Exposure: A Conceptual Framework for End Users Engagement Through Complexities-Driven Participatory Design for Patient-Facing Systems

By

Khalid W. Tearo

Submitted in partial fulfillment of the requirements for the degree of the Doctor of Philosophy

at

Dalhousie University

Halifax, Nova Scotia

June 2021

Table of Contents

List of Tables

List of Figures

Abstract

Prototyping techniques can be utilized as tools to aid the design and development of computer-based systems. A wide breadth of stakeholders can be involved in the prototyping activities throughout the development cycle. End user involvement at the initial stages of system design is known to be crucial to develop systems that meet end users' expectations and needs, particularly within the context of Patient-Facing Systems (PFS), which are operated by end users with or without minimal external guidance. However, the literature is lacking a clear and detailed description of how to involve and intentionally engage end users at the initial stages of the PFS design process. We present a study comparing two participatory design-based protocols: operational complexities-aware group versus operational complexities-unaware group. We found that when exposed to potential operational complexities (complicated situations that end users may expect to encounter), end users provide more comprehensive and rich design artifacts, in terms of features, to address usage complexities. Our results imply that involving exposed/aware users in the design process yields comprehensive design decisions and features that can be used by developers to guide system development. Contrary to our expectations, exposing end users to operational complexities gives them this advantage (comprehensive design decisions and features) independent of their electronic health knowledge. This approach provides deeper design insights before investing time and resources to develop a first prototype. Based on the "exposure" factor (exposing end users to operational complexities prior to a PFS design activity) and the other three literature-supported factors (end user involvement, early involvement, and competencies), we developed a conceptual framework for end user involvement in PFS design. We call the framework "Exposure" which is a complexities-aware Participatory Design (PD) framework for PFS. The conceptual framework is built on four inter-related pillars: exposure, end user, initial design stage, and electronic health literacy. The core feature of the proposed framework is end user exposure to operational complexities, in which the exposure process will yield well-informed and comprehensive design decisions (in terms of features and rationale). The framework addresses the need for a set of guidelines describing the engagement of end users at the initial stages of system design. We also briefly present research in which the author was involved, the Medication Adherence Reminder (MAR) study. It utilized a form of user-centered and participatory design to engage end users in the testing process of MAR. MAR provided a way to compare and contrast the design methodologies with the "Exposure: online booking study" which is the primary focus of this dissertation.

List of Abbreviations and Symbols

PFS	Patient-Facing Systems
HCI	Human Computer Interaction
NSBSP	Nova Scotia Breast Screening Program
NS	Nova Scotia
PICTIVE	Plastic Interface for Collaborative Technology Initiatives
HIT	Health Information Technology
e-HLA	Electronic Health Literacy Assessment
PD	Participatory Design
RD	Rapid Prototyping
UCD	User-Centered Design
COVID-19	**Co**rona **Vi**rus Disease of 20**19**

Glossary

Exposure	The process of exposing design activity participants (end users) to potential operational complexities.
Operational Complexities	Potential complexities that may be encountered by end users while interacting with Patient-Facing Systems due to proficiency of digital skills in any of four dimensions: operational, formal, information or strategic (Van Deursen & Van Dijk, 2008, 2009).
Prototyping	An experimental process of designing/proposing inter-related features and design elements that represent a model of a system.
Artifact	According to the Interaction Design Foundation, Artifacts means “any product of human workmanship or any object modified by man. It is used to denote anything from a hammer to a computer system, but it is often used in the meaning "a tool" in Human Computer Interaction (HCI) or Interaction Design terminology”.

Acknowledgments

I am deeply grateful to my supervisors, Dr. Jennifer Payne and Dr. Derek Reilly for their assistance at every stage of the research study, continuous support, and patience during my Ph.D. study. I would also like to extend my sincere thanks to Dr. David Persaud and Dr. John Blake for their insightful suggestions and comments on my research study. I would like to express my sincere gratitude to Dr. Lynne Robinson for her treasured support during the critical stages of my research study.

This research would not have been possible without the Nova Scotia Breast Screening Program. I am, therefore, eternally grateful for their support and for providing me with the required data to complete my research study.

