health information. Although much of these individual and contextual determinants of health information are beyond the control and scope of my study, they helped inform my decisions during the data analysis part of my study and will be explored further in this dissertation.

Health Literacy

Health literacy, as defined by Weiss (2003), is, "an individual's ability to read, understand, and use healthcare information to make effective healthcare decisions and follow instructions for treatment" (pg. 4). Several studies have demonstrated the importance of health literacy on users' ability to read and understand the health information they find, discern the quality of the information, an use the information appropriately to make informed decisions about their health and perform health behaviors (Bodie et al., 2008; Melonçon, 2016; Melonçon, 2017; Monkman et al., 2013b; Monkman et al., 2015b; Morony, McCaffery, Kirkendall, Jansen & Webster, 2017). Health literacy goes beyond just being able to read health information, it includes being able to access health information, comprehend it, and use it to perform health behaviors and share in the decision-making process with their physician regarding treatment options (Artnak et al., 2001; Hsu et al., 2014; Melonçon, 2016; Melonçon, 2017; Monkman et al., 2013b). Health literacy encompasses listening and problem solving and is influenced by culture and societal factors (Ratzan & Parker, 2000). Most literature regarding health literacy tends to refer to eHealth literacy, because so much health information is delivered and retrieved through the use of technology, health literacy often requires a sufficient level of computer literacy and internet access (Hsu et al., 2014; Norman et al., 2006; Fox et al., 2003). eHealth literacy involves a suitable knowledge of how to use health technologies, in a particular context, and discriminate among online resources when accessing and using online health information (Agree et al., 2015). Additionally, the mobile environment is another context of use that affects usability by affecting many of the other usability determinants discussed next. When reading text on a mobile device, user comprehension may suffer or it may take an individual longer to read and comprehend information on a mobile device than the same information when read on a desktop computer screen (Norman & Budiu, 2013). A mobile environment is demonstrated to impact users' memory, focus, and navigation (Norman et al., 2013).

Health literacy and the usability of eHealth and other HIS are intricately connected. Users must be able to access health information from a variety of digital resources, such as websites and mobile health applications, comprehend the health information, and apply the information that is relevant to them to improve their health (Monkman et al., 2015a). Likewise, health literacy levels have the potential to affect data quality, accuracy, and the usability of HIS; for instance, users may enter incorrect medical data into a PHR as a result of misunderstanding medical terminology (Monkman et al., 2013b).

Low health literacy is associated with a number of poor health criteria, such as more emergency care and hospitalizations, less use of preventative healthcare services, poor medication administration, and poor self-efficacy in managing health conditions (Berkman, Sheridan, Donahue, Halpern & Crotty, 2011). Agee et al. (2015) state, “Low health literacy among older adults is compounded by the fact that older adults experience more chronic diseases, take more medications, and visit health care providers more often than younger adults” (online). Health literacy has an intricate and intimate affect on the usability of telemedicine. Sarkar et al. (2010) identify low health literacy as a barrier to even being aware of alternative healthcare interventions, which may explain limited use among target populations. Ameliorating usability issues that are related to health literacy and context of use may result in an increased adoption and acceptance of telemedicine and may increase positive health outcomes of users. These types of usability problems are able to be identified during usability tests, such as the think aloud usability tests performed in my research.

Readability

Understanding that health literacy is an essential component for people to have to navigate and use complex health information to improve health outcomes, Wilson (2009) contends that reading level is one of the major determinants of health literacy and is a consideration when evaluating the usability of health information. Older adults, minority populations, and those in typically underserved geographic locations have statistically been shown to have poor health literacy (Berkman et al., 2011; Dewalt et al., 2004; Sandefer et al., 2015). Readability is the comprehension difficulty of text and is mathematically calculated. Wilson (2009) and the American Medical Association contend that health information should not be written at more than a 6^{th} grade reading level (Weiss, 2003). If consumers are able to read, understand, and use ehealth tools effectively, it will increase the ability of these alternative health interventions to positively impact the health outcomes of those who use them—especially for racial minorities and those in typically underserved, rural areas who have low health literacy and less access to healthcare (Bassett et al., 1986; Dutta-Bergman, 2004; Kutner, Greenberg, Jin, Paulsen & American Institutes for Research, 2006; Uscher-Pines & Mehrotra, 2014). It should be noted that readability does not equate to comprehension (a component of health literacy), but it does affect it (DeWalt et al., 2004; Nielsen, 2015; Nielsen et al., 2013; Norman, 1988), which demonstrates the web of aspects of usability that must be considered when designing HIT for target audiences. Besides readability, which influences health literacy, one's context of use affects these usability factors, as well. Nielsen Norman Group's readability studies show that even easy-to-read text becomes more difficult on mobile devices (Moran, 2016b; Nielsen et al., 2013). The reading space is smaller, which reduces comprehension, and the need to scroll to read large passages of text degrades memory and takes more time.

Morony et al., (2017) regard readability as a proxy for or representative of usable health information. Birru, et al. (2004a) found most of the online health information available was, on average, available at an 11th grade reading level based on the Flesch-Kincaid Reading Scale. Overwhelmingly, the literature shows that health information providers are not cognizant of users' low health literacy levels, which is partially influenced by not delivering health information and patient education materials that are written at an appropriate reading level or that reflect the language and cultural values of the target user group (Wilson et al., 2003; Wilson, 2009). Health and medical professionals and clinicians are encouraged to perform readability assessments of the health information they provide to patients and recognize the impacts of health literacy and the affects it can have on individuals' health outcomes.

Motivation and Affect

Individuals motivational and emotional state impact their ability to understand and use health information or other HIT or appropriately in their context of use. Because health information is complex, humans have limited cognitive abilities to process and understand health information. Depending on the context of use and users' motivation, people appear to use either analytical or experiential modes of information processing (Damman et al., 2009). The analytical mode of information processing is slow and deliberate. Users are highly motivated to search for health information and use logic and reasoning in order to determine if the information they find is of quality and is going to be useful (Damman et al., 2009; Sillence et al., 2007). Users employ a more superficial, quick judgement of health information based on heuristics and affect when using the experimental mode of information processing (Damman et al., 2009; Sillence, et al., 2007). Users might employ the experimental mode of information processing if they are not highly motivated or have an urgent need to find information quickly. Other scholars call refer to these two different information processing routes as the central route and the peripheral route (Freeman et al., 2004). The central route is used when an individual is making a conscious cognitive effort to process information, and the peripheral route is activated when users use cues to make quick judgments without having to employ much cognitive effort (Freeman et al., 2004; Gigerenzer & Goldstein, 1996; Sillence et al., 2007). For instance, in highly urgent situations, nurses rely on simple rules to guide their decisions (Leprohon et al., 1995). Other scholars suggest that lack of motivation may prevent individuals from learning to use HIT, which exacerbates the limited use by individuals who may benefit the most from alternative healthcare interventions, such as those with low health literacy and less access to traditional healthcare systems (Sarkar et al., 2010).

Much work has been done to show that technology acceptance and individuals' perception that technology will be useful to them is significantly influenced by one's self-efficacy (Agarwal, Anderson, Zarate & Ward, 2013; Lu, Yao & Yu, 2005; Rai, Chen, Pye & Baird, 2013). Self-efficacy is an individual's subjective perception of his or her own ability to perform a task (Bandura, 1994). For example, individuals who have more knowledge and confidence to self-manage their health exhibit more health-related behaviors, such as reading about drug interactions and eating healthy foods (Hibbard et al., 2004). Rai et al. (2013) used personal innovativeness toward mobile services (PIMS) as a proxy for self-efficacy and measured PIMS's impact on individuals' intention to use and assimilate mHealth as a substitute for traditional in-office doctor visits. Rai et al. (2013) found that PIMS has a significant influence on individuals' intention to use mHealth, even more so than an individual's perception of her or his health status. However, having a high PIMS (or self-efficacy to use HIT) coinciding an individual's high perception of healthiness appeared to augment one's intention to use mHealth (Rai et al., 2013). Telemedicine communications must effectively inform individuals how to perform a virtual physician visit and ease concerns that he or she does not have the ability to do so.

Affect is also influenced by the level of engagement a user has with HIT, which stems from the overall user experience (UX) (Chen, Wu, Tomasino, Lattie & Mohr, 2019; Milward et al., 2017). The HCI community describes engagement as a state arising out of an individual's interaction with and use of a system—a quality of the user experience described in terms of difficulties; positive affect; endurability; aesthetic and sensory appeal; attention; feedback; variety/novelty; interactivity; and perceived user control (Chen et al., 2019; O'Brien & Toms, 2008). Users who have a positive emotional response during their interaction with HIT are more likely to continue to engage with the technology. Several studies demonstrate that patients' perception of the quality of a telemedicine service are shaped by the personal contact with the physician and other psychological factors (Demiris, Speedie, Finkelstein & Harris, 2003). Milward et al. (2017) report that users are more motivated to use HIT when they experience a positive experience of usability, which where those that were personally relevant and tailored to their needs. Similarly, Demiris et al. (2003) discovered that attending to patients' psychosocial needs and emotional status by demonstrating empathy and engaging with patients yielded higher levels of patient satisfaction despite experiencing technical problems during the virtual physician visit.

Time is another determinant of usability (Slovic, 1982). Often individuals may access and need to use health information or telemedicine in an urgent or stressful health situation; thus, may operate in different modes of information processing (Damman et al., 2009). When searching for health information online, with limited time, users want to see the health information clearly, at first sight, and may reject a health information website immediately if there is too much information on one page (Damman et al., 2009). Users may retreat from a website because they have difficulty understanding and interpreting complex health information or may feel overwhelmed by the amount of information on one webpage (Damman et al., 2009). Consumers generally only scan complex health information quickly to search for the specific information they are looking for or based on their expectations for use (Carroll et al., 1986; Eysenbach, 2005a; Redish, 1989; Sillence et al., 2006). Therefore, personal relevance and trust play a key role in usability (Damman et al., 2009; Redish, 1989; Sillence et al., 2006). Such factors are central to a related and important concept: trust.

Trust—and its effect on users' decisions to access and use a website for information is a key to understanding how to effectively design health websites that are to be used to educate consumers and provide accurate health information (Dutta-Bergman, 2003). Trust is often conceptualized as being a users' perception that information they access is provided by an expert, from a credible source, and is quality information (Sun et al., 2019). Trusted online sources of health information differ in terms of user demographics, health beliefs, and health-information orientation. Most individuals still express a high level of trust for information provided by to them directly from physicians rather than other sources (Dutta-Bergman, 2003, Hesse et al., 2005). Yet, online health information is increasingly searched for and accessed by individuals (Cline et al., 2001; Fox et al., 2000). Users trust health information published, sponsored, or authored by major health institutions or physicians (Cline et al., 2001; Dutta-Bergman, 2003). However, Dutta-Bergman (2003) and Freeman et al. (2004) stress that what users deem credible is dependent upon the integration of several factors, such as demographics, health beliefs, tailoring of content, and initial transactions with a website (Alrubaiee, 2011; Dutta-Bergman, 2003; Freeman et al., 2004; McKnight, Choudhury & Kacmarc, 2002). Damman et al. (2009) suggest that with the increased focus on healthcare transparency, a drift in public healthcare has been towards the goal of improving consumer health literacy and enabling individuals to make knowledgeable healthcare decisions, which will anticipatedly improve individuals' overall health.

The lack of awareness of and use of DTC telemedicine may be a consequence of telemedicine providers not providing personalized health information that appeal to patients' trust that the telemedicine is a quality healthcare intervention.

Usefulness

Regardless of which information processing mode a user employs when searching for health information online, a user's perception of whether the health information is going to be useful to them determines whether it gains their attention and prompts them to access the information (Davis; 1989). Sun et al. (2019) argue that perception of fitness for use is key to getting users to engage with health information. Often, users will employ both information processing modes in tandem and may switch back and forth between each information processing route depending on their activity, the information they find, and their motivation (Freeman et al., 2004). For instance, users may use peripheral cues initially, and if they find information immediately, they may use their central route to process the information, but if they perceive the information to not meet their needs, they may return to their search results and peripheral route of information processing (Birru, et al., 2004a; Freeman et al., 2004). Furthermore, it has been observed by several researchers that users do not do what they say they do (Damman, et al., 2009; Eysenbach et al., 2002a; Silberg et al., 1997). For example, when asked, consumers impart that they assess the authority of a health information website or only access information on trusted websites, but in reality, consumers often do not even visit the home page of a health information website nor can they recall which website they used when accessing health information (Eysenbach et al., 2002a). Overwhelmingly, there is a disparity in what consumers said they do and find important and what they actually do when making a decision.

The complexity or comprehensiveness of health information is also a significant determinant of usability. Too much information can be deleterious to a user's ability to process it, creating cognitive overload (Damman et al., 2009; Hibbard et al., 1997; Slovic, 1982). For instance, users may have difficulty managing too much health information; however, providing too little information diminishes the quality of the health information, and correspondingly, the usability of the health information (Damman et al., 2009; Gray, Lein, Cantrill & Noyce, 2002). Damman et al. (2009) observed that some users wanted more detailed information than what health information websites provided, but recognize that negotiating the balance of providing too much information and too little is challenging. Impicciatore et al. (1997) found the quality of health information relating to the home management of children with fever was poor, and some websites even provided inaccurate and potentially harmful treatment information. Often, websites recommended rectal temperature measurement, yet provided no detailed instructions for taking the temperature via this method (Impicciatore et al., 1997). Complications can occur if parents do not perform a rectal temperature correctly (Impicciatore et al., 1997). Also, paracetamol was the most widely recommended antipyretic drug; however, few websites that recommended this treatment gave specific instructions about the dose and frequency of administration (Impicciatore et al., 1997). Milward et al. (2017) suggest that there is a fine line between providing users with as much content as possible and tailoring content for target users' needs when it concerns usability.

Participants and Stakeholders

Healthcare does not occur in isolation, there are many stakeholders involved in the delivery of healthcare. Patients engage in health information in a variety of contexts that include various stakeholders, such as healthcare providers, caregivers, friends, and family (Dang et al., 2008; Goldberg et al., 2011; Dang et al., 2008). For instance, Dang et al. (2008) discovered that a telephone-linked care program designed to provide communication, support, and education to caregivers of patients with dementia did not result in lowering the incidence of depression amongst caregivers enrolled in the program; however, the caregivers were satisfied with the support the assisted technology offered and found it easy-to-use. In Marco-Ruiz et al.'s (2017) think aloud usability study of Consumer-oriented Clinical Decision Support Systems (CDSSs), it was discovered that users desired options that specifically allowed them to enter information on behalf of another person, which indicates that often health situations involve other people. Other studies suggest that the lack of interpersonal or social aspects of telemedicine systems, in particular those that provide remote home monitoring or virtual physician consultations, is a major barrier to user acceptance and adoption of telemedicine (Agnisarman et al., 2017; Alaiad, et al., 2017). Jetha, Faulkner, Gorczynski, Arbour-Nicitopoulos, and Ginis (2011), surmise that many health information websites only provide general health information and do not consider the many stakeholders who are involved in an individual's health situation, such as community-based organizations and caregivers, and that these specific audiences require more specific health messages. Sarkar et al. (2010) agree that inadequate socially and culturally relevant health communications influence the use of internet-based HISs. For instance, most physical activity information websites aimed for patients with spinal cord injuries do not include social and cognitive approaches to motivating patients to be physically active nor do they tailor the health information to patients at different stages in their recovery from spinal cord injury (Jetha et al., 2011).

HIT that includes a social feature has been perceived as useful and liked by users as it allows for users to connect with others and share similar health situations, which elevates user motivation to use the HIT (Milward et al., 2017). To increase the acceptance and uptake of telemedicine, healthcare professionals and providers must be sensitive to the social and cultural aspects of healthcare and individual health contexts and design HIT and health information that address the social and assisted living needs of patients and other stakeholders (Greenhalgh, Procter, Wherton & Sugarhood, 2012).

An individual's social network and relationships sway her or his decision to accept and use new technology. Lu et al. (2005) found that social influences shape perceived usefulness and ease of use of wireless internet services via mobile technology (WIMT), which impact one's adoption of technology. However, internal beliefs seem to have a more powerful affect on one's intention to use new technology (Lu et al., 2005). Because both internal beliefs and social influences directly and indirectly impact technology acceptance and adoption, a variety of marketing strategies and communications should be considered to attract different users and encourage widespread diffusion of telemedicine.

Previous Knowledge and Experience

Lastly, a well-known contributing factor to usability is an individuals' previous knowledge of or experience using a product or technology (Carroll et al.,1986; Johnson et al., 2005). When interpreting symptoms provided by online health information websites, most individuals rely on matching symptoms with their existing medical knowledge or previous medical experiences (Luger, Houston & Suls, 2014). For instance, studies show that medical experts rely heavily on their previous knowledge, often in the form of mental schemas, and existing data to produce rapid, correct diagnoses, whereas novices use backward reasoning by first formulating a hypothesis, then using data to make a diagnosis, which can result in incorrect diagnoses (Leprohon & Patel, 1995; Patel & Groen, 1986). However, individuals are not well-equipped to predict their own health information needs, especially when experiencing a health crisis or urgent health situation (Hibbard et al., 997). Furthermore, research suggests that users are unable to recognize their own health information needs—or—if they do recognize their health information needs, they do not demand or access essential health information that may help them make appropriate decisions about their health even if it is available (Alzougool, Chang & Gray, 2008). For example, individuals may recognize that they have a need for health information regarding treatment options for their disease, yet feel anxious and frightened about their health situation, and may refuse to access health information that is available online.

Users' health information needs, both recognized and unrecognized, change depending on the context in which they act on the health information, which is dynamic, as well as individuals' willingness to act on the information (Alzougool et al., 2008). For instance, individuals may not demand health information regarding how to treat an illness until they become ill and require the health information. In another context of use, individuals may be unwilling to access essential health information or choose to ignore available health information because they believe it will make them anxious or worrisome, such as if an individual is going to have surgery and do not access online health information regarding post-surgical care. There is another group of health information users described as the, "ignored group," which are those individuals with, "unrecognized, undemanded information needs" (Alzougool et al., 2008). Alzougool et al. (2008) refers to the "ignored group" as individuals who neither recognize their need for essential health information nor have the ability to act on it as a result of her or his context of use. It is often the most challenging to meet the health information needs of the "ignored group" as it requires being able to predict their health information needs and deliver health information in multiple, easily accessible and recognizable ways because individuals may not accept some forms or types of available health information, such as that from a certain website or portal (Alzougool et al., 2008).

The individual and contextual factors that influence the usability of health information are important considerations when designing and delivering health information, including telemedicine communications, to be able to meet users' health information needs and support their changing health contexts. A multi-level framework is required given that any one of these dimensions of usability can influence the acceptance and adoption of telemedicine.

CHAPTER THREE – THEORETICAL FRAMEWORK

In this chapter, I will describe the theoretical foundation for my research. Because I will be focusing on how the rhetorical information in and design of DTC telemedicine provider websites and mobile interfaces influences individuals' understanding of the telemedicine services and whether the telemedicine communications meet their information needs in a specific context of use, my research has theoretical underpinnings in activity theory and mobile interface theory. Together, these theories inform my analysis of the rhetoric in and design of telemedicine interfaces and communications and provide a lens through which to understand how users interact with telemedicine communications and use the communications to achieve certain goals within their context of use. I first describe the value of the user-centered design process in the healthcare industry and describe the current research's aim to advocate for user-centered design. In the following sections, I describe activity theory and mobile interface theory as they apply to my analysis of telemedicine communications.

User-centered Design

User-centered design is known to be an effective method of understanding users' information needs and involving them in the design and development process in order to ensure their feedback is included in the design of the final product. User-centered design focuses on creating usable, effective technology products and communications that meet the information needs of the target user. User-centered design has roots in the scholarship of HCI (Norman & Draper, 1986) and has propagated into other fields as a multidisciplinary approach to understanding users and involving them in the design and development of products that are going to be easily used by individuals to perform activities aimed at reaching goals. The practical implications of user-centered design were described by Gould and Lewis (1985), in 1985, when providing an operational definition of usability, “Any system designed for people to use should be easy to learn (and remember), useful, that is, contain functions people really need in their work, and be easy and pleasant to use” (p. 300). Gould et al. (1985) advocate that users must be a part of the development of a system because they are the individuals for whom the product is intended to be delivered to and used to achieve the outcomes they expect to obtain from using the product.

In order to grasp the needs of the user and implement them into the design of a system, Gould et al. (1985) outlined three steps to performing user-centered design:

1. An early focus on users and the tasks they perform; this step is performed to access users’ cognitive, behavioral, anthropometric, and attitudinal characteristics.
2. An empirical measurement using simulations and prototypes to observe users executing their real work and be able to record and analyze their reactions.
3. The performance of iterative design. Iterative design consists of the continuous testing with end-users and using their feedback to make design changes that improve the usability of the product.

Gould et al. (1985) claim that designers often think they are incorporating user needs into the design of a system, but in reality, they are not and may have little interaction with users. The limited understanding of users is often expressed as a gap between designers’ conceptual model of how a system or user interface should function and be designed to be easy to use and how individuals actually interact with the system and are able to use it easily and effectively (Norman, 1988; Spinuzzi, 1999; Vrazalic, 2003a; Xie, Zhou & Wang, 2017). Norman (1988) suggests that most usability problems exist because technology products are not designed in ways in which the user understands or is able to perform tasks successfully. Norman (1988) suggests that designers, “often think of themselves as typical users,” (p. 155), and understand how users will interpret the technology and be able to use it to achieve their expected outcomes. In addition, because designers are so intimately connected to the product they are designing, they are unable to perceive design elements that are apt to create usability problems (Norman, 1988). Gould et al. (1985) and other scholars assert that despite user-centered design being an effective method for designing usable technology and products, user-centered design not being applied in practice (Brunner et al., 2017; Eshet & Bouwman, 2016; Friess, 2010; Gould, Boies & Lewis, 1991).

There are several barriers to employing user-centered design processes as part of routine industry practices, especially in the healthcare sector. Designers face complex challenges that prohibit them from performing user-centered design or limit their ability to apply user-centered design as a strategic method for creating usable products (Eshet et al., 2017; Nielsen, 1994b; Rosenbaum, Rohn & Humburg, 2000). Major obstacles to applying user-centered design include: resource constraints, organizational resistance to user-centered design or usability, lack of knowledge about usability, and limited access to users (Eshet et al., 2017; Nielsen, 1994b; Rosenbaum et al., 2000). Norman (1988) observes that designers are separated from end-users by layers of corporate decision-making, and costs are a top barrier to performing usability testing with end-users. Additionally, Vrazalic (2003a) points out that usability goals may be too ambitious or not every part of a system can be tested for usability issues, thus increasing the complexity of the usability testing process and time. Usability testing that is too complex appears to deter designers and developers from performing any usability testing with end-users (Vrazalic, 2003a).

Clinicians and healthcare professionals face additional challenges given the immense amount of information they need to access, manage, and conceptualize quickly (Johnson et al., 2005), such as a patient's medical history and current prescription medications. The disparity between a designer's conceptual model of what is usable and how clinicians or patients actually interact with or use a technology to obtain certain health outcomes can be problematic, and often new health interventions are developed within the confines of an academic setting and not in the clinical environment where it will be used in real-life (Agnisarman et al., 2017; Kushniruk et al., 2013; Wozney et al., 2016). Furthermore, telemedicine evaluation has dominantly focused on technical feasibility, cost effectiveness, and measures of health outcomes after a telemedicine system has already been implemented (Kaufman et al., 2013).

Researchers increasingly emphasize the importance of performing iterative design processes and the significance of understanding the context of use (Eshet et al., 2017; Kaufman et al., 2013; Kinzie et al., 2002; Kushniruk et al., 2013; Johnson et al., 2005; Schmettow, Schnittker & Schraagen, 2017; Vredenburg, Mao, Smith, & Carey, 2002). HCI emphasizes users' motives, affect, and situated environment as important to understanding the end-user and their goals for a technology project. These internal processes stimulate users' external interaction with a technology or system and what they expect to be able to accomplish by using the technology product or system (Eshet et al., 2017; Kaufman et al., 2013; Monkman et al., 2013b). Performing user-centered design, with real end-users, sheds light on the influences and consequences of contextual factors and the goals the user aims to achieve by interacting with the technology that would not be possible if only localized attributes of the interface were examined (Spinuzzi, 1999). Understanding usability as an attribute of the interactions with technology or a system that are distributed across an activity network involving humans within a certain context provides a more encompassing view of the system and its interface. Vrazalic (2003a) argues, "An activity network represents a unit of analysis that takes into account individual users working with others as part of a larger activity" (p. 28). Usability testing, which is a part of the user-centered design process, must develop usability testing methods that are informed by this distributed view of usability, which is articulated by activity theory (Vrazalic (2003a). I explain activity theory in more detail in the next section.

Scholars underscore the need to involve healthcare professionals and patients in the requirements analysis and the design process of a telemedicine system and have performed successful iterative design processes when designing and testing telemedicine systems and other HIT (Kaufman et al., 2013; Kushniruk, 2002; Kushniruk et al., 2013; Wozney et al., 2016). Within the context of a health situation, it is impossible to fully specify the needed and desired features and functions that support individuals in achieving their goals for using a telemedicine service. Every individual is unique and will experience a health condition differently; for instance, individuals may have poor eyesight, experience different symptoms, or feel stressed by their health condition—these individual and contextual attributes inherently impact how individual use telemedicine provider interfaces. Iterative design involves repeatedly testing with end-users, evaluating their interactions with a technology or system to identify usability problems, and successively redesigning the system until usability and user satisfaction is achieved (Kaufman et al., 2013; Kushniruk, 2002; Patel & Kushniruk, 1998). Kushniruk et al. (1996) describe what the user-centered design process aims to achieve, "The long-term goal of this work is to feed information about user difficulties back into system design in a process of iterative system development" (p. 23).

A user-centered design approach to creating telemedicine services that better meets consumers' needs and expectations can be used to increase telemedicine adoption. In fact, the Office of the National Coordinator for Health Information Technology (ONC) (2012) issued a final revision to the Permanent Certification Program for Health Information Technology requiring that, "at a minimum, only lab-based summative [usability] testing," of Electronic Health Records (EHRs) and other HIT must be demonstrated in order to be compliant with the certification (p. 54189); however, encourage vendors to implement formative usability testing in clinical settings into their routine system development lifecycle. The application of user-centered design processes is an essential element in ONC's focus on usability and regarded as an effective method to designing and delivering effective, efficient, and safe HIT that meets the needs of all end-users, including clinicians and patients, and will increase adoption. In addition, the National Institute for Standards and Technology (NIST) has even issued several guidelines to support vendors in implementing user-centered design into the design and development of HIT, which outline the iterative design approach to designing technology, performing usability testing with target end-users, and making iterative changes in the technology to increase usability and reduce technology-induced errors that impede on patient safety (Schumacher et al., 2010; Wiklund, Kendler, Hochberg & Weinger, 2015).

Even prior to the ONC's final ruling on the requirement for user-centered design to be performed in order to meet the criteria for the Permanent Certification Program for Health Information Technology, other researchers were performing usability testing on federal telemedicine initiatives (Lathan, Newman, Sebrechts & Coarn, 1997). Lathan et al. (1997) described the findings from applying usability engineering methods to an internet telemedicine system developed by NASA to provide medical education worldwide. Lathan et al. (1997)

determined that a complete system development lifecycle included usability testing with end-users so that usability problems could be addressed before deployment; this, in effect, would optimize system performance and maximize participation in telemedicine.

Scholars and practitioners agree that user-centered design is an effective method of designing technology products and communications for optimal usability (de Korte et al., 2018; Casey et al., 2014; Wolpin et al., 2015). However, due to several organizational, financial, and knowledge barriers, there is scant research to suggest that user-centered design is typically used in modern practice. By performing the type of usability testing that is often employed during the user-centered design process, I was able to identify usability problems that may not have surfaced nor have been anticipated by the designers of telemedicine provider interfaces. In doing so, this study demonstrates the significance of user-centered design practices in the design and delivery of telemedicine provider communications.

Activity Theory

In the last section, I described the importance of user-centered design in the design and development of HIT. The principles of user-centered design are to engage with users during the design and development phases of technology so that designers gain a better understanding of how users interact with the technology and can make iterative changes to the technology in ways that better meet the users' needs. It is necessary to support the notion of distributed activities across a network of humans interacting with technology to achieve specific goals when developing and applying usability evaluation methods; activity theory and mobile interface theory offer such frameworks (Vrazalic, 2003a). In this section, I describe the theories providing insight into my analysis of the usability of telemedicine provider interfaces and the research methods that I used. I begin with an explanation of activity theory and then explain my use of mobile interface theory.

Activity Theory Introduction

Activity theory is a descriptive tool used to understand how consciousness and intentionality influence individuals' use of artifacts as tools to perform different activities to reach specific goals (Wilson, 2008). Activity theory originated in the 1920s by Russian psychologists, Vygotsky (1978) and Leont'ev (1978) as an approach to understanding human activities as phenomenon situated in a social system. Activity theory posits that individuals are a part of a system consisting of humans and artifacts (physical tools, sign systems, human language, technology, and communications) that work together to reach goals (Kuutti, 1996; Nardi, 1996; Kaptelinin & Nardi, 2009). Vygotsky (1978) introduced the concept of the "mediated act," which sets forth the idea that humans' interaction with objects or tools is by means of mediation. Leont'ev (1978) later expanded on the concept of mediation by adding a hierarchical system consisting of a socio-technical system where individual activities constitute the execution of one main operation. From Leont'ev's (1978) perspective, individuals interact with one another and objects in order to reach a universal objective or goal. Engeström (1987) introduced the concept of a networked system or collective work, which is composed of individuals using tools or objects, to perform various activities in order to achieved specific objectives or goals. Again, in Engeström's (1987) networked model, the basic unit of analysis the activity, but individuals' activities constitute a collection of activities performed by a community of individual governed by a set of rules (Makovhololo, Shaanika, Sekgweleo & Okigui, 2017). The results of individuals' activities are resources for other activities, and collectively, aim to achieve an outcome or a main goal. Engeström's (1987) model of activity theory is often called an, "activity system," and is composed of several components. Figure 2 illustrates the activity system and provides an example of each variable depicting a typical healthcare practice.

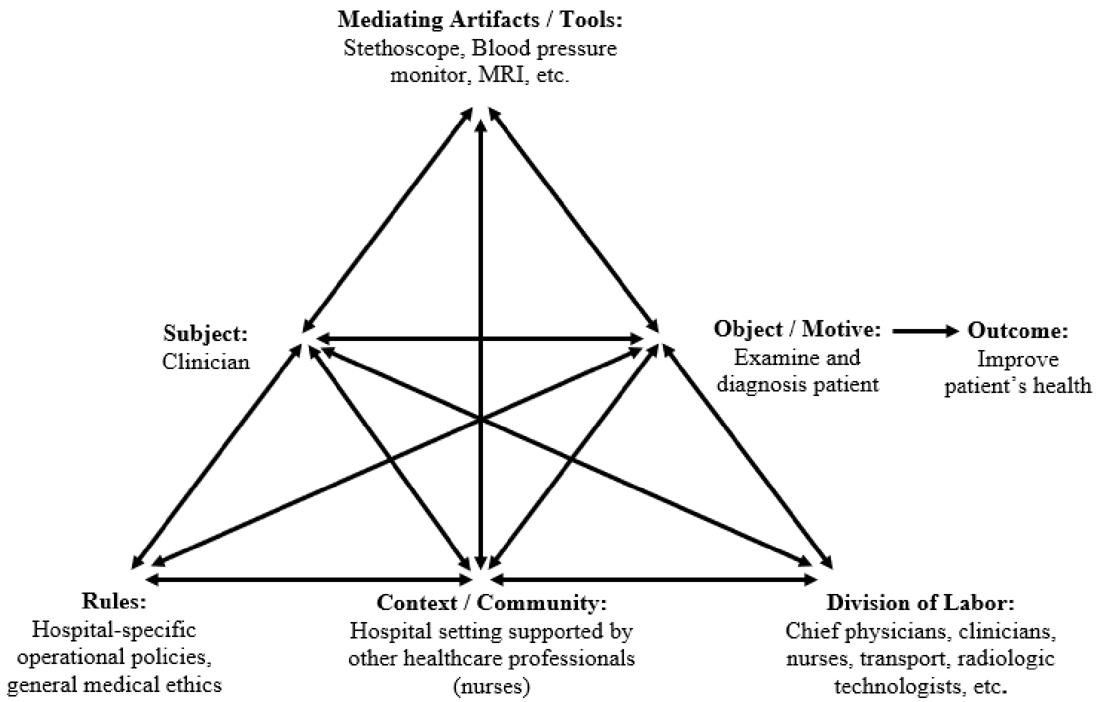

Figure 2: The Activity System of a Healthcare Practice

The components of an activity system include: subject, object / motive, context / community, mediators / tools, rules, and division of labor. These elements interact to transform an activity into an outcome. Each component of an activity system is briefly described below:

- Subject – The subject, often an individual, makes conscious decisions and is motivated to perform activities that are goal-directed. A clinician who performs a physical examination is the *subject*.

- Object / Motive – Physical or intangible constructs, like an idea, for which is the activity is directed towards (by the subject). The object or motive is often referred to as, "objective." The object or objective of a subject's activity can be altered and evolve during the activity. Motivated by diagnosing and treating a patient, the physical examination is the *object* of the activity.
- Context / Community – The community is the social context of an activity, for instance, a group or team in which the subject is performing the activity or other stakeholders involved in the activity. The hospital is the *context* in which the activity is performed.
- Tools – Tools, or mediators, are the physical or non-material artifacts that mediate the relationship between subjects and objects; tools shape external behaviors and influence cognitive processes. Clinicians use various *tools*, such as a stethoscope and blood pressure monitor, to perform a physical examination.
- Rules - Guidelines, laws, and values which the subject must follow; rules determine the interaction between subject and its community. Hospitals have specific administrative practices, policies, and plans which are *rules* used to guide actions and decisions; additionally, healthcare professionals and organizations abide by code of ethics.
- Division of Labor – The hierarchical structure of individuals in the activity and roles each take with regards to the object; these are defined both implicitly and explicitly. Clinicians, nurses, administrators, and other healthcare professionals perform specific activities according to their expertise to support patient care; the *division of labor* encompasses the role structure and interaction among each of these subjects.
- Outcome – The modified and altered object resulting from the successful performance of the activity. The patient receives quality healthcare and a positive health *outcome* as a

result of the activity. (Kuutti, 1996; Nguyen & Choon Poo, 2016; Sadeghi, Andreev, Benyoucef, Momtahan & Kuziemsky, 2014; Wiser, Durst & Wickramasinghe, 2017).

Activities may be co-dependent, such that the outcome of an activity simultaneously is a goal-reached and a motive to begin another activity, which has a different objective (Vrazalic, 2003b). For instance, one activity could be a consumer's interaction with a website; the motive or objective is to learn more about a product or service. Having become educated about the product or service, the consumer would have reached their objective of the activity and might be motivated to purchase the product or use the service, which fundamentally initiates a new activity. Activities are also dependent on the available conditions (Vrazalic, 2003b).

Likewise, to collaborate successfully to reach a desired goal, "shared meaning" must exist between each component of an activity system, as well as between one or more activity systems that cooperate to achieve jointly produced outcomes (Igira & Gregory, 2009; Weber, 2003). For instance, if a doctor and nurse are collaborating together to care for a patient, each subject (the doctor and the nurse) must understand the role that she or he performs in the care of the patient, understand the tasks she or he performs, and understand how each uses the instruments and medical data in the care of the patient in order to successfully care for the patient. Similarly, if a physician is using a Clinical Information System (CIS), which stores patient medical information, to support her or his diagnosis and treatment of a patient, the buttons, labels, terminology, and other design elements of the user interface must be meaningful to the physician and interpreted correctly or as the designer intended in order for the physician to efficiently and effectively use the system and make an accurate diagnosis. If shared meaning does not exist between the interacting components of an activity system, the activities in which they are jointly engaged with may not successfully transform the object into the desired outcome.

The concept of “shared meaning” is especially critical in the examination of information technology in the healthcare sector because HIT, CISs, and telemedicine are all computer-based or electronic-based approaches that are intended to transfer information and impart knowledge to the subjects who utilize it to ultimately improve the quality of healthcare and individuals’ health. Literature is saturated with instances when the usability of HIT and telemedicine is negatively affected due to users’ misunderstanding or misinterpretation of how a technology or system was intended to be used or was unable to engage in a meaningful interaction (Brunner et al., 2017; Horsky et al., 2016; Kushniruk et al., 2004; Tieu et al., 2017). Activity theory perceives successful outcomes to result from the collection of jointly constructed, meaning interactions between subjects and tools, set within a certain context.

Activity theory draws knowledge from several disciplines, including cognitive psychology, HCI, anthropology, philosophy, and linguistics (Patel et al., 1998), and it is useful as a descriptive tool to understand humans’ cognitive processes as they interact with objects in relationship to other socio-technical constructs (Engeström, 2000; Nardi, 1996; Patel et al., 1998).

Furthermore, as the technical communication discipline often sits in the boundary space between writing and rhetoric, HCI, and usability/UX, activity theory has attracted the technical communication community and has been employed frequently. Activity theory has been used as as a conceptual framework to understand HCI within certain contexts by describing each component of the activity system, such as in virtual, cross-cultural collaboration (Paretti & McNair, 2008) and both the instruction of and practice of technical communication (Spinuzzi, 1996; Spinuzzi, 2003; Winberg, 2005). Also, technical communicators use activity theory as a research tool to analyze users’ mediated interactions with designed information and be able to identify usability problems and redesign technology that better supports users' work activities (Shearer, 2011; Spinuzzi, 2003). Activity theory is congruent to the nature of my study and employing activity theory as a descriptive tool and research method is a opportunity for me to ground my study in my technical communication education and professional experience.