I would like to thank all the members of the Faculty of the Medical Applied Sciences, King Saud University, and the Saudi Cultural Bureau in Canada for the funding opportunity to undertake my studies at Dalhousie University.

I would like to express my gratitude to “Allah” most gracious and most merciful, to my parents for their unwavering support and belief in me.

Chapter ONE: Introduction

This study explores the influence of exposing end users to operational complexities underlying online booking systems on their design decisions. End user involvement in the design process of computer systems is recognized as a strategy to elicit features that meet end user needs and expectations. This involvement gains a higher precedence when the systems are intended to be operated by the end users without external guidance. In this study, we focus on Patient-Facing Systems (PFS), which are operated by patients with or without minimal external guidance. The lack of external guidance contributes to other complexities underlying PFS, including competencies required to operate the systems and the wide discrepancy between users in terms of needs and literacies.

It is important to consider end users during the design process of PFS. This can be done by applying prototyping strategies when designing the proposed system. Prototyping provides clear communication channels between developers and end users during the early stages of systems development, which is essential to develop systems that meet end user' needs and expectations (Rodriguez-Calero et al., 2020, Norman, 1993, Kirsh, 2010). Prototyping strategies that consider end user involvement are described in the Human Computer Interaction (HCI) literature and within the context of design engineering (Sanders & Stappers, 2014, Rodriguez-Calero et al., 2020, Houde & Hill, 1997). However, through our literature review, very few resources describe end user involvement in the design process within the context of PFS. This has motivated us to explore this research context in a specific applied domain: online booking systems for breast re-screening patients.

We describe a study that was conducted in two phases. In phase one, we worked with the booking clerks at the Nova Scotia Breast Screening Program (NSBSP) to identify the potential complexities that might be encountered by end users of PFS (online booking

system). In phase two, we worked with patients to explore the influence of the exposure to usage complexities on their design decisions (exposed group versus un-exposed group of patients) and compared these with those of booking clerks, who would already be familiar with these complexities. This study contributes to the understanding of the influence of evoking patients, by exposing them to operational complexities, in their design decisions while participating in the design process.

This thesis is presented as nine chapters. Chapter Two provides an overview of the literature about the core topics that contributed to forming this study, including online-based services within the context of public commercial services and healthcare services, and the roots of healthcare online booking systems and how they are classified. Chapter two also presents various Human Computer Interaction methods of end user involvement in the design process of computer systems.

Chapter Three presents the research gap that was identified based on the literature review, in which we argue that the literature lacks detailed evidence of the influence of end users engagement in designing PFS on the proposed design features.

In Chapter Four we provide an overview of our research methods that were implemented to conduct this study. Our study was conducted in two phases: interviews with the booking clerks (phase one) and design activities with booking clerks and breast screening patients (phase two).

Chapter Five presents the research methods used for phase one and the results that were used to develop scenarios of usage complexities based on mixed HCI methods. These scenarios each represent an extreme fictional character (patient) who is trying to book an appointment using an online booking system. Scenarios and extreme characters were utilized to inform the design phase two of the study.

Chapter Six presents the research methods used for phase two and associated results. The objective of phase two was to investigate the influence of exposing end users to complexities underlying online booking systems on their design decisions. The results showed a significant difference between the design decisions made by the exposed and the non-exposed participants. The design artifacts[1] that were produced by the exposed participants, showed more rich and comprehensive decisions, than those of the un-exposed participants.

Chapter Seven presents the main points of discussion, service provider and end user engagement in the design process of PFS, followed by the strengths and limitations of the research study.

Chapter Eight presents the Medication Adherence Reminder Mobile Application (MAR) research study. This study utilized forms of User-Centered Design that engaged end users in the evaluation of high fidelity prototypes. This study is considered to compare and contrast design methodologies with the “Exposure: online booking study”.

Finally, Chapter Nine concludes the dissertation a framework - the “Exposure: A Conceptual Framework for Complexities-Driven Patient-Facing System Design”. This conceptual framework describes how service providers and end users may be engaged in the PFS design process.

[1] According to the Interaction Design Foundation, Artifacts means “any product of human workmanship or any object modified by man. It is used to denote anything from a hammer to a computer system, but it is often used in the meaning "a tool" in HCI or Interaction Design terminology”.

Chapter Two: Literature Review

The main theme of our study centered on end user involvement in the design process of online booking systems for healthcare services. This literature review covers the roots of online booking systems, prototyping techniques as design tools, and end user involvement strategies in the design process of computer systems.

1.1 Computer Technology Advancements and Online Services

Across many aspects of public services, advances in computer software and communication have significantly improved the overall quality of life measures (Mishra et al., 2014). Easy access to the internet and increased coverage have impacted the usage rate of the internet. Recent reports show that in 2020, there were 4.54 billion active internet users (Clement, 2020). It was reported that within 3 years of its invention, the internet reached 50 million users, while it took the radio 38 years and the television 13 years to reach the same number of users (Bell & Tang, 1998). The rapid growth in internet users, advances in the computer (hardware & software), and communication services have motivated different public service providers to adopt online solutions as a portal to their services (for the purpose of this dissertation, the term 'provider' refers to any service provider within an organization as well as to individuals). Flight bookings, hotel reservations, shopping, banking, and many other commercial services are easily accessible through online portals. A closer look at the history of online services shows that the first online booking system accessed directly by customers was Travelocity in 1996 (Altexsoft, 2019). Travelocity was created and deployed by Sabre Corporation, and it allowed customers to reserve and purchase tickets through a virtual travel agency accessed through the internet (Altexsoft, 2019). This service has changed how travelers plan their trips, including car rentals, hotels, and flight reservations (Diefenbach, 1998). Currently, there is no need to visit a travel agency office to plan and book a trip, and users are not limited to regular business hours to engage with these agencies, given that these virtual agencies are open 24 hours per day, 7 days per week (Law & Leung, 2000). Reports

show that 180 million clients use online travel services on a monthly basis, with an expected growth rate of 3.8% annually (Rizal, 2020, Nasr, 2015). The banking industry is no exception, as it went through major changes in terms of workflow related to customer services (Chou & Chou, 2000). The concept of self-banking dates back to 1970, where some bank clients were provided with access to "touch-tone" telephone services (Chou & Chou, 2000). This approach suffered from the inability to provide visual information. Another major impediment was ensuring the secure integration of online services with existing services (Chou & Chou, 2000). This required improvements in hardware, software, networking, and IT expertise. On October 18th, 1995, the Security First National Bank (SFNB) provided the first internet-based banking services (Chou & Chou, 2000).

There are several factors that influence the adoption of online banking among end users. The factors are access to the internet, the trust level between the client and the financial institute, and the variety of online banking services offered by financial institutes (Szopiński, 2016). The most influential factor is the variety of online products, which is why banking institutes are competing to provide a wide variety of online services like credit cards and mortgages (Szopiński, 2016). Concerns related to personal and financial data privacy are not a concern as long as the financial institution is able to gain the end users' trust (Szopiński, 2016). The rapid advancement of computer technology and research efforts to investigate influential factors on the adoption of online banking have impacted the adoption rate among end users; the adoption rate among populations in developed countries is estimated to be over 50% (Pikkarainen et. al, 2004).

Our review demonstrates that the adoption and acceptance rate of online commercial services, like online banking and travel reservations, are high and expected to continue to increase. Although online banking services require accessing sensitive personal and financial information, end users find the advantages of online banking outweigh the privacy concerns (Altexsoft, 2019). Literature indicates that the collaborative relationship between financial institutes and their customers offers the

opportunity to know what the customers are looking for (Szopiński, 2016). Hence, services can be customized based on the customers' needs and expectations. This may explain why the adoption rate of online banking systems is rapidly growing among customers.

1.2 Health Information Systems

Now that we have explored commercial online services, we will explore online services within the context of healthcare, in order to contrast the spread and adoption of commercial online services and healthcare online booking services.