Spinuzzi (2003) argues,

> "Information designers, including technical communicators, should be trained, principled, and capable user advocates, and they should understand how workers are often constrained and disempowered by existing tools and ways of doing work." (p. 18-19)

Activity theory explicates the dynamic and enmeshed relationship between individuals, tools, motives, context, and activities, such that individuals' shape the way they use tools to perform activities, which are socially, culturally, and historically determined. Any change in one of these components will inherently change the other. Because activity theory posits that human consciousness is integral to the activity, which is embedded within a certain context, all of these constructs combined make up the basic unit of analysis (Kuutti, 1996). The context of an activity in activity theory is depicted as constantly changing (Uden & Helo, 2008). Thereby, individuals make conscious decisions to perform activities which are both determined by and conducted within a certain context. For instance, a user might be compelled to interact with their smartphone to access the internet when they are mobile because they have no other "tool" to use when they are mobile and need to access the internet. Thus, one cannot understand humans at the level of consciousness and their intent for using certain tools without also having knowledge of the context in which the activity is performed. Kuutti (1996) states, "Because the context is included in the unit of analysis, the object of our research is always essentially collective even if your main interest is in individual actions" (p. 26).

Correspondingly, the activity is always transforming and purposeful, but consciously performed (Jonassen & Rohrer-Murphy, 1999; Makovhololo et al., 2017; Mursu, Luukkonen, Toivanen & Korpela, 2007; Varazalic, 2003). Healthcare is a collective activity which encompasses numerous subjects, motives, tasks, tools, and stakeholders, and healthcare activities take place in a number of different contexts; therefore, activity theory supports a holistic evaluation and understanding of how users interact with technology to achieve specific health outcomes.

Activity theory also contributes the notion of "contradictions" in the activity system. Given that activities are constantly evolving and altered, contradictions appear in an activity system when there are tensions between an activity and any other construct in the activity system or with other activity systems (Engeström, 1987; Sadeghi et al., 2014; Wiser et al., 2017). Contradictions reveal when a subject may not understand or comply with given rules or when there is resistance to alter and update existing systems (Engeström, 1987; Vrazalic, 2003a). Contradictions can result when users' do not understand how a technology or system functions or how to interact with it effectively to support the activity they are performing. For instance, if a clinician must enter patient medical data in an EHR, and the EHR user interface does not include a specific medical code in a menu, this is a contradiction between how the clinician needs to use the EHR and how the EHR is designed. When evaluating subjects' interactions with tools or mediators, such as a telemedicine provider website, contradictions can be perceived as a proxy for usability problems. Contradictions might also reveal gaps of knowledge between a designer's conceptual model of how users' use a system and how the system is used in a real-life context (Chun et al., 2012; Kushniruk et al., 2005; Kushniruk et al., 2013). In this study, I apply activity theory to guide the interpretations of participants' motivations for performing certain actions during their interactions with the telemedicine interfaces.

Applying Activity Theory in the Analysis of Telemedicine Provider Interface Interactions

Activity theory provides a broad conceptual framework that can be applied in the analysis of human-computer interface interactions in such a way as to emphasize how human activities are served by technology, rather than only the technology itself. Because this study aims to understand the interaction between the subject and the mediator, or tool, I only focus on these components of the activity system in my analysis and not the entire activity system. Nardi (1996) promotes activity theory as a clear way of isolating one activity from another and as a comparative tool for analysis. It can be assumed that people will access telemedicine communications in order to gain information on what conditions they are able to get diagnosed and treated for via a telemedicine consultation. Another motive for individuals' access of a telemedicine communication is that they may already know what telemedicine is and may simply want to know how to perform the telemedicine consultation and will only be looking for specific pieces of information that will help them reach their goal. Additionally, individuals may be mobile or only have a smartphone to use to access the internet and would be motivated to interact with the telemedicine provider website on their smartphone.

Next, I provide two examples of how I perceive the telemedicine provider communication activity system to operate that guide the inferences I made during data analysis and help answer my research questions. One, the telemedicine communication can be perceived at the communication level, as a tool users interact with to become informed about the telemedicine service and how to perform a virtual doctor visit. See Figure 3. In this case, the rhetoric and information on the telemedicine website must be the information users are looking for, be comprehendible, and contain motivational messages to stimulate users to successfully perform a virtual doctor visit. The goal is to become informed about the telemedicine service and be able to perform a virtual doctor visit and obtain quality healthcare (the anticipated outcome). In this case, the rhetoric and information provided in the telemedicine communication is perceived to be tool the users employ or interact with to achieve their expected positive health outcome.

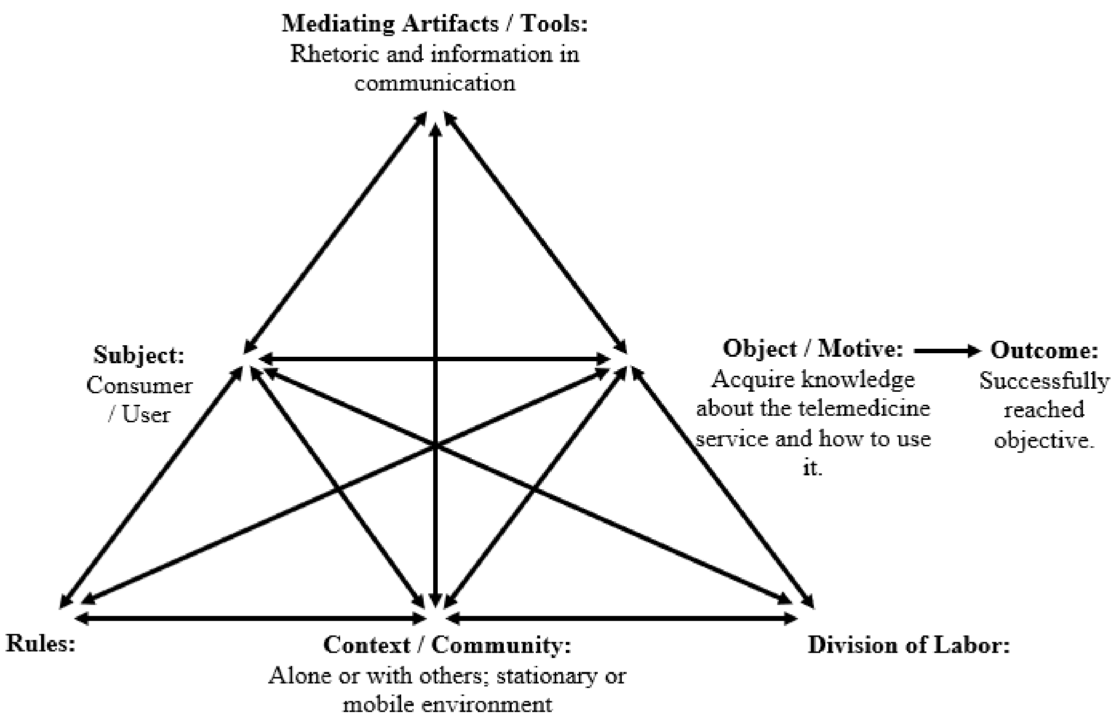

Figure 3: Activity System of a Telemedicine Provider Communication (Communication-level)

Secondly, the telemedicine communication can also be perceived as a tool at the user interface level or medium, and this is context dependent because users may be in a mobile environment and only able to access the telemedicine provider interface from a smartphone. See Figure 4. In this context, the telemedicine interface can be perceived as the tool itself, which is accessed and interacted with to become informed about the telemedicine service and how to perform a virtual doctor visit. In this case, the telemedicine provider interface must contain the necessary design elements, such as buttons and links, navigation options, and placement of information that enable the user to employ the interface successfully to achieve their goal.

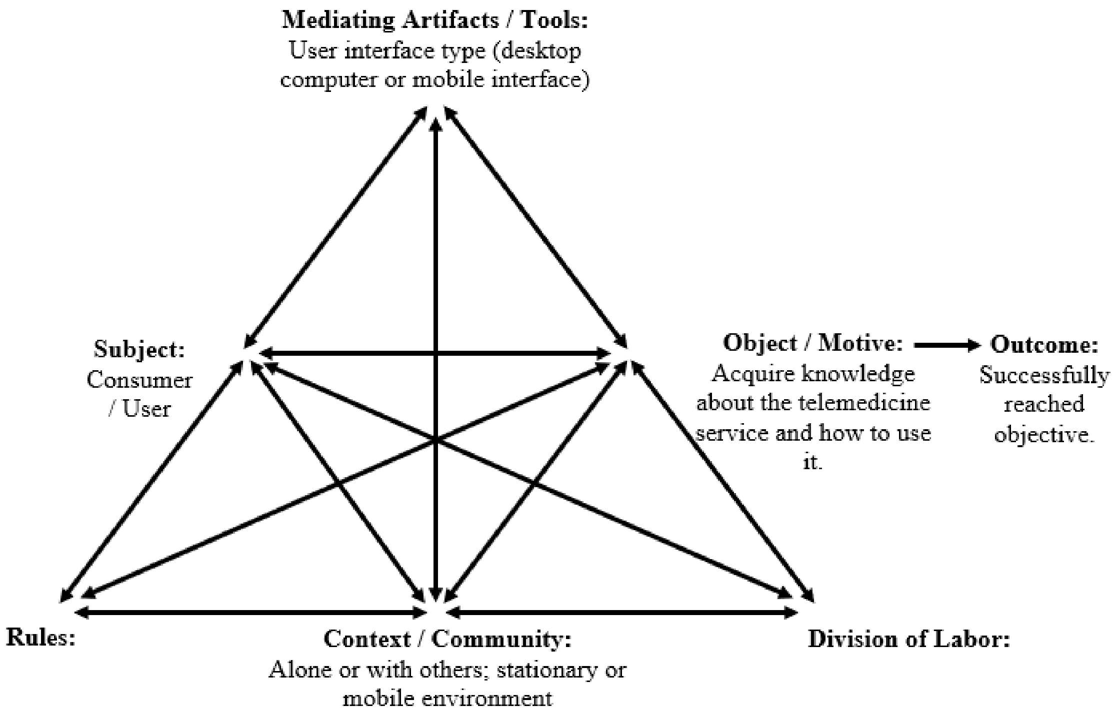

Figure 4: Activity System of a Telemedicine Provider Communication (User Interface-level)

One can see that the activities are co-dependent (Figure 5).

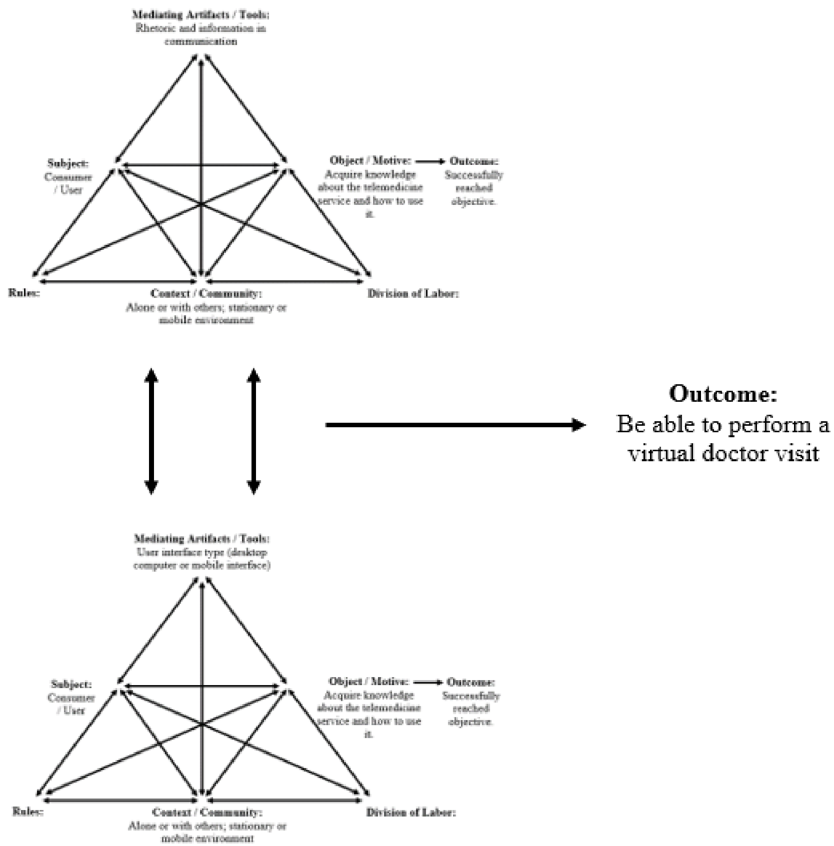

Figure 5: Co-dependency of the Activity Systems of a Telemedicine Provider Communication

Both activities, concomitantly, must be transformed into successful outcomes in order for a user to perform a virtual doctor visit or use the telemedicine provider service.

Affordances of Activity Theory

Because HCI has taken a prominent role in the delivery of healthcare, through such applications like telemedicine, activity theory offers a unique perspective in the study of humans' interactions with the telemedicine interfaces and improves the understanding of usability problems. Mapping the contradictions – or usability problems – in the activity system between a human and a HIT can have an important impact for the design of health-related user interfaces that are more intuitive and acceptable by end-users. Furthermore, activity theory calls attention to the significance of context in the design of online platforms and mobile computing applications that is often neglected by designers (Uden et al., 2008).

Activity theory is a powerful lens through which to describe human activity with technology because of its explanatory benefits:

1. it respects individuals' differences and motives for performing goals
2. it maintains the concept of mediation (humans' use of tools to facilitate activities)
3. it situates human activities in certain contexts, such that one cannot analyze human behavior outside the context in which it occurs
4. it is flexible and able to be adapted for one's object under investigation and study context given that activities and social systems are dynamic and in constant flux and technology is always changing and advancing (Jonassen et al., 1999; Kaptelinin et al., 2009; Wiser, Durst & Wickramasinghe, 2019).

Until recently, activity theory has had limited application in the healthcare sector (Sun & Qu, 2015; Wiser et al., 2019). However, as more HIT continues to be used by clinicians, nurses, and patients, an emphasis on the human factors involved in the usability of these technologies is critical in order to achieve the benefits and avoid compromising patient safety. Scholars recognize that there are many stakeholders and objects involved in the design and implementation of HIT, including designers, organizational workflows, physicians, and patients, and all need to be accounted for to ensure HIT can be implemented and effectively used (Carayo, & Hoonakker, 2019).

Activity theory is a useful framework because it identifies human activities with mediators embedded within a context of collective work and it is concerned with the users' goals and motives and mainly, the activity itself, that users perform in order to achieve their goals. Telemedicine websites are spaces where activities occur and the information, icons, buttons, links, and other media are the objects that users interact with. In this way, artifacts—or objects—can be perceived as "affordances" as described by Norman (1988). Humans act on objects in ways that both determine the capabilities of the object and extend the capabilities of the human, which is to say that humans use tools to help them perform activities more efficiently and more effectively. Norman (1988) advises that the presence of an affordance is uniquely determined by the qualities of the object and the creativity of the individual who is interacting with the tool. Kaptelinin (1996) echoes Norman (1988) in contending that humans consciously create the meaning of objects in the process of interacting with their environment. The idea that humans make conscious decisions to use specific objects in certain ways is a valuable method of perceiving how individuals interact with and use telemedicine provider interfaces and communications.

Moreover, understanding the context in which telemedicine communications are used is also essential to illustrate the network of actors and actions being performed in the delivery of healthcare (Kushniruk et al., 2013). Kuutti (1996) argues that artifacts, "should be never treated as given" (p. 26). Researchers in the health and medical field emphasize the need to account for the artifacts that a user might encounter in a health situation and identify the activities they will perform using these objects (Kushniruk et al. 2013; St.Amant, 2017).

Activity theory also provides the discourse for describing users' interactions with telemedicine interfaces (Mursu et al., 2007) and insight into potential barriers to usability and acceptance of telemedicine (Mursu et al., 2007; Patel et al., 1998). Therefore, using activity theory as a lens through which to explicate users' interactions, I can identify usability problems associated with the telemedicine provider interface.

Applying Activity Theory as a Methodology

Activity theory has been used as a methodology and analytical framework for decades in the HCI realm because of its implications for the design of technology or systems that are considered usable by intended users (Bødker, 1991; Nardi, 1996; Bertelsen and Bødker, 2003; Kaptelinin et al., 2009). Given that the focus of my study is on the activity that takes place between humans and telemedicine provider interfaces, which is an essential activity for the communication and use of telemedicine, activity theory was used to inform the methodological approach I used, in particular, when designing the think aloud usability testing. The activity-theory usability testing framework aims to examine real users employing technology to support their real-world activities and considers the context in which users execute these activities, including the environment and social factors (Banna, Alkayid, Hasan & Meloche, 2009; Varazalic, 2003). Traditional usability testing, which takes place in laboratory or a controlled environment, fails to take into account the physical, social, cultural, organizational, and other contextual factors that occur when users perform their natural, everyday activities, and may not reveal severe usability problems that erupt in the real world (Vrazalic, 2003b). Thus, an activity theory-based approach to usability testing develops testing scenarios that simulate that of the typical real-life activity that a user would perform whilst interacting with the object under evaluation (Banna, et al., 2009; Varazalic, 2003). Activity theory is a, "conceptual framework that can be applied to the human-computer interface in such a way as to empower the computer user with the necessary tools to work though the interface in order to achieve desired outcomes (Varazalic, 2003, p. 43).

Activity theory adopts a certain set of practices and rules used to approach usability testing, which are performed in a systematic way (Banna et al., 2009). The activity theory usability testing model typically includes the following steps:

1. Establishing the test goals
2. Establishing the system purpose
3. Identifying representative users
4. Identifying representative activities
5. Developing user testing scenarios or simulations
6. Conduct usability testing
7. Perform data analysis (Banna et al., 2009; Vrazalic, 2003a; Vrazalic, 2003b).

The careful selection of methods, representative subjects, tasks, and data analysis rules used in this study were guided by activity theory in order to optimize the study's rigor and pragmatic application of the findings. Additionally, by identifying the key elements of usability that create problems during users' interactions, I can offer design guidelines for telemedicine provider websites that can be extended to a wider context or situation in which HIT is used to delivery healthcare. Bødker (1991) claims that artifacts are created and intended to support user activities and arise out of this need; therefore, telemedicine communications and interfaces can be understood to arise out of consumers' need for information and directions on how to perform a telemedicine consultation.

Activity Theory: A Flexible Framework

Some critics of activity theory contend that it is not a useful model by which to describe and predict phenomena (Halverson, 2002). Wiser et al.'s (2019) systematic review revealed several shortcomings of activity theory that are purported to thwart researchers use of activity theory. Researchers suggest that the definition of an activity is ambiguous and find it challenging to identify the unit of analysis when studying human socio-technical phenomena (Wiser et al., 2019). Along these same lines, because activities are malleable and evolve over time, researchers might only be able to document a “snapshot” of an activity and not be able to obtain insight into how the activity changed or individuals’ motives changed over time (Wiser et al., 2019). Others struggle with labeling and measuring the components of an activity system, such as the subject or division of labor (Wiser et al., 2019). For instance, recognizing an “employee” to be the subject in an activity is oversimplifying the individual characteristics of the subject. The differences between individuals and their impact on the overall activity is not supported by just the label, “employee” (Wiser et al., 2019). Also, putting together the complex puzzle of activity networks and how each activity relates to and influences the successful performance of other activities is difficult (Wiser et al., 2019). Understanding how each activity of each subject within a healthcare organization interacts and collaborates to provide quality healthcare to patients is difficult to say the least. Clinicians, nurses, administrators, technology, information, processes, procedures, and patients all interact to successfully achieve a positive health outcome. Each health practice is a complex, yet unique activity that takes place, and it is understandable why there are apprehensions with applying activity theory.

That said, proponents argue that activity theory is to be loosely applied as a conceptual framework and not for predictive purposes (Wilson, 2006). Activity theory purports that human actions are performed with the intentional use of tools, situated within a specific context (Nardi, 1996); thus, there is no a priori code of this descriptive account. Every HCI interaction is unique. Humans’ actions with telemedicine provider communications are only able to be analyzed within each specific context of use and are unique for each individual user. Activity theory is intended to be applied loosely, meaning there is no universal subject or object. Whilst drawing from the same terminology and overarching components of humans' interaction with HIT and one another, researchers should adapt how they use activity theory for their particular study and context. To fully evaluate and understand humans' interaction with HIT and telemedicine, scholars and practitioners must be capable of utilizing activity theory in a holistic fashion rather than emphasizing any one of its individual constitutes (van Gemert-Pijnen et al., 2011). Mapping individuals' interactions onto the constructs of the activity theory framework expresses how individuals use telemedicine provider communications as mediators to gain the information they need to support their ability to perform a telemedicine consultation.

Activity theory is a powerful and effective, yet flexible framework for analyzing HCI. Because activity theory sets forth a particular set of components which comprise an activity and collection of activities, for instance, the subject, object, and tool, it is useful for identifying usability problems that users encounter when interacting with a technology or system. Yet, activity theory does not prescribe how these constructs are defined or interact. Thus, activity theory can be used flexibility as an analytical framework or to support researchers when designing their study. Researchers can apply activity theory to obtain a holistic understanding of an activity or activity network, such as identifying all the components of an activity in a workplace. Or, researchers can obtain more granular data, such as individual subject's use of tools in the context of one activity and are free to select the best metrics that illustrate their unit of analysis. For these reasons, activity theory can be applied in any field or discipline. Lastly, studies take place in different contexts and exploit different resources; thus, researchers require theories that afford them the ability to design their study based on their available resources.

This study contributes to both theory and practice by uniquely applying activity theory to the examination of user's interactions with telemedicine provider interfaces as both an analytical tool and as a methodological framework that guided how I designed my study.

Mobile Interface Theory Introduction

In the last section, I described how I used activity theory to interpret users' interactions with the telemedicine provider websites, as well as a methodological approach. In this section, I describe how mobile interface theory contributed to my understanding of users' interactions with the telemedicine provider websites on their smartphone.

Because much of the human experience is in multimodal spaces, mobile interface theory provides a theoretical foundation for understanding how people experience mobile technology and semiotic remediations of paper and print communications (like interactive websites, mobile responsive websites, and video chats). In mobile interface theory, interface is described as a set of relations that are habituated through our social interactions (Farman, 2012). Mobile interface theory articulates the notion that users experience telemedicine interfaces and communications as sensory-inscribed, embodied experiences in a digital space—or mobile space. Mobile interface theory complements my use of activity theory, which perceives the context of use to be a determinant of the successful performance of an activity. Drucker (2011) explains that a substantial amount of humans' interactions occur in graphical environments and that humans rely on visual cues to help them navigate and gain meaning from the relationships they stitch together from various structural elements, such as videos, graphs, images, and the layout and organization of the user interface. Because most DTC telemedicine consultations are performed via mobile devices and interfaces (Uscher-Pines et al., 2014), it is necessary to understand how individuals interact with telemedicine communications in the digital space of mobile technology. Individuals perception of telemedicine relies heavily on their sensory-inscribed experience of engaging with mobile telemedicine interfaces. Although mobile interface theory is a relatively new theoretical perspective, it is highly relevant and useful for identifying usability problems individuals experience when interacting with mobile interfaces, which are becoming an increasingly important context for the delivery of healthcare interventions (Casey et al., 2014; Klasnja et al., 2011; Casey et al., 2014; Zhang, Johnson, Patel, Paige & Kubose, 2003).

Mobile interface theory posits that humans have an embodied experience when interacting with a mobile interface because it requires to use of many senses to engage in activities in the liminal space between the physical and digital world (Farman, 2012). Farman (2012) suggests that humans are proprioceptively engaged in the situation of their interactions with mobile interfaces. Thus, mobile interface theory might suggest that a participant will have a more positive sentiment towards telemedicine when seeing images of satisfied patients on their smartphone than when seeing the same images on a desktop computer monitor because their experience is articulated through more senses.

Sensory-inscribed Experience in Virtual Space

Farman (2012) argues that the cultural transformation that has occurred as humans shifted from using paper to computing technologies to now mobile interfaces characterize our identities and define our embodied activities of our everyday lives. The objects we use in our daily interactions—computing technologies and mobile interfaces—have become pervasive. Farman (2012) says, “Space and embodiment are intimately and indelibly linked” (p. 4), and because of space and embodiment are connected, the production of social and embodied space through our practices with mobile technology become so entwined in our everyday lives that they go unnoticed.

Intelligent mobile technologies often blur our understanding of the virtual space and the actual space we embody in the physical world with responsive capabilities, such as a global positioning system (GPS). An individual can experience the embodied physical state, while also being situated in the same location in the digital space. The integration of bodies and digital space informs how individuals may experience telemedicine. It seems that in order to be successfully adopted and perceived as quality healthcare, the experience of a telemedicine consultation must appear to individuals as a normal, everyday embodied experience that they would experience in an in-office visit with a physician. The mobile technology must fluidly integrate with humans' bodies and surroundings so much that they interact with the digital device and gain immediate feedback, such as from the physician, yet they do not distinguish it as different from a real-life engagement with the physician. This human mechanism by which one experiences healthcare through mobile interfaces is described as an "attachment" to one's mobile phone given individuals' "checking habit" being reinforced immediately by visible information, rewards, and entertainment (Oulasvirta, Rattenbury, Ma & Raita, 2012). Of course, attachment to one's mobile phone can occur in many contexts, but applying mobile interface theory in the health and medical field has important implications. Scholars have already studied the impact of individuals' innate checking habit on health behavioral change (Casey et al., 2014; de Korte et al., 2018). Farman (2012) describes that humans' interaction with mobile interfaces is sensory-inscribed and given the pervasiveness of mobile interfaces, mobile interface theory is an effective lens in which to view how embodiment and space are produced in the digital age. McNamara and Kirakowski (2006) contend that functionality, usability, and user experience are interdependent aspects of usage. For instance, McNamara et al. (2006) offer an example that expresses the concept of mobile interface theory: “the usability of the [mobile] is awful, but their experience may be very immersive and compulsive” (p. 26). McNamara et al. (2006)’s example illustrates how individuals’ interaction with a mobile interface is an embodied experience and, despite poor usability, individuals are compelled to continue to use the mobile interface.

Such factors indicate that mobile interface theory is a mechanism by which to explain how individuals use the telemedicine website on their smartphone and how their experience may be different than their experience using the website on a desktop computer. Each context of use partially shapes the user experience and likely users’ intention to use telemedicine. For instance, a user may have low technical literacy and may not be able to use a smartphone effectively, which may result in a negative experience (Bagchi et al., 2018; Sarkar et al., 2010). Similarly, a user may experience navigational problems when trying to find certain inforamtion, which may result in a negative experience (Bolle et al., 2016; Sarkar et al., 2010). In both cases, the usability of the user interface shaped the user experience. Mobile interface theory sheds light on the internal cognitive processes and perceptions of an individual as they interact with technology in a mobile environment.

Because mobile interface theory is so contemporary, this study affords the opportunity to explore how mobile interface theory can be applied in the investigation of the usability of user interfaces when accessed in a mobile environment. I employ mobile interface theory to guide my interpretation of participants’ interactions with the telemedicine websites on their smartphone in terms of usability. Remember, mobile interface theory, describes, “interface,” as a set of relations that are habituated through our social interactions (Farman, 2012). The interface is the mediating environment that constitutes the user experience of embodiment in a social space. This embodied experienced significantly impacts users' understanding of and perception of telemedicine when interacting with a mobile-responsive telemedicine website on their device. For instance, subjects' may appear more at ease and comfortable when using their smartphone. A mobile interface theoretical perspective might suggest that because of the pervasiveness of mobile technology, the portability, and the multi-sensory experience individuals have when using their smartphone, subjects prefer interacting with the mobile interface as opposed to the desktop computer interface.

Reciprocity is key to the creation of embodied space in locative media (Farman, 2012). Reciprocity is the acknowledgment between individuals across social spaces and can take place between individuals and technological objects (Farman, 2012). For instance, when interacting with a telemedicine website on a smartphone, the time between a user's gesture and response time to gain the desired information must be seamless and effective at meeting the user's information needs. Haptic reciprocity engages users and could lead to a positive affective reaction; however, if users do not obtain a response with the information they were seeking, this negative reciprocity could lead users to question the ethos of a telemedicine website. A negative affective reaction can impact a user's perception of the telemedicine service. Especially if the telemedicine interface or communication is a user's first engagement with telemedicine. A user that experiences a positive affect from her or his first interaction with a telemedicine website is likely to increase her or his intention to use the service. A user that experiences a negative affect from her or his first interaction with a telemedicine website may hamper their perception of the telemedicine service and decrease the likelihood they will use it. Scientific evidence supports the notion that habitual interaction with mobile technology may, in fact, "rewire" individuals' brains because of the sense of connection with one's smartphone and ability to act like a cognitive prosthetic device that individuals may experience diminished attentional capacity and develop a need for immediate gratification (Wilmer, Sherman & Chein, 2017). Mobile interface theory provides a sound theoretical standpoint for these shifts in cognitive functioning. Given that smartphones and other portable media devices are increasingly being interlaced with our cognitive functioning, detailed usage metrics and usability studies are needed to understand how these interactions affect and shape human lives and the user experience.

Mobile interface theory centers on the understanding that as humans engage with one another through mobile media interfaces, the interface becomes a site for interactions and is essential to the production of embodied space across networks (Farman, 2012). Site-specific alterity and proximity are key to our sense of implacement and intersubjectivity as we navigate the digital social space (Farman, 2012). This concept is critical to a user's perception of telemedicine and explains why users may be sensitive to the user experience of telemedicine provider websites and communications and slow to adopt and accept telemedicine as a quality healthcare delivery system. When users interact with telemedicine provider websites and communications, they oscillate between their embodied experience of telemedicine and their material existence. Farman (2012) explains, "To balance this notion, we must also take into account that the acknowledgement of one another in these spaces is a fundamental component of embodiment" (p 61). When users interact with telemedicine provider interfaces, they enter into a constitutive relationship with the other because the interface itself becomes a site for interactions with objects and people and can either pose a threat to users or take the form of a meaningful social exchange (Farman, 2012); thus, impacting how a user will perceive telemedicine. Bodies and spaces are indelibly linked in our world of ubiquitous mobile technologies.

Summary of Theoretical Approaches

Activity theory and mobile interface theory both offer significant contributions to my examination of telemedicine communications. Both activity theory and mobile interface theory are used in my analysis of the telemedicine provider interfaces and description of users' interactions. Telemedicine communications should include rhetoric that motivates individuals to use telemedicine from their perception that telemedicine will be valuable and beneficial to them and is a quality healthcare delivery system. Activity theory and mobile interface theory provide insight for making inferences about users' interactions with telemedicine provider interfaces and discourse for describing users' experience of telemedicine communications and how their perception of and understanding of telemedicine is influenced by the design of the communication. User interfaces on smartphones represent an extension of the conventional desktop computer interface and mobile interface theory supports a deep understanding of users' interactions with telemedicine communications on these devices. A considerable focus on the user interface and how it changes the activities of the user can be better understood through the lens of activity theory and mobile interface theory. Combined, activity theory and mobile interface theory offer a robust framework that reflects the individual and contextual determinants of usability as individuals interact with telemedicine communications and can be used to describe cognitive and behavioral phenomena that are observed in this study.

CHAPTER FOUR – METHODOLOGY

This chapter describes the mixed-methods used in this study comprising of content analysis methodology, remote usability testing using a survey instrument, and think aloud usability testing that concluded with a retrospective TIUQ to solicit further end-user feedback. The selection of the telemedicine interfaces, recruitment of subjects, data collection, criteria and coding procedures, and data analysis performed in each part of the study is presented. Each part is described in this chapter as having increasing degrees of reliability, fidelity, and validity due to the systematic nature of the methods and protocols used and the rich data corpus obtained. Numerous researchers advocate for employing mixed-methods in usability studies of HIT, ehealth, and other health informatics because the limitations of any one method can be offset by the advantages of another and more data sets can be obtained[6]. Combined, these methods enabled me to make stronger inferences and triangulate data.

The soundness or quality of qualitative research methods are evaluated much differently than quantitative research methods and are still considered rigorous and systematic in nature (Mays & Pope, 1995). In the health sciences, qualitative research is arguably more imperative because the consequences are greater when human lives are affected, and the findings are more valuable if used to improve the design of HIT that is going to be efficacious. With that said, it is important to define how the methods used in this study are evaluated in terms of rigor and prime readers with an understanding of the terminology that will be used to discuss the integrity with which each part of this study was designed and conducted to ensure the credibility of the

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[6] Göransson, Ehrenberg, Ehnfors, & Fonteyn, 2007; LeRouge et al., 2007; Lundgrén-Laine, & Salanterä, 2010; Kushniruk, Patel, Patel & Cimino, 2001; Kushniruk, et al., 2004; Kushniruk et al., 1996; Kushniruk et al., 1997; Martins, Gonçalves & Branco, 2017; Wolpin et al., 2015

findings. Next, I provide a discussion of how the mixed-methods used in my study qualify as rigorous by defining the main quality concepts used to evaluate research practices and methods.

Optimizing reliability and validity in qualitative research methods is accomplished by designing appropriate research methods as it relates to the phenomenon being investigated and the systematic application of these methods (Mays et al., 1995; Noble & Smith, 2015). A transparent and complete account of one's methods and protocols ensures that qualitative research methods can be replicated in other contexts and can be generalized to a specific target population (Maher, Hadfield, Hutchings & de Eyto, 2018; Mays et al., 1995; Morse, Barrett, Mayan, Olson & Spiers, 2002). The terminology used to illuminate the principled and rigorous nature of this study are defined next.

Validity is the accuracy and precision of the findings as they relate to the phenomenon being studied (Golafshani, 2003; Lincoln & Guba, 1985; Long & Johnson, 2000). For instance, in this study, validity can refer to whether the inferences made from the think aloud usability tests accurately represent the subjects' experiences (Mays et al., 1995).

Ecological validity is the extent to which the context of the study and circumstances under which subjects are evaluated matches their real-world, natural setting and the activities subjects would normally carry out (Kushniruk et al., 2013). This study demonstrates ecological validity because the think aloud usability tests were conducted in a setting that is natural to the subjects, and subjects were instructed to imagine they were sick, which acted as simulations of real-world behaviors (Kushniruk et al., 2013).

Predictive validity is the extend in which the criteria measured on a test matches a test subjects' actual experience or behaviors (Cronbach & Meehl, 1955). This study reflects predictive validity because the TIUQ questions were able to be compared with the empirical data gained from the think aloud usability tests (Sarkar et al., 2010).

Reliability is the extent to which the methods used in the study can be replicated and achieve the same, consistent results (Golafshani, 2003; Lincoln & Guba, 1985; Long & Johnson). For instance, in this study, reliability relates to whether the instruments used to gather data, such as the TIUQ were established as reliable (Kandemir et al., 2018; Sauro, 2011; Tullis & Stetson, 2004). In addition, one strategy to ensure reliability is to keep a detailed audit trail of each step of a study, including any challenges that arose and how they were resolved (Maher et al., 2018). This level of detail is provided in this chapter as each part of the mixed-method study is comprehensively described.

Generalizability refers to the degree in which the findings from one study can be applied to other contexts, groups, or settings (Cropley, 2019; Mays et al., 1995; Lincoln et al., 1985; Long et al., 2000). This study demonstrates generalizability because one part of the mixed-methods study included a remote usability test with a large, heterogenous subject pool that has been demonstrated to represent the U.S. population (Mason & Suri, 2012; Paolacci, Chandler & Ipeirotis, 2010). In addition, because each instrument, protocol, and procedure performed in this study is clearly described in the rest of this chapter, with attention to detail, the insight gained is able to be generalized to similar contexts, target populations, and conditions (Mays et al., 1995).

Fidelity is one of the most important considerations in the design and execution of empirical research. Fidelity is the degree in which the research setting mimics or simulates the context in which a user would interact with technology and how the user would interact with the technology (Kushniruk, 2002; Kushniruk et al., 2013). The think aloud usability testing performed in this study can be considered to have a high degree of fidelity because they were conducted in a naturalistic environment for the subjects being tested and although the environment was the same for each subject, not all factors were controlled for, such as distractions from other people. Kushniruk (2002) insists that when attempting to generalize how usable a HIT is to complex real-world situations, such as when an individual experiences poor health, controlling for all factors that may occur in real-world situations is not desirable. Furthermore, the subjects simulated real-life interactions with the telemedicine interfaces, which is also considered to have high fidelity (Kushniruk, 2002).

Lastly, optimization of research methods is achieved through triangulation. *Triangulation* refers to the collection of data from multiple sources in order to obtain a rich data corpus and have the ability to make comparisons across data sets; this ultimately improves the rigor (Creswell, 2002; Golafshani, 2003; Mays et al., 1995). Numerous scholars contend that a mixed-methods research, such as this study's design, is a successful way of triangulating data (Bryant et al., 2008; Fonteyn, Kuipers & Grobe, 1993; Peute et al., 2015b; Wolpin et al., 2015), and can strengthen and enrich results. By engaging with multimodal data, including textual, video, and statistical data, this study was able to achieve triangulation allowing for the ability to gain a broad perspective of the overall usability of the telemedicine communications, as well as obtain the detailed perspectives of potential end-users (Maher et al., 2018).

Selection of Telemedicine Provider Interface Sample

The first step to the study was to select the telemedicine providers whose communications would be evaluated. The selection of telemedicine provider interfaces was determined based on authority or age and healthcare specialty, such as primary, critical, or palliative, to name a few. The criteria were selected in order to be able to draw comparisons between how a top-ranking telemedicine provider company designed and delivered information about their services and a small telemedicine provider company. Additionally, selecting different healthcare specialties was appropriate to diversify the sample and be able to discover how each differed in the design and delivery of their health information and instructions for using their services.