Technological advancement can positively impact the quality of care provided by healthcare providers. Healthcare providers have demonstrated a significant level of interest in adopting health information systems (Brooks & Grotz, 2010, Levey, 2009). The information systems within the healthcare sector can be recognized as systems that are meant to be managed and operated by healthcare providers. The same systems may be operated by patients to achieve specific tasks (Fox & Jones, 2009, Houston et al., 2004, Weingart, 2006). The adoption and implementation of information systems for healthcare providers have been fast in terms of growth and adoption compared to the systems meant to be operated by patients. Many incentives increased this rate for healthcare providers, like reduction in the cost of services through computerization, document (clinical, administrative, and financial) events, easy web-accessibility, and network-based service delivery (Raghupathi & Tan, 2002). The advantages and incentives are clear for health care providers, which may then lead to an increased adoption rate of health information systems when developed for use by healthcare providers (Raghupathi & Tan, 2002, Buntin, 2011).

In the following section, we explore a specific type of healthcare information system that is intended to be used by a specific type of end user (i.e., patients).

1.2.1 Patient-Facing Systems (PFS)

Health information systems that are developed for use by patients, with or without minimal external guidance, are recognized as Patient-Facing Systems (PFS) (Ahern et al., 2011). PFS can support access to health-related information (Fox & Jones, 2009), safe communication with healthcare providers (Houston et al., 2004), and appointment scheduling (Fox & Jones, 2009, Weingart, 2006). PFS can support access to health-related information through simple browsing. Such systems are expected to be easier to operate in comparison to communication and appointment systems, which may require a set of skills for successful operation. These skills, known as operational skills, vary across end users (Rodriguez-Calero et al., 2020). The Centers for Medicare and Medicaid Services (CMS) published the Meaningful-Use rule, which provides guidelines for PF (Patient-Facing) technologies (CDC website, Ahern et al., 2011). PFS is organized under three main categories with the consideration of meaningful use. The three categories are information and transactions, expert care and self-care, and community. In this framework, the service to book and/or view an appointment is under the information and transactions category. The information and transactions category covers the services that grant access to the Health Information System (HIT) features and functions that enable self-support (Ahern et al., 2011). Direct access to self-support and healthcare services by patients requires consideration of their skills and competencies as system end users (Karnoe et al., 2018, Nutbeam, 1998). As described above, when it comes to health information systems, the consideration of functions and features that align with patients' needs leads to a higher adoption rate (Irizarry, 2015).

The literature about booking issues faced by healthcare providers shows that the internet and personal health records (PHR) technology can facilitate more convenient booking methods. An Australian study to evaluate the acceptance and adoption of online booking services found that patients' acceptance rate is affected by their computer skills and accessibility to the internet (Maeder & Martin-Sanchez, 2012). Therefore, it is recommended to consider effective online booking solutions and strategies to overcome

the inherited limitations that affect the adoption rate. In 2009, Chinese health authorities launched a national program that aimed to provide outpatients with an online booking system to overcome traditional booking issues such as long waiting times (Zhang M, Zhang C, Sun, Cai, Yang & Zhang, 2014). Results from the evaluation of the national program revealed that both patients and healthcare providers require training programs, and that they must work together as stakeholders to create solutions to address their needs. In addition, the online booking system needed more promotion to ensure that patients and physicians are aware of its features, benefits, and how it can be utilized (Zhang M et al., 2014). However, the study did not clarify what types of education programs and material should be used to train patients and healthcare providers. In 2014, a study was conducted to evaluate the online services offered by 900 family physicians from the US News & World Reports' best doctors list (Alpert, 2014). The results revealed that only 21% of the physicians had a website and that they generally only provide basic information with no significant functionality. In addition, only 24% of those websites supported online booking services. Although the study investigated each website's features and functions, it did not evaluate the type of language and terms used on the web pages. The study did not address the language used on the interface, in addition, it did not communicate directly with the physicians (website owners) to find out why they have websites with limited functionality. Knowing the rationale behind this type of website would be beneficial to inform the literature of online-based healthcare services and the barriers of having online-based services.

As discussed above, healthcare information systems are not supported like the other online commercial systems. For example online banking is supported by live chat, phone support, and e-mail inquiry forms. In addition, all external support services are operated by customer service agents who are available beyond normal working hours. In contrast, healthcare services are not similarly staffed and structured. Health systems are further complicated by the need for understanding medical terminology. In the next

section, we explore the nature of competencies that are required to operate PFS and their influence on the end users.