Two primary care telemedicine providers were selected, Teladoc and Carie Health. Teladoc has been rated as a global leader in virtual healthcare and is one of the oldest telemedicine providers in the market (CPOE.org, 2018; Dyrda, 2018; Preece, n.d.; Roland, 2015). Carie Health delivers similar telemedicine, but is a smaller healthcare provider than Teladoc and assumingly less experienced because of it’s recent entrance into the telemedicine market (Cline, 2018). KADAN Institute was selected as the third telemedicine provider in this study’s sample because KADAN Institute provides remote delivery of functional medicine and according to their LinkedIn page, was founded in 2018 and has just recently entered the market. I was also motivated to select the three telemedicine providers from my own experience in the health and medical field. Larger health organizations typically have more experience and resources to allocate to marketing, and I anticipated that the Teladoc website would offer the most optimal usability in comparison to the other telemedicine providers in my sample.[7] The three telemedicine providers in the sample make up one of the conditions that are controlled for during the think aloud usability tests. See Table 1 for the telemedicine providers selected in this sample and the URL for each’s commercial website.

[7] When using the term, “optimal,” to define usability I am referring to the best or most favorable usability. This term may be used when comparing telemedicine provider interfaces or may be used to refer to “the best it can be.”

Table 1: Sample of Telemedicine Provider Communications: Telemedicine Provider, Year Founded, and URL

Telemedicine Provider	Year Founded*	Website URL
Teladoc	2002	https://www.teladoc.com/
KADAN Institute	2018	https://kadaninstitute.com/
Carie Health	2015	https://www.carie.com/

(*Year Founded was referenced from each telemedicine provider's corporate LinkedIn page)

Part One: Content Analysis

Content analysis is one of the most frequently used methods to evaluate user interfaces (McKay et al., 2018) because it is considered a systematic and objective method for identifying what content and information are contained in discourse (Krippendorff, 1980; Shuyler & Knight, 2008). Content analysis has historically been applied by technical communicators to print communications or textual information to analyze the meaning of text and assess the rhetorical qualities (Boettger & Palmer, 2010; Thayer, Evans, McBride & Spyridakis, 2007). As technical communication continues to evolve with the remediation of text to digital communication, such as in the form of websites, content analysis remains a valuable methodological approach to assess the rhetorical qualities of remediated text that technical communicators can adapt to the nature of their study, such as the size of their sample, the concepts they want to investigate, and the data they want to obtain (Boettger et al., 2010; McNely, Spinuzzi & Teston, 2015). Given that one of the objectives on my research was to find out the rhetorical messages and information that telemedicine providers included on their websites, a content analysis was a valuable method that allowed me to evaluate and quantify the data I wanted to obtain. Content analysis has been effectively applied to discover the quality of and type of content used to promote EHRs (Walsh et al., 2017), which are similar interfaces as the telemedicine provider websites I am analyzing in this study. Content analysis has also been applied in usability studies that sought to obtain and quantify patients’ perceptions of telemedicine (Alami, Gagnon & Fortin, 2018) and the marketing strategies used to promote telemedicine (Dansky & 2005) by analyzing interview transcripts. Content analysis is touted as an important part of an integrated approach to usability testing and thus is an important component of my mixed-methods study. (Moran, 2018; Neales & Nichols, 2001).

The systematic techniques and a priori criteria used when conducting the content analysis of the telemedicine provider interfaces in this study equates to greater reliability and validity (Erlingsson & Brysiewicz, 2017). The content analysis part did not require Institutional Review Board (IRB) approval by the University of Central Florida’s (UCF).

Kayyali et al. (2017) offer a useful and relevant coding schema applied as a priori coding when categorizing the rhetorical content and information provided on the telemedicine websites because the types of content identified by Kayyali et al. (2017) were considered essential to the promotion of telemedicine and knowledge that consumers would need to acquire from their interaction with telemedicine communications. Additionally, Kayyali et al.’s (2017) guidance criteria reflects current knowledge on the rhetorical content and information in telemedicine leaflets (print communications), which allowed me to evaluate the remediated forms of these communications, the telemedicine provider websites, against these themes. This approach allowed me to systematically order and sort the content available on the telemedicine provider websites into the types of information they provide the user and the extent to which they guide users to performing a virtual doctor visit. Table 2 depicts each of these critical pieces of content and the guidance criteria used when performing the content analysis.

Table 2: Rhetorical / Content Code and Guidance Criteria Used for Analysis

Code / Theme	Guidance Criteria
Knowledge	• Information about the service (what it is and how to use it)
Outcomes	• Noting what will be done with the results • Identification that the patient will be diagnosed and prescribed medications if needed
Reassurance	• Technology and equipment is easy to use (reassurance to patients they do not need to have high technical literacy) • Noting patients have support for technical problems • Confidentiality is ensured • Cost is low
Benefits	• Noting the benefits to users
Choice	• Noting the service is optional and not a substitute for traditional face-to-face physician consultations • Noting that the service is not a substitute for emergency services
Previous Experience	• Testimonials • Patients quotes about positive use of service to encourage potential consumers to use it
Further Information	• Identification of who to contact for further information • Identification of who will help the patient if they need help
Appearance	• Visuals, images, and graphics are included • Information visuals are used as an alternative means of providing information to users • Diversity (age, ethnicity, gender) is used in visuals
Readability	• Readability of health information (text) compared to recommended 6th grade-level • Use of Flesch-Kincaid Grade Level (FKGL)

The telemedicine websites were analyzed using a plus (+) / minus (-) technique whereby each telemedicine interface was assigned a plus (+) if it appeared to exhibit any level of detail defined by the guidance criteria for each code and a minus (-) if it did not provide any content or reference to the information defined by the guidance criteria for each code. Table 3 shows the guidance criteria used to analyze the content on the telemedicine provider websites and an example of a passage of text from a telemedicine provider website that is considered representative of the content (see Table 3).

Table 3: Rhetorical / Content Code, Guidance Criteria Used For Analysis, and an Example of Representative Content From a Telemedicine Provider Website

Code / Theme	Guidance Criteria	Example of Representative Content
Knowledge	• Information about the service (what it is and how to use it)	*Speak to a licensed doctor by web, phone or mobile app in minutes.* (Teladoc)
Outcomes	• Noting what will be done with the results • Identification that the patient will be diagnosed and prescribed medications if needed	*The KADAN Institute provides a natural lifestyle healthcare solution for both health professionals and clients. Using the most advanced Functional Medicine techniques alongside proven systems implemented by our experienced practitioners, your wellness is in the best of hands.* (KADAN Institute)
Reassurance	• Technology and equipment is easy to use (reassurance to patients they do not need to have high technical literacy) • Noting patients have support for technical problems • Confidentiality is ensured • Cost is low	*The Carie platform is HIPAA secure and your health data is always encrypted and never shared.* (Carie Health)
Benefits	• Noting the benefits to users	*Save time and money.* (Carie Health)
Choice	• Noting the service is optional and not a substitute for traditional face-to-face physician consultations • Noting that the service is not a substitute for emergency services	*Common conditions include sinus problems, respiratory infection, allergies, flu symptoms and many other non-emergency illnesses.* (Teladoc)
Previous Experience	• Testimonials • Patients quotes about positive use of service to encourage potential consumers to use it	*"So nice to stay home and receive care instead of going to a doctor's office with other sick people. Warm and comfortable care at home, on my time!" Nikki N.* (Teladoc)

Code / Theme	Guidance Criteria	Example of Representative Content
Further Information	• Identification of who to contact for further information • Identification of who will help the patient if they need help	*The Carie support team is available 24/7 by email, live chat, and phone.* (Carie Health)
Appearance	• Visuals, images, and graphics are included • Information visuals are used as an alternative means of providing information to users • Diversity (age, ethnicity, gender) is used in visuals	 (Teladoc)

This type of coding technique was adapted from past content analyses of computer-based disease management systems (Or & Tao, 2012) and the frequency of positive or negative sentiments reported by users in when using similar healthcare interfaces (Kushniruk et al., 2002).

Because the objective of the content analysis was to detect whether the telemedicine provider delivered the type of information patients would be seeking and the ease in which a user is able access the particular piece of content, the number of screen transitions a user is required to click through to navigate to the content in each category was also recorded. This value expresses the depth in which a user is required to search for information about the telemedicine provider's services. This number represents how many clicks a user is required to perform to navigate to that specific piece of information. The ability to retrieve information quickly is an essential value of effective telemedicine provider websites and should not require numerous screen transitions. Dansky et al. (2005) assert, "Navigation within the site should be intuitive and require a minimum number of clicks" (p. 33). One of the main features of usability is efficiency, and the more steps required to perform a task contribute to reduced efficiency, and correspondingly, reduced usability (Farrahi, Jeddi, Nabovati, Jabali & Khajouei, 2019).

It is well-established in the literature that the readability of textual information influences one's ability to understand and process information and is a necessary aspect of health literacy (Berland et al., 2001; Raj et al., 2016; Wilson et al., 2003). Health literacy has an intrinsic relationship with usability and cannot be separated as one affects the other and vice versa (Melonçon, 2016; Melonçon, 2017; Monkman et al., 2013b; Monkman et al., 2015a), and one's ability to read and comprehend text is an essential component of health literacy. Thus, the Flesch-Kincaid Grade Level (FKGL) calculation was used to estimate the average grade reading level of a passage of text from each telemedicine provider website. Originally developed to calculate the suitability of Navy training materials for Navy enlisted personnel (Kincaid, Fishburne, Rogers & Chissom, 1975), the FKGL is a commonly used readability metric expressing the average grade level an individual reading a passage of text would need to be in order to read it fluently and understand it sufficiently in order to use it.

Although there are contentions surrounding the use of readability equations, such as the FKGL, the content analysis part of this study is only reporting on the information and content delivered in the telemedicine provider communications; thus, an objective assessment of the readability of the content is an appropriate metric to obtain. Research demonstrates that there is slight variation in the readability scores across different readability equations, but these variations result from punctuation and other mechanical elements and decrease as the passage of text analyzed increases (Zhou, Jeong & Green, 2017). Additionally, the most common readability formulas, such as the FKGL, the Fry Score, and the Simple Measure of Gobbledygook Readability Formula (SMOG) are all calculated similarly, by the length of the words and sentences (Nielsen, 2015; CDC, 2009). The CDC (2009) American Medical Association (Weiss, 2003) and usability experts (Nielsen, 2015) agree that it does not matter which readability formula one employs, it is more important to understand it is an approximation of readability. Furthermore, numerous studies have used the FKGL to evaluate the readability of health information and have determined it to be a valid and reliable estimate (Birru et al., 2004b; Raj et al., 2016; Taylor et al., 2011; Wilson et al., 2003). Regardless of which readability calculation is used, what is most important is consistency with which readability calculation is used. Considering that many researchers have already used the FKGL to evaluate the readability of online health information (Birru et al., 2004b) and patient education materials (Wilson, 2009) the FKGL was used in order for the results to be able to be compared with other studies. Additionally, the FKGL score is an easy, yet valuable for gauge for health information providers to be able to obtain and use as a yardstick to continuously improve the readability of the health information media they provide patients.

There is no sample size requirement specified for the FKGL, but samples used by Kincaid et al. (2017) were passages of text of 170 words. Thus, a passage of sample text containing 170 words from each telemedicine provider website was used to evaluate readability. Because each website varied substantially in the amount of text on the homepage and on each additional webpage, the first webpage with a continuous passage of text containing 170 words or more that provided information that would be pertinent to a patient was used, and the first 170 words from that webpage was used as the sample passage. The online readability tool offered by, Readable.com (https://readable.com/text/), was used to calculate the average grade level reading score for each passage of text from each telemedicine website as Readable.com's readability calculator has been validated to provide an accurate calculation of the FKGL (Zhou et al., 2017).

Although readability of health information is a critical aspect of health literacy, it should be noted that readability scales do not take into account the way the text is designed and organized on a page, such as the use of white space to separate chunks of complex information, font size, or the use of bullet points, which supports users' ability to find information and their comprehension of it (Ozkan & Ulutas, n.d.; Nielsen, 2015; Norman, 1988).

I used Chrome internet browser[8] to access each telemedicine provider website and an Excel spreadsheet to perform the coding according to the codebook. I used Excel to identify patterns and visualize the results.

Part Two: Remote Usability Testing

Part two of this mixed-methods study consisted of remote usability testing of the Teladoc website on a desktop measuring task completion. Remote usability testing using online instruments has been purported as a feasible method to testing the usability of HIT from a diverse range of users from various locations (Kushniruk et al., 2001). Amazon Mechanical Turk was used to recruit participants, and SurveyMonkey[9] was used to develop a new survey that measured subjects' ability to perform specific tasks using the Teladoc telemedicine provider website. The methods used in this part were reviewed by the UCF IRB (ID: STUDY00000638) and found to be exempt from any regulations regarding human subjects research. See Appendix A for the IRB Exemption Determination. Prior to taking part in the usability test, subjects were provided a written explanation of research in Amazon Mechanical Turk and informed that their participation was voluntary. Appendix D contains the explanation of research displayed on the Amazon Mechanical Turk platform. This section describes the usability testing that was performed using the Teladoc Website Usability Survey (TWUS) that I developed to measure task

[8] I used Chrome internet browser because it seems to be one of the most reliable internet browsers in most areas and it is my preferred internet browser.
[9] I used SurveyMonkey rather than other online survey tools because I have previous experience using SurveyMonkey, and I was able to use part of my research grant to fund a student account.

completion. This part of my mixed-methods study was made feasible by a grant from the UCF College of Graduate Studies (See Appendix C).

Amazon Mechanical Turk Platform for Recruitment of Participants

Amazon Mechanical Turk was used in combination with SurveyMonkey to gain an understanding of subjects' ability to perform specific tasks using the telemedicine provider websites. In conjunction with Amazon Mechanical Turk, a survey built in SurveyMonkey, called the Teladoc Website Usability Survey (TWUS), was used as the remote usability testing instrument in this part of the study. Amazon Mechanical Turk is a crowdsourcing online marketplace where *requesters* (for instance, researchers) can recruit participants (called *workers*) to execute Human Intelligence Tasks (HIT) and be paid (called *reward*) for the performance of such work (Paolaci et al., 2010; Summerville et al., 2013). Because Amazon Mechanical Turk offers an easily accessible, large population from which to source participants, it was selected to be used to perform the remote usability testing.

Selection of Unit of Analysis (Telemedicine Website)

Because it was not feasible to perform three separate remote usability tests for each of the telemedicine providers selected to evaluate in this mixed-method study and still use a large sample population, only one telemedicine provider was selected to be used in the remote usability testing. Feasibility was established based on the costs to pay the Amazon Mechanical Turk workers and complexity to set up and develop the remote usability tests. Teladoc, as one of the largest and most well-known telemedicine providers (CPOE.org, 2018; Preece, n.d.; Roland, 2015), was used as the unit of analysis in this part of the study. Assumingly, as a large corporate enterprise, Teladoc, would have the most accessible and reliable website for which to use to perform remote usability testing from a range of users at different geographic locations.

Selection of Representative Users / Participants

Fifty participants were recruited on Amazon Mechanical Turk. Amazon Mechanical Turk Masters workers were requested because these workers have been monitored and recognized by Amazon to have demonstrated excellent performance and high-quality work (Amazon Mechanical Turk, n.d.); therefore, are assumed to be more trustworthy. Subjects were required to be at least 18 years old, have internet access, and be able to read instructions in English to participate in the study. Worker requirements are set up in the Amazon Mechnical Turk platform when designing a study, and there were no other restrictions put on those who could participate so that the sample population from which the participants were recruited from was a heterogenous population from different geographic locations.P rior to accepting the work, Amazon Mechanical Turk workers had to read the explanation of research provided on the Amazon Mechanical Turk recruitment platform (see Appendix D). The Amazon Mechanical Turk remote usability test using the 50 recruited participants was run on September 9, 2019. Amazon collects a fee to host the service based on how much a requester pays the participants (Amazon Mechanical Turk, n.d.). Participants were rewarded $15 for their completion of the survey, which was paid to them by Amazon and subtracted from the costs to run the remote usability study. The costs to perform the remote usability study was afforded by my research grant.

A second remote usability test using 33 Amazon Mechanical Turk workers was performed on November 5, 2019; however, it was discovered that Teladoc Health, Inc. had gone live with an improved, redesigned website on October 24, 2019 (A. S. Alday, personal communication, January 7, 2020), and thus this data was excluded from analysis in this study because the insight gained from the remote usability tests were to be compared and triangulated with the in-person usability tests performed in part three of this study. The decision to perform the second run of the remote usability testing was made because I had additional funds left from my research grant, and there were no funds left to perform a third running. Additionally, performing another remote usability test of the same website would not have been possible since the Teladoc website had changed and the results, again, would not have been comparable with the first.

Survey Design: Development of the Teladoc Website Usability Survey (TWUS)

In combination with Amazon Mechanical Turk, SurveyMonkey was used as the survey tool to develop a new usability testing survey that assessed whether participants were able to complete certain tasks and locate specific information using the Teladoc website. A link to the new survey, titled, Teladoc Website Usability Survey (TWUS), was used in the Amazon Mechanical Turk Request for work. Participants who accepted to participate would click on the link in the Amazon Mechanical Turk platform and be redirected to the survey in SurveyMonkey. No personal identification data was gathered. Using an external link for the survey means that the survey data was never be available to Amazon.

There are several surveys that have been developed to access the usability of HIT; these instruments are specifically designed to measure different constructs and use different scales to qualify usability. For instance, the Telemedicine Satisfaction Questionnaire (TSQ) (Yip, Chang & Chan, 2003) and the Telemedicine Satisfaction and Usefulness Questionnaire (TSUQ) (Bakken et al., 2006) measure constructs such as patients' perception of the technical quality of the equipment used during the telemedicine consultation, patients' perception of the quality of the healthcare provided, efficiency of telemedicine, and overall patient satisfaction with their experience. The Telehealth Satisfaction Scale (TSS) is a 10-item scale that similarly measures patients' perception of the quality of a telemedicine consultation using videoconferencing and patient satisfaction (Morgan et al., 2014).

Given that there was no pre-existing survey instrument to test the usability of patient interactions with telemedicine communications, specifically the Teladoc website, I developed the TWUS to measure end-users' ability to perform specific tasks and activities using the Teladoc website and obtain their subjective perspective of usability. Three questions asked for basic demographic data, such as age and native geographic location. One question asked if respondents were familiar with telemedicine. Five items were task completion questions that asked respondents to perform specific tasks using the website, such as locate the contact information and instructions on how to perform a virtual consultation with a physician. Six questions were task completion questions that asked for, "Yes," or, "No," responses regarding their experience using the interface and ability to locate certain information using design features, like menus and buttons. The task completion questions captured whether participants interactions with the website were successful or unsuccessful.

The development of the realistic usability testing scenarios is a critical part of usability evaluations (Kushniruk et al., 2013; Russ et al., 2010). Langbecker, Caffery, Gillespie, and Smith (2017) stresses that survey items must be carefully formulated in order to be able to measure the usability dimension or aspect of the user experience they are supposed to measure (Langbecker et al., 2017). The questions ask subjects to perform tasks that were identified as those that would be undertaken by users in a real-life scenario in which they were interested in seeking a virtual doctor visit from Teladoc.

The questions on the TWUS were formulated to induce subjects to work through realistic tasks a user might perform when interacting with the telemedicine website, as well as to meet the objective of the usability test (Russ & Saleem, 2018). A range of simple to complex tasks were asked of subjects (Kushniruk et al., 2013), which aimed to capture the following usability metrics: task completion success, participants' interpretation of the interface features and information, and end-users' perception of usability. For instance, the question, "What is the number you must call to "talk to a doctor" using Teladoc?" is a simple task, and the question, "Can you find the page that describes what kinds of health conditions you can get medical treatment for?" is a more complicated task that requires more cognitive effort from users. Task completion success has been identified as valuable metric when performing mixed-methods research on similar telemedicine applications (Henshall, Davey, Jacelon & Martin, 2019). To solicit end-user feedback and provide insight on users' perception of the telemedicine communications, the last question on the TWUS asked participants to provide suggestions that would improve the usability of the telemedicine provider website. See Table 4 for the complete TWUS built in SurveyMonkey.

Table 4: Teladoc Website Usability Survey Built in SurveyMonkey

Title: Teladoc Website Usability Survey

Description: The purpose of this survey is to find out how easy it is to use and understand the information on the Teladoc website. You will first be asked basic demographic data and then asked to go to www.teladoc.com, which is the Teladoc website. You will be asked a series of questions that has you look for information on the website and describe your experience with "yes" or "no" and free text responses to the questions.

Your responses are confidential and your privacy will be maintained. No personal identification information can be ascertained. You are free to withdraw at any time, and your data will not be retained.

Thank you for your participation.

Question	Type of Response
1. What is your age?	Free text response
2. What is your gender?	Female / Male / Other
3. In what city, state, and country were you born and raised—or—where have you spend the majority of your life?	Free text response
4. Are you familiar with or do you know what telemedicine is – or what a virtual doctor visit is?	Yes / No / Unsure
5. Please go to the website, www.teladoc.com. Please answer the following questions while you interact with the Teladoc	Free text response

website. When you first land on the home page of the website, is it clear what Teladoc is or what service Teladoc provides? If yes, in a few words, describe what Teladoc is.	
6. Can you find the page that describes what kinds of health conditions you can get medical treatment for? If yes, please name three health conditions you could see a virtual doctor for.	Free text response
7. Can you find the page that discusses how you can get prescription medications sent to your pharmacy?	Yes / No
8. Can you find the page that describes how Teladoc works? If yes, what are the two ways you can see a virtual doctor?	Free text response
9. What is the number you must call to “talk to a doctor” using Teladoc?	Free text response
10. Can you find the Contact Us page?	Yes / No
11. If you want to “Talk to a doctor,” what do you have to do first?	Free text response
12. Do the buttons and icons on the website use terminology and graphics that you are able to understand?	Yes / No
13. Where you able to recover quickly and easily whenever you made a mistake using the website?	Yes / No
14. Where there any distracting sidebars, popups, or messages during your interaction with the website that obstructed your performance or progress?	Yes / No
15. Do you feel you would be able to perform a virtual doctor visit easily using the Teladoc website?	Yes / No
16. Please provide one or two suggestions that would improve your use of the website and allow you to find the information you were searching for more easily or faster.	Free text response

I attempted to achieve an acceptable magnitude of construct validity (the survey items measure the usability dimensions they were designed to measure) and concurrent validity (each survey item relates to various dimensions of usability that are captured with different tasks, such as navigation task questions and comprehension questions) by grounding the usability-related questions in the fundamental tasks and interactions potential Teladoc users would need to perform in order to understand how to and be capable of using the Teladoc service successfully (Hyppönen et al., 2019). I pretested the TWUS items with a small pilot study using two representative Teladoc end-users, and the TWUS items were found to be interpreted accurately, useful, and administered effectively.

Data Analysis

The desired number of participants responded and completed the TWUS. I exported the survey results from SurveyMonkey as an Excel spreadsheet and used Excel to perform data analysis. Task completion success and failure frequencies were tabulated and visuals were completed in Excel. Responses to question 16 asking participants to provide one or two suggestions that would improve the usability of the Teladoc website was coded for usability improvements using the qualitative, open coding approach, thematic analysis (Braun & Clarke, 2006; Damman et al., 2009).

Thematic analysis allows one to identify themes and report patterns within individual data sets and across the entire data corpus as it relates to the overall research inquiries (Braun et al., 2006; Damman et al., 2009). Thematic analysis is an effective data analysis technique used to identify and describe patterns across qualitative data (Braun et al., 2006). This allowed for the identification of themes regarding the design elements and features and functions that users suggest would improve the usability of the website. Relevant themes were extracted and categorized according to previously identified usability principles for user interfaces offered as guidelines by the U.S. Department of Health and Human Services (HHS) (n.d.) and that have been used in other HIT studies of user interfaces (Monkman et al., 2013a).

Other emergent codes were also developed based on the patterns discovered during data analysis that were relevant to each category (Rothstein et al., 2016; Ulin, 2005), such as *Cost / Pricing*; *Privacy, Confidentiality, and Security*; and *Easy to Use or Intuitive*. Integrating the newly discovered usability issues as codes and excluding codes from the original codebook (Monkman et al., 2013a) regarding usability aspects that were not suggested by any respondents resulted in a final codebook specific to the telemedicine communication interface being analyzed. Table 5 features the final codebook developed that includes salient usability themes, subcodes, and descriptions of the criteria to be coded under each category.

Table 5: Telemedicine Interface Usability Themes, Subcodes, and Descriptions Adapted from HHS (n.d.) and Monkman et al. (2013a) (*Newly Added Emergent Codes Identified During Data Analysis)

Usability Dimension / Code	Subcode	Description
Screens	Home Screen	Have a simple and engaging home screen.
	Registration	Make registration and logging in as simple and obvious as possible.
Content	Hierarchy	Put the most important information first.
	Positive Tone	Stay positive and realistic. Include the benefits of taking action.
	Specific	Provide specific action steps.
	Spacious	Display content clearly on the page.
	*Cost / Pricing	Clearly display the cost or fees for a virtual physician visit or clearly identify common health insurance plan costs for the benefit.
	*Restricted Access	Do not require one to log in or create an account to find out more information about membership or benefits.
	*Privacy, Confidentiality, and Security	Make evident that individuals' personal information remains private and confidential, and that the transfer of data is secure.
	*Updated / Relevant Content	Provide frequent updates to content that are relevant and current.
Display	Font	Ensure the font is easy to read.
	Contrast	Use bold colors with contrast and avoid dark or busy backgrounds.
	Accessibility	Make the system accessible to people with disabilities.
Navigation	Topics	Put topics in multiple categories.
	Orientation	Enable easy access to home and menu screens.
	Back Button	Make sure the "Back" button works.
	Linear Navigation	Use linear information paths (e.g., numbered screens).
	Buttons	Simplify screen-based controls and enlarge buttons.
	Links	Label links clearly and use them effectively.
	Search	Include simple search and browse options.
	*Mobile-responsiveness	Design content to be mobile-responsiveness and important information easy to find on mobile devices.
Interactivity	Multimedia	Incorporate audio and visual features.
	New Media	Explore new media such as Twitter or text messaging.
*Performance	*Page Loading Speed	Support fast loading of website and individual webpages.
*No Usability Improvements Required	*Easy to Use or Intuitive	Interface is user-friendly and designed to make information intuitively easy to find.

Because there was not a second or third researcher coding the data, the coding scheme that evolved was consistently referred to in order to ensure each response was coded consistently and according to the criteria described under each category. This improves the rigor and principled nature of the procedure and internal validity and reliability of the final codebook (Golafshani, 2003; Mays et al., 1995).

Following the coding of each response, descriptive statistics were obtained by calculating the frequency of each coded response (Borycki & Kushniruk, 2005; Tieu et al., 2017). These usability themes are discussed in Chapter Six in comparison to the usability issues discovered in part three of this study, the think aloud usability tests, along with narrative discourse (Mirel et al.., 2008; Bengtsson, 2016).

<u>**Part Three: Think Aloud Usability Testing**</u>

Part three of this multi-part study comprised of a systematic empirical data collection protocol that obtained both video recorded, observational data from subjects interacting with one of each of the telemedicine interfaces in this study's sample, as well as the verbal reports of the subjects' thought processes during these interactions. This usability testing technique, called the think aloud protocol, is a powerful method to recording subjects' cognitive processes and tying it to the tasks they perform with user interfaces (Ericsson & Simon, 1980; Jaspers, Steen, van den Bos & Geenen, 2004; Kushniruk et al., 1997; Kushniruk et al., 2001; Kushniruk et al., 2004; Kushniruk et al., 2005).

There are many techniques by which usability testing is accomplished, such as heuristic evaluations and cognitive walkthroughs (Cheng et al., 2014; Gray & Salzman, 1998; Hartson, Andre & Williges, 2003; Jeffries, Miller, Wharton & Uyeda, 1991; Marco-Ruiz et al., 2017; Nielsen, 1993; Nielsen & Molich, 1990).). Usability evaluation methods (UEMs) or usability inspection methods, are any technique or method by which a system or interface is evaluated for the purpose of identifying usability problems or issues that affect the end-users (Gray et al., 1998; Nielsen & Landauer, 1993). The think aloud usability method has been known as the "gold standard" of usability tests because they are performed with real end-users (Fonteyn, Kuipers & Grobe, 1993; Marco-Ruiz et al., 2017, Nielsen et al., 1990) and aim to understand users' cognitive process in HCI (Ericsson et al., 1980; Ericsson & Simon, 1984; Fonteyn et al., 1993; Lundgrén-Laine & Salanterä, 2010). The goal of UEMs is to find usability problems in the design or functionality of a system or product in order to correct them in future versions (Nielsen et al., 1993).

There are two types of think aloud usability tests: concurrent think alouds and retrospective think alouds. During *concurrent think alouds,* subjects are instructed to verbalize—or think aloud—their thoughts as they concurrently perform the predefined tasks and interactions with the technology under observation (Peute, et al., 2015a). Subjects' are generally video and audio recorded in order to obtain the empirical data. The results of the subjects' verbal reports and interactions are thought to reveal the contents of the subjects' working memories and cognitive processes, which will reveal the specific usability problems encountered during their interactions (Fonteyn et al., 1993; Ericsson et al., 1984; Peute et al., 2015a). *Retrospective think aloud* usability tests have subjects first perform the predefined tasks and activities with the technology under study and then retrospectively provide their verbal reports describing their interactions while watching a video recording of their performance (Fonteyn et al., 1993; Peute et al., 2015a). Think aloud methodology was used because it allowed me to gather information on users' experience as they interacted with the telemedicine provider websites and be able to identify usability problems users' encountered as they performed real-life tasks using the websites and verbalized their thoughts. The combination of observational data and the verbal reports attained from think aloud usability testing allowed me to make inferences about the type of usability problems users' experienced and be able to describe their interactions using activity theory and mobile interface theory.

Although there are challenges with both methods, concurrent think alouds are recognized to be more effective at providing a more accurate account of subjects' cognitive processes because they are captured in real-time, while the subject is performing a task; whereas, retrospective studies rely on subjects' recall or information retrieval, which may be inconsistent or have incomplete information (Ericsson et al., 1984; Fonteyn et al., 1993; Lundgrén-Laine et al, 2010). Furthermore, concurrent think aloud usability testing are verified to reveal more usability problems than retrospective think aloud usability tests, as well as other UEMs (Cooke, 2010; Fonteyn et al., 1993; Jeffries et al., 1991; Olmsted-Hawala, Murphy, Hawala & Ashenfelter, 2018; Peute et al., 2015a; Peute et al., 2015b). For instance, Jeffries et al. (1991) found that more severe usability problems with user interfaces are discovered when performing think alouds with real end-users than when performing heuristic evaluations. Similarly, Peute et al. (2015a) reported that concurrent think aloud outperformed retrospective think alouds when evaluating the usability of a CIS. The concurrent think alouds were demonstrated to be more effective at detecting usability issues, efficient in terms of time needed, and more valuable in terms of eliciting users' mental model of their interactions with the user interface (Peute et al., 2015a).

Because of such factors discussed above, I selected to perform concurrent think alouds as the type of think aloud to perform in this study. I conducted the think aloud usability testing between September 13, 2019 and October 15, 2019, according to the principled, standardized procedures offered by several HIT usability engineering experts (Borycki et al., 2005; Cooke, 2010; Kastner et al., 2010; Kaufman et al., 2003; Kushniruk et al., 1997; Kushniruk et al., 2013; Or et al., 2012; Pang, et al., 2014). Each usability test lasted approximately 30 to 40 minutes. Given the systematic and pragmatic execution of the think aloud usability tests I performed and the rich, descriptive insight the results concerning the usability of telemedicine communications offer, part three of this mixed-methods study entails the highest degree of reliability, fidelity, and validity (Kastner et al., 2010; Kushniruk et al., 2005; Kushniruk et al., 2013). The techniques I used to select the subjects and develop the artificial health-related scenarios, as well as the protocols used to execute the think aloud usability tests are described next. This part of my mixed-methods study was made feasible by a grant from the UCF College of Graduate Studies (See Appendix C).

Selection of Representative Users / Subjects

Fifteen University of Central Florida undergraduate students were recruited to participate in the study. I asked several professors, in the Arts & Humanities Department, at UCF, to send a recruitment email to their undergraduate students inviting them to be participants in this study. To qualify to participate, students must have been 18 years of age or older, have a smartphone available and be willing to use it to access the internet during the usability student. The methods used in this part were reviewed by the UCF IRB (ID: STUDY00000567) and found to be exempt from any regulations regarding human subjects research. See Appendix B for the IRB Exemption Determination. Prior to taking part in the usability test, subjects were provided a written explanation of research and gave verbal informed consent. See Appendix E for the explanation of research that subjects read prior to their participation. Following their participation, subjects were rewarded with a $15 Amazon gift card handed to them. The $15 Amazon gift cards were afforded by my research grant.

Studies reveal that college students predominantly use the internet, often in a mobile environment, to source health information (Heuberger & Ivanitskaya, 2011), yet college students have been demonstrated to have suboptimal or poor health literacy skills (Escoffery et al., 2005; Hollman, 2011; Robb et al, 2014). Therefore, undergraduate students are ideal candidates to use to examine the usability of telemedicine provider interfaces because they may be more prone to encounter usability problems during their interactions with the interfaces. Because of such factors, and for the reason that undergraduate students were easily accessible, they were selected as the subject population from which to pool from.

Study Context / Environment

The think aloud usability tests took place in the UCF Texts & Technology Lab, in Trevor Colbourn Hall (TCH), Suite 236, which is set-up like other university student computer labs as a workspace for students. The environment in which the think aloud usability tests took place represented a real-life context in which the subjects might interact with the telemedicine interfaces, which fall on a continuum of laboratory or artificial environments to naturalistic, real-life, and in situ contexts (Borycki et al., 2005; Kushniruk et al., 2004; Kushniruk et al., 2005; Kushniruk et al., 2008; Kushniruk et al., 2013) (Figure 6).

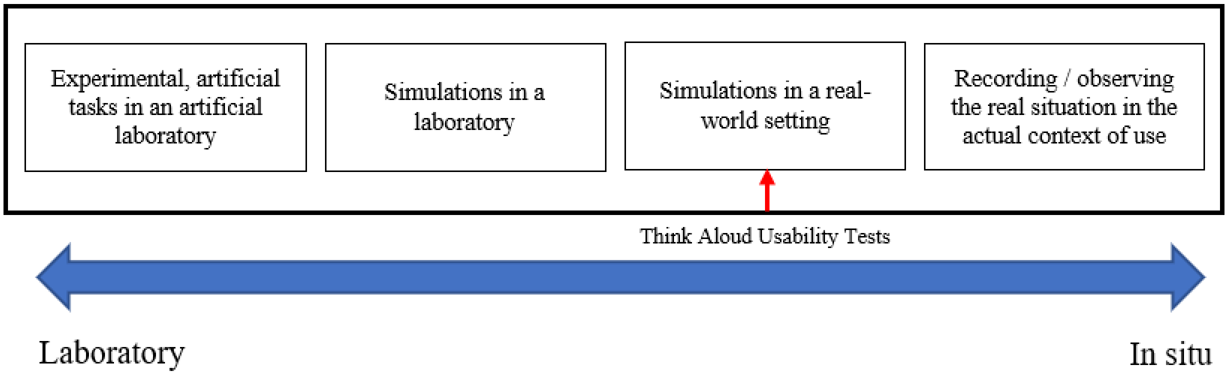

Figure 6: The context of system usability testing—a continuum from experimental, laboratory settings to naturalistic, real-world settings.

It is recognized that usability studies that better mimic the actual environment and conditions under which a user would perform activities and tasks with the interface or system being tested yield better results. This focus on the context of use of the telemedicine interface brings to surface aspects that impact usability that cannot be controlled for in a laboratory setting, but are critical considerations when it comes to the acceptance and adoption of telemedicine

Study Design

Chrome internet browser[10] was used during each participant's interaction with the desktop computer version of the telemedicine provider website. A between-subjects study design was used whereby each subject interacted with only one of the telemedicine provider communications (Kushniruk et al., 1997). The between-subjects design allowed for the comparison of the usability of the different telemedicine provider interfaces (Aiyegbusi, 2020; Kushniruk et al., 1997). Each subject performed the mobile interface portion of the think aloud usability tests using their own smartphone in order to avoid any variable effects of learnability or

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[10] Chrome internet browser was used again in this part to remain consistent with using the same internet browser as was used to perform the content analysis.

technical skill acquisition that would influence subjects' use of the telemedicine provider website on a smartphone they are unfamiliar with. Although each subject was allowed to access the telemedicine provider website on their smartphone using the internet browser of their preference or that they regularly used, this level of variation was deemed acceptable because the goal of the usability test was for them to simulate the interaction as they would in a real-life mobile environment. Also, Google's Mobile-Friendly Test tool tests websites for mobile-friendliness for a single interface size—that of a typical smartphone (Google)—so the variation between subjects' smartphone interface display was likely minimal.

Unit of Analysis: Three Conditions

Because one aim of the think aloud usability tests was to be able to compare each telemedicine provider's interface with one another, participants were randomly assigned one of the three telemedicine provider interface conditions (n = 3), each having two variables (Table 6). The two variables that controlled for were the type of interface the subjects accessed the website from: the telemedicine provider website on a desktop computer and the mobile version accessed on a smartphone.

Table 6: Think Aloud Conditions Randomly Assigned to Participants

Condition (n=3)	Telemedicine Interfaces to be Interacted with by Participant
1	Teladoc website Teladoc interface on a smartphone
2	KADAN Institute website KADAN Institute on a smartphone
3	Carie Health website Carie Health interface on a smartphone

Because each condition required participants to interact with the same telemedicine provider website on the desktop computer and a smartphone, to minimize the variable of memory and recall that would interfere with the results, each variable was altered for each participant. A participant would first interact with a telemedicine provider website on a desktop computer, followed by their interaction with the same telemedicine provider website on a smartphone and vice versa for the next participant and condition. For instance, the first participant interacted with the telemedicine provider website on a desktop computer *first* followed by her or his interaction with the website on a smartphone, and the second participant interacted with the telemedicine provider interface on a smartphone *first* followed by her or his interaction with the website on a desktop computer.