1.3 End users' Competencies and Online-Based Services

The discrepancy between people who do and do not use digital technology effectively is described as a "digital divide" (Van Dijk, 2005, 2006, Bertot, 2003, DiMaggio & Hargittai, 2001, Hargittai, 2001, Warschauer, 2004, Van Deursen & Van Dijk, 2009). However, van Dijk (2005) argues that the term "divide" is a misleading term and may be intrusive to the efforts to bridge differences in usage (Van Dijk, 2005). Furthermore, Van Dijk (2005) proposes that there are four reasons behind this misunderstanding. First, the term divide is used to explain a phenomenon of a clear division between two things and the digital divide is much more complex. Second, the "divide" is uncorrectable and cannot be "bridged". Third, the divide is usually used to describe "inequalities" between two groups or more of people (users). Fourth, this division is not separated by one line that represents inequality, it is more complex and involves four divisions. According to Van Dijk, the divisions are motivational, physical, skills-related, and usage-related divisions (Van Dijk, 2005).

To solve the issue of the "divide," it is crucial to realize that it is not about two groups who are facing unequal access to digital services. Therefore, more attention must be directed into the root issue (Van Deursen & Van Dijk, 2009). Policymakers assume that passing rules and policies to increase access to computers and the internet will solve the issue of the "digital divide" (Van Deursen & Van Dijk, 2009). They assume that people who gain better and faster accessibility will successfully operate the public online systems and complete the tasks required to get the service they are looking for. According to Van Deursen & Van Dijk (2005), the root issue of using online-based tools is not the accessibility to such services, it is more about the ability to complete the tasks correctly using online-based services (Van Deursen & Van Dijk, 2009). A study conducted in 2009 in Denmark to assess the internet operational skills of Danish citizens used an operational

framework to measure the internet operational skills of their participants (Van Deursen & Van Dijk, 2009). The researchers used an operational framework to measure the internet operational skills of their participants. This framework considered four dimensions of digital skills which were measured and evaluated (Van Deursen & Van Dijk, 2008, 2009). The dimensions are operational skills which focus on the ability to operate internet content, formal skills which focus on skills required to navigate through the digital interface, information skills which focus on skills to search for information on the digital domain and strategic skills which focus on the ability to utilize the identified information to complete digital tasks (Van Deursen & Van Dijk, 2008, 2009). The researchers selected nine internet-based tasks that were categorized by the Dutch government as easy tasks that can be completed by the public. Tasks were completed by 109 participants and their performance was measured by calculating the success rate of task completion and time spent to complete each task (Van Deursen & Van Dijk, 2009). The results indicated that participants managed to complete 80% of the operational skill tasks, 72% of formal skills tasks, 62% of the information skills tasks, and 22% of strategic skills tasks (Van Deursen & Van Dijk, 2009). The results did not match the expectations of the policymakers, as they assumed that such tasks would be achievable if access to internet services was granted (Van Deursen & Van Dijk, 2009). It is recommended that policymakers pay more attention to skills-related competencies and not just focus on the accessibility to digital technologies and services (Van Deursen & Van Dijk, 2009, Bertot, 2003, Van Dijk & Hacker, 2003, Hargittai, 2002).

The strength of the study by Van Deursen & Van Dijk (2008) is it refutes the notion that improving the accessibility to computers and the internet improves end user readiness to operate online-based services. The relatively small sample size (109) limits the generalization of the results. In addition, their inclusion criterion of using the internet at least once per month is too broad to define the targeted population. This is due to the high internet usage per household in Denmark, which is known to be the highest in Europe (Seybert & Lööf, 2010). More specific inclusion criteria based on the educational

background may have provided more meaningful results, because educational background may have an influence on internet usage in terms of frequency and purpose. We also noticed that the tasks were completed by the participants did not include terminology-related tasks (Van Deursen & Van Dijk, 2009).

Therefore, end user competencies must be considered when assessing the readiness to use online systems. This is to ensure that the end users will be able to overcome potential operational complexities related to the above-mentioned digital skill dimensions (operational, formal, information and strategic). Competencies vary across the domains of online systems and given that our study focuses on healthcare systems, it was important to explore competencies within the context of PFS, as outlined in the following section.