Selection of Representative Tasks and Procedures

Development of Artificial Testing Scenario

Three artificial health-related scenarios were developed for this study for each condition that would simulate a real-life situation the subjects might find themselves in and stimulate them to access the telemedicine provider website on a desktop computer or their smartphone. An illness vignette describing the types of symptoms an individual might experience when she or he is ill and seeking medical treatment from a physician was developed for each telemedicine provider that was relevant to the type of healthcare service the telemedicine provider offered (Luger et al., 2014) (Table 7).

Table 7: Illness Vignette Used to Describe the Artificial Testing Scenario

Telemedicine Provider	Illness Vignette
Teladoc	You have been coughing and have had congestion in your chest for the past week. You feel extremely tired and short of breath, and often cough up clear, white mucus. You have sometimes gotten the “chills.” You do not want to go any longer without feeling better, and you are afraid you might get worse if you do not see a doctor.
KADAN Institute	Since the beginning of the year, you have had an upset stomach most of the time—sometimes the pain is very

	severe. You often have painful cramping and extreme bloating after eating, and it doesn't go away after passing a bowel movement. Your bowel movements are inconsistent, and you are either constipated or have diarrhea. You have tried everything, from changing the foods you eat to taking Tums, but nothing seems to give you relief. You do not want to go any longer without feeling better, and you are afraid you might get worse if you do not see a doctor.
Carie Health	You have been coughing and have had congestion in your chest for the past week. You feel extremely tired and short of breath, and often cough up clear, white mucus. You have sometimes gotten the "chills." You do not want to go any longer without feeling better, and you are afraid you might get worse if you do not see a doctor.

It is an imperative that when selecting the representative tasks that subjects are expected to undertake that they include the tasks and activities that most emulate what users would do if in that situation in real-life (Borycki et al., 2005; Kushniruk et al., 2004; Kushniruk et al., 1997; Kushniruk et al., 2005; Kushniruk et al., 2008; Kushniruk et al., 2010; Russ et al., 2010; Russ et al., 2018). Three different health-related scenarios were developed in order for the subjects to be able to simulate how they would act if in that real-life situation and for their interactions with each telemedicine provider interface to reflect how they would if in that real-life situation. Because each telemedicine provider provided a different type of healthcare, the illness vignettes developed had to be different in order to stimulate the subjects to perform the types of tasks and actions they would during their interactions with each telemedicine provider interface, and thus elucidate usability problems. Using the same illness vignette across all conditions would not have been a representative of the activity of using the telemedicine provider website to become informed of the telemedicine service and be able to use it because users would likely retreat from the website if they did not perceive it to be useful to them (Bolle et al., 2016; Sillence et al., 2006).

Procedures

A systematic protocol was developed to execute the think aloud usability tests consistently with each subject. The same protocol was used for each subject except the illness vignette read to each subject changed based on the condition. See Appendix F for the complete protocol for each condition. Protocol analysis is a systematic, principled approach to ensuring each usability test follows the same procedures and minimizes any affects the observer may have on subjects' behaviors (Ericsson et al., 1993; Lundgrén-Laine et al., 2010). Using a standardized protocol for each condition ensures rigor and replicability of this study (Kastner et al., 2010; Kushniruk, 2002; Kushniruk et al., 2004).

Followed by a brief introduction summarizing the research, participants read a written explanation of research and provided verbal informed consent to participate. See Appendix E for the explanation of research that subjects read prior to their participation. Using a scripted protocol for each condition, subjects were given oral instructions to think aloud their thoughts while they were performing the prescribed tasks and interactions with the telemedicine interface.

An example of "talking aloud" was provided to subjects to help them prepare for thinking aloud whilst simulating the artificial test scenarios. This example is provided in the protocol that was read to each subject (Appendix F). The traditional approach to executing concurrent think alouds provided by Ericsson et al. (1993) and replicated by other scholars (Aiyegbusi, 2020; Alhadretti & Mayhew, 2017; Jaspers et al., 2004; Peute et al., 2015a) does not have the facilitator intervene during the subject's performance, thus, providing the subjects an example of how to "think aloud" minimized intervention by the facilitator.

It is suggested, however, that if subjects fall silent for a period of five to 15 seconds that facilitators may provide gentle guidance to "keep talking," as was performed in this study

(Alhadretti et al., 2017; Ericsson et al.; 1993; Luger et al., 2014). Therefore, subjects were instructed to ask the facilitator if they required any guidance or were unable to perform a task or when they felt they had exhausted the use of the website, which subsequently ended the usability test. Using the same methodological approach to execute each usability test increases the rigor of study and the reliability of the results because it is systematic and theoretically informed by previous research (Boren & Ramey, 2000; Borycki et al., 2005; Kushniruk, 2000; Kushniruk et al., 2004;). See Appendix F for the complete protocol for each condition.

Data Collection: Video Recordings and Verbal Reports

All think aloud usability tests were video and audio recorded with a Panasonic Full HD Camcorder set-up using a tripod facing at an angle to be able to capture subjects' interactions with the interface, such as mouse-clicks, as well as their body gestures and facial expressions, which may reveal confusion (Kushniruk et al., 1996; Peute et al., 2015). A small microphone was also placed next to each subject in order to capture high-quality audio recordings of subjects' verbal reports. See Figure 7 for the video and audio recording set-up used to capture the raw video and audio data for each think aloud. The camera was adjusted appropriately to capture high quality video depending on the height of each subject.

Figure 7: Think Aloud Usability Test Video / Audio Recording Set-up

Retrospective Questionnaire: Development of the Telemedicine Interface Usability Questionnaire (TIUQ)

Following the think aloud sessions, subjects were asked to complete the TIUQ that I developed for this study. The TIUQ is the newly developed data collection instrument whose questions were adapted from the SUS (Brooke, 1989), the PSSUQ (Lewis, 1992), and the TUQ (Parmanto et al., 2016). The TIUQ asks specific questions that pertain to the usability of the telemedicine provider interfaces being studied in order to obtain users' subjective feedback. The

TIUQ first asked for basic demographic information and was developed to evaluate the usability of DTC telemedicine provider communications from the user's perception.

Modified Usability Questionnaires

The SUS is a 10-question Likert scale that asks respondents to indicate their degree of agreement or disagreement with a statement regarding a system's usability (Brooke, 1989). The PSSUQ is similar to the SUS in that it assesses users' perception of a system's usability and user satisfaction; however, it was developed by Lewis (1992) specifically to be implemented as a post-usability test questionnaire for scenario-based usability studies. The PSSUQ is based on a 7-point Likert scale and consists of 18 questions that ask specific questions that pertain to scenario-based usability studies that have subjects perform specific tasks and activities while interacting with a technology (Lewis, 1992), like the artificial illness-related testing scenario used in study. Parmanto et al. (2016) developed the TUQ specifically to evaluate the usability of telemedicine and the implementation of the service, which impact the acceptance and adoption of the service by target end-users (Demiris et al., 2003; Demiris et al., 2010).

TIUQ Questions

Because each of the aforementioned usability scales (SUS, PSSUQ, TUQ) measures the subjective usability and satisfaction of an interaction with a technology, they are appropriate guides to adapt questions from and develop the TIUQ specifically for telemedicine interfaces. The TIUQ is an objective complement to empirical usability testing (Brooke, 2013; Tieu et al., 2017).

The TIUQ consists of 12 positive statements regarding the usability of the telemedicine provider interfaces and asks subjects to respond with their level of agreement or disagreement on a five-point Likert scale with one meaning, "I strongly disagree," and five meaning, "I strongly agree." A separate TIUQ was developed for each interface accordingly, one for the website on a desktop computer and one for the mobile-responsive interface. The TIUQ included four initial questions to capture subjects' demographic information and initial understanding of telemedicine. Sample TIUQ statements include: "The main navigation menu used terminology I understood and directed me to the pages I expected," and, "Buttons and icons used terminology and graphics that I was able to understand." See Appendix G for the complete TIUQ.

TIUQ Interpretation

To interpret the score of the TIUQ, the SUS scoring and metric of overall system usability was used. The SUS, and correspondingly, the TIUQ, provides a metric that gauges users' overall impression of the usability of a system; it does not divulge any one dimension of usability. Brooke (2013) warns that the individual statements do not diagnose specific features or functions of the system that lead to unsatisfactory use by the end-user.

In order to interpret the TIUQ scores, one must understand what the SUS scores signify. After a quick calculation, the final SUS score is based on a scale of 0 – 100, which is a percentile ranking of any one subject's overall perceived usability of the system (Brooke, 1986; Sauro, 2011; Sauro, 2019). According to research, the average SUS score is 68, which is considered to be above average (Brooke, 2013; Sauro, 2011). The percentile ranking of the original SUS score is similar to grading on a curve that academics might be familiar with (Lewis et al., 2018; Sauro, 2011). Therefore, the mean score of 68 is in the 50^{th} percentile and equivalent to a "C" letter grade. A score above 80.3 gets an "A" for usability and any score below 51 is considered to have very poor usability and assigned an "F" letter grade (Lewis et al., 2018; Sauro 2011; Sauro, 2019). Because the SUS is known to be easy to administer, in practice, and valid and reliable, other scholars have developed alternative means to interpreting the SUS score (Sauro, 2018; Bangor et al., 2009) that are more effective at illustrating the overall usability of the system.

Along with the curved grading scale, Bangor et al. (2009) developed an adjective that expresses subjects' sentiment when using the technology being evaluated to align with each percentile ranking and grade accordingly to support a better understanding of users' perceived usability of the system. Several usability and UX experts have rounded these scores to ease interpretation of the overall usability and converted them into the letter grade and adjective rating that Bangor et al. (2009) added to the SUS scale ranking (Alathas, 2018; Lewis et al., 2018; T, n. d.). Each participant's final TIUQ score was calculated and converted into a scoring system based on a scale of 0 – 120. The matching SUS benchmark metrics were converted into TIUQ scores respectively in order to map each percentile ranking, letter grade, and adjective rating used to rate and express overall interface usability and user satisfaction. Table 8 illustrates the SUS score, the matching TIUQ score, the percentile range, the letter grade, and the adjective that best represents users' subjective appraisal of usability. Composite scores of subject's individual TIUQ scores was calculated and the mean value for each condition and each interface was obtained to provide insight into the overall usability of each telemedicine provider communication and be able to compare each interface. Descriptive statistics was used to summarize subjects' demographics and prior familiarity with telemedicine (Or et al., 2012; Tieu et al., 2017; Zhang et al., 2019).

Table 8: Curved Grading Scale for the TIUQ and Adjective Rating for Subject's Impression of Usability (Adapted with permission from Bangor et al., 2009 and Lewis et al., 2018)

SUS Score	TIUQ Score	Percentile Range	Grade	Adjective Rating

> 80.3	> 96.36	Top 15 percentile	A	Excellent
68-80.3	81.6-96.36	50 – 85 percentile	B	Good
68	81.6	50th percentile (medium)	C	Okay
51-68	61.2-81.6	15 - 50	D	Poor
< 51	< 61.2	Bottom 15 percentile	F	Awful

Decades of research demonstrates that the SUS is an effective, reliable, and valid tool for measuring the usability of a system or technology from the user's perspective and that it performs similarly when using a large sample population or when using as few as eight to 12 end-users (Bangor, Kortum & Miller, 2009; Sauro, 2011; Tullis et al., 2004). Additionally, both the PSSUQ and the TUQ are determined to be valid tools used to measure the subjective constructs they are intended to measure when applied to the specific platforms they were designed to test (Parmanto et al., 2016; Sauro, 2019). Because the TIUQ was developed for the specific telemedicine interfaces under investigation in this study and adapted from usability scales that have already been determined to be valid and reliable, it holds an acceptable level of reliability and validity.

Numerous researchers consider implementing post-usability test or retrospective surveys and questionnaires to be a valuable addition to a mixed-methods study of HIT and other user interfaces, as well as an integral part of the iterative, user-centered design process (Johnson et al., 2005; Kushniruk et al., 1997; Kushniruk et al., 2001; Kushniruk et al., 2013). When applied immediately following subjects' interaction with the technology being tested, retrospective questionnaires allow for a deeper understanding of the user experience and subjective impression of the system's usability, as well as allow for the comparison with the video and audio-based data (Kushniruk et al., 1997; Kushniruk et al., 2001; Kushniruk et al., 2013; Kushniruk et al., 2019a). There is also evidence supporting the assertion that when questionnaires are implemented retrospectively, they afford valuable predictive data that can be directly applied to the iterative design or user-centered design of HIS and user interfaces that numerous scholars advocate (Horsky et al., 2016; Johnson et al., 2005; Kushniruk et al., 1997; Kushniruk et al., 2001; Kushniruk et al., 2002; Kushniruk et al., 2004; Wolpin et al., 2015).

Data Analysis Using Nvivo Software

All 15 think aloud video and audio recordings were imported as mp4 files and coded in QSR International's NVivo 12 qualitative data analysis software, which allows for the coding of video and audio recordings as one unit (the verbal reports are able to be depicted and coded in the context of the interaction). Appropriate transcription of subjects' verbal reports was performed in NVivo as additional descriptive data. NVivo was selected as the data analysis tool because it allows for audio and video segments to be selected and categorized according to pre-established codes or as new themes emerge, thus, allows for greater efficiency when performing data analysis of complex qualitative data. NVivo's interface is similar to Microsoft, which makes it easy to learn and use, and enables researchers to compare data across variables and gain insight quickly by generating reports and visuals. Also, NVivo has been used to analyze data from other think aloud usability tests and was found to have these benefits (Göransson et al., 2007).

Employing the guidance from Kushniruk et al.'s (2019a) codebook and expanding on the initial categories, thematic analysis was performed to include new codes focusing on the types of usability problems and errors users experienced when interacting with DTC telemedicine websites on a desktop computer or smartphone.

The a priori codebook, developed by Kushniruk et al. (2019a), was used as the initial coding scheme, which consisted of several categories that characterizes problems identified in a HIS's usability. Kushniruk and colleagues (1996; 1997; 2004; 2004b; 2005b; 2013; 2019a; 2019b; Monkman et al., 2013a) have performed copious usability evaluations using cognitive-based approaches and have refined a coding scheme primarily for identifying variables such as layout and navigation and other socio-technical aspects of HCI that appear to stimulate usability problems in HIS telemedicine user interfaces.

In addition to the a priori usability codes, several additional categories of usability problems specific to the analysis of the telemedicine provider interfaces were also derived as data analysis progressed based on the inferences that could be made from the video and audio recordings. The newly emergent usability issues that were discovered during data analysis were grafted onto the coding scheme under relevant main categories or new themes were developed that provide insight into the overall user experience and intention to use telemedicine and support this study's investigation into the usability of telemedicine interfaces. When all video and audio recordings were coded, a final coding dictionary was developed integrating the newly discovered usability issues as codes and subcodes and excluding codes from the original codebook (Kushniruk et al., 2019a; 2019b) that were not utilized when analyzing the video and audio recordings. Table 9 features the final coding scheme that was developed that includes the critical problems that have been observed to reduce or obstruct the usability of telemedicine interfaces and an example of a statement that was coded in each category.

Table 9: Coding Scheme for Identifying Usability Problems with DTC Telemedicine Interfaces (*Newly Added Emergent Codes Identified During Data Analysis)

Usability Dimension / Code	Subcode	Applied When	Example Coded Statement
Content	Understanding of error messages or no error messages	Coded when a review of the video data indicates the user does not understand the meaning of error messages, or the user interface fails to provide an error message to support the user in recovering from an error	*It's not showing any results. I'm confused. It's not showing any doctors.*
	Understanding of instructions	Coded when a review of the video data indicates the user does not understand instructions	*I just clicked on Patients and it's directing me to create an account…hum…okay; it's just a little odd because it was going through the steps…*
	Cost	Coded when the user comments on the desire to know the cost of the telemedicine service	*This is a paid service, but at least we can talk to real doctors.*
	*Aesthetics / Minimalist design / Content	Coded when a review of the video data indicates there is too much information on a page and negatively impacts user's ability to understand	*Wow, that if very unappealing, to be honest; on the website it was a lot better constructed; if I was sick I would definitely not have the energy to look over all this. Because on the website it's like four pages, and that's easy to get through, but on here it's probably like ten, so definitely would be way to exhausted to go through all that.*
Display	Visibility of elements or system status	Coded when a review of the data indicates the visibility of user interface elements negatively impact the user or the user does not know what the system is doing	*So something I noticed...the three bars, they actually kinda blend into the background so I may not have even seen it if I was super sick and wasn't paying attention because the only thing you see is like a blue outline and my screen is kinda bright right now so I was barely able to see that.*
	Layout	Coded when a review of the video data indicates there are problems with the layout of screens or information on those screens	*It's like advertising itself, but I want to find out my diagnosis.*
	Color	Coded when a review of the video data indicates the user does not like the color or color schemes used in the interface	*The website, scrolling down looks, pretty amazing so.*
	Font	Coded when a review of the video data indicates the font is too small or not readable	*Uhh it's kinda hard to read but it says to start with a free health assessment to uncover the root of your symptoms.*
Navigation	Navigation	Coded when a review of the video data indicates the user has problems moving through the system or user interface; coded when a navigational element does not function as the user expects it to function; coded when a user has	*I'm not exactly sure how to find if my criteria meets the health conditions. I'll try the Frequently Asked Questions.*

Usability Dimension / Code	Subcode	Applied When	Example Coded Statement
		problems locating the information they are searching for	
	Meaning of icons / terminology	Coded when a review of the video data indicates the user does not understand the language or terminology or labels used in the user interface	*So, the first thing is it that it asks If I am a Member and If I am a Provider, which I'm guessing I don't have a provider; it automatically assumes I am a member. It automatically assumes I am a member or I am a provider, so I'm not exactly sure what a member is.*
Interactivity	Graphics	Coded when a review of the video data indicates there are issue with graphics, or user does not like the graphics	*Free Health Assessment...? Umm, ok...It's hard to see cause the graphic right here because the top right hand corner the background goes white and the text is white so the last section of it kind of fades into the background.*
Performance	Speed / Response time / Performance	Coded when a review of the video data indicates the system is slow or response time is an issue	*Attention: It looks like you are using a cell phone or tablet to access this system. Please note that only desktop and laptop computers are supported at this time.*
Cognitive	*Validation of symptoms or health condition	Coded when the user refers to using another website to match symptoms with existing symptoms to make sure	*I would actually probably then click See More since I don't know what I have I would see if there was something that is similar to my conditions. I would actually probably look up my conditions on another website, see what that comes with, and see if that matches anything similar to here.*
	Stress / Fatigue / Exhaustion	Coded when the user comments on feeling stress or refers to cognitive overload when interacting with the user interface	*I feel like I'm helpless.*
Trust / Ethics	Trust / Quality of healthcare	Coded when the user comments on the desire to trust in the telemedicine service, physician, and quality of healthcare provided	*This would probably the most important thing to me at least: Do I talk to your doctors, because if I have this sickness I really want to make sure I am getting it done quickly, and if I'm paying for it I want to make sure I am in good hands and they can figure out what's wrong with me and I don't have to keep suffering with it.*
Technical issues	Technical issues	Coded when the user comments on technical issues related to accessing or using the website in a particular context	*Observation: Subject 11 was unable to access the website on her smartphone because of poor WIFI service in the area; this was*

Usability Dimension / Code	Subcode	Applied When	Example Coded Statement
		of use or technical issues occurred during the interaction with the interface	*coded as a technical issue. The subject used the primary investor's smartphone instead.*
	Accessibility	Coded when the user is unable to access content or information due to having to have login credentials	*I'm just going to go back to the homepage since I don't have an account I can't access that.*
Overall Ease of Use	Positive	Coded when the user positively comments on overall usability of the user interface or review of the video data indicates that the user is better able to navigate the interface and locate the information they are searching for	*Lot's of links to what I assume is the same thing so booking a free call, "Book your free call," "Book your free call," "Book your free call," "Book your free call," six times...five times on the same page, so it is definitely easy to find if you were looking to call.*
	Negative	Coded when the user negatively comments on overall usability of the user interface or review of the video data indicates that the user is unsatisfactorily able to navigate the interface and locate the information they are searching for	*I kinda think that's more of a little bit more of a hassle. I personally would rather do a basic questionnaire, figure out how that goes, depending on what that recommends me, I might think about going to the doctor.*

Similar to the coding procedure performed in part two of this study when coding the responses to question 16 on the TWUS, because there was not a second or third researcher coding the data to ensure inter-rater reliability, two video and audio recordings were first analyzed and coded whilst consistently referring to the coding scheme. The resulting codes were compared with each other and the coding scheme to ensure interpretations matched and all video and audio recordings were coded to correspond with these initial results. Additionally, the evolving codebook was consistently referred to in order to ensure the inferences made from subjects' verbal reports and behavioral data and facial expressions were coded consistently and according to the criteria described under each category. This improves the rigor and principled nature of the procedure and internal validity and reliability of the final codebook (Golafshani, 2003; Mays et al., 1995; Maher et al., 2018).

Descriptive statistics were performed in NVivo as previous work expresses is the most principled and valuable approach to gaining insight from think aloud usability tests (Borycki et al., 2005; Kushniruk et al., 1997; Kushniruk et al., 2002; Patel et al., 2000). Tabulating frequencies in order of rank allows for the usability problems that were most frequently experienced by users to be uncovered and inferences can be made to identify the specific aspect of the telemedicine provider interface that generated the usability problem.

This chapter provided a detailed description of the mixed-methods used in this study consisting of content analysis, remote usability testing using the TWUS I developed, and think aloud usability testing. Combining the use of different methods sheds new insight on the usability of telemedicine provider interfaces by being able to compare different data sets, make valuable inferences about users' interactions with the websites, and reveal usability problems. The next chapter presents the results of each part of this study, and the insight gained will be discussed in Chapter Six.

CHAPTER FIVE – RESULTS

This chapter presents the results of this mixed-methods study. A tripartite, multimethod framework was performed that allowed for a rich data corpus and insight into the usability of the telemedicine communications. A content analysis, remote usability testing, and think aloud usability testing was conducted using meticulous procedures with increasing degrees of reliability, validity, and fidelity. In part one, a content analysis was performed on the three selected telemedicine provider websites (Teladoc, KADAN Institute, and Carie Health) using a priori coding. Part two entailed remote usability testing using a survey and Amazon Mechanical Turk. Lastly, in part three, think aloud usability testing was performed using a simulated health-related scenario whereby subjects interacted with each telemedicine interface as if they desired treatment for a health condition. Following the think aloud usability tests, a TIUQ was implemented to solicit further insight into subjects' individual perception of usability. In the next sections, I will discuss the key results of each of these parts of the study. The results presented in this chapter support and guide the discussion of the findings in Chapter Six.

Part One: Content Analysis

Three telemedicine providers were selected as the sample telemedicine interfaces to be analyzed. A prior coding (Kayyali et al., 2017) was used to identify the type of content and information provided by each telemedicine provider on their website and the number of screen transitions from the homepage the specific information was located. The readability grade level of a passage of text was also recorded. This number indicates how many clicks a user is required to perform to navigate to that specific piece of information. This figure is also significant given that users require information that is easily visible and scannable in order to use it effectively

(Chun & Patterson, 2012; Damman et al., 2009; Horsky et al., 2016; Rizvi et al., 2017). The FKGL was calculated by entering a passage of text of 170 words into Readable.com’s readability calculator. Appendix H includes the website URL and the exact passage of text that was used to calculate the FKGL score for each condition.

During the time period in which the content analysis was performed, it was discovered that all three telemedicine provider’s launched redesigned websites. Therefore, a portion of the content analysis was performed using the Internet Archive: Wayback Machine, found at http://web.archive.org/, which allows one to interact with historical snapshots of websites. The KADAN Institute and Carie Health websites had already been analyzed, but the Teladoc website was accessed through the Internet Archive at times when performing the content analysis.

Overall, the Teladoc website was found to meet all the criteria in the codebook and required the fewest mouse clicks to navigate to the information. The Teladoc website was also found to have the lowest readability score (9.1). The Carie Health website appeared to meet more of the criteria in the codebook in terms of content and number of screen transitions than KADAN Institute website, but scored the highest in terms of readability (13.2). KADAN Institute was discovered to not depict two of the classifications of salient information in the codebook: Choice (noting that the service is optional and not a substitute for traditional face-to-face physician consultations) and Appearance (information visuals supporting users’ ability to understand information) and had a readability score of 12.2. See Table 10 for the complete results of the content analysis.

Table 10: Content Analysis Results for Each Telemedicine Provider Interface: Pre-established Guidance Criteria Content Included, Number of Screen Transitions to Locate Content, and FKGL Readability Score

Key:

- **+ / -:** + = Interface does include the content or information at the code; **-** = Interface does not include the content or information at the code
- **# of Screen Transitions:** N/A = Not Applicable; 0 = Homepage; 1 = 1 Click from Homepage; 2 = 2 Clicks from Homepage; etc.)

		Teladoc		KADAN Institute		Carie Health	
Code / Theme	Guidance Criteria	+ / -	# of Screen Transitions	+ / -	# of Screen Transitions	+ / -	# of Screen Transitions
Knowledge	• Information about the service (what it is and how to use it)	+	0	+	1	+	0
Outcomes	• Noting what will be done with the results • Identification that the patient will be diagnosed and prescribed medications if needed	+	0	+	0	+	0
Reassurance	• Technology and equipment is easy to use (reassurance to patients they do not need to have high technical literacy) • Noting patients have support for technical problems • Confidentiality is ensured • Cost is low	+	0	+	1	+	0
Benefits	• Noting the benefits to users	+	0	+	0	+	0
Choice	• Noting the service is optional and not a substitute for traditional face-to-face physician consultations • Noting that the service is not a substitute for emergency services	+	2	-	N/A	+	2
Previous Experience	• Testimonials • Patients quotes about positive use of service to encourage potential consumers to use it	+	0	+	0	-	N/A

Further Information	• Identification of who to contact for further information • Identification of who will help the patient if they need help	+	0	+	1	+	0
Appearance	• Visuals, images, and graphics are included • Information visuals are used as an alternative means of providing information to users • Diversity (age, ethnicity, gender) is used in visuals	+	0	-	N/A	+	0
Percent Criteria / Mean # of Screen Transitions		100%	.25	75%	.5	87.5%	.286
Flesch-Kincaid Grade Level (FKGL)		9.1		12.2		13.2	

It is also important to note that the mean number of screen transitions was calculated for each condition according to the content and information they provided. This number represents how many "mouse clicks" away from the homepage a user would need to perform in order to locate that piece of information. The mean number of screen transitions that a user would assumingly need to complete to locate the pre-established content and information on the Teladoc website is .25 (2/8).

The KADAN Institute website requires a mean number of .5 (3/6) clicks to locate the pre-established content and information, and the Carie Health website mean number of screen transitions was calculated to be .286 (2/6). These figures should be analyzed in comparison to the guidance criteria because both KADAN Institute and Carie Health were not found to provide all of the information and content that a potential patients would desire and need to know according to the pre-established codes. These results suggest that Teladoc appears to display the important content and information directly on their homepage, immediately available to users, and does not require the user to perform a number of information searching activities in order to attain the information they need to be able to perform a virtual physician visit.

The objective of the content analysis was to identify whether telemedicine provider websites contained the important information that potential patients would desire and need to know in order to use the telemedicine service safely and efficiently. The significance of these results will be further discussed in Chapter Six.

Part Two: Remote Usability Testing

A novel TWUS was developed in order to measure end-users' ability to perform specific tasks and activities using the Teladoc website, as well as obtain their subjective feedback on how the use of the website could be improved.

Fifty participants took part in this study (n=50). Participants were recruited and completed the TWUS remotely using Amazon Mechanical Turk. Respondents ranged in age from 23 to 59, with a mean age of 35.6. All but one respondent indicated they were born and raised in the United States, and one was from India. Most participants (84 percent) reported that they were familiar with telemedicine prior to completing the survey and only one participant reported to have not been familiar with telemedicine. Fourteen percent of the participants indicated they were unsure. There was not a definition of telemedicine provided in the TWUS; thus, this may have been a confounding factor that may have altered subjects' responses. For instance, some subjects may have known what telemedicine was, but did not know the term, "telemedicine," and may have selected, "Unsure," as their response. See Table 11 for the TWUS participant demographics and characteristics.

Table 11: Amazon Mechanical Turk Worker Respondent Demographics and Characteristics

Gender		Age Range (years)					
		18-21	22-29	30-39	40-49	50-59	60-61
Female	22 (44%)	0	3 (6%)	13 (26%)	5 (1%)	1 (2%)	0
Male	28 (56%)	0	6 (12%)	17 (34%)	4 (8%)	1 (2%)	0
Total	50	0	9 (18%)	30 (60%)	9 (18%)	2 (4%)	0
Previous Knowledge of or Experience with Telemedicine							
Yes	42 (84%)						
No	1 (2%)						
Unsure	7 (14%)						

To recall, the TWUS asked respondents questions that had them perform the types of tasks and activities a potential patient would need to perform using the Teladoc website if they were ill and seeking treatment from Teladoc. On average, most respondents were able to perform the tasks and activities they would need to in order to perform a virtual doctor visit using the Teladoc website. Table 12 shows the frequency of successful and unsuccessful tasks that were completed for each of the 11 activities that participants were asked to perform on the TWUS.

Table 12: Amazon Mechanical Turk Remote Usability Testing of the Teladoc Website: Task and Completion Success or Failure

Question / Task	Task Completion	
	Success	Failure
When you first land on the home page of the website, is it clear what Teladoc is or what service Teladoc provides? If yes, in a few words, describe what Teladoc is.	50	0

Question / Task	Task Completion	
	Success	Failure
Can you find the page that describes what kinds of health conditions you can get medical treatment for? If yes, please name three health conditions you could see a virtual doctor for.	50	0
Can you find the page that discusses how you can get prescription medications sent to your pharmacy?	49	1
Can you find the page that describes how Teladoc works? If yes, what are the two ways you can see a virtual doctor?	47	3
What is the number you must call to “talk to a doctor” using Teladoc?	48	2
Can you find the Contact Us page?	46	4
If you want to “Talk to a doctor,” what do you have to do first?	50	0
Do the buttons and icons on the website use terminology and graphics that you are able to understand?	39	11
Were you able to recover quickly and easily whenever you made a mistake using the website?	50	0
Were there any distracting sidebars, popups, or messages during your interaction with the website that obstructed your performance or progress?	46	4
Do you feel you would be able to perform a virtual doctor visit easily using the Teladoc website?	50	0

The average rate of task completion success was 95 percent. See below for how this metric was calculated.

x = Number of Respondents Who Successfully Completed the Task

550 = Total Possible Successful Task Completions (50 Participants × 11 Tasks)

$$\text{Average Rate of Task Compltion Success} = \frac{\sum (x)}{550}$$

The average failure rate was 5 percent.

Responses to the last question, question 16, which asked participants to provide one or two suggestions that would improve the usability of the Teladoc website were coded and tabulated under the four usability themes and subcodes that are relevant to the usability of HIT and healthcare user interfaces (Monkman et al., 2013a; U.S. HHS, n.d.). Table 13 includes the results of the coded responses, the frequency distribution of each coded statement, the calculated percent distribution across all of the coded statements, and an example of coded response from a participant. Because some respondents offered multiple usability improvement suggestions, the percent distribution was calculated using the sum total of the coded statements, which was 87 (n = 87).

Table 13: Summary of Usability Suggestions Provided by Respondents on TWUS (*Newly Added Emergent Codes Identified During Data Analysis)

Usability Dimension / Code	Subcode	Frequency of Responses (n = 87)	Example of Coded Statement
Screens	Home Screen	2 (2.3%)	Maybe making the member and businesses section separate from another instead of all kind of mixed together on the home page.
	Registration	2 (2.3%)	An easier way to create an account would be nice. When I'm feeling sick the last thing I want to do is fill out a bunch of crap to create an account. Being able to quickly create one using the basic google API would be nice as well as secure.
Content	Hierarchy	6 (6.9%)	It would be easier to find some information if Learn more, solutions and contact were also at the top of the page along with overview and members.
	Positive Tone	2 (2.3%)	Maybe it's easier once you create an account, but the site, to me, seems like it's not targeted towards attracting new patients. I can usually find my way around any website, but this one seemed really confusing to me. I just didn't find it inviting at all.
	Specific	1 (1.1%)	Have a section that is clearly labeled and each section is clickable. Under each section (such as pharmacy, specialists, accessibility, etc.) it would clearly explain how to access those areas.
	Spacious	1 (1.1%)	I think you should make the login box at the top right a little more prominent. This would let you use the top of the main page to provide an overview instead of wasting it on another member login box.
	*Cost / Pricing	9 (10.3%)	I wish the cost was advertised. I didn't get a great feel for whether or not health insurance companies tend to cover this service. Provide a direct link to cost/payments and insurance coverage. It says that the cost varies based on plan design, but what does plan design mean? Do you have to pay a subscription to the website? Or is that talking about my health insurance plan I already have? More transparency regarding pricing and plans is my #1 suggestion.

	*Restricted Access	2 (2.3%)	I didn’t want to set up an account right now, I think having the number visible would have been better.
	*Privacy, Confidentiality, and Security	1 (1.1%)	I would like some information about how you keep my information safe.
	*Updated / Relevant Content	1 (1.1%)	More Doctors profile update.
Display	Consistency	1 (1.1%)	The pages aren't all uniform. the login page looks different than the main site. it should either be integrated into the main site or at least keep the same color/structure as the other pages.
	Font	9 (10.3%)	I actually feel everything was straight forward and easy to find except finding the number to call a Dr. The print is small (though colored), I feel if it was bolder and throughout the webpage more in a Red color instead of blue it would be easier to notice.
	Contrast	2 (2.3%)	I would personally like a dark mode where it's a black background with white letters as it's easier on the eyes.
	Accessibility	1 (1.1%)	For those that might not learn the best through text, have a supplemental video/audio example to help navigate the site. Might be useful for those blind/deaf.
Navigation	Topics	3 (3.4%)	Also the therapist option is something I've never seen before from a virtual doctor site. That seems like it could be handy for a lot of people in high stress jobs. It might be worth having it in it's own section to draw attention to it's self.
	Orientation	8 (9.2%)	I probably would have had a more thorough menu at the top. For instance, at the top, there are 4 sections in the "Members" drop down menu. I would eliminate the drop down menu, and just list these 4 options at the top.
	Back Button	4 (4.6%)	Also on the login page, clicking on the logo didn't take me back to the homepage like I expected it would.
	Linear Navigation	3 (3.4%)	Then there's too many options between health/business/etc that are confusing for the average family consumer.
	Buttons	4 (4.6%)	Make the "Login" buttons bigger, they were kind of small.
	Links	3 (3.4%)	I would like to see a "sign up now!" link or something similar that is displayed in the very bottom footer (the one that is in purple. A lot of the time I will look in the footer for useful links rather than having to jump around on the site to find what I'm looking for. There IS a "Set Up Account" button right above the footer, but I think having one in the footer would make things easier.
	Search	4 (4.6%)	A search box would also be nice that allows me to search for things quick and easy without having to log in.
	*Mobile-responsiveness	1 (1.1%)	I found it a bit difficult using the mobile version to locate how to contact a doctor.
Interactivity	Multimedia	8 (9.2%)	Provide an optional video that users can view to learn more about Teladoc's service. A video that would demonstrate a scenario where you would use this service would be great.
	New Media	3 (3.4%)	It might be nice if the phone number in the header was one you could tap to auto open in your phone app.

Performance	*Page Loading Speed	2 (2.3%)	Slow loading website, improve the page loading speed.
No Usability Improvements Required	*Easy to Use or Intuitive	3 (3.4%)	The web site was well built, I can't think of an improvement.

As illustrated on Table 13, a number of participants (10.3%) commented about the cost or pricing to use Teladoc suggesting that it was desired information and should be more transparent on the Teladoc website. The *Cost / Pricing* subcode was a new code added to the codebook during data analysis given its relevancy to using a telemedicine service, and it was discovered to be one of the most frequently suggested usability aspects. Within the *Display* usability theme, the other usability aspect that received the most frequent comments (10.3%) about was the *Font*. Many participants suggested that the font size should be larger and that it was difficult to locate the contact phone number or that significant text, such as the, “3,100+ licensed healthcare professionals,” was very small and should be emphasized.

The *Navigation* and *Interactivity* themes were also usability aspects that were frequently comments about by respondents. Within the *Navigation* theme, improving the understanding of menu options and accessibility to other screens or webpages were among the top usability improvements suggested by respondents (9.2%) that reside under the *Orientation* subcode. Similarly, many respondents (9.2%) suggested that including a video demonstrating how the telemedicine service worked would improve the usability of the website, which was coded as *Multimedia*, withing the *Interactivity* theme. Figure 8 illustrates the distribution of coded usability improvement suggested for the Teladoc website that may instigate problems with users’ ability to perform tasks and activities using the Teladoc website.

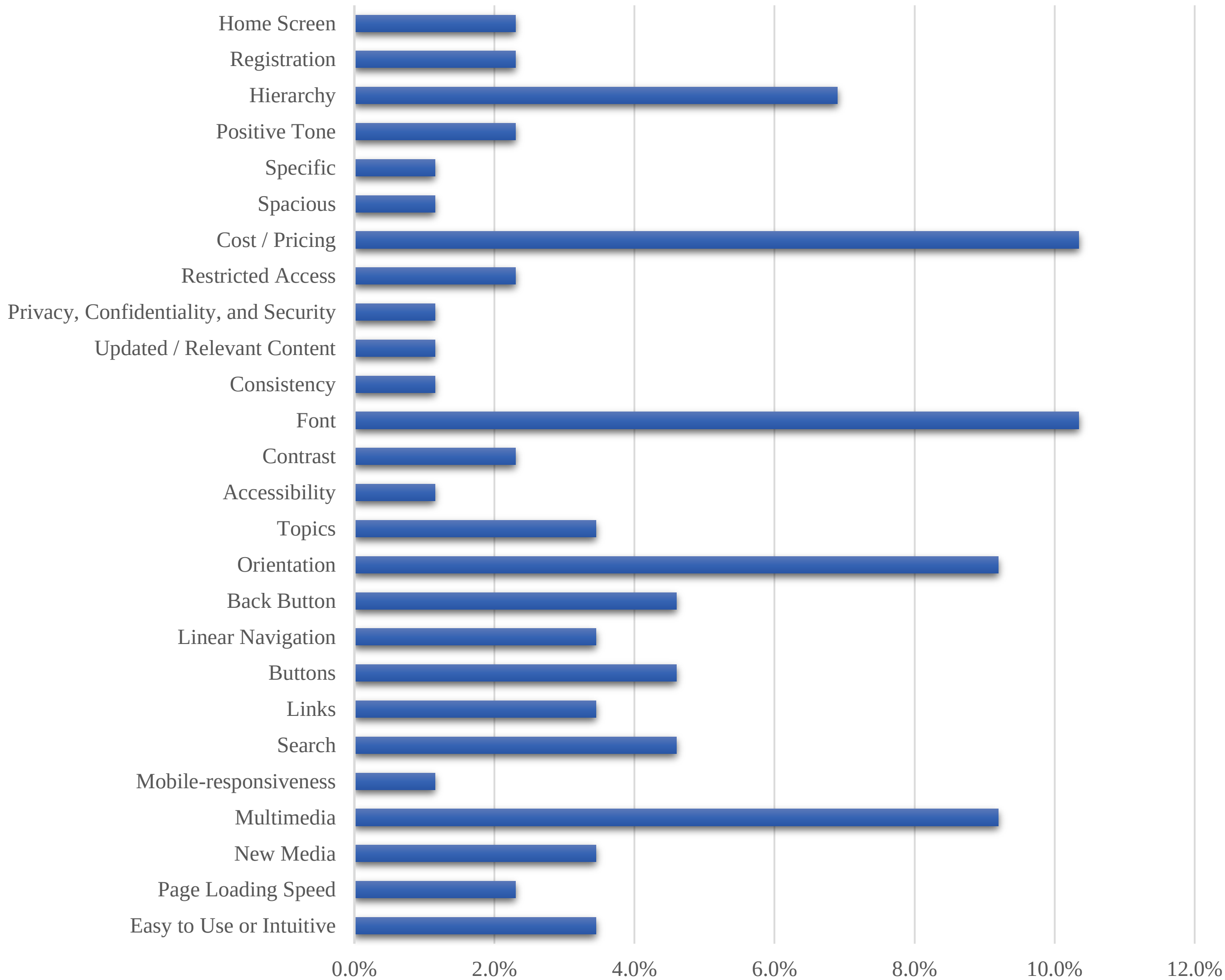


Figure 8: Percent Distribution of Coded Usability Improvement Suggestions for the Teladoc Website for Each Subcode

Part Three: Think Aloud Usability Testing

Think aloud usability testing was performed using 15 (n=15) subjects interacting with one of three telemedicine provider websites (Teladoc, KADAN Institute, Carie Health) both on a desktop computer and on a smartphone then coded under themes that were detected to provoke usability problems. Of the 15 participants who took part in this study (n=15), eight were female and seven were male. All participants were between the ages of 18-21, with the exception of two female participants who were between the ages of 22-29. All but one respondent indicated they were born and raised in the United States, and one was from Honduras. Most participants (66.6%) reported that they were familiar with telemedicine prior to performing the usability test; however, four of these subjects referred to their knowledge of "virtual doctor visits," and not specifically the term, "telemedicine."

Upon analyzing the data from the think aloud usability tests, which included both the verbal reports and behavioral data, a total of 110 usability-related codes (n=110) were issued among all six telemedicine provider interfaces; 57 (51.8%) of these were associated with the usability of the website on a desktop computer and 53 (48.2%) of the total codes were discovered when subjects' interacted with the telemedicine provider websites on their smartphone.

The category of *Overall Ease of Use* will be discussed independently because this category refers to subjects' overall positive or negative sentiment gained from their experience using the telemedicine provider website on either the desktop computer or their smartphone. A positive sentiment was coded when a user positively commented on overall usability of the user interface or review of the video data indicated that the user was better able to navigate the interface and locate information. A negative sentiment was coded when the user negatively commented on overall usability of the user interface or review of the video data indicated that the user was unsatisfactorily able to navigate the interface and locate information. This category, *Overall Ease of Use*, is discussed independently because it does not identify any specific usability issue, but rather is an indication of the overall user experience. When excluding the value associated with the *Overall Ease of Use* category, the total potential usability issues detected is 110 (110). Table 14 shows the cumulative outcomes of the coding and frequency of each usability problem for each telemedicine provider condition and interface type.

Table 14: Overview of Usability Issues Detected for Each Telemedicine Provider Condition and Interface Type (*Newly Added Emergent Codes Identified During Data Analysis)

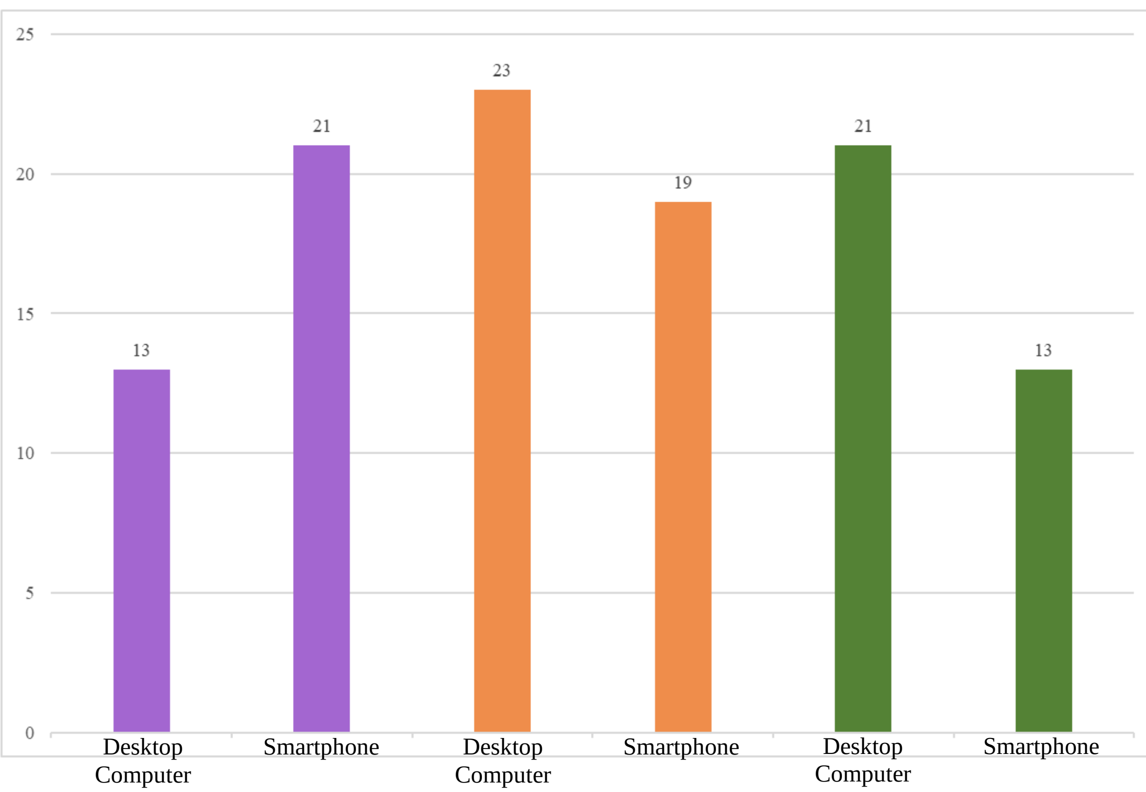
		Desktop Computer			Smartphone		
Usability Dimension / Code	**Subcode**	**Teladoc**	**KADAN Institute**	**Carie Health**	**Teladoc**	**KADAN Institute**	**Carie Health**
Content	Understanding of error messages or no error messages	0	2	6	0	1	0
	Understanding of instructions	0	0	0	0	0	1
	Cost	0	1	0	1	0	0
	*Aesthetics / Minimalist design / Content	0	2	2	3	2	2
Display	Visibility of elements or system status	1	0	0	1	1	1
	Layout	1	0	1	0	1	0
	Color	0	0	0	0	1	0
	Font	0	0	0	0	2	0
Navigation	Navigation	3	8	6	8	5	5
	Meaning of icons / terminology	1	5	4	1	1	2
Interactivity	Graphics	0	0	0	0	1	0
Performance	Speed / Response time / Performance	0	0	0	0	1	0
Cognitive	*Validation of symptoms or health condition	1	0	0	0	0	0

		Desktop Computer			Smartphone		
Usability Dimension / Code	**Subcode**	**Teladoc**	**KADAN Institute**	**Carie Health**	**Teladoc**	**KADAN Institute**	**Carie Health**
	Stress / Fatigue / Exhaustion	1	1	0	1	0	1
Trust / Ethics	Trust / Quality of healthcare	2	1	0	2	1	0
Technical issues	Technical issues	0	0	0	0	1	0
	Accessibility	3	3	2	4	1	1
Total (n=110)		13 (11.8%)	23 (20.9%)	21 (19.1%)	21 (19.1%)	19 (17.3%)	13 (11.8%)

Of the 110 (n=110) total potential usability issues detected, the Teladoc website and Carie Health website had the same amount of cumulative usability issues detected (34), resulting in 30.9% of the total usability problems overall. Most of the Teladoc website usability issues stemmed from the subjects' interaction with the mobile interface, whereas more of Carie Health's usability problems were detected when subjects interacted with the desktop computer interface. The KADAN Institute website had the most usability problems associated with representing 38.2% of the total usability problems detected; 23 attributed to the desktop computer and 19 to the mobile interface.

When comparing the usability of telemedicine providers' interfaces overall, subjects encountered fewer usability issues when interacting with telemedicine provider websites on their smartphone than on a desktop computer; however, this difference was minimal with 53 usability issues discovered when subjects' used their smartphones and 57 usability issues discovered when subjects used a desktop computer to perform the activities they would as they simulated the health-related scenario.

When comparing each telemedicine provider interface individually, the Teladoc website on a desktop computer demonstrated better usability than the mobile-responsive website. Only 13 usability issues were uncovered when subjects interacted with the Teladoc website on a desktop computer in opposition to the 21 potential usability problems that were discovered when subjects used their smartphone to interact with the Teladoc website. In contrast, when subjects interacted with both the KADAN Institute website and the Carie Health website on a desktop computer, more usability issues were detected than when subjects interacted with their mobile interfaces indicating that each telemedicine provider's mobile-responsive website was more optimized for usability than a traditional interface on a desktop computer. Figure 9 shows a side-by-side comparison of the usability issues detected for each telemedicine provider and interface type.



Teladoc KADAN Institute Carie Health

Figure 9: Frequency of Coded Usability Problems for Each Telemedicine Provider Interface

The most frequent usability problems for all telemedicine provider interfaces were classified as navigation problems; the next most common usability issue was related to the content provided. Figure 10 illustrates the frequency of the major classification of usability issues discovered across each telemedicine provider interface type.

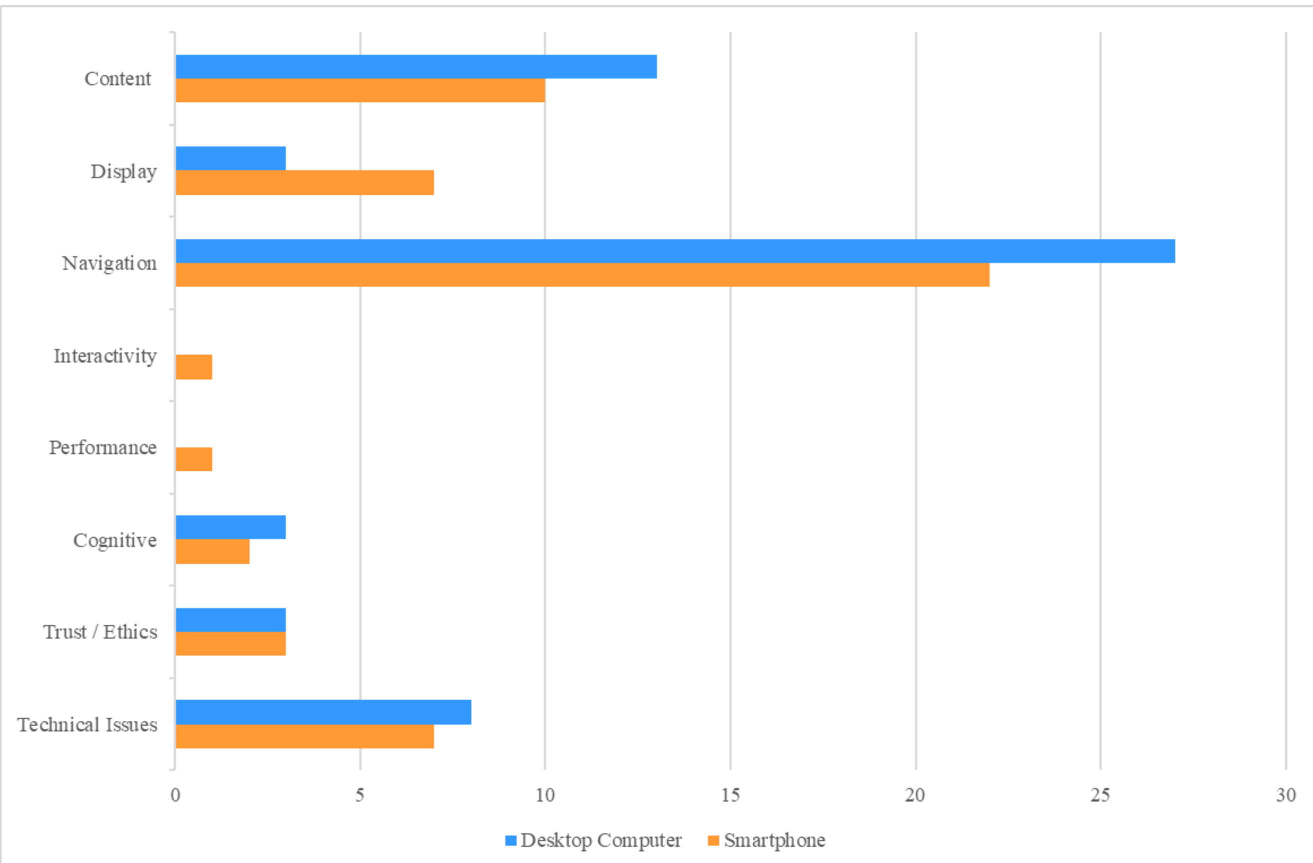


Figure 10: Frequency of Main Usability Codes Detected For Each Telemedicine Provider Interface Type

Navigation problems arose when subjects had difficulty moving through the system and locating the information they were searching for or when a navigation element did not function as subjects expected it to. Usability problems related to navigation was coded 27 times (24.5%) when subjects used the desktop computer telemedicine provider website and 22 times (20.0%) when subjects used their smartphones to interact with the telemedicine providers' websites.

The next most frequent usability issue common amongst all three telemedicine provider communications were content-related aspects related to the design of the interface and the way in which information was organized and presented on the interface or the lack of error messages to support the user in recovering from an error. Usability problems classified under the main theme *Content* were discovered 13 times (11.8%) on the desktop computer versions of the telemedicine providers' websites and 10 times (9.1%) on the mobile version of the telemedicine providers' websites. The third aspect that generated the most usability problems were technical issues related to accessing the telemedicine website in certain contexts or environments or encountering restricted access to certain information provided by the telemedicine providers. Technical issues were detected 8 times (7.3%) during subjects' interactions with the telemedicine provider websites on a desktop computer and 7 times (6.4%) when using their smartphones.

Figure 11 shows the distribution of usability issues identified for each telemedicine provider website when subjects interacted with the interface on a desktop computer. Figure 12 shows the distribution of usability issues identified for each telemedicine provider website when subjects interacted with the interface on their smartphone. A comparison of each figure illustrates the overlapping usability issues for each interface type.

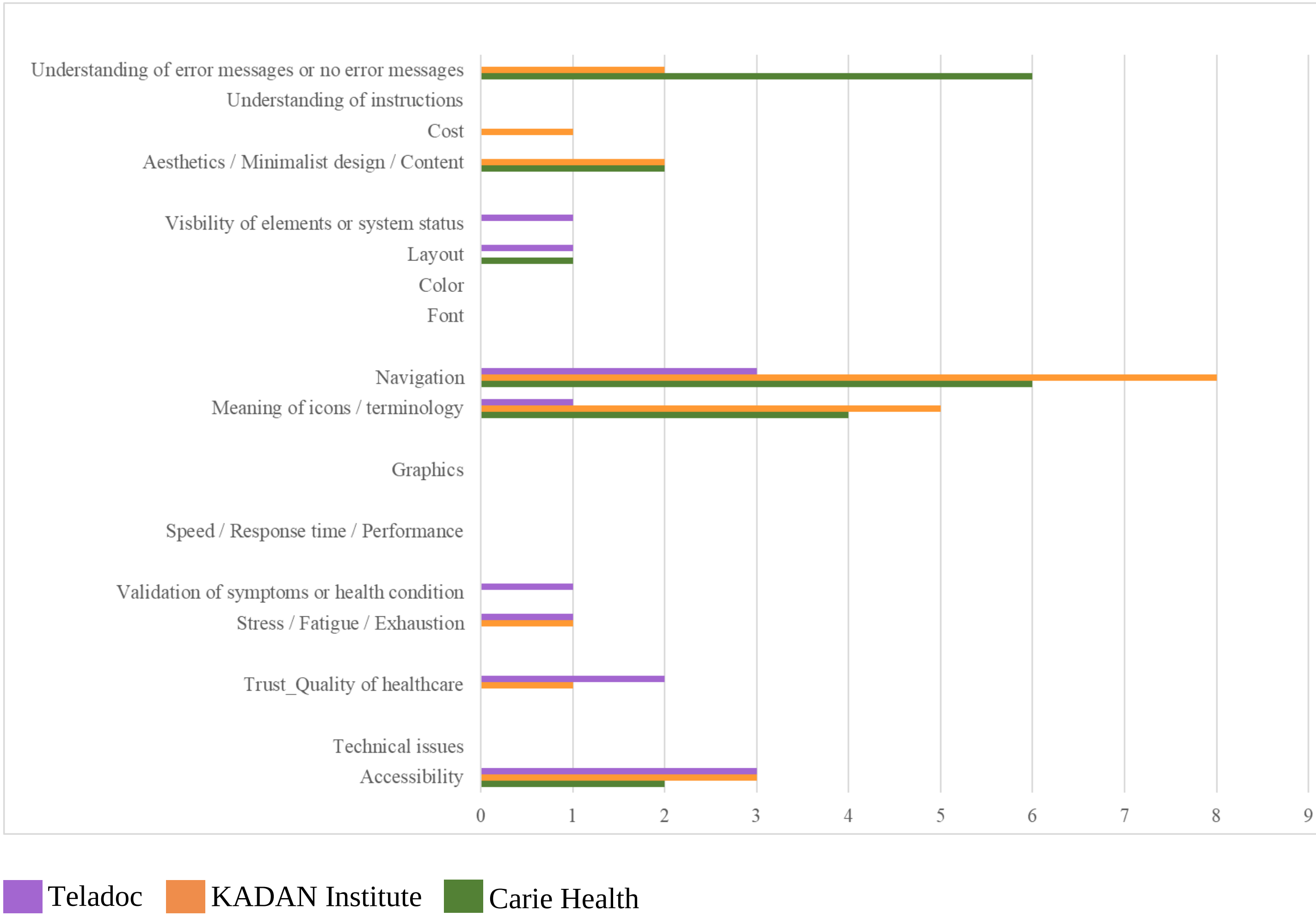


Figure 11: Distribution of Usability Problems Identified for the Desktop Computer Interface of Each Telemedicine Provider Website

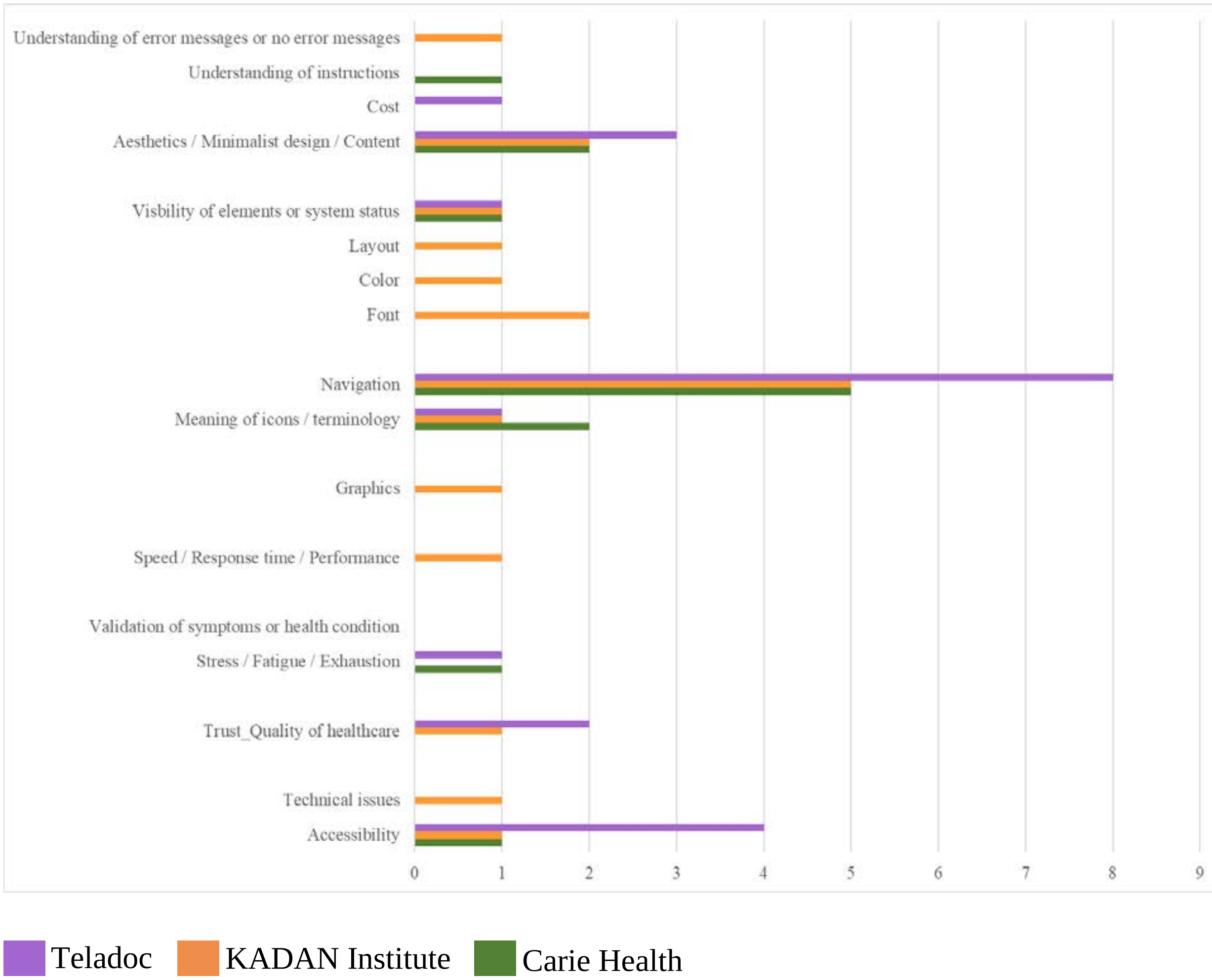


Figure 12: Distribution of Usability Problems Identified for the Mobile-Responsive Interface (Accessed on a Smartphone) of Each Telemedicine Provider Website

Upon analysis of the observational data and verbal reports from subjects, it was inferred from subjects' positive or negative sentiment that the Teladoc website on a desktop computer offered a better overall user experience for users than the corresponding mobile-responsive website; however, the Carie Health website on a desktop computer and the mobile version received the same number of positive comments. The KADAN Institute website, when accessed from a smartphone, appeared to offer a better overall user experience than the desktop computer version because subjects more frequently commented positively during their interaction with the KADAN Institute on their smartphone. Table 15 shows the number of positive and negative *Overall Ease of Use* codes associated with each telemedicine provider interface.

Table 15: Frequency of Coded Positive or Negative Sentiment for Overall Ease of Use for Each Telemedicine Provider and Interface Type

		Desktop Computer			Smartphone		
Usability Dimension / Code	**Subcode**	**Teladoc**	**KADAN Institute**	**Carie Health**	**Teladoc**	**KADAN Institute**	**Carie Health**
Overall Ease of Use	Positive	3	2	2	1	3	2
	Negative	0	1	2	1	1	1

TIUQ Results

A retrospective TIUQ was given to subjects following their participation in the think aloud usability test in order to solicit subjects' perception of the overall usability of each the telemedicine provider communication. The TIUQ consists of two separate sets of questions pertaining to the usability of telemedicine communications, one for the desktop computer version of the telemedicine provider website and one for the mobile interface. The TIUQ is based on a five-point Likert scale that asks respondents to indicate their degree of agreement or disagreement with a statement regarding a system's usability. The TIUQ was developed from previously validated and reliable instruments that aim to capture and quantify users' subjective evaluation of a technology's or interface's usability and satisfaction from their experience (Brooke, 1989; Lewis, 1992; Parmanto et al., 2016). The same metrics as the SUS are used to present the results of the TIUQ and illustrate the usability of each telemedicine provider interface type based on the 15 subjects' feedback.

Using Brooke's (1989) SUS scoring method, each subject's individual raw TIUQ score was calculated. Mean scores of each telemedicine provider interface type were then calculated and converted into percentile rankings and other associated metrics that offer interpretive value. See Figure 13 for how each individual TIUQ score was calculated and Figure 14 for how the average TIUQ score was calculated for each telemedicine provider and interface type.

x = Subject's Response to each individual TIUQ question

Individual TIUQ Score = $(\sum (x - 1)) \times 2.5$

Figure 13: TIUQ Individual Raw Score Calculation Based on a Five-point Likert Scale with 12 Questions

$$\text{Mean TIUQ} = \frac{\sum (\text{Individual subject's TIUQ Score})}{5}$$

Figure 14: Mean (Average) TIUQ Score Calculation

The best way to interpret the results of the TIUQ is first to understand them in terms of percentile rankings, which are based on the finding from a number of usability studies that the average score is 68 (Brooke, 2013; Lewis et al., 2018; Sauro, 2011; Sauro, 2018; Sauro 2019). A score of 68 is at a 50th percentile ranking (Brooke, 2013; Lewis et al., 2018; Sauro, 2011; Sauro, 2018; Sauro 2019), and all other scores out of 100 are distributed according to their percentile ranking based on the average score of 68. Percentile rankings have also been associated with letter grades, which afford a better interpretation of the overall usability of a system or interface;

in addition, the TIUQ results can also be interpreted in terms of users' perceived-satisfaction of their experience by an adjective rating that Bangor et al. (2009) assigned to each letter grade.

The percentile ranking benchmarks for the SUS were converted into the equivalent percentile rankings, letter grades, and adjective rating for the TIUQ, presented previously in Table 8. Using the TIUQ score conversion and percentile ranking equivalent to the SUS benchmark metrics, a usability grade and adjective rating was assigned for each telemedicine provider interface. Table 16 and Table 17 express the average score of the TIUQ for each telemedicine provider and interface type and the associated letter grade and user subjective expression of usability by the adjective rating. Table 16 presents the results from the TIUQ developed for the desktop computer version of the telemedicine provider website; Table 17 presents the results for the TIUQ developed for the telemedicine provider website when accessed on a smartphone.

Table 16: Subjects' Overall Impression of Usability of the Telemedicine Provider Website Accessed from a Desktop Computer: Values Interpreted Based on Industry Benchmarks (Grade and Adjective Rating)

Condition - Telemedicine Provider	Mean TIUQ Score (n=5)	Grade	Adjective Rating
1 – Teladoc	102	A	Excellent
2 – KADAN Institute	84.5	B	Good
3 – Carie Health	69.5	D	Poor

Table 17: Subjects' Overall Impression of Usability of Telemedicine Provider Website Accessed from a Smartphone: Values Interpreted Based on Industry Benchmarks (Grade and Adjective Rating)

Condition - Telemedicine Provider	Mean TIUQ Score (n = 5)	Grade	Adjective Rating
1 – Teladoc	81	B	Good
2 – KADAN Institute	83	B	Good
3 – Carie Health	66	D	Poor

From the results of the retrospective, post-usability TIUQ, the Teladoc website, when accessed from a desktop computer, was perceived to have the best usability out of all telemedicine providers studied and demonstrated better usability than the mobile version of the website. Both Teladoc and KADAN Institute mobile interfaces appeared to have "good" usability, being graded as a "B," and the Carie Health website demonstrated poor usability on both interface types, the desktop computer version and the mobile version.

This concludes the presentation of the results from this study's three-parts: the content analysis, the remote usability testing, and the think aloud usability tests. The next chapter will summarize the results of the three parts and provide a discussion of the results in light of the research questions. Activity theory and mobile interface theory are used to discuss and interpret the usability of the telemedicine provider websites based on the findings, and Chapter Seven concludes with a discussion of the implications of this research.

CHAPTER SIX – DISCUSSION

This chapter first provides a summary of the mixed-methods research that was conducted and then discusses the results using activity theory and mobile interface theory as a means of interpretation and as an explanatory tool to answer each research question. This discussion chapter addresses each research question individually and ends with rationale for the study limitations.

Review of Study

The purpose of this study was to investigate the design and usability of telemedicine provider communications, specifically those that are provisioned online, such as telemedicine provider websites, and in parallel, those that are delivered to consumers in a mobile environment; for example, the telemedicine provider website accessed on a smartphone. Telemedicine has received minimal acceptance and uptake by consumers as it has faced many barriers to successful implementation (Brown et al., 2013; Tang et al., 2006). However, it is well-established that improving the usability of HIT improves patients' perception of the healthcare interaction, healthcare delivery technology, and use of various healthcare interventions, like telemedicine (Middleton et al., 2014; Patel et al., 2014; Wilkes et al., 2000). Thus, it was determined that evaluating the design and usability of telemedicine provider interfaces was instrumental to discovering the affects on the overall adoption rate of telemedicine and, in addition to the healthcare sector, would contribute to other fields, such as HCI, IT, and marketing.

Based on activity theory's concept that human consciousness motivates and guides human activities, which are mediated through tools (Wilson, 2008), this mixed-methods study encompassed three parts: a content analysis, remote usability testing using, and in-person think aloud usability testing using fifteen subjects. Employing multiple methods in the context of one study offered a rich and comprehensive data corpus that allowed for an intimate interaction with the data, a more useful interpretation of the results, and a valuable elucidation of the usability of the DTC telemedicine provider interfaces that were being examined in this study.

This study addressed the following research questions:

1. What rhetorical content, information, and design strategies are currently used in telemedicine interfaces?
2. When described a particular health-related scenario, in what context of use are potential telemedicine users most likely to access a specific telemedicine communication? Put another way, where might a potential telemedicine user be when accessing the telemedicine provider website, and where might a potential telemedicine user be when accessing the telemedicine provider mobile interface?
3. How effective and usable are telemedicine interfaces and communications from the consumer perspective? Are users able to find and comprehend the information they need to perform certain actions and activities?
4. How likely are potential telemedicine users to access and use a telemedicine service following their interaction with and engagement with the telemedicine providers' communications?
5. Are potential telemedicine users able to perform a telemedicine consultation following their interaction with the telemedicine provider communication or interface? Which telemedicine provider communication is most effective at mediating users' activities to reach the goal of performing a telemedicine consultation?

The next sections will address each research question and offer an interpretation of the findings using activity theory and mobile interface theory to explicate how humans interacted with the telemedicine provider interfaces. I triangulate the results of the three methods by exploring them all together and comparing and contrasting the results as they relate to the usability of the telemedicine provider interfaces. In addition, I use activity theory for its predictive value to offer design recommendations that will lead the design and delivery of more usable health communications and HIT.

Research Question 1: What rhetorical content, information, and design strategies are currently used in telemedicine interfaces?

To answer this research question, the content analysis part provides the most useful evidence because the content analysis allowed me to explore each telemedicine website in depth and discover what rhetoric, design elements, terminology, and media they used to promote their telemedicine service. Activity theory considers the integration of the telemedicine provider communications and the user interface as the "tool" mediating users' goal-oriented activities. Assuming the end-goal of an individual's use of a telemedicine provider is to be able to perform a telemedicine consultation efficiently and safely, the telemedicine provider interface needs to contain the important information potential patients would look for and be designed to be used effectively, in multiple settings in which a patient might access it; for instance, while mobile.

Kayyali et al. (2017) suggested several types of critical information that users would want to know when being educated about telemedicine or that promote telemedicine as a quality healthcare delivery mechanism, such as information about telemedicine and how it works. Likewise, a plethora of eHealth studies suggest that users need a website that is easy to navigate, contains specific keywords that users understand, has salient information immediately visible, appears to be credible, and is aesthetically appealing (Horsky et al., 2016; Johnson et al., 2005; Ozkan et al., n.d.; Reen, Muirhead & Langdon, 2019; Sillence et al., 2006; Usher & Skinner, 2007; Zhang, von Dran, Small & Barcellos, 1999), among many other usability criteria.

The Teladoc website met all the criteria suggested by Kayyali et al. (2017). Teladoc is the the largest and oldest telemedicine provider under investigation in this study (CPOE.org, 2018; Dyrda, 2018; Preece, n.d.; Roland, 2015), and the website appeared to include content that addressed many of the common barriers to patient acceptance and uptake of telemedicine. For instance, providing information on what telemedicine is, how it works, and reassurance that patients are well supported are suggested to be essential to include in telemedicine communications, and Teladoc displayed this discourse and the other criteria that is used to promote telemedicine directly on the homepage of their website. The Teladoc website header displays, "The quality care you need with the convenience you want Speak to a licensed doctor by web, phone or mobile app in minutes," which satisfies the users' need to know what telemedicine (*Knowledge*), and, "Our mobile app is the most convenient way to Teladoc and feel better. Schedule a doctor visit, manage your medical history, or even send a prescription to the nearest pharmacy – all from the palm of your hand," was coded in the *Reassurance* category because this information is intended to reassurance patients that the service is easy to use and that they have support if they experience technical difficulties.

Carie Health, the similar telemedicine provider, also displayed most of the key content according to the guidance criteria. For instance, like the Teladoc website that expressed what telemedicine was (*Knowledge*), Carie Health featured this type of *Knowledge* content directly on the homepage, "Connect with your doctor online and instantly receive the care you need," as well as on the Clients page, "Connect with your primary doctor, or with an available Carie™

board-certified doctor, at any time, any place." Both Teladoc and Carie health also communicated the benefits to patients on their homepages, which was coded under the *Benefits* category. The Teladoc website featured three icons stating, "24/7 anytime, anywhere; 92% issues resolved after first visit; 95% member satisfaction," (See Figure 15).

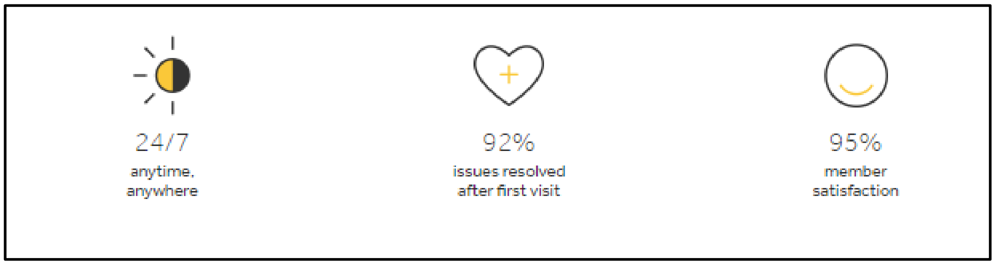


Figure 15: Teladoc Website Featured Content Coded as *Benefits* Content

The Carie Health website displayed similar graphics and statements, "24/7 Access to Care; Receive care and prescriptions nationwide —even when you travel… Save time and money, See a doctor anytime, anywhere. No more busy waiting rooms or long commutes," (See Figure 16).

Figure 16: Carie Health Website Featured Content Coded as Benefits Content

That said, the Carie Health website did not present one of the key types of information that has been discovered to promote the use of telemedicine services, that being the *Previous*

Experience code (testimonials or positive quotes from patients regarding the use of the service). Potential patients seeking healthcare from a telemedicine provider might want to read previous patients' experience with the service to corroborate that the service is of high quality and/or easy to use. Including patient testimonials can be considered as a rhetorical device to motivate individuals to use the telemedicine service. For instance, several testimonials from patients' positive experience were conveyed on the homepage of the Teladoc website:

> "So nice to stay home and receive care instead of going to a doctor's office with other sick people. Warm and comfortable care at home, on my time!"
>
> "Teladoc is a godsend for anyone who has spent three hours in a waiting room for something that can be resolved with a simple phone call."
>
> "I don't like to take off from work to sit in a waiting room. With Teladoc, I went to work not feeling well and a doctor called, listened, and sent in my prescriptions." (Teladoc)

Because Teladoc is older than Carie Health, it can be assumed that Teladoc has a larger patient population from which to obtain testimonials. In fact, the Teladoc website notes they have over 20 million members (Teladoc). It may increase Carie Health's patient population if the Carie Health website featured content that would be considered as *Previous Experience*.