1.3.1 Patient-Facing System Users' Competencies

With advancements in computer technologies used within the healthcare context, it is necessary to evaluate technology-oriented competencies within the healthcare domain: electronic literacy and health literacy (Karnoe et al., 2018). The relationship between patients' health literacy and computer-related skills must be considered to ensure the best possible use of PFS (Karnoe et al., 2018). Health literacy can be defined as the "cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand, and use information in ways which promote and maintain good health" (Nutbeam, 1998). The tools that were first used to measure health literacy were developed with a focus on patients' ability to read and comprehend health-related information (Karnoe et al., 2018, Parker et al., 1995, Murphy et al., 1993).

Karnoe et al., (2018) believe that it is essential to evaluate health-related and technology-related competencies to ensure the best possible results of eHealth projects. The e-Health Literacy Assessment toolkit was developed over five years of experimentations, evaluations, and refinements (Karnoe et al., 2018). The motivation

was the lack of a multidimensional evaluation tool that can be used in populations with a wide range of sociodemographic characteristics. Originally, they started with 10 tools that were pilot tested among patients over the period 2011 to 2015. The definitive version was validated among 475 outpatients and general community members. The final validated version of the toolkit consists of 7 tools, each tool is made of a set of questions, to evaluate competencies needed to navigate and operate e-Health services, such as completing health surveys and forms using a digital interface. Each tool focuses on an independent and specific competency: functional health literacy, health literacy self-assessment, familiarity with health and healthcare, knowledge of health and disease, technology familiarity, technology confidence, and incentives for engaging with technology (Karnoe et al., 2018). Karnoe et al. (2018) recommend the e-Health Literacy Assessment toolkit (e-HLA toolkit) in e-Health projects to gain a deeper insight into the potential future users and to inform design decisions by PFS developers. To our knowledge, the e-HLA toolkit is the only e-health literacy assessment tool that was validated within healthcare context and the only tool that considers electronic and health literacy of the intended end users (patients).

As previously discussed, the literature indicates that the notion that increasing accessibility to computers and the internet will *necessarily in itself* increase the use of online-based services is not correct (Van Deursen & Van Dijk, 2009). In addition, more attention must be paid to the competencies and skills that are required to complete online tasks (Karnoe et al., 2018). We believe that the interrelated set of competencies, health and electronic, increase the complexities underlying PFS. This can be resolved by improving the targeted end user competencies or/and designing systems that match the end users expectations and skills (Karnoe et al., 2018). These results led to an examination of current practices for designing PFS and how developers are accommodating the end user competencies in the design process.

1.4 Human Computer Interaction Research Methods

Human-Computer Interaction (HCI) "is a multidisciplinary field of study focusing on the design of computer technology and, in particular, the interaction between humans (the users) and computers" (*What Is Human-Computer Interaction (HCI)?,* n.d.). Our research focuses on the influence of exposing end users to operational complexities on their design decisions. It was important for us to explore the foundations of end user involvement in the design process. This was achieved by reviewing PFS design processes and design studies within the context of Human-Computer Interaction.

Exploring and understanding the interaction between end users and computer systems enables developers to design systems that can be used effectively by a wide range of end users (McCrickard, 2004). In addition, the consideration of functions and features that align with users' needs, increases adoption rates among users and providers (Irizarry, 2015). The Participatory Design (PD) approach is well-accepted and highly adopted by HCI researchers (Hartson & Pyla, 2019). This approach considers the involvement of the end user who will be directly interacting with the information and communication technologies (Robertson & Simonsen 2013). It has been demonstrated that design is better developed in direct collaboration with the main users: this is to ensure a design that fulfills the needs and values of the main users (Robertson & Simonsen 2013, Leong & Robertson 2016). Involving users in the design process helps to identify valuable functions and features for the users (Simonsen & Robertson 2012, Christensen, 2014).