One quality that the Teladoc website and the Carie Health website did share is integrating information that was considered to be *Choice* discourse, which is content that communicates that the telemedicine service is optional and not a substitute for traditional face-to-face physician consultations or for emergency services." Considering that some potential users, who are unfamiliar with telemedicine, may seek medical treatment from a telemedicine doctor in an emergent situation, displaying *Choice* content immediately to users on the homepage would be most beneficial and safe. Yet, both the Teladoc website and Carie Health website appeared to bury *Choice* content several clicks away from the homepage. The Teladoc website featured this content on their FAQ page, "What are some of the common conditions Teladoc treats? Common conditions include sinus problems, respiratory infection, allergies, flu symptoms and many other non-emergency illnesses." However, this page was not directly accessible from the homepage. One must first click on an option under the Members dropdown menu on the main navigation, then navigate to the FAQ page, which appeared as the last option on the left sidebar menu (See Figure 17).

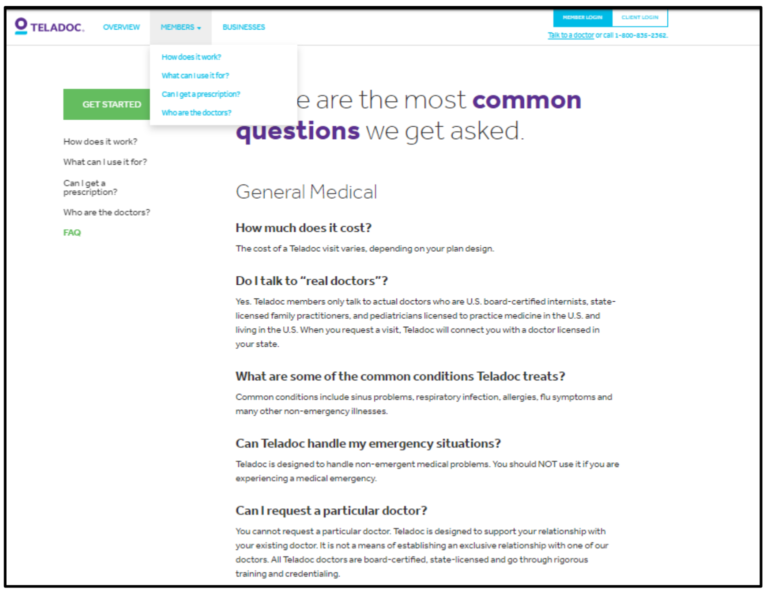


Figure 17: Teladoc Website – Main Navigation Members Dropdown Menu, FAQ page and *Choice* Content

Carie Health placed this *Choice* information even deeper on the website, "Q2. Can Carie handle my emergency situations? A2. Carie is designed to handle non-emergency medical problems. You should NOT use our service if you are experiencing a medical emergency." Like Teladoc, this content was also included on a Frequently Asked Questions page, but Carie Health made the FAQ content only available as a downloadable PDF, rather than accessible on an HTML website page. To locate the Frequently Asked Questions PDF, users had to first click on the Resources option in the footer, then locate the Frequently Asked Questions PDF thumbnail image, and download the PDF. Figure 18 is a screenshot of the Resources page and the PDF that patients would need to download to locate the information.

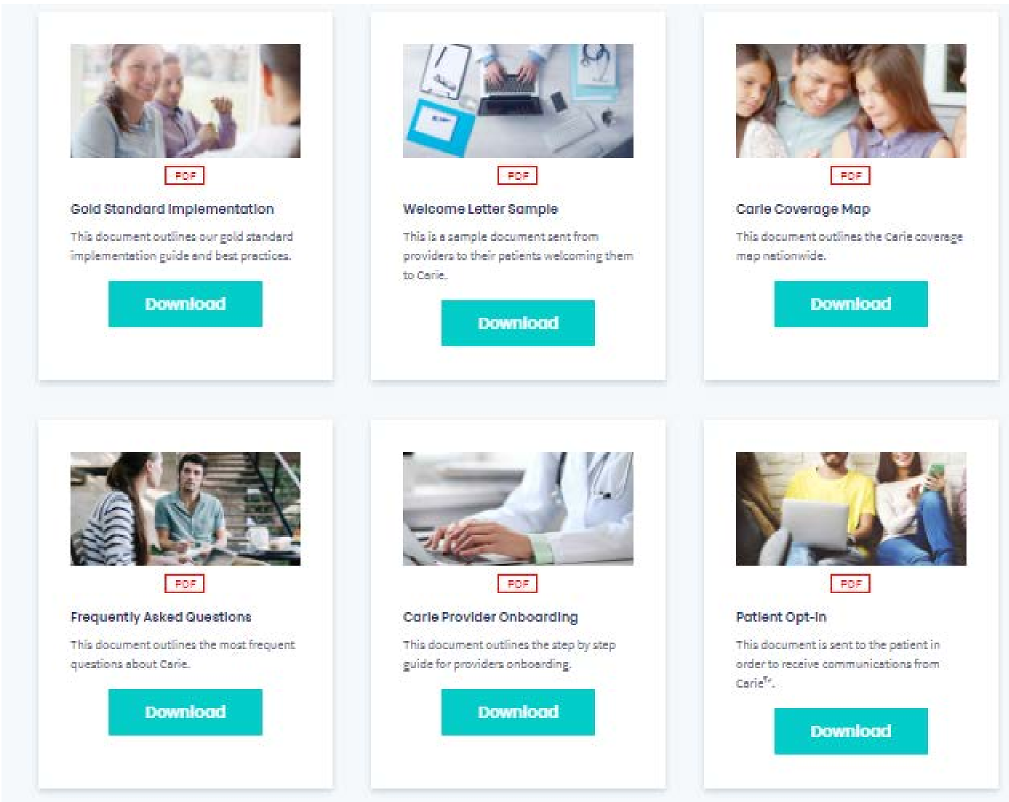


Figure 18: Carie Health Website – Resources Page and Frequently Asked Questions PDF Thumbnail with a Download Button

If a patient is experiencing an emergency situation or under stress or fatigued from being ill, it is unlikely the patient would find the content that communicated to her or him that the service should not be used for their health situation.

Lastly, KADAN Institute, the functional medicine telemedicine provider, did not appear to provide two types of the salient information that potential patients would need to know to use the service: *Choice* (noting that the service is optional and not a substitute for traditional face-to-face physician consultations) and *Appearance* (information visuals supporting users' ability to understand information). As a reminder, functional medicine seeks to find out the root cause of chronic health conditions, such as irritable bowel syndrome, and practitioners create personalized treatment plans for patients by working with them one-on-one to understand their health practices (KADAN Institute, 2020). Although KADAN Institute offers virtual healthcare for patients with chronic conditions and is different from the primary, acute healthcare that Teladoc and Carie Health provide, KADAN Institute appears to communicate to users that the service they offer—functional medicine—is the only type of healthcare that will be able to treat patients and provide them long-term relief from disease. The concept that functional medicine was more effective than traditional healthcare delivered with prescription medications was depicted from passages such as:

> "Stop Suffering: Don't keep struggling alone. Don't continue to see doctors with too little time to properly understand you and your important health concerns."
>
> "At the KADAN Institute we trust your body's ability to heal. We are convinced that by addressing the root cause of your health concerns, not only will your symptoms improve, but you will be empowered to live a healthier, more energetic, more vibrant life."
>
> (KADAN Institute)

From a usability standpoint, using the constructs of activity theory, if the subject (the patient), is using the KADAN Institute as a tool for information, she or he might feel pressured to use the service given the rhetoric, "stop suffering…, don't continue to see doctors," albeit it may not be a suitable for the patient or even delay her or him from obtaining healthcare that enables the patient to achieve their goal, a positive health outcome. Therefore, it can be argued that efficiency of the KADAN Institute website is hindered and patient safety may even be compromised.

The KADAN Institute website included a variety of visuals; however, I judge the visuals displayed are for aesthetic appeal only and do not appear to be implemented in a meaningful way to help users comprehend complex information (Figure 19). For instance, the physician in Figure 19 may appear pleasant or intelligent, yet the image does not afford the user any information to help their comprehension and cognition. I am not suggesting that the visual aesthetics of a website is not a significant motivating factor users rely on to help make decisions and promote a positive affect (Damman et al., 2009; Flavián, Raquel & Orús, 2008; Sillence et al., 2006). In this way, the visual aesthetics of a website does shape the user experience and therefore affect usability (Yen et al., 2011). In fact, there is evidence that users' make quick determinations to trust health information based on the design and visual appearance of a website (Eysenback, 2005; Eysenbach et al., 2002a; Sillence et al., 2006). However, because this research question has me analyze the activity where users interact with the telemedicine provider communication to become informed about the telemedicine service and how to perform a virtual doctor visit, I do not perceive the visuals on the KADAN Institute website to mediate this activity, which is to say they are not tools that support users in their ability to achieve their objective for using the website.

Figure 19: Examples of Visuals from KADAN Institute Not Coded to Adhere to the Appearance Criteria

Both Teladoc and Carie Health met the *Appearance* criteria and included numerous information visuals on their websites that support users' comprehension of information and are easily visible when scanning the website (Figure 20 and Figure 21). For instance, the first image in Figure 20 has immediately visible headings embedded in a graphic of the context—a smartphone—where users may access the telemedicine service. The large headings are specific questions users might have that help grasp users' attention and support users' interaction with the website by helping users both locate and understand how telemedicine service is accessed. The second graphic in Figure 20, similarly, is an information visual that mediates a user's activity (completing medical history) by providing information embedded in the tool (smartphone) they can use to perform it. The Carie Health website also displayed many icons and graphics that represented a term or action and provided an alternative means of understanding the information provided. The first image in Figure 21 displays features of the telemedicine service with both the term and an icon. Using an image, such as an icon, allows users to quickly understand some of the benefits the telemedicine service affords users. Furthermore, some users may not understand what some of the complex health terms mean, such as, "Device Agnostic," or, "HIPAA," but by featuring an image along with the term supports user comprehension. The second graphic in Figure 21 is a map that is offered by Carie Health once the user creates an account and searches for a physician. The map quickly allows users to see, visually, if there is a physician in their geographic location. Contextually speaking, if a patient is ill and is seeking healthcare, the patient may feel hurried and stressed. Information visuals, such as the map in Figure 21 allow patients to perform the activity of finding information, quickly, in their time of need.

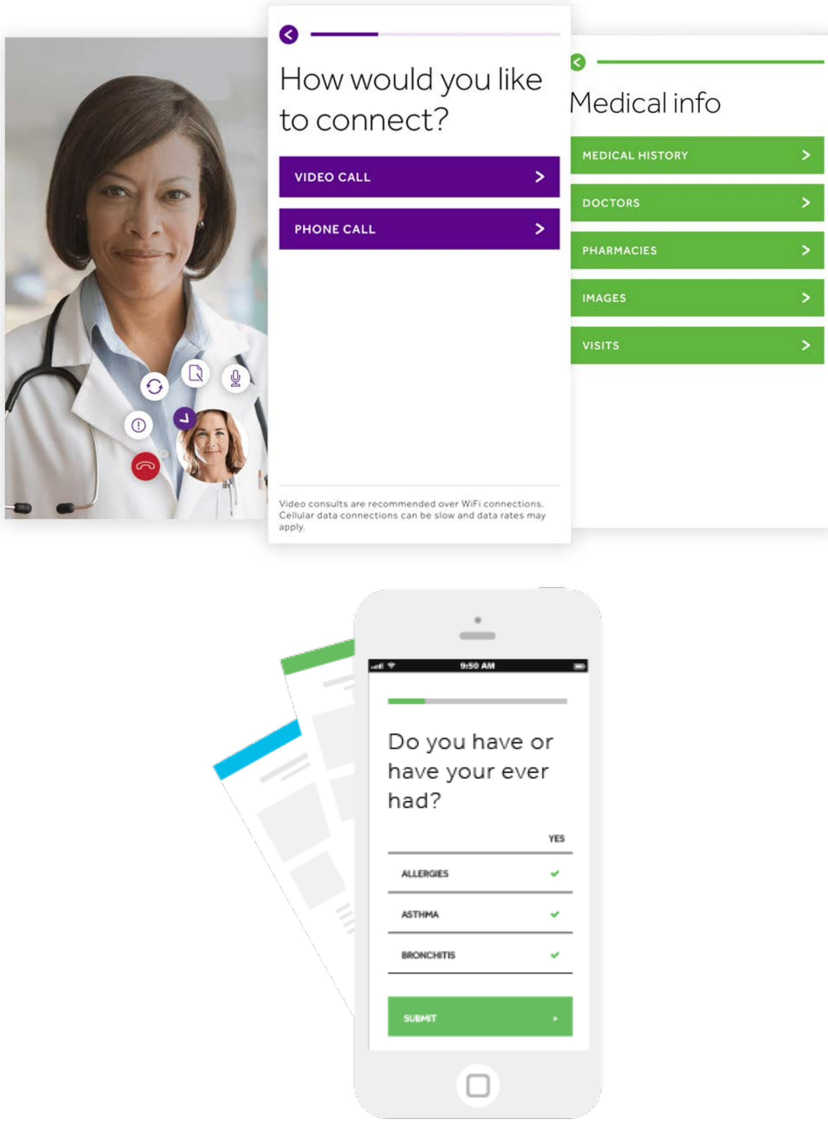


Figure 20: Examples of Visuals from Teladoc Coded to Adhere to the Appearance Criteria

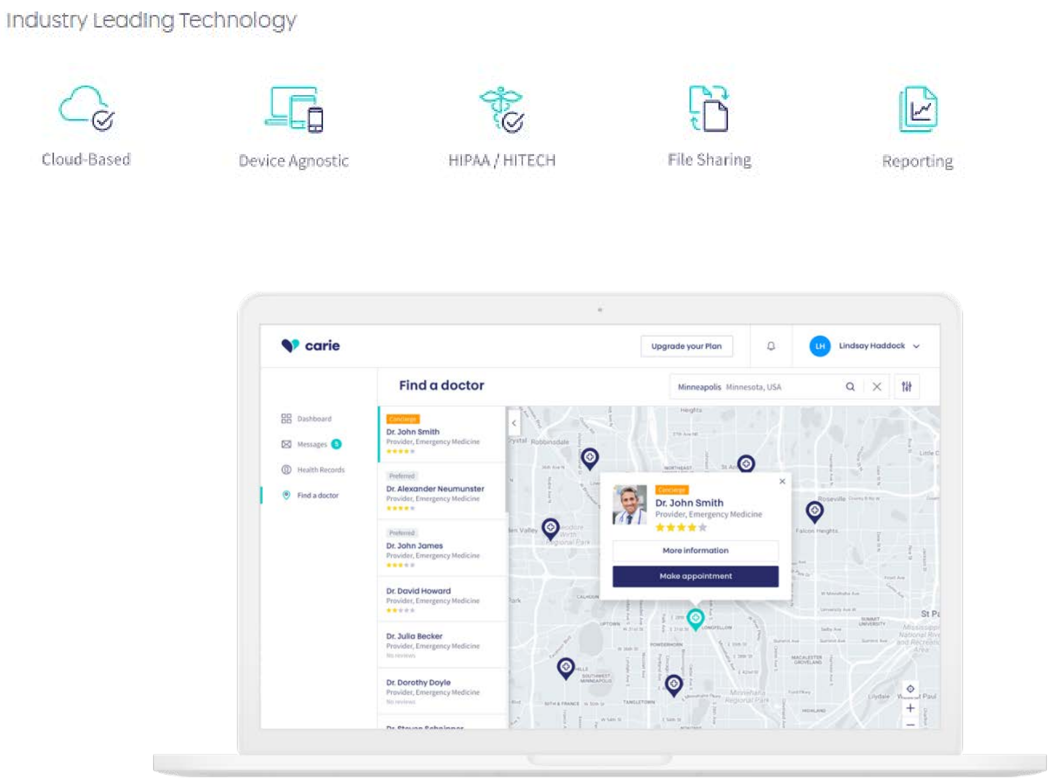


Figure 21: Examples of Visuals from Teladoc Coded to Adhere to the Appearance Criteria

To evaluate whether content and salient information was able to be discovered quickly, the mean number of screen transitions was calculated for each condition according to the content and information they provided. The number of screen transitions represents the number of clicks of a mouse a user must perform to locate certain information. The average number of mouse clicks a user needs to complete to locate the pre-established content and information coded for (Kayyali et al., 2017) is .25 on the Teladoc website, .5 on the KADAN Institute website, and .286 on the Carie Health website. This figures illustrate that Teladoc appears to display the important content and information directly on their homepage, immediately available to users, and does not require the user to perform a number of information searching activities in order to attain the information they need to be able to perform a virtual physician visit. In terms of usability, the Teladoc seems to be the most efficiently used telemedicine provider website, if users' intention for using the website is to become informed about the telemedicine service and how to perform a virtual doctor visit. However, the Carie Health and KADAN Institute websites are not far behind, which demonstrates that most of the information users may be searching for when visiting a telemedicine provider website is displayed on the homepage.

Lastly, it is increasingly recognized that the success or failure of HIS and other healthcare interventions that are delivered using technology largely depends on the design of the user interface and the demands that it places on the user's health literacy (Monkman et al., 2015a). Health literacy involves a myriad of competencies, one of which is one's reading level (Monkman et al., 2015a). Telemedicine communications must provide information that is adapted for the lay audience—the target user population—whom are disproportionally known to have inadequate health literacy (Bickmore et al., 2010; Kutner et al., 2006). Therefore, the readability of each telemedicine provider website was accessed using the FKGL. The FKGL score for each telemedicine provider website was calculated to exceed the 6^{th} grade reading level that consumer health information is recommended to be written in (Doak, Doak & Root, 1996; Raj et al., 2016; Taylor et al., 2011; Weiss, 2003). When comparing each telemedicine provider website, the Teladoc website had the best readability grade level, exceeding the 6^{th} grade level by 3.1 grade levels, with a FKGL score of 9.1. The KADAN Institute FKGL score was calculated to be 12.2, which is 6.2 grade levels above the recommended 6-grade level, followed closely by Carie Health, which had a FKGL of 13.2, far above the 6^{th} grade level maximum by 7.2 grade levels. These readability results illustrate that telemedicine communications may be written in such a way as to not be comprehensible by the average user, which affects usability and users' ability to use the telemedicine service (Bickmore et al., 2010; Eltorai, Ghanian, Adams, Born & Daniels, 2014). The poor readability of the telemedicine provider communications aligns with research showing that most web-based health information that is intended for consumer use is written well above what the average user would be able to comprehend, exceeding the grade level recommended by the American Medical Association, (Raj et al., 2016; Walsh & Volsko, 2008; Weiss, 2003).

Overall, the telemedicine provider communications appear to be providing the critical information that potential patients would need to know in order to mediate their activity, and the information appears to be quickly locatable on the homepage; however, the information may be written at readability levels too difficult for the general population.

Research Question 2: When described a particular health-related scenario, in what context of use are potential telemedicine users most likely to access a specific telemedicine communication?

My second inquiry into the usability of telemedicine provider communications regarded the context of use a patient is likely to access a telemedicine provider website on a desktop computer or use the mobile version. In an effort to help users assimilate and cognitively process information quickly, the user interface must be user-friendly and take into account the users' needs and contextual factors that may affect usability (Allen et al., 2006; Johnson et al., 2005; Kaipio et al., 2017). Although this inquiry is difficult to evaluate given that every individual offers a distinct perspective and every health situation is unique, I found that interpreting the subjects' behaviors during their interactions with the telemedicine provider interfaces from a mobile interface theory viewpoint allowed me to make the most accurate assumptions the context of use an individual would use each interface type.

When comparing the usability of telemedicine providers' interfaces overall, subjects encountered fewer usability issues when interacting with telemedicine provider websites on their smartphone than on a desktop computer. Subjects encountered 53 usability issues when interacting with the telemedicine provider websites on their smartphones and 57 usability issues when interacting with the telemedicine provider websites on the desktop computer. This data might suggest that telemedicine provider websites are mobile-responsive or that individuals are simply more comfortable or familiar with the activity of using a smartphone because they have it with them nearly all of the time and more engaged when using mobile technology due to the sense of connection (Nguyen et al., 2016). Farman (2016) argues that the activity of using mobile technology is an embodied act, yet this depends on the, "cognitive unconscious" (p. 27). From perpetual use of mobile technology, humans gain a sense of connection and "being" in the world when the technology and their use of it becomes unnoticed (Farman, 2016). If using the telemedicine provider interface as tool or mediator of information, it should be so intuitive that it disappears from consciousness. Further observations suggest the ladder is more accurate, which is to say that humans find interacting with mobile technology to be easier and intuitive.

That said, I also observed that subjects tended to proceed through the task of creating an account and entering personal information when interacting with the desktop computer interface. This was one step in the activity of performing a virtual doctor visit. This observation implies that telemedicine provider websites on a desktop computer are more user-friendly and designed more suitability for their intended audience. Subjects' overall positive or negative sentiment about their experience using each telemedicine provider interface corroborates this inference. More subjects remarked positively about their experience using the telemedicine provider website on the desktop computer than on their smartphone.

Despite this data, I suspect that telemedicine providers are not designing and delivering communications that are mobile-friendly, or at least it is not a high-priority for them to be testing their websites to verify they provide the same user experience in a mobile environment. To substantiate this assertion, one subject tried to take the free health assessment offered by KADAN Institute when interacting with their smartphone and when the subject began entering information, the following message appeared:

> "Attention: It looks like you are using a cell phone or tablet to access this system. Please note that only desktop and laptop computers are supported at this time." (KADAN Institute) (Figure 22).

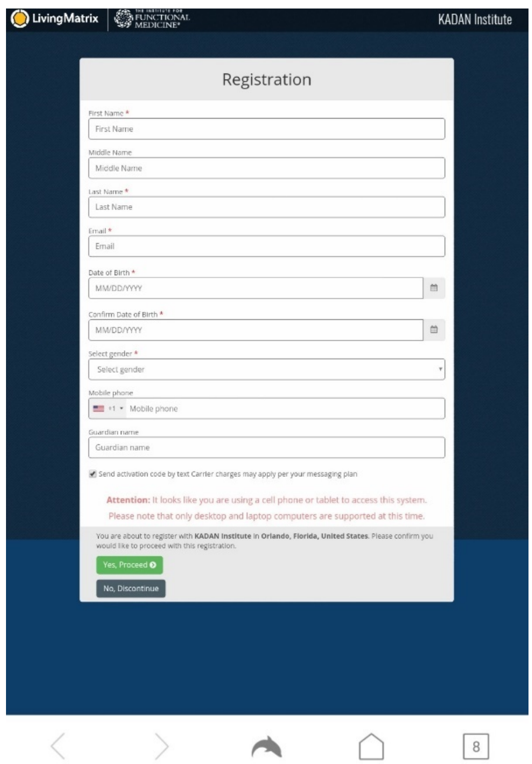


Figure 22: KADAN Institute Website Accessed on a Smartphone: Patient Health Assessment Registration Page

By not designing websites to be mobile-friendly or accessible on various mobile devices, telemedicine providers may block some users from using their telemedicine service because they cannot access it if they are in a mobile environment or only have a smartphone available. This aligns with research that shows that the design guidance offered to designers of health information technology are not all applicable to mobile health applications (Monkman et al., 2013a). In addition, from my own professional experience in content and communications in the health and medical field, healthcare organizations failed to take into account clients or patients' context of use when designing and delivering health communications or information about their service. This finding might express that conceptual gap between a designer's understanding of what a HIT should feature and how it should function and how an end-user uses it to perform activities that enable them to achieve positive health outcomes that other researchers have discussed (Chun et al., 2012; Kushniruk et al., 2005; Kushniruk et al., 2013. Mobile-friendly health communications were often not a priority for the organization owners, nor do immature, small healthcare providers have the funds to allocate to the design of their corporate website and marketing their healthcare service (Atkinson & Gold, 2002). Researchers understand that successful implementation of mobile health technology requires a detained understanding of the individual and contextual variables that influence users' interactions with technology in order encourage sustained use (Steinhubl, Muse & Topol, 2015).

Additionally, it was also discovered that subjects who did try to create an account on the desktop computer version of the telemedicine provider website always used their smartphone to check their email to retrieve their confirmation code. This is an interesting observation because rather than opening a new internet browser tab on the interface they were already interacting with to check their email, they quickly grabbed their smartphone, which was by their side or in their pocket, to check their email. Farman (2012) suggests that humans are proprioceptively engaged in the situation of their interactions with mobile interfaces. Mobile interface theory posits that humans have an embodied experience when interacting with a mobile interface because it requires to use of many senses to engage in activities in the liminal space between the physical and digital world (Farman, 2012). Because individuals have a more sensory experience when using their smartphone, their use of it may be so intuitive that it is unconscious and goes unnoticed. This insight from mobile interface theory and from the observations that subjects appeared to intuitively check their email using their smartphone despite being already engaged in and activity using a different interface (desktop computer interface) causes me to speculate that more individuals would access that telemedicine provider website using their smartphone. If an individual is ill and are under stress, she or he will intuitively reach for her or his smartphone to access a telemedicine provider website. Activities are also dependent on the available conditions (Vrazalic, 2003b).

To recall, activity theory states that the necessary conditions must be present in order for an activity to take place; therefore individuals in a mobile environment and those who do not have access to a desktop computer would certainly *only* be able to access the telemedicine provider interface on their smartphone. Research corroborates this finding that designing mHealth applications remains a difficult task (Uden et al., 2008). Therefore, telemedicine providers appear to be providing the required content, but the design of the user interface attenuates usability.

In the context of “mobility,” users are more likely to access a telemedicine communication. Mobile technology carries considerable promise for telemedicine acceptance and uptake by consumers, but is appears that telemedicine providers are fairly immature in their progress towards creating a positive user experience when their websites are not designed to be mobile-responsive or even accessible on mobile devices (Lienhar & Legner, 2017; Sheehan, Lee, Rodriguez, Tiase & Schnall, 2012; Valdez et al., 2018).

Research Question 3: How effective and usable are telemedicine interfaces and communications from the consumer perspective? Are users able to find and comprehend the information they need to perform certain actions and activities?

To evaluate the effectiveness and usability of telemedicine interfaces, the think aloud usability tests offered me the most valuable insight because these allowed me to gauge whether users are able to interpret the content accurately and use the telemedicine provider websites in a meaningful way. I phrased this research question in two ways to clarify how I was measuring usability. Usability is the extent to which a product can be used by target users to achieve specific goals with effectiveness, efficiency, and satisfaction in their context of use (ISO, 2018; Yen & Bakken, 2012). Therefore, in terms of activity theory, in order for the telemedicine interfaces to qualify as usable, users must be able to find and comprehend the information they need to perform the activity they need to reach their objective.

To summarize my conclusions thus far, it is the integration of the rhetoric displayed *on* a telemedicine provider website and the design *of* the website that mediate users' motive and ability to become informed about the telemedicine service, which is secondary to and a required condition for the primary activity of being able to perform a virtual doctor visit to take place. Although telemedicine providers may be provisioning the content that individuals would need to be able to perform a virtual doctor visit successfully, which was discovered in response to my first research question, the content and information may not be designed appropriately for the intended audience.

Results from the think aloud usability tests revealed that subjects encountered several usability problems when interacting with the telemedicine provider websites, both on the desktop computer and on their smartphone. A total of 110 usability issues were discovered between all six telemedicine provider interfaces. Usability issues were classified under seven main themes based on the type of usability problem: *Content*, *Display*, *Navigation*, *Interactivity*, *Performance*, *Cognitive*, and *Trust / Ethics*. Each main usability category included several subcategories (subcodes) that were included in the original codebook provided by Kushniruk et al. (2019a; 2019b) or were discovered during thematic analysis of the data.

The most frequently encountered usability issues were attributed to the *Navigation* of the website, which is considered a problem in the design of the user interface rather than the content provided or individual determinants, such as perception of overall ease of use or intent to use the telemedicine service. Navigation problems were revealed when subjects found it challenging to move through the interface, when a navigational element did not function as expected, or simply when the subject had difficulty finding the information she or he was looking for. For instance, when interacting with the Teladoc website on a smartphone, one subject was trying to locate information about her symptoms (as described to her with the illness vignette), and when attempting to click on the “Cold & Flu” statement, she stated, “My symptom is like cold and flu so I am going to go to that…oh no you can’t click on it. Um…okay…” Another subject encountered the same usability problem when using the Teladoc website on a smartphone. This subject believed she may have an upper respiratory infection, “I’m going to click on ‘Upper respiratory infections.’ Oh, wait, oh they’re not clickable. So never mind.” Figure 23 shows the section of the Teladoc website on a smartphone that displays the health conditions Teladoc can prescribe treatments for and the text that subjects thought would direct them for additional information about their health condition.

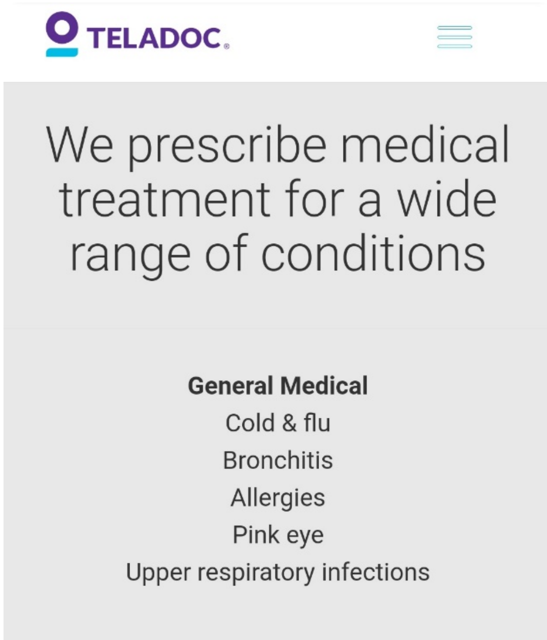


Figure 23: Teladoc Website on a Smartphone: Health Conditions Teladoc Can Treat (Not Clickable)

Similarly, subjects had trouble locating the content that provided information on what health conditions the telemedicine provider could treat on the KADAN Institute website. After several seconds of moving through the KADAN Institute website on a desktop computer, the subject remarked, “I’m still trying to find where I can see what is wrong with me.” A subject interacting with the Carie Health website on a desktop computer remarked having the same usability problem, “I'm not exactly sure how to find if my criteria meets the health conditions. I'll try the Frequently Asked Questions.”

One of the tasks that potential telemedicine users would use the telemedicine provider website for is to find out if their health condition met the criteria to use the service. By making it difficult to locate this pertinent information, telemedicine providers hinder usability and likely patient uptake and use of the service. If a patient is ill and cannot find whether the telemedicine service can successfully treat their health condition quickly in their time of need, they will retreat from the website quickly and not use it. Studies corroborate this finding that consumers quickly reject a health information website or eHealth tool if they cannot find what they are looking for or do not immediately see visual cues that they can trust the healthcare provider (Eysenbach, 2005; Sillence et al., 2004).

The second most frequently experienced usability problems were related to *Content*. To clarify, the main *Content* theme <u>does not</u> represent content in terms of the rhetoric and health information; the *Content* theme represents content in terms of the error messages provided, instructions, and spaciousness. I also coded content I identified as "missing" from the telemedicine communications, for instance, information regarding the cost or fee to use the service. The telemedicine provider interfaces on a desktop computer were discovered to have more content-related usability problems than the mobile interfaces. Most of these usability problems resulted from error messages being unclear, a lack of error messages to support the user in performing a task, or simply not abiding by the minimalist design convention recommended by usability experts (Instone, 1997; Karoulis & Pombortsis, 2004; Nielsen et al.; 1990). Participants were often unsure if they had successfully completed a task or expressed confusion. For all three telemedicine providers under investigation, the task of creating an account or entering personal information on a web-based form, such as name and contact information, is the first step to being able to perform a remote consultation with a physician. The following excerpts from subjects indicate a content-related usability problem coded under the *Understanding of error messages or no error messages* code. Often these usability problems arose when subjects attempted to create an account and enter personal information. “It says my health assessment is pending, but I'm not sure where to actually do the assessment,” stated one subject when trying to take the free health assessment offered by KADAN Institute on a smartphone.

After creating an account on the Carie Health website on a desktop computer, one subject selected, Yes, I Have A Provider, option which prompts the display of a dropdown menu for the user to select a state their provider is in. Upon selecting a state, no names appeared in the Provider Name list for the user to select his existing provider from, “I mean theoretically it's easy, I'm just, I don't know. I mean I feel like the provider I have is a fairly well-known provider, so I guess I'll just go to no provider then.” There was no error message to inform the user that there were no providers in his state or what he should do next to continue the task of creating an account. This subject encountered even more usability problems when working through the process of creating an account. For instance, when trying to Choose a Provider, the subject became confused, “Oh now it's just...cause it signed me a doctor, but it doesn't...do I have to find a doc...okay.” [Enters in search bar to locate a doctor and no results.] “That's confusing because it said that I should, it seemed like I should once I got assigned to a doctor I should be able to instantly.” The subject appeared lost and disoriented by the lack of response from the telemedicine provider interface. A message communicating to the user that there are no doctors in his geographic location and what to do next that appeared following the user’s interaction would have guided the user through the use of the system more efficiently. Figure 24 shows the Carie Health patient dashboard Find a doctor page.

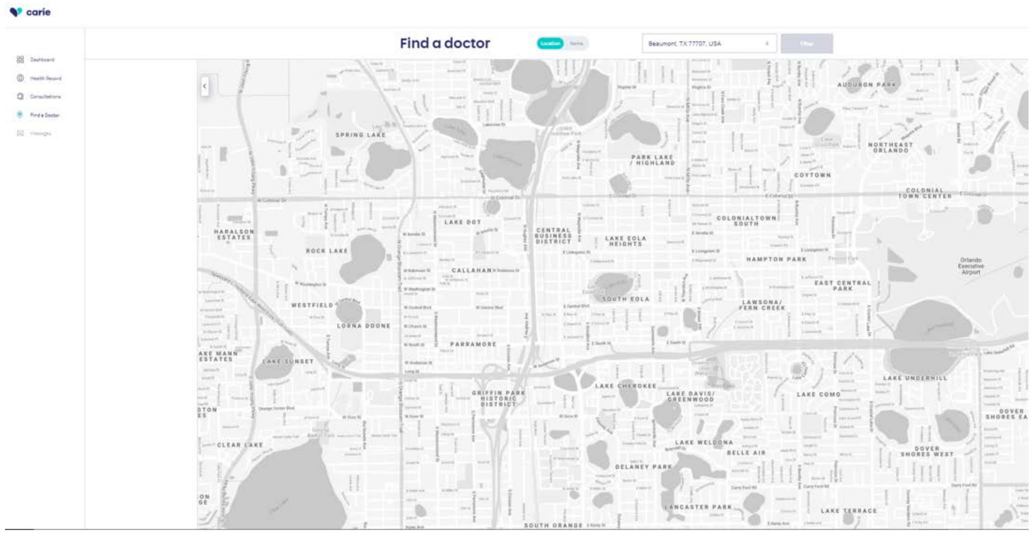


Figure 24: Carie Health Patient Dashboard: Find a Doctor Page

The finding that poor system response to users' interactions affects usability and contributes to patients' dissatisfaction with HIT (Crane, Garnett, Brown, West & Michie, 2017). Additionally, the understanding of instructions and error messages is a design heuristic first inspired by Nielsen et al. (1990) and has been applied an the evaluation of information technology in a number of clinical settings (Kushniruk, 2001; Kushniruk et al.,2008; Kushniruk et al., 2013; Kushniruk et al., 2004; Marco-Ruiz et al., 2017).

Usability problems classified in the *Display* and *Technical Issues* main categories were discovered when subjects used both types of telemedicine provider interfaces, the desktop computer interface and the mobile interface. Usability problems subjects encountered on the desktop computer seemed to correlate with the respective mobile interface except for the *Display*, *Interactivity*, and *Performance* classifications. No usability problems were identified that were associated with *Interactivity* or *Performance* problems when subjects interacted with the telemedicine provider websites on a desktop computer, and only three usability problems were detected that were classified as *Display* problems on the telemedicine provider desktop computer interfaces as oppose to seven on the mobile interfaces. Usability problems related to the display of the interface were revealed when subjects commented on disliking the overall aesthetics of the interface, had difficulty seeing certain elements of the interface because of small font, poor contrast, or poorly placed graphic, or if there was too much information on one page. For example, when one subject was using her smartphone and attempting to locate more information on the free health assessment offered by KADAN Institute, the subject said:

> “Free Health Assessment...? Umm, ok...It's hard to see cause the graphic right here, because the top right hand corner the background goes white and the text is white so the last section of it kind of fades into the background.” See Figure 25.

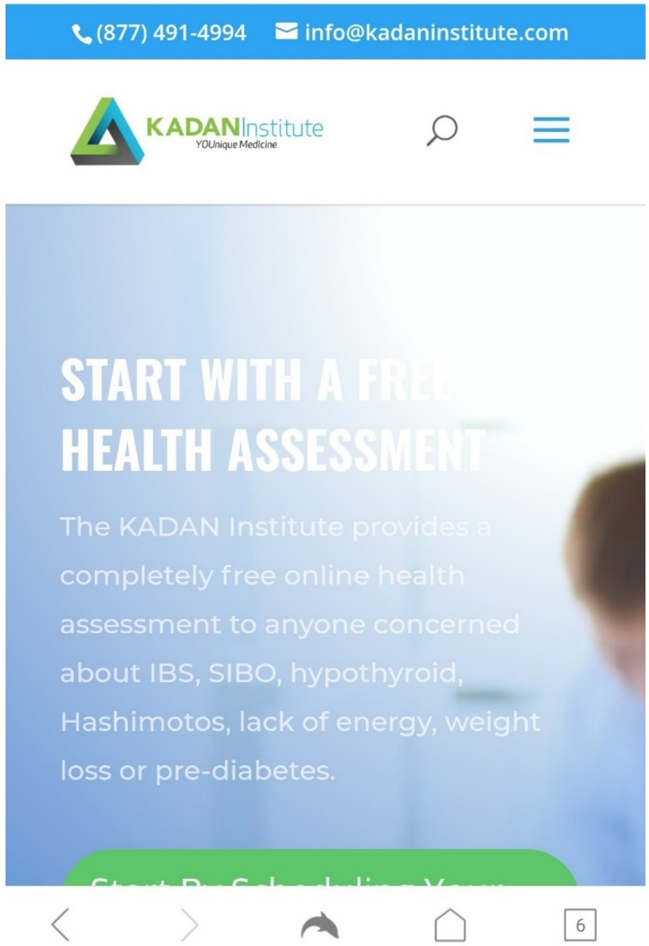


Figure 25: KADAN Institute Website Accessed on a Smartphone: Free Health Assessment Page

This statement was coded under multiple subcodes representing two main usability themes: *Color*, *Visibility of system elements*, and *Font* (all attributed to *Display*) and *Graphics* (attributed to *Interactivity*).

Another subject reacted quickly when first accessing the Teladoc website on his smartphone expressing his distaste for the display:

> "Wow, that if very unappealing, to be honest; on the website it was a lot better constructed; if I was sick, I would definitely not have the energy to look over all this.

Because on the website it's like four pages, and that's easy to get through, but on here it's probably like ten, so definitely would be way to exhausted to go through all that." (See Figure 26).

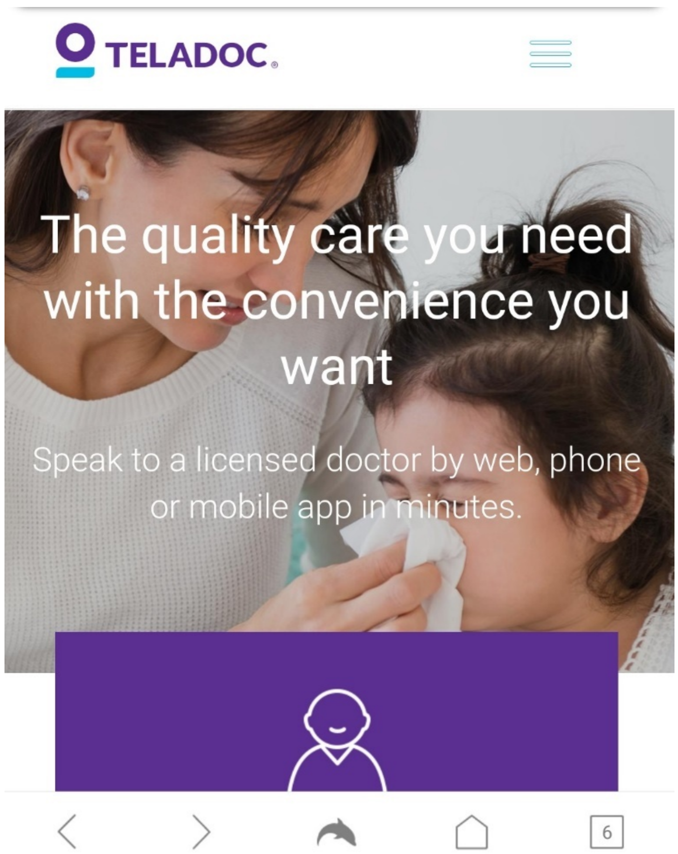


Figure 26: Teladoc Website Accessed on a Smartphone: Immediately Visible Homepage

A subject experienced a similar usability problem when trying to read the text on the Clients page on the KADAN Institute website when using her smartphone, "Uhh it's kinda hard to read but it says to start with a free health assessment to uncover the root of your symptoms." (See Figure 27).

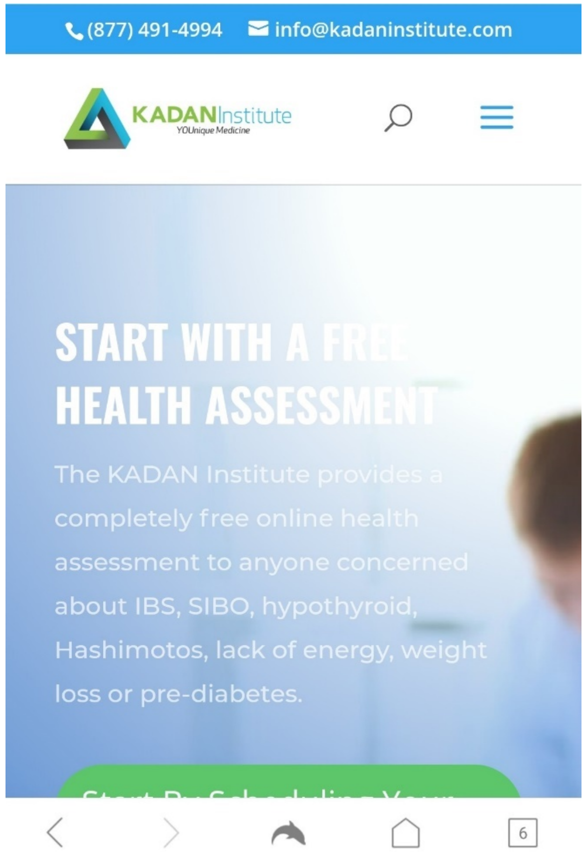


Figure 27: KADAN Institute Website Accessed on a Smartphone: Clients Page

The *Layout* (in the *Display* main usability category) of the Teladoc website on a desktop computer seemed to be problematic for one subject when trying to locate the types of health conditions that Teladoc could treat. This subject navigated from the Members page back to the homepage and was observed to scan and scroll for several seconds before stating, “Oh, I believe it is this down here that shows this information.” I inferred from his behavior and statement that the location of the information he was looking for was not in an appropriate area on the homepage. Figure 28 shows the section on the Teladoc homepage that communicates the types of health conditions Teladoc can treat.

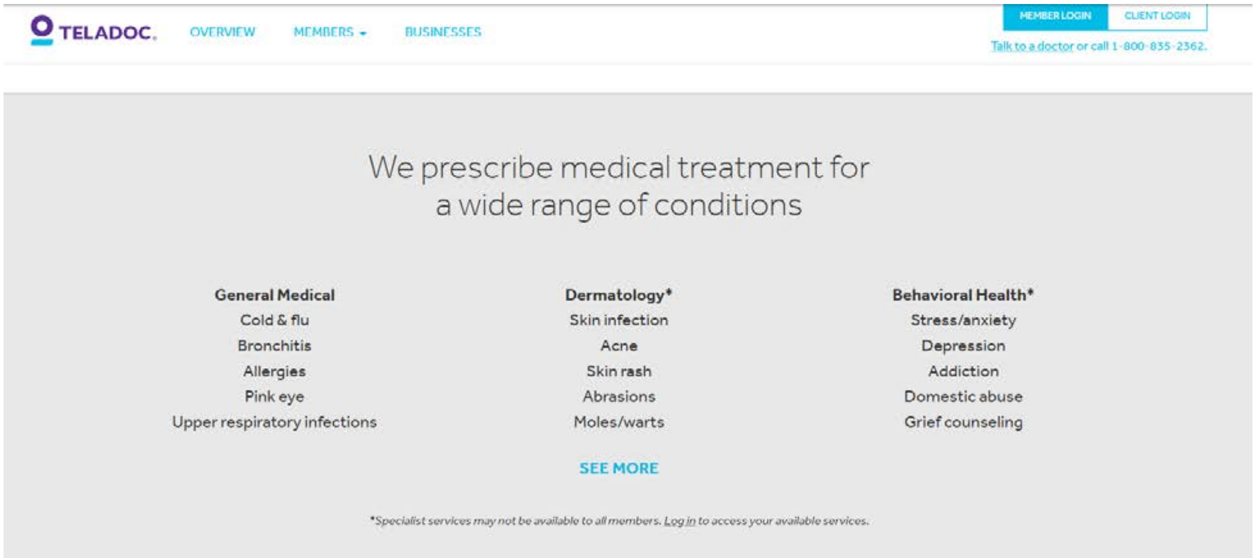


Figure 28: Teladoc Website Accessed on a Desktop Computer: Scrolling Down the Homepage Reveals the Health Conditions Teladoc Can Treat

According to design guidelines offered by the HHS and other scholars, displaying important information immediately and high on a website, above the fold, accentuates the content and is more likely to capture users' attention and motive them to use it than content that is further down on the page and that requires the user to scroll to locate (Monkman et al., 2013a; Horsky et al., 2016; Rizvi et al., 2017; U.S. HHS, n.d.).

These findings correlate with results from the remote usability tests. When asked to perform various tasks that a potential patient might perform using the Teladoc website, the single task that had the highest rate of failure, 22 percent, appeared to be an activity that would be critical to the successful performance of a virtual doctor visit. This question on the TWUS asked participants to describe what they had to do first in order to, "Talk to a doctor." I surmise that users may have been confused by the terminology the website used to communicate to users to, "Set Up Account," which, if clicked on, redirected users to an external webpage that had them enter personal information in order to, "Confirm Benefits," and, "Create Account" (Teladoc).

Using these statements alone does not make it clear to individuals, who are likely under stress or unfamiliar with telemedicine, that they need to create a member account prior to being able to see a doctor remotely.

Similarly, many of the suggestions to improve the usability of the Teladoc website the remote usability test participants provided regarded making pertinent information more clearly visible and easier to access. Examples of some of the suggestions from the remote usability test participants include:

> “Put the “range of conditions” list higher up on the page, or as part of the dropdown menus (I was most interested in this aspect).”
>
> “Have a section that is clearly labeled, and each section is clickable. Under each section (such as pharmacy, specialists, accessibility, etc.) it would clearly explain how to access those areas.”
>
> “I might put a list of the things that are on the long front page on the top as a navigation bar.”
>
> “Most of the information I'd want to find on the Overview page is instead on the Members page. This makes the Overview page too generic. Add an easy to see search box to search the contents of the website.”

Accessibility was another source of usability issues subjects faced when interacting with the telemedicine provider interfaces both on a desktop computer and smartphone. *Accessibility* was coded under the main *Technical Issues* usability theme and was often the result of users being unable to access or enter certain information pages because of being blocked by having to enter login credentials. Upon being blocked from accessing specific content, subjects often retreated from the page. An excerpt from one subject’s reaction when navigating to the Teladoc

Member Login page on a desktop computer is, “I’m just going to go back to the homepage since I don’t have an account, I can’t access that.” See Figure 29.

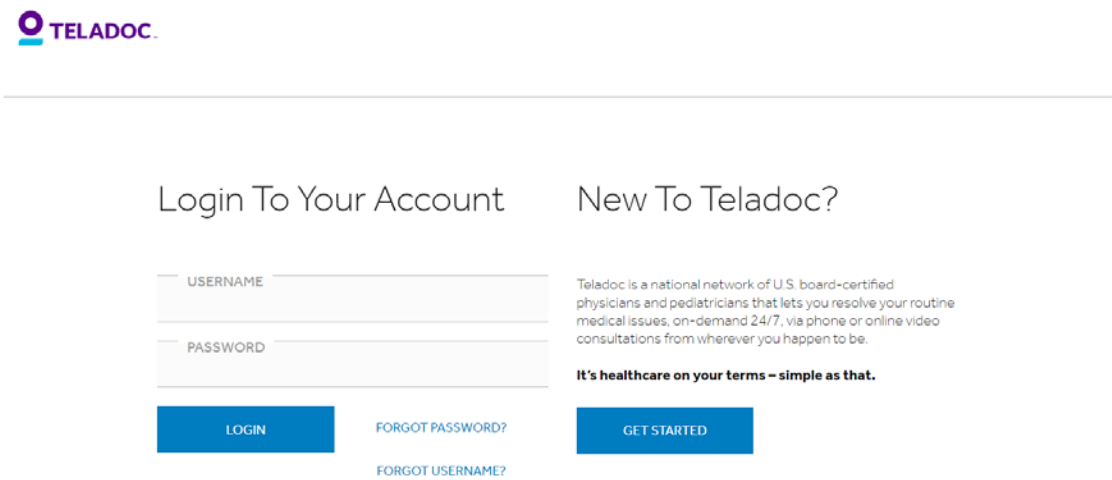


Figure 29: Teladoc Website Accessed on a Desktop Computer: Member Login Page

Similarly, when navigating to the KADAN Institute Health Assessment page on a desktop computer one subject remarked “I thought I could take the assessment without signing up for it.” See Figure 30.

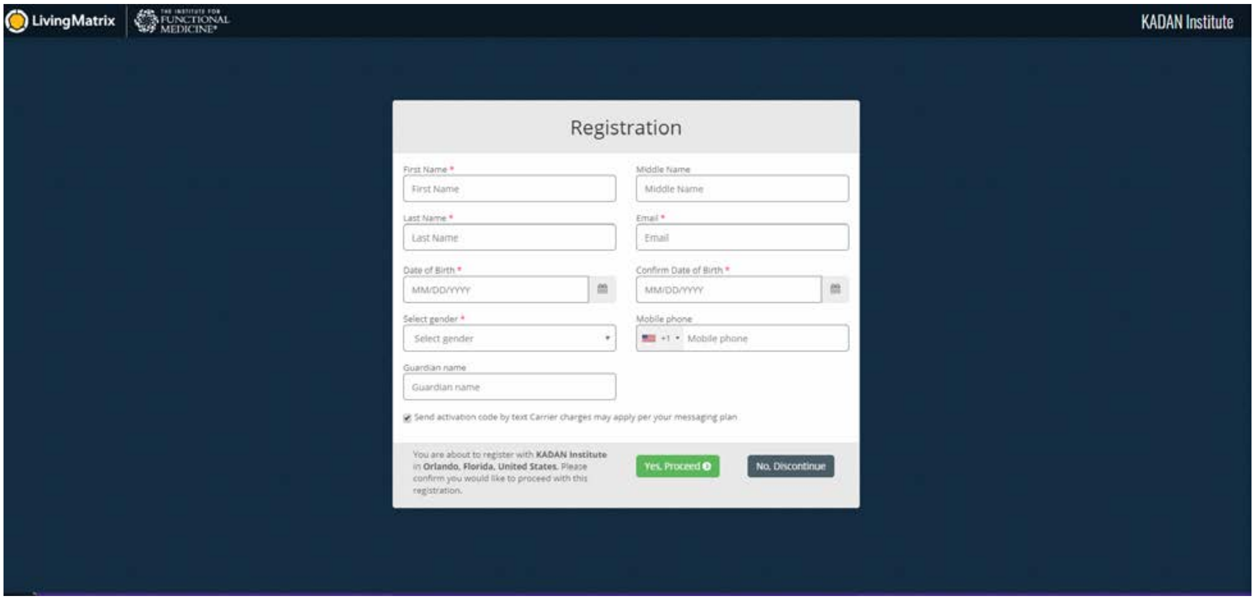


Figure 30: KADAN Institute Website Accessed on a Desktop Computer: Health Assessment Registration Page

Telemedicine providers may inhibit and certainly disenchant or frustrate potential patients when blocking them from accessing information that may motivate them or prompt them to use the telemedicine service.

Deconstructing the activity of becoming informed about the telemedicine service and how to perform a virtual doctor visit using the components of activity theory, the telemedicine provider interface is the *tool* component that users employ to help them achieve their goal. Combating usability problems during the performance of this activity can frustrate and obstruct users from achieving their objective, which impacts individuals' acceptance and adoption of telemedicine. Considering the large number of various usability problems identified in the telemedicine provider interfaces, I conclude that telemedicine provider interfaces are not designed to be effectively used by consumers or, at a minimum, would require several design modifications to improve the usability and support users in being able to perform the activities they need to when using the website in various contexts.

Research Question 4: How likely are potential telemedicine users to access and use a telemedicine service following their interaction with and engagement with the telemedicine providers' communications?

The fourth research question asks whether users would use the telemedicine service following their interaction with the telemedicine communication, it does not ask whether they are capable of using the telemedicine service – this is distinct from research question five because whether users are motivated and willing to use the telemedicine service is based on their subjective perception of the ease of use of the communication, their perception of the quality of the telemedicine service, and the urgency of their health situation or their need to use the service. Although many of the conditions that motive users to use a telemedicine service are individual and dynamic, such as one's need to use a telemedicine service, there are motivating qualities the telemedicine provider interface can express that may make users more likely to use the telemedicine service. To answer this research question, I reference previous literature suggesting that healthcare facilities can use a blend of information about their service with messages that appeal to consumers' needs and desires in order to motivate users to use the service (Tsai et al., 2012); for instance, patient testimonials that the healthcare service is of quality (Kayyali et al., 2017). In addition, the readability of health information has been demonstrated to affect patient activation to use the information to make decisions about their health (Bodie et al., 2008). If patients are able to read and comprehend health information, they are more likely to use it to make health decisions. The rhetoric and content that includes both motivational messages and information that attends to users' needs was analyzed in in part one of this study, the content analysis. Results from the content analysis indicate that telemedicine providers are providing the type of rhetorical content and motivational messages that are likely to motivate consumers to use the service. When exploring each telemedicine provider website, the Teladoc website provided 100% of the eight types of content being inspected for, the KADAN Institute website provided 75%, and the Carie Health had 87.5% of the content. For instance, all of the telemedicine providers included information on the benefits that their service offered to patients and provided reassurance to patients that the service was easy to use. This content is known to be effective at increasing users' willingness to use a healthcare intervention, such as telemedicine (Davis, 1989; McKnight et al., 2002). The Carie Health website did not include any patient testimonials, however, which also boost users' motivation to use a healthcare intervention (Kayyali et al., 2017).

The readability of the information that was displayed on each telemedicine website was found to be much higher than what a layperson is able to read and comprehend (Weiss, 2003; Wilson, 2009). Therefore, although the qualities that motivate users' positive perception of the service and that may cajole users to use the service are expressed on telemedicine provider websites, these qualities could better mediate the users' perception by lowering the readability.

In general, telemedicine providers do appear to be providing the type of rhetoric and content that will increase users' likelihood to use the telemedicine service following their interaction with the telemedicine communication; however, they could improve the users' interaction by making the information easier to read.

Additionally, to give credence to this assertion, I turn to results from the think aloud usability testing. One theme I analyzed and coded for during analysis of the think aloud usability tests was *Overall Ease of Use*. Users' positive or negative comments about the overall ease of use of the telemedicine provider interface they were interacting with was recorded in order to gain an understanding of users' subjective attitude when using the telemedicine provider communication to perform the tasks they would perform if experiencing an adverse health situation. A significant determinant of technology acceptance and willingness to use telemedicine is perceived ease of use (Davis, 1989). Positive comments were coded the subject commented on positively on the overall usability of the user interface or review of the video data indicated that the user was better able to navigate the interface and locate the information they were searching for. Overall, more subjects commented positively on the usability of the telemedicine provider interfaces, both when using the desktop computer and their smartphone. For instance, when interacting with the KADAN Institute on a desktop computer, one subject stated:

> "Lot's of links to what I assume is the same thing so booking a free call, 'Book your free call,' 'Book your free call,' 'Book your free call,' 'Book your free call,' six times...five times on the same page, so it is definitely easy to find if you were looking to call."

Similarly, when interacting with the Teladoc website on a desktop computer, one subject stated, "I'm going to click on the "See More" option. This is all the things it can treat, which I think that's good. Specialists. It has better information easily."

Lastly, several studies demonstrate that costs and convenience of the telemedicine service affect patients' decision to use the telemedicine service (Gardner et al., 2015; Powell et al., 2017). Participants suggestions for improvement of the usability of the Teladoc website corroborate these claims. With the exception of increasing the font size, displaying the costs to use the service was most frequently suggested as content that was desired by potential patients (10.3%). This was not analyzed for directly during the content analysis as it was considered under the *Reassurance* category; however, it appears that the cost to use the service needs to be expressed more clearly to users. This distinction is illustrated with comments such as:

> "I wish the cost was advertised. I didn't get a great feel for whether or not health insurance companies tend to cover this service. Provide a direct link to cost/payments and insurance coverage"
>
> "I did not see any info on pricing. I would like to know how much this costs before I consider signing up."

I can triangulate the frequency in which subjects commented about one telemedicine interface being easy to use or more useful in comparison to the other with results from the TIUQ. To recall, the TIUQ is a retrospective questionnaire subjects completed following their interaction with the telemedicine provider communications. The TIUQ was developed as a data collection instrument whose questions were adapted from previously validated and reliable tools (Brooke, 1989; Lewis, 1992; Parmanto et al., 2016), and is a method to gain an understanding of users' subjective perception of the usability of the telemedicine provider interfaces. Furthermore, a useful and valuable scoring method was used to measure each telemedicine provider interface's overall usability from the perception of the user and compare between conditions and interface types. To recall, the TIUQ scores are able to be interpreted as letter grades that rank users' satisfaction with their overall experience when using each telemedicine provider interface and was also translated into a psychometric adjective so researchers and practitioners can easily grasp which telemedicine provider interface has been judged to have the best usability by users (Bangor et al., 2009; Lewis et al., 2018; Sauro 2011; Sauro, 2019). Figure 31 is a comparison chart of the frequency in which a positive ease of use was captured from subjects' verbal reports during the think aloud usability tests with the letter grade and adjective rating of subjects' overall perception of usability of each telemedicine provider interface.

	Desktop Computer			Smartphone		
	Teladoc	KADAN Institute	Carie Health	Teladoc	KADAN Institute	Carie Health
Frequency of Subjects' Positive Comments about Ease of Use	3	2	2	1	3	2
TIUQ Letter Grade and Adjective Rating of Subjects' Overall Impression of Usability	A = Excellent	B = Good	D = Poor	B = Good	B = Good	D = Poor

Figure 31: Comparison Chart of Subjects' Overall Impression of Usability of the Telemedicine Provider Websites When Accessed from a Desktop Computer and Smartphone: Values Interpreted Based on Industry Benchmarks (Letter Grade and Adjective Rating)

One can see that there does not appear to be a significant correlation between the number of comments subjects had regarding a telemedicine provider interface being easy to use during their interaction with it and their overall impression of usability following their interaction. Although I cannot draw any conclusions from comparing these metrics, one might expect that the more positive comments about ease of use a telemedicine provider interface receives the more likely that telemedicine interface is to receive a high usability rating or offer the subject a positive user experience. One reason the expectation that the more positive comments subjects had during their interaction with a telemedicine provider interface would directly relate to the telemedicine provider interface being rated as having a high usability was not demonstrated by the results is because of individual differences. Some subjects may have simply been more expressive and verbalized their positive thoughts about their experience during their interaction while other subjects may have had a positive experience, but were not as vocal about their experience. Nevertheless, both of these two different subjects could have given the telemedicine provider interface an “A” or “B” in terms of their user experience.

Perceived ease of use is dependent upon a mixture of visual aesthetics, rhetoric, and usability (Kinzie et al., 2002 Sillence et al., 2007; van Gemert-Pijnen et al., 2011), and considering that the telemedicine providers under evaluation in this study appear to be emanating most of these qualities, I surmise that consumers are likely to use the telemedicine service if they have a need. However, they could improve users’ perception by lowering the readability of the information and clearly expressing the cost to use the service.

Research Question 5: Are potential telemedicine users able to perform a telemedicine consultation following their interaction with the telemedicine provider communication or interface? Which telemedicine provider communication is most effective at mediating users’ activities to reach the goal of performing a telemedicine consultation?

This research question regards the overall usability of the telemedicine provider interfaces, as well as inquires about which telemedicine provider interface is the most effective tool or mediator enabling users to perform a virtual doctor visit successfully. Usability is a combination of technology effectiveness, efficiency, and user satisfaction (ISO, 2018; Yen & Bakken, 2012). Measuring usability according to these qualities requires a holistic understanding of users’ interaction with the telemedicine provider interfaces, which my mixed-methods research offers me. To answer this research question, I refer to all three parts of this mixeds-methods study, the content analysis, the remote usability testing, and the think aloud usability testing results because each provides specific insight into the how the telemedicine interfaces are supporting users' activities and ability to achieve their goal of performing a virtual doctor visit. Activity theory states that users or subjects shape how they use a tool to achieve a specific goal, yet the qualities of the object or tool being used influence a subject's ability to use the tool successfully (Vygotsky, 1978; Nardi, 1996). Thus, mediating objects can enhance usability or diminish usability. In addition, the performance of an activity is determined by specific conditions (Igira et al., 2009; Kaptelinin et al., 2009; Vrazalic, 2003b).

Using activity theory as a guide, I consider the formula for the optimal usability of telemedicine provider communications to be: the correct context of use or user experiencing a health condition (context), which sends them seeking a remote physician consultation (motive), the existence of traditional rhetoric and information provisioned by the telemedicine provider communication (textual and visual information), a digital rhetoric that includes design elements that support users' tasks and activities (easy navigation, buttons, clickable links, etc.), and finally the user's subjective perception of usability (user satisfaction).

Results from the content analysis indicate that telemedicine provider communications are conveying the type of rhetoric and information that potential patients require in order to perform a virtual physician visit. The telemedicine provider communications, similar to other health information provisioned online, do not appear to be written in an appropriate readability grade level as recommended (Berland et al., 2001; Raj et al., 2016; Weiss, 2003; Wilson, 2009). However, I argue that, overall, telemedicine providers are providing the type of rhetoric, such as patient testimonials, and information, like what the service is and how to use it, that support usability.

That said, historically, patient education and healthcare promotional materials were provisioned using leaflets, pamphlets, and brochures. Rhetorical strategies used in these print materials include textual and visuals. However, because many of these printed materials have been remediated to online messages and mobile applications, accessed digitally, such as the telemedicine provider websites in this study, it appears the translation of usability factors for the digital environment has not been successfully. I argue there is a “digital rhetoric” that telemedicine providers are unaware of that needs to be included in their online communications in order to increase usability, as well as users’ motivation to use telemedicine.

There is a digital rhetoric that is intrinsic in the digital world and as patient educational materials and marketing campaign messages have been remediated to the digital world, the rhetoric must also be remediated. Digital rhetoric has been pluralistically described to be applying rhetorical theory in the production of digital texts (Eyman, 2015). Granted, Eyman’s definition of digital rhetoric is liberal and draws from many fields from classic Aristotelian rhetorical theory to visual rhetoric, to contemporary fields, such as computer science and game design. However, I expand the definition and application of digital rhetoric by offering a more practical approach. Digital rhetoric includes using more than just traditional textual messages; it is the heathy combination of design elements, such as buttons and labels that accurately represent the action they enable, consistency in the webpage “look and feel,” and responsive design, as well as marketing strategies, such as displaying pleasant, positive images and using layperson terminology that mediate one's interaction and successful use of the telemedicine communications now delivered through digital mediums. Because the context of use an individual is going to use to access a telemedicine communication varies, designers must account for not only the communication level, but also the contextual level, and users’ conceptual model of how they interact with the interface to facilitate their activities.

To provide insight into how individuals interacted with the telemedicine provider communications and understand their cognitive processes during their interaction, I look to the results from the think aloud usability testing. Usability problems were discovered as subjects interacted with each telemedicine provider interface and "talked aloud" their thought process during their interaction so that I could gain an understanding of why the were performing the types of tasks they performed during their interaction. Subjects were stimulated to perform certain tasks based on a simulated health scenario so the way in which subjects used the telemedicine interface could be observed and usability problems identified (Luger et al., 2014; Kushniruk et al., 2004; Peute 2015a). From the number of usability problems identified, I can infer which telemedicine provider interface had inadequate usability or offered the worst user experience out of the three telemedicine providers under evaluation in this study. Figure 32 illustrates the number of usability problems identified for each telemedicine provider interface.

	Telemedicine Provider		
Total Number of Usability Problems Identified	**Teladoc**	**KADAN Institute**	**Carie Health**
Desktop Computer	13	23	21
Smartphone	21	19	13

Figure 32: Number of Usability Problems Identified During the Think Aloud Usability Testing Illustrating Which Telemedicine Provider Interface Can Be Inferred to Have the Worst Usability

All of the telemedicine providers in this study: Teladoc, KADAN Institute, and Carie Health, were discovered to have several usability issues. However, given that the Teladoc website had the least amount of usability problems associated with subjects' interactions on a desktop computer, I consider Teladoc to be providing the most usable communications to users through their website. Yet, the Teladoc website does not appear be mobile-responsive because when subjects interacted with the Teladoc website on their smartphone, they encountered several more usability problems than the desktop computer interface. The similar telemedicine provider, but much younger, Carie Health, had the most usability problems associated with the subjects' interactions on the website on a desktop computer, but appeared to have the best mobile-responsive website. Although the same number of usability problems were detected when subjects interacted with the Carie Health website on their smartphone as with the Teladoc website on the desktop computer, one reason for this finding is that subjects tended to not progress through the same tasks they did when using the Carie Health website on a desktop computer, such as setting up an account, which had them enter personal information. Thus, they did not have the opportunity to confront usability problems that they would have because their activity was simply not as complex or meaningful. This observation may suggest that the Carie Health website is easier to use when having to enter information and/or subjects were fatigued from their interaction and lacked the motive to continue engaging with the Carie Health website on their smartphone.

Teladoc is the oldest and most well-known telemedicine provider in this study's sample, and I anticipated that Teladoc would offer the best user experience, with optimal usability, out of the three conditions. I did not expect to discover that Teladoc had so many usability problems associated with the mobile interface because one can assume that a large healthcare organization has sufficient resources to put into designing a high-quality, usable website.

The KADAN Institute website appeared to have the worst usability having the most cumulative usability problems (42, 38.2%); however, the KADAN Institute website on a smartphone appeared to have slightly better usability that the Teladoc website on a smartphone.

An explanation for this is subjects differed in their subjective impression of the aesthetical appearance of the websites and information search strategies as they are individual variables that affect usability (Klouche et al., 2015; Pang et al., 2016; Sun et al., 2019). For instance, one subject commented that he did not like the appearance of the Teladoc website on the smartphone. One task a user may perform when interacting with a telemedicine provider communication is locating the types of health conditions the telemedicine provider can treat so they know whether the symptoms they are experiencing qualify them to use the telemedicine service. When subjects' interacted with the KADAN Institute, they indicated they were searching for specific keywords, such as, "symptoms," "treatment," or, "patients." Users appear to look for keywords to help them find what they are looking for (Pang et al., 2016). The KADAN Institute website did not use these types of terms, but rather referred to, "functional medicine," "focusing on root cause discovery," and, "clients," which did not appear to be interpreted by subjects in a meaningful way. Misunderstanding of terminology and simply having too much information on one page were amongst the most frequently encountered usability problems with the KADAN Institute website. Too much information can be deleterious to a user's ability to process the information, creating cognitive overload (Damman, et al., 2009; Hibbard, et al., 1997; Slovic, 1982).

Results from the remote usability testing corroborate the finding that the Teladoc website does have, at least, a sufficient level of usability enabling users to perform the activity of becoming informed about the telemedicine service and how to perform a virtual doctor visit with a 95 percent task success computation rate. It should be noted that the remote usability testing performed was only measuring task completion success or failure, it was not measuring the time it took the participants to perform the tasks, which is a sign of efficiency, and an aspect of usability. Usability is a complex, dynamic phenomena that is influenced by multiple components, and must be evaluated in terms of all of these elements (Bakken et al., 2006; Farrahi, Rangraz Jeddi, Nabovati, Jabali & Khajouei, 2019).

Lastly, to understand the third component of usability and complete the holistic understanding of users' activity of using the telemedicine provider communications, I refer to the retrospective TIUQ subjects completed following their participation in the think aloud usability tests. As mentioned previously, a critical determinant of usability is users' overall satisfaction with their experience, and this quality was able to be measured with the TIUQ that I developed to from standardized scales (Brooke, 1989; Lewis, 1992; Parmanto et al., 2016). The TIUQ results provide me with an impression of the overall usability of each telemedicine interface from the user-perspective and offers a useful and practical scoring method that can be interpreted as letter grades and adjective ratings. Therefore, the TIUQ offers a quick, at-a-glance, impression of usability and user satisfaction.

The TIUQ captures users' subjective perception of the usability of the telemedicine provider interfaces and is able to be interpreted as letter grades that rank users' satisfaction with their overall experience when using each telemedicine provider interface and translates this experience into an adjective (Bangor et al., 2009; Lewis et al., 2018; Sauro 2011; Sauro, 2019). Figure 33 is a comparison chart of subjects' average rating of usability of each telemedicine provider interface.

	Telemedicine Provider		
TIUQ Average Score	**Teladoc**	**KADAN Institute**	**Carie Health**
Desktop Computer	A = Excellent	B = Good	D = Poor
Smartphone	B = Good	B = Good	D = Poor

Figure 33: Comparison Chart of Subjects' Overall Impression of Usability of the Telemedicine Provider Websites When Accessed from a Desktop Computer and Smartphone: Values Interpreted Based on Industry Benchmarks (Letter Grade and Adjective Rating)

Both the Teladoc website and KADAN Institute website were perceived to have an above average usability rating by users, both the desktop computer and mobile versions. The Carie Health website was ranked as having a below average usability, both the desktop computer and mobile version. The Teladoc website appeared to provide the overall best user experience given that it had the least amount of usability problems associated with it and was rated to have a high level of usability by subjects.

Summary of Usability of the Telemedicine Provider Interfaces

Acceptance and use of telemedicine requires one to study utilization, or users' interactions in their context of use, as well as users' perceptions of ease of use and usefulness of the telemedicine provider communication in supporting this activity. The telemedicine provider communication is a tool, in which users employ in order to learn more about the telemedicine service and be able to perform a virtual doctor visit. Telemedicine provider communications that are provisioned online must contain both the traditional rhetoric and digital rhetoric in order to motivate users to use the tool to support their activity. Combined, these factors constitute the necessary conditions for the activity of gaining knowledge and the ability to perform a virtual doctor visit, which in turn, is a prerequisite to achieve the final outcome of the activity system, which is to actually perform the virtual doctor visit and achieve a positive health outcome.

Given that the Teladoc website included the rhetorical content and information that users would need to be able to use the service successfully, had the least number of usability problems associated with it, and received a high appraisal of usability from the subjective perception of users, I believe that the Teladoc communication is the most effective at mediating users' activity. I also suggest that users are more likely to first access a telemedicine provider on their smartphone, considering that smartphone ownership is increasing (Taylor et al., 2019), and mobile interface theory would suggest using a smartphone is intrinsically embedded in our everyday experience and easier for users to employ. That said, given that telemedicine providers do not appear to being using responsive-design, I anticipate that users may quickly retreat from using the telemedicine website on their smartphone, which may result in the user not using the telemedicine service.

Study Limitations and Rationale

Next, I describe some of the limitations of the methods used, study design, and instruments used in this mixed-methods research and rational for my selections. The aim of this study was to examine the rhetoric in and design of telemedicine provider websites in various contexts to gain insight on its affects on usability. A rigorous and principled approach was used in order for the study to have a high degree of reliability, validity, and fidelity; however, no study is without limitations.

Use of Amazon Mechanical Turk

Using Amazon Mechanical Turk to perform qualitative research has been interrogated (Newman, 2019; Samuel, 2018); however, it offers a useful and quick way of recruiting subjects to participate in HCI studies. Given that telemedicine is available for use by a heterogenous population consisting of a broad audience of consumers and target groups for telemedicine services, it is important that the selection of participants be representative of this target end-user group. Therefore, I choose to use Amazon Mechanical Turk in one part of my study because it afforded me the ability to configure the subject pool from which I recruited participants based on specific demographics (Amazon Mechanical Turk, n.d.; Paolacci et al., 2010). Also, Amazon Mechanical Turk allows for researchers to recruit participants based on the quality of work they have performed in the past (Amazon Mechanical Turk, n.d.; Paolacci et al., 2010). Amazon Mechanical Turk has been used in many other studies because of the rich availability of subjects that more closely resemble the heterogenous population like that of the U.S. (Paolacci et al., 2010), therefore making results more generalizable to this target population (Paolacci et al., 2010). Moreover, Amazon Mechanical Turk workers have been demonstrated to perform online behaviors consistently, meaning that when asked to perform certain tasks, their interactions match their actual real-life behaviors despite being exposed to an artificial situation (Summerville & Chartier, 2013). Therefore, by recruiting participants who were Amazon Mechanical Turk Masters and rewarding them with $15 for their participation, I was able to perform usability testing with a large, heterogeneous audience and ensure results were reliable.

One limitation I discovered only the remote usability testing was completed is that I failed to specify the interface type that participants used when completing the survey. I assumed that participants would perform the tasks and activities that the survey asked them with the Teladoc website using a desktop computer; however, I should have specified that in order to participate in the study, one must perform the study using a desktop computer in the summary of research that participants agreed to prior to completing the survey.

Because Amazon Mechanical Turk workers were only required to have internet access in order to participate in the study, participants were able to perform the usability test on either the Teladoc website on a desktop computer or on a mobile device, such as their smartphone. Furthermore, it was not required for participants to disclose which internet browser or mobile app was used to access the Teladoc website. Therefore, it is unknown what interface type the remote usability testing was performed on; however, this is similar to a real-world situation, whereby individuals generally access the internet from the device they have available and are most comfortable with using and underscores the need for telemedicine communications to be designed to be accessed and used on multiple devices. An essential ingredient to usable health information is designing it to be responsive to the various mobile devices that users may access it from and are relevant to the usability of telemedicine communications, as well as the actual telemedicine platforms that users access to be able to perform a virtual physician visit.