A main advantage of PD is that it strongly ties the design process with the end users who will be directly impacted by the outcomes. PD ensures that participants who represent the main stakeholders (users) will feel their direct contribution to the design process (Robertson & Wagner, 2013). They will feel empowered once they realize that their expertise, expectations, and needs have been utilized in the design process (Leong & Robertson 2016, Robertson & Wagner, 2013). There are two different approaches of PD, the Scandinavian and American approaches (Spinuzzi, 2005). Where the Scandinavian

approach promotes the direct interaction between the researchers and participants, the latter approach promotes remote observation by the researchers (Spinuzzi, 2005). PD usually starts by initiating an exploration stage, where developers interact directly with the participants to gain a deeper insight into how they perform in the usage environment (Spinuzzi, 2005). The second stage involves discovering the overall goals and values of the intended users. The third and final stage involves building design artifacts directly by users, based on the previously identified goals and values (Spinuzzi, 2005). Just like any methodology, PD has its limitations. It is argued that the PD approach heavily relies on the features and functions that are identified in the produced artifacts. Focusing on the final products in terms of features neglects the workflow of the system implementation of the PD methodology, requires a high level of commitment by the researchers and participants, which imposes a limitation due to the required resources in terms of time, budget, and effort. PD studies tend to be implemented over multiple stages that take a long time, which discourages some participants from fully committing to all study stages (Bertelsen, 1996 & Spinuzzi, 2005).

We believe that PD is a useful HCI research method that enables the direct participation of end users in the system development, but this direct participation by specific participants in the development process is limited in that it may only accommodate the needs and expectations of the participants that were involved in the design process. Therefore, we explored the literature to identify an approach that provides the ability to identify design features beyond the needs and expectations of the participating end users.

User Centered-Design (UCD) is a design approach that accommodates the stakeholders, with a focus on users, by considering their requirements and expectations (Junior & Filgueiras, 2005). Early in the design process, user needs and behaviours are often captured using one of the following user modeling techniques: user roles, user profiles, user segments, marketing segments, personas, and non-user personas (Junior & Filgueiras, 2005). In contrast to user modeling, the PD approach relies on directly involving

the end user in the design process. Interestingly user modeling techniques offer more flexibility in exploring users' needs because they do not rely only on real end users in the development process. For example, using extreme characters as a user modeling technique enables developers to build systems by accommodating unique and unusual end user needs (Junior & Filgueiras, 2005). User roles, user profiles, user segments, and marketing segments can be considered as high-level user modeling techniques (Junior & Filgueiras, 2005, Cooper et al., 2014, Brusilovsky, 1998, Constantine & Lockwood, 1999). Such techniques may be not comprehensive enough to cover a wide variety of end users with diverse needs and expectations (Junior & Filgueiras, 2005). On the other hand, extreme characters and personas techniques do consider end users with specific and unique needs. By focusing on accommodating distinct and extreme personas in the design, needs shared broadly across the user population should also be accommodated. According to Rich, users must be recognized as individuals while considering their objectives behind using the intended system (Rich, 1979). Creating users' profiles with extreme characters with unusual needs and expectations can be helpful in terms of identifying usage scenarios that are hard to discover (Djajadiningrat et al., 2000). Unusual and unique requirements and features can be identified through the Extreme Character method (Junior & Filgueiras, 2005). A model for creating personas and scenarios by Nielsen was adopted to inform the creation of the complex booking scenarios (Nielsen, 2003). According to this model, personas should be complex and reflect characters interacting within settings that can be associated with reality (Nielsen, 2003, Nielsen, 2002).

Exploring and utilizing different personas to inform usage scenarios allow developers to gain a deeper insight into a wide range of potential future users (Junior & Filgueiras, 2005). This leads to the development of systems that accommodate broad needs and expectations by end users. Incorporating extreme characters into the usage scenarios may also lead to the development of more immune systems to unexpected usage complexities (Junior & Filgueiras, 2005). However, we believe that limiting the

design process to extreme characters may lead to systems designs that are overly complicated and may be overwhelming for mainstream users. Utilizing personas and extreme characters requires a medium for conduction and implementation. Therefore, it was important to identify a method that can be used as a medium to explore system designs.

1.4.1 Prototyping Methods to Explore Systems Design

Prototyping methods provide a rich medium to exchange ideas between end users and developers (Rodriguez-Calero et al., 2020, Norman, 1993, Kirsh, 2010). The choice of prototyping method is dependent on the objective of the prototyping activity. System developers often limit the advantages and capabilities of prototyping by using it to evaluate a system user interface that was already designed either at an early or late stage; this is an appropriate approach, but if considered