Survey as an Instrument to Test Usability

Another limitation of the remote usability testing is the use of a survey because it does not afford insight into the cognitive processes of users and subjects may not interpret questions accurately to respond appropriately (Aiyegbusi, 2020; Langbecker et al., 2017). However, survey methodology is one of the most frequent methods used to collect end-user feedback (Cheng & Mustafa, 2014; Creswell, 2002; McKay et al., 2018; Yen et al., 2012) and commonly used in telemedicine research to assess usability and patient satisfaction across a number of constructs (Langbecker, Caffery, Gillespie & Smith, 2017; Whitten, Johannessen & Soerensen, 2007b). For instance, the Telemedicine Satisfaction Questionnaire (TSQ) (Yip, Chang & Chan, 2003) and the Telemedicine Satisfaction and Usefulness Questionnaire (TSUQ) (Bakken et al., 2006) measure constructs such as patients' perception of the technical quality of the equipment used during the telemedicine consultation, patients' perception of the quality of the healthcare provided, efficiency of telemedicine, and overall patient satisfaction with their experience. The Telehealth Satisfaction Scale (TSS) is a 10-item scale that similarly measures patients' perception of the quality of a telemedicine consultation using videoconferencing and patient satisfaction (Morgan et al., 2014). The TSQ, TSUQ, and TSS are all composed of different scales and measurements, which makes it difficult to compare results of studies that use each of these different instruments. Also, surveys are generally not able to explore the user experience in-depth (Yen et al., 2012). However, the TSQ, TSUQ, and TSS have all been validated to have both internal consistency and construct validity enabling comparison and replication of results when applied in similar study contexts (Langbecker et al., 2017).

Despite these limitations, surveys are able to be rapidly deployed to a large sample population and able to be generalized to target populations (Langbecker et al., 2017). Also, surveys are shown to be a reliable and valid tool to the extent that they measure the conditions and constructs that they were developed to measure and individuals do appear to accurately complete them (Bryant et al., 2008). Surveys can produce useful results when paired with other usability inspection methods, such as the think aloud usability tests performed in this mixed-methods study (Johnson et al., 2005; Kushniruk et al., 1996; Kushniruk et al., 1997).

Think Aloud Usability Tests

Think aloud usability testing was selected as the most valuable usability inspection method because it involves a close observation of the target-end user, is used to gain qualitative data, and aims to identify major or severe usability problems that have the potential to impede, deter, or result in unsafe use of the system (Aiyegbusi, 2020; Li et al., 2012; Middleton et al., 2013). Because the aim of my study was to examine the rhetoric in and design of telemedicine provider websites in various contexts to gain insight on its affects on usability. Essentially, I wanted to find out "what" content is in telemedicine communications and "how" and "why" are users using it to perform an activity successfully. The content analysis part afforded me the "what," and the remote usability testing allowed me to understand whether users were successful. The think aloud usability testing focused more on the “how” and “why” insight that I wanted to gain and its relationship with the usability of telemedicine communications.

Since the 1990s, theories and usability methods borrowed from cognitive science, psychology, and usability engineering are beginning to be applied in the iterative design of HIT in order to design and implement more effective health information and technology (Kushniruk et al., 2004; Kushniruk et al., 2008). Also called, cognitive task analysis, think aloud usability tests provide knowledge of how the end-user interacts with technology and allows for the identification and characterization of user problems (Kushniruk et al., 2008).

In addition to aiming to improve the design of user interfaces by employing usability testing of HIS, several scholars have focused on refining a systematic usability testing framework and have developed principled qualitative analysis techniques in order to better evaluate the cognitive issues surrounding the design and implementation of HIS (Borycki et al., 2005; Kushniruk & Patel, 1995; Kushniruk et al., 2004; Kushniruk et al., 2005; Zhang, Johnson, Patel, Paige & Kubose, 2003). Kushniruk et al. (2004a) describe the think aloud to be the foremost usability test because it involves evaluating users who are representative of the target population of a technology and it has them perform representative tasks using the information technology, which are those simulating how an individual would interact with and use the technology in a natural setting. This is presumed to be because during heuristic evaluations, experts who already have experience with the technology under evaluation will not encounter usability problems that a novice user would in the real-world (Jeffries et al., 1991). During a heuristic evaluation, experts only evaluating the usability according to the guidelines provided by the primary investigator, and again, may not encounter usability problems that a novice user might encounter during a real-world interaction (Jeffries et al., 1991). It is suggested that experts only observe user interface features and do not attend to how the system functions when performing tasks. Contrarily, end-users of the system become visibly absorbed in using the system to perform specific activities and tasks, and this is one of the reasons why heuristic evaluators fail to identify many usability problems that end-users find during think aloud usability tests that could possibility prevent them from using the system (Doubleday, Ryan, Springett & Sutcliffe, 1997). Therefore, the think aloud usability testing afforded me the insight I wanted to gain to answer my research questions.

Use of Undergraduates as Representative Users

Despite concerns that college students may not be a representative population of users for which to conduct this study with, adults in this age group have been demonstrated to have suboptimal or poor health literacy skills (Escoffery et al., 2005; Hollman, 2011; Robb et al, 2014). Digital natives are individuals who have been raised in a high-technology society and who are assumed to be proficient users of these technologies, such as the internet and the myriad of available mobile devices (Moran, 2016a). Concordantly, studies show that college students predominantly use the internet and mobile to source health information (Heuberger & Ivanitskaya, 2011). Moreover, despite being digital natives, college students are unable to recognize their poor ability to seek, locate, appraise, and use online health information (Hanik & Stellefson, 2011; Ivanitskaya et al., 2010). Given that telemedicine is targeted to be delivered to a heterogenous population, many whom have insufficient or low health literacy, it is essential that telemedicine communications be designed for usability on various devices, for a lay audience (Monkman et al., 2013b; Monkman et al., 2015a; Norman et al., 2006). The goal of the think aloud usability tests in this study were to identify features and elements of the telemedicine interfaces that are problematic to a target user's ability to use the communications effectively and successfully perform a virtual doctor visit (Kaplan, 2003), an audience that is demonstrated to have less than adequate health literacy is one of these target lay audiences (Alpay et al., 2009; Bagchi et al., 2018). Therefore, undergraduate students are ideal candidates to represent one target audience of telemedicine and are an optimal sample group for which to conduct this research. Furthermore, the results of the think aloud usability tests may be generalized for a lay audience because most individuals appear to have low health literacy and research shows it does influence their ability to make knowledgeable healthcare decisions (Diviani, van den Putte, Giani, & van Weert, 2015; Tao, LeRouge, Smith & De Leo, 2017; Sun et al., 2019).

Dynamic eHealth

During the course of executing the methods used in this study and writing this dissertation, I discovered that all three telemedicine providers changed their websites. The Teladoc website appeared to publish a completely redesigned website on October 24, 2019 (A. S. Alday, personal communication, January 7, 2020), and the KADAN Institute website and Carie Health website changed unexpectedly after January 2020, and I have been unable to find out the exact date. Some screen shots of the Teladoc website used in this dissertation had to be captured from the Internet Archive (http://web.archive.org/), which allows one to interact with historical snapshots of websites. This is one limitation of the study, but also expresses the dynamic ability of online health information or eHealth, to be changed, updated, and redesigned. This benefits healthcare providers because they can quickly modify their online health information and applications based on the conditions of society, user needs, and to improve usability. This is evidence to support that telemedicine providers have the ability and responsibility to perform iterative design changes to improve their communications in ways that increase consumer awareness of, acceptance of, and adoption of telemedicine.

CHAPTER SEVEN - CONCLUSION

In the last chapter, I discussed the results of the mixed-methods usability research on telemedicine provider communications through the lens of activity theory and mobile interface theory, as well as some of the study limitations. This chapter ends my dissertation with a brief discussion of two key takeaways for practitioners and researchers based on the insight I gained from the content analysis and usability testing of telemedicine provider communications I performed in this study. I first provide a list of important rhetoric and design attributes that health information providers and designers can apply in the design and development of HIT. Based on evidence from my mixed-methods research and literature that substantiate my findings, I was able to develop a short list of critical rhetoric and design practices for the healthcare community. Additionally, these design guidelines are applicable to other information technology or systems. Next, I discuss the implications for practitioners and researchers in the health and medical field and future research. I end my dissertation with a brief discussion of my study's key contributions.

Key Rhetorical Strategies and Design Guidelines for HIT

This section can be used as a practical design guide for the design and development of HIT and other information technology. The design recommendations can also be used as quick heuristics for designers to ensure the HIT they have designed and developed offers the best usability for the target audience. These are not provided in a ranked order of importance; all are essential to the design and delivery of usable HIT.

Health Information Technology Design Guidelines

1. **Navigation -** Use clear terms and make evident the information located under those main tabs so users do not have to do a lot of jumping from page to page just to see what information is located on those pages, such as have hover-over dropdown menus showing subheadings.
2. **Terminology and Language -** Use terminology laypeople users understand in text and as labels and buttons to represent actions they can perform such as create a patient account to see a doctor not member account or client they are patients or "new to our practice." Use clear, plain, and simple language and keep readability to at or under 6th grade reading level.
3. **Salient information first -** Salient and important immediately visible and clear above the fold. Also, important information should be located in several areas through website and on homepage because different users may perform activities and information search behaviors vary with user.
4. **Tell users what to do clearly -** Tell users what they have to do in clear simple statements and have brief messages throughout the actions they perform letting them know they are performing correctly and or how to recover from errors and what to do next. Always have the logo redirect back to the homepage, and I recommend having a Home main navigation tab always available as well. Let users know where they are in the system or in the progression of an activity, such as have a breadcrumb trail pathway and make easy to recover from errors if they get lost.
5. **Consistency and congruency -** Make sure all website pages are use the same theme and appear to be a part of the same website. For instance, when creating a patient account, the

look and feel (format, color, and display) of the page should match the homepage and main website.

6. **Multimedia -** Use a variety of multimedia like images and videos that act as quick informatives and alternative means of communication.
7. **Include motivational messages -** Include motivational and socially attenuating messages to motivate patients and express the quality of healthcare. For instance, testimonials and quick facts about ease of use, doctors' credentials, number of patients treated and successfully helped.
8. **Make contact information always visible -** Make contact information always visible and use large font, like display the phone number on a sticky header and in the footer. Or, have a left or right sidebar with the contact information always displayed.
9. **Add innovative communication methods -** Consider adding innovative methods of communicating, like a chat box or ability to SMS text message a customer support representative to help guide through activity or for questions.
10. **Use pleasantly appealing aesthetics -** Make the communication aesthetically pleasing by using a pleasant color scheme, font, and type, but make large font so easy to read.
11. **Reduce complexity -** Do not put too much information on one page or in any one passage.
12. **Make clear telemedicine is optional and not for emergencies -** Make clear the types of health conditions telemedicine is a suitable and safe alternative healthcare intervention for and that if you [the user] are experiencing an emergency medical situation, call 911 or visit the nearest emergency department and that it is not a replacement for traditional face to face healthcare with one's primary physician.

13. **Make responsive to multiple devices -** Make sure to use a mobile-responsive design and test on multiple devices, such as tablets, and iPads because they all have different screen dimensions that may alter how the interface appears and is used by users.

User-centered Design and Interdisciplinary, Collaborative Research

The key insight I gained from this research is that every user is different and with a heterogenous audience practitioners may find it challenging to attend to all the information needs of each target audience or each individual user, but this is the importance of user-centered design and including usability testing during the design and development phases of a full system lifecycle. This includes working with real end-users, including all stakeholders involved in the activity, such as clinicians, nurses, patients, caregivers, administrators, and even financial advisors to know the availability of funds. Many stakeholders are involved in the delivery and receiving of healthcare and all provide unique insight, from their perspective, that may improve usability.

Lastly, there is a need for interdisciplinary research and collaboration between academics and practitioners so that each can inform on the best methods to use to design, develop, and test HIT for various target audiences and in different contexts to ensure it will be easily assimilated into a clinical workflow or practice, be applicable to and efficacious in patients' various contexts of use, and never compromise patient safety. Furthermore, if telemedicine and other HIT is to reach is potential and be successfully used to increase the access to and quality of healthcare there needs to be a collaboration between practitioners, researchers, and the use of interdisciplinary methods to be able to continuously evolve and hone the methods used to articulate on the human factors involved in the usability of HIT.

Key Contributions of Research

Lastly, I will discuss the key contributions of my research. I contributed to both theory and practice. I contributed to theory through my use of activity theory as a lens in which to view my discovery of telemedicine provider communications. In addition, I further developed and evolved the application of mobile interface theory as it has been underrepresented in the literature. I contributed to the health and medical field by performing usability evaluations of telemedicine provider communications which provides insight into its impact on the acceptance and adoption of telemedicine that may be attributed to the usability of the communications. The mixed-methods I used in this study contribute to the further development of rigorous and principled qualitative research on usability because it can be replicated and applied to other HIT in the health and medical field, as well as in other disciplines that regard HCI. Additionally, I have developed novel codebooks that can be repeatedly used in the usability testing of other telemedicine communications or modified for any researcher's unit under scrutiny and study context. I urge researchers to further refine and develop the codebooks, as well as modify them to fit their unit of analysis.

The increasing use of mobile technology to access the internet for health information on and use of mHealth drives the need to perform usability testing on these devices, and organizations are making improvements towards ensuring internet services are optimized for mobile devices (Lu et al., 2005). However, little is known whether telemedicine providers are making the same investments into ensuring their websites are mobile-friendly. Researchers argue that successful implementation and deployment of telemedicine and other HIT is required and that the scenario-based, usability testing must be completed on the various devices for which health information is delivered and used (Klouche et al., 2015; Rai et al., 2013; Rogers et al., 2005). Successful telemedicine deployment depends on the effective integration of telemedicine communications into a target users' typical lifestyle, which includes accessing the internet on their smartphone. Therefore, the need to elucidate on the usability of telemedicine communications when delivered on a mobile interface was one motivation for this study and for future research to be performed. Future research can address questions such as: Are telemedicine providers aware of the importance of usability? Are they allocating resources to design and delivery usable health communications? To what extent are telemedicine providers performing usability testing?

In light of the recent pandemic (The Medical Futurist, 2020) that occurred during the writing of this dissertation, telemedicine has become even more important in our society. What was initially proposed as an alternative healthcare intervention, telemedicine is now a necessity and often the only healthcare individuals can receive as social distancing restricts many people from leaving their homes. The usability of telemedicine provider communications is now more important than ever, but this sufficient and optimal usability extends to every health communication and medium, including television news broadcasts, YouTube videos, health information websites, social media, and government official speeches. Health messages are mediated to individuals through a diversity of stakeholders and platforms and it is critical that it be usable: accurate, timely, comprehensible, trusted, and able to be successfully acted on by a heterogenous audience in order to reduce their risk of becoming infected, reduce disease transmission, and ultimately be in health.

APPENDIX A: UNIVERSITY OF CENTRAL FLORIDA IRB EXEMPTION DETERMINATION

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

EXEMPTION DETERMINATION

June 18, 2019

Dear Jessica Campbell:

On 6/18/2019, the IRB determined the following submission to be human subjects research that is exempt from regulation:

Type of Review:	Initial Study, Exempt Category
Title:	Amazon Mechanical Turk Survey
Investigator:	Jessica Campbell
IRB ID:	STUDY00000638
Funding:	Name: College of Graduate Studies
Grant ID:	

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Adrienne Showman
Designated Reviewer

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APPENDIX B: UNIVERSITY OF CENTRAL FLORIDA IRB EXEMPTION DETERMINATION

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

EXEMPTION DETERMINATION

June 14, 2019

Dear Jessica Campbell:

On 6/14/2019, the IRB determined the following submission to be human subjects research that is exempt from regulation:

Type of Review:	Initial Study, Category 2(ii)
Title:	Think Aloud Usability Testing of Telemedicine Provider Websites and Mobile-responsive Interface
Investigator:	Jessica Campbell
IRB ID:	STUDY00000567
Funding:	Name: College of Graduate Studies
Grant ID:	

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Renea Carver
Designated Reviewer

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APPENDIX C: UNIVERSITY OF CENTRAL FLORIDA COLLEGE OF GRADUATE STUDIES DOCTORAL RESEARCH AWARD

University of Central Florida
UCF College of Graduate Studies

November 20, 2018

Jessica Campbell
2131 Brook Drive
Maitland, FL 32751

Dear Jessica Campbell,

Congratulations! You are the recipient of a Doctoral Research Support Award from the College of Graduate Studies. This award is meant to assist you with dissertation research expenses as you work towards completing your doctoral degree at the University of Central Florida.

If you accept the award, the funding amount listed below will be transferred to your academic department for processing to cover approved expenses as needed based on the budget you provided as part of your award application.

If you have questions about utilizing the funds, please speak with your Graduate Program Director or Dissertation Chair. Purchases must be approved by your program in order for you to receive the funds.

Academic Year: 2018-2019

Fellowship Stipend: $2,785.00 in Fall
Total Fellowship Stipend: $2,785.00

Acceptance of Award

Please visit https://ww2.graduate.ucf.edu/student_financials/index.cfm?id=65757E7E6A7576 to accept or decline this funding. We look forward to receiving your positive response as soon as possible, but no later than **November 30, 2018**, as the offer can be rescinded after that date. Joy Kittredge, Assistant Director, Graduate Financial Support (gradfellowship@ucf.edu) would be happy to answer any questions you may have regarding this offer.

Sincerely,

Dr. John F. Weishampel
Senior Associate Dean & Director of Interdisciplinary Studies
UCF College of Graduate Studies

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APPENDIX D: EXPLANATION OF RESEARCH RECRUTIMENT DESCRIPTION IN AMAZON MECHANICAL TURK

You are being invited to take part in a research study. Whether you take part is up to you.

Survey Link: https://www.surveymonkey.com/r/KQLHWWB

The purpose of this study is to assess the usability and effectiveness of the Teladoc website (www.teladoc.com/). Teladoc is a leading provider of telemedicine, which are commonly known as virtual doctor visits. I would like to know how well the Teladoc website communicates what telemedicine services they offer, what health conditions are best suited for virtual doctor visits, and how easy it is to perform a virtual doctor visit if provided guidance from the website.

This study has you complete a survey in SurveyMonkey. The survey will ask you to perform different activities and tasks using the Teladoc website and respond to the survey questions following your interactions with the website.

You will complete the survey only once, and it is expected to take you 60 minutes or less to complete the survey.

You must be 18 years of age or older to take part in this research study. You must be able to interact with a computer, able to read instructions in English, and have agreed to the Amazon Mechanical Turk Participation Agreement, found at https://www.mturk.com/worker/participation-agreement.

Because Amazon Mechanical Turk will be used, survey responses will be anonymous, and no personal identification information will be gathered or made available to the PI; therefore, the confidentiality and privacy of participants will be maintained. Basic demographic data will be asked. Your Amazon Mechanical Turk Worker ID will be used to facilitate the survey and validate your completion of the survey, but Worker IDs cannot be used to reveal personal information or the real identity of the Worker.

An external link to the SurveyMonkey survey will be used to direct you to the survey (below), and all survey data will be retained in SurveyMonkey and never made available to Amazon. Survey responses will be downloaded as an Excel spreadsheet from SurveyMonkey, and all data handling, transferring, and maintaining will be performed using password-protected data analysis software and stored on a password-protected USB and computer.

Your participation in this study is voluntary. You are free to withdraw your consent and exit the survey at any time.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, please contact Jessica Lynn Campbell (jessicalynn@knights.ucf.edu), or Dr. Sonia Stephens (Sonia.Stephens@ucf.edu), Ph.D., Assistant Professor, UCF Department of English.

If you agree to take part in this survey, please click on link below to begin the survey.

https://www.surveymonkey.com/r/KQLHWWB

When you are finished with the survey, copy and paste the URL from the completion page here:

APPENDIX E: EXPLANATION OF RESEARCH USED FOR THINK ALOUD USABILITY TESTING

UNIVERSITY OF CENTRAL FLORIDA

EXPLANATION OF RESEARCH

Title of Project: Think Aloud Usability Testing of Telemedicine Provider Websites and Mobile-responsive Interface

Principal Investigator: Jessica Lynn Campbell, Texts & Technology PH.D. Student

Other Investigators: Dr. Sonia Stephens, Ph.D., Assistant Professor, UCF Department of English is faculty chair of the PI's dissertation committee and secondary investigator

Faculty Supervisor: Dr. Sonia Stephens, Ph.D., Assistant Professor, UCF Department of English is faculty chair of the PI's dissertation committee and secondary investigator

You are being invited to take part in a research study. Whether you take part is up to you.

The purpose of this study is to assess the usability and effectiveness of telemedicine provider websites that are intended to provide information about telemedicine consultations, commonly known as virtual doctor visits. I would like to know how well the telemedicine provider websites communicate what telemedicine services they offer, what health conditions are best suited for virtual doctor visits, and how easy it is to perform a virtual doctor visit if provided guidance from the website.

This study has three parts:

- Part 1: You will be described an artificial health-related scenario relevant to the telemedicine service being tested and provided a written description (in English).
- Part 2: You will be asked to access a telemedicine provider website and be asked to perform a series of activities and tasks that has you find specific types of information and describe your thought process as you perform these tasks. During this time, you will be video recorded in order to gain observational data to be analyzed later.
- Part 3: You will be asked to complete a Telemedicine Interface Usability Questionnaire (TIUQ), which asks basic demographic data, not including any personal identification data, and questions about your experience using the interface.

This will be a one-time, in-person session. This one-time session is expected to last about one hour.

To participate in the study, you must be 18 years of age or older, able to interact with a computer, able to read instructions in English, and have a smartphone available and be willing to use it to access the internet for one activity. You will be video-recorded in order to obtain data to be analyzed. All video recordings will be first captured on the video camera and transferred to the PI's USB and password-protected computer until uploaded into a password-protected data analytics software. All data will be de-identified in regards to the name and contact information of the participant. The TIUQ data will not contain personal identification information and the responses will be transferred to an Excel spreadsheet and stored on the PI's USB and password-protected computer until uploaded into a password-protected data analysis software. Each participant will be assigned a code to label their information, and their personal information will not be attached to data files. All data will remain confidential, and all video recordings with identifiable data will be destroyed after the completion of the PI's dissertation, which is anticipated to be in Summer 2020. The results of the data, which are de-identified, may be published in future publications or presented at conferences.

Your participation in this study is voluntary. You are free to withdraw your consent and discontinue participation in this study at any time without prejudice or penalty. If you do not want to be video-recorded, you will not be able to participate in this study because the audio and video recordings are needed for this study. Discuss this with the researcher if you have questions or concerns. Your decision to participate or not participate in this study will in no way affect your relationship with UCF, including continued

APPENDIX F: THINK ALOUD PROTOCOLS

Introduction to Primary Investigator For All Conditions

Hi, my name is Jessica. I am a UCF graduate student in the Texts & Technology PhD program. I am studying telemedicine communications to see if they contain the information that people need to be able to understand what it is and to be able to perform a virtual doctor visit. The type of communications I am studying are telemedicine providers' websites on a computer and on a smartphone. Your participation will help me understand how effective these websites are and how easy they are to use to locate information.

Condition 1 - Teladoc

Introduction & Health-related Scenario

1. Please read the summary of research, which provides an explanation for the research and a description of what you will be performing. If you have any questions, please feel free to ask me.
2. (After they read the summary of research) If you agree to participate in this research, please provide your verbal consent. Do you understand the research and what you are expected to do, and do you agree to participate? Please say yes or no.
3. (Pointing to the video recorder). The video recorder is pointed at an angle so that it can record your facial expressions and actions using the mouse, as well as capture what is happening on the monitor. The microphone is placed in a location so it can capture quality audio of our voices. Do you have any questions? (If none.) I will now start the recording.
4. (Review what they will do). I am going to give you a scenario in which you imagine that you are sick and want to see a doctor for your condition. I will ask you to access a

website and perform different activities and tasks using the website as you continue to pretend you are sick. I will ask that you talk out loud as you perform these tasks and describe your thought process and reasons why you are doing what you are doing. For example, if you want to find out information about a company, you might visit their website and click on the About button to find out more about the company. If this is the case, you will talk out loud, "I am looking for the About page to find out more about the company."

5. In this scenario, your goal is to figure out if your illness meets the criteria for performing a virtual doctor visit and then how you could actually perform the virtual doctor visit using the information on the website.
6. If you ever get lost during your interaction with the website or make an error, simply correct your actions to your best ability. If you need to go back to the homepage and begin again, that is okay. Also, if you cannot find information you have been asked to find or you think you should know, you can also simply describe that you cannot find it or ask me for help. Again, I'd like you to keep talking out loud as you use the website and just tell me what you are doing and why.
7. Any questions? (If none). Okay, here is your health-related scenario.
8. You have been coughing and have had congestion in your chest for the past week. You feel extremely tired and short of breath, and often cough up clear, white mucus. You have sometimes gotten the "chills." You do not want to go any longer without feeling better, and you are afraid you might get worse if you do not see a doctor.

9. The company you work for has a free healthcare option called Teladoc. You decide you'll try to use it to see the doctor virtually, as well as find out how you would get a prescription.

Part 1 – Desktop Computer

1. (Begin the usability session). Access the www.teladoc.com website. Again, you are sick and want to use Teladoc. Locate the information that you would desire if you were sick and wanted to see a doctor virtually and get a prescription. Remember, please talk out loud what you are thinking.

Part 2 – Smartphone

1. Thank you. Now that you have accessed the Teladoc website on the computer, I ask that you perform the same procedures on your smartphone.
2. Again, pretend you are sick; you have been extremely tired, congested, and coughing for days and are using your smartphone to access the Teladoc website (www.teladoc.com). Again, as before, locate the information that you would desire if you were sick and wanted to see a doctor virtually. Also, you might want to know how to get prescriptions so you will probably want to find that information, too. Remember, please talk out loud what you are thinking.

Provision of Questionnaire

1. (After they have completed the usability test session). Thank you. Now that you have completed the usability test, I will ask that you complete this short Telemedicine Interface Usability **Questionnaire (TIUQ) regarding your experience.**

Conclusion

1. (After they have completed the TIUQ). Thank you for participating. Do you have any final questions? (If none.) Here is your $15 Amazon gift card.

Condition 2 – KADAN Institute

Introduction & Health-related Scenario

1. Please read the summary of research, which provides an explanation for the research and a description of what you will be performing. If you have any questions, please feel free to ask me.
2. (After they read the summary of research) If you agree to participate in this research, please provide your verbal consent. Do you understand the research and what you are expected to do, and do you agree to participate? Please say yes or no.
3. (Pointing to the video recorder). The video recorder is pointed at an angle so that it can record your facial expressions and actions using the mouse, as well as capture what is happening on the monitor. The microphone is placed in a location so it can capture quality audio of our voices. Do you have any questions? (If none.) I will now start the recording.
4. (Review what they will do). I am going to give you a scenario in which you imagine that you are sick and want to see a doctor for your condition. I will ask you to access a website and perform different activities and tasks using the website as you continue to pretend you are sick. I will ask that you talk out loud as you perform these tasks and describe your thought process and reasons why you are doing what you are doing. For example, if you want to find out information about a company, you might visit their website and click on the About button to find out more about the company. If this is the

case, you will talk out loud, “I am looking for the About page to find out more about the company.”

5. In this scenario, your goal is to figure out more about your illness and find a doctor who can help you and then how you could actually perform a virtual consultation with the doctor using the information on the website.
6. If you ever get lost during your interaction with the website or make an error, simply correct your actions to your best ability. If you need to go back to the homepage and begin again, that is okay. Also, if you cannot find information you have been asked to find or you think you should know, you can also simply describe that you cannot find it or ask me for help. Again, I’d like you to keep talking out loud as you use the website and just tell me what you are doing and why.
7. Any questions? (If none). Okay, here is your health-related scenario.
8. Since the beginning of the year, you have had an upset stomach most of the time—sometimes the pain is very severe. You often have painful cramping and extreme bloating after eating, and it doesn’t go away after passing a bowel movement. Your bowel movements are inconsistent, and you are either constipated or have diarrhea. You have tried everything, from changing the foods you eat to taking Tums, but nothing seems to give you relief. You do not want to go any longer without feeling better, and you are afraid you might get worse if you do not see a doctor.
9. You go online to find information on your health condition, treatment, and doctors who may be able to help you. You find a website that seems to have information you are looking for and want to explore further to find out more about your condition and how you can see a doctor virtually. I’d like you to access a website and explore the

information as you would if you were sick and are seeking a treatment and a doctor who may be able to help you.

Part 1 – Desktop Computer

1. (Begin the usability session). Access the www.kadaninstitute.com website. Again, you are sick and want to find out more information about your health condition and use KADAN Institute's healthcare services to get treatment. Locate the information that you would desire to find out more information about your illness and to see a doctor virtually. Remember, please talk out loud what you are thinking.

Part 2 – Smartphone

1. Thank you. Now that you have accessed the KADAN Institute website on the computer, I ask that you perform the same procedures on your smartphone.
2. Again, pretend you are sick; you have had a very severe upset stomach, and either diarrhea or constipation for several months and are using your smartphone to access the KADAN Institute website (www.kadaninstitute.com). Again, as before, locate the information that you would desire if you were sick and are seeking information and treatment. Remember, please talk out loud what you are thinking.

Provision of Questionnaire

1. (After they have completed the usability test session). Thank you. Now that you have completed the usability test, I will ask that you complete this short Telemedicine Interface Usability Questionnaire (TIUQ) regarding your experience.

Conclusion

1. (After they have completed the TIUQ). Thank you for participating. Do you have any final questions? (If none.) Here is your $15 Amazon gift card.

Condition 3 – Carie Health

Introduction & Health-related Scenario

1. Please read the summary of research, which provides an explanation for the research and a description of what you will be performing. If you have any questions, please feel free to ask me.
2. (After they read the summary of research) If you agree to participate in this research, please provide your verbal consent. Do you understand the research and what you are expected to do, and do you agree to participate? Please say yes or no.
3. (Pointing to the video recorder). The video recorder is pointed at an angle so that it can record your facial expressions and actions using the mouse, as well as capture what is happening on the monitor. The microphone is placed in a location so it can capture quality audio of our voices. Do you have any questions? (If none.) I will now start the recording.
4. (Review what they will do). I am going to give you a scenario in which you imagine that you are sick and want to see a doctor for your condition. I will ask you to access a website and perform different activities and tasks using the website as you continue to pretend you are sick. I will ask that you talk out loud as you perform these tasks and describe your thought process and reasons why you are doing what you are doing. For example, if you want to find out information about a company, you might visit their website and click on the About button to find out more about the company. If this is the case, you will talk out loud, "I am looking for the About page to find out more about the company."

5. In this scenario, your goal is to figure out if your illness meets the criteria for performing a virtual doctor visit and then how you could actually perform the virtual doctor visit using the information on the website.
6. If you ever get lost during your interaction with the website or make an error, simply correct your actions to your best ability. If you need to go back to the homepage and begin again, that is okay. Also, if you cannot find information you have been asked to find or you think you should know, you can also simply describe that you cannot find it or ask me for help. Again, I'd like you to keep talking out loud as you use the website and just tell me what you are doing and why.
7. Any questions? (If none). Okay, here is your health-related scenario.
8. You have been coughing and have had congestion in your chest for the past week. You feel extremely tired and short of breath, and often cough up clear, white mucus. You have sometimes gotten the "chills." You do not want to go any longer without feeling better, and you are afraid you might get worse if you do not see a doctor.
9. You have heard of being able to see a doctor online and go online to find out more information on your illness and try to find online doctors who may be able to help you and perform a doctor visit virtually. I'd like you to access a website and explore the information as you would if you were sick and want to perform a virtual doctor visit.

Part 1 – Desktop Computer

1. (Begin the usability session). Access the www.carie.com website. Again, you are sick and want to use Carie™. Locate the information that you would desire if you were sick and wanted to see a doctor virtually and get a prescription. Remember, please talk out loud what you are thinking.

Part 2 – Smartphone

1. Thank you. Now that you have accessed the Carie™ website on the computer, I ask that you perform the same procedures on your smartphone.
2. Again, pretend you are sick; you have been extremely tired, congested, and coughing for days and are using your smartphone to access the Carie™ website (www.carie.com). Again, as before, locate the information that you would desire if you were sick and wanted to see a doctor virtually. Also, you might want to know how to get prescriptions so you will probably want to find that information, too. Remember, please talk out loud what you are thinking.

Provision of Questionnaire

1. (After they have completed the usability test session). Thank you. Now that you have completed the usability test, I will ask that you complete this short Telemedicine Interface Usability Questionnaire (TIUQ) regarding your experience.

Conclusion

1. (After they have completed the TIUQ). Thank you for participating. Do you have any final questions? (If none.) Here is your $15 Amazon gift card.

For PI Use Only

Additional Think Aloud Prompts

Because participants may forget to think aloud during their interaction with the interface, below are additional verbal cues to have them continue to talk out loud their thoughts as they are interacting with the interface.

- Keep talking.
- Umm huh?

- What are you thinking?
- Describe your thoughts.

APPENDIX G: TELEMEDICINE INTERFACE USABILITY QUESTIONNAIRE (TIUQ)

Please answer the following questions:

1. What is your age?

2. What is your gender?

3. In what city, state, and country were you born and raised – or – where have you spend the majority of your life?

4. Before this study, where you familiar with or did you know what telemedicine is – or what a virtual doctor visit is?

Please answer the following questions regarding your experience with the telemedicine website. Your response may be provided by circling the point, on a scale of one to five, that best corresponds to how you feel about your experience.

Scale

I strongly disagree.	**I disagree.**	**I neither agree nor disagree.**	**I agree.**	**I strongly agree.**
1	2	3	4	5

Website Questionnaire

It was simple to find the information I was looking for.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
It was easy to navigate the website.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
The main navigation menu used terminology I understood and directed me to the pages I expected.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
Buttons and icons used terminology and graphics that I was able to understand.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I believe I could be productive quickly using the website.				

I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I think the website provided the information I needed to perform the tasks asked of me.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
Whenever I made a mistake, I could recover quickly and easily.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
There were no distracting sidebars, popups, or messages during my interaction with the website that obstructed my performance or progress.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I was easily able to locate the contact information and contact someone if I needed help.				

I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I believe I understand what telemedicine is following my experience.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I believe I understand what types of health conditions I can use telemedicine for.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I would be able to perform a virtual doctor visit easily using the telemedicine interface.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5

Please answer the following questions regarding your experience using the telemedicine website on your smartphone. Your response may be provided by circling the point, on a scale of one to five, that best corresponds to how you feel about your experience.

Scale

I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5

Smartphone Questionnaire				
It was simple to find the information I was looking for.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
It was easy to navigate the website on my smartphone.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
The main navigation menu used terminology I understood and directed me to the pages I expected.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5

Buttons and icons used terminology and graphics that I was able to understand.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I believe I could be productive quickly using the website on my smartphone.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I think the website provided the information I needed to perform the tasks asked of me.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
Whenever I made a mistake, I could recover quickly and easily.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
There were no distracting sidebars, popups, or messages during my interaction with the website on my smartphone that obstructed my performance or progress.				

I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I was easily able to locate the contact information and contact someone if I needed help.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I believe I understand what telemedicine is following my experience.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I believe I understand what types of health conditions I can use telemedicine for.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.
1	2	3	4	5
I would be able to perform a virtual doctor visit easily using the telemedicine interface.				
I strongly disagree.	I disagree.	I neither agree nor disagree.	I agree.	I strongly agree.

1	2	3	4	5

APPENDIX H: CONTENT ANALYSIS – PASSAGE OF TEXT USED TO CALCULATE READABILITY SCORE FOR EACH TELEMEDICINE PROVIDER WEBSITE

Below is the passage of text that was copied exactly as is, including capitalization and punctuation, from each telemedicine provider website, and pasted into Readable.com's readability tool (https://readable.com/text/), in order to calculate the FKGL for the content analysis part of this study.

Condition 1 – Teladoc

Retrieved from https://www.teladoc.com/frequently-asked-questions/ (via Internet Archive)

These are the most common questions we get asked.

General Medical

How much does it cost?

The cost of a Teladoc visit varies, depending on your plan design.

Do I talk to "real doctors"?

Yes. Teladoc members only talk to actual doctors who are U.S. board-certified internists, state-licensed family practitioners, and pediatricians licensed to practice medicine in the U.S. and living in the U.S. When you request a visit, Teladoc will connect you with a doctor licensed in your state.

What are some of the common conditions Teladoc treats?

Common conditions include sinus problems, respiratory infection, allergies, flu symptoms and many other non-emergency illnesses.

Can Teladoc handle my emergency situations?

Teladoc is designed to handle non-emergent medical problems. You should NOT use it if you are experiencing a medical emergency.

Can I request a particular doctor?

You cannot request a particular doctor. Teladoc is designed to support your relationship with your existing doctor. It is not a means of establishing an exclusive relationship with one of our doctors. All Teladoc

Condition 2 – KADAN Institute

Retrieved from https://kadaninstitute.com/

TIRED OF SEEING DOCTOR AFTER DOCTOR, AND STILL NOT FEELING BETTER?

Many of our patients have seen multiple providers and GI specialists – who have dismissed their symptoms or told them that it's "all in their head."

Oftentimes, they are sent home with prescription medications that don't address the root cause of their chronic digestive issues and cause possible side effects – all in an attempt to cover symptoms.

Does this sound familiar?

In our clinical experience, the answer is getting to the root of what is causing your digestive dis-ease so we can pinpoint the specific imbalances to get you rebalanced, healed and back on track living the life you deserve to have.

Our functional medicine programs combine state-of-the-art lab testing with nutritional coaching, along with other lifestyle modifications and appropriate pharmaceutical-grade supplements.

Let's work together to create the best environment for natural healing and a personalized plan that gets you quickly back to a lifetime of health and wellness.

Unlike most conventional health practitioners that simply go "downstream" from your

Condition 3 – Carie Health

Retrieved from https://www.carie.com/about-us/

Visionary

leadership

Matt Wanderer created the concept for Carie and continues as our CEO and visionary, because he feels driven to do his part to help rescue our country's remaining 300,000 independent doctors from being swallowed up by a healthcare system that no longer values them correctly, and increasingly treats our medical care like it were something akin to fast food delivery. He launched Carie to remind Americans of the high-quality medical care that our parents and grandparents once received from their family doctors, and to tell them that it's about to come back in a big way.

During a life-changing trip to Chennai, India in 2011 Matt, got to see how a few simple technologies (when combined) created an amazing service called virtual care (telehealth or digital health). It may at first sound a little techy, but quality virtual care is really just the natural progression of what great medical care should be, with a powerful technology boost that makes it vastly more convenient and easier to access. He

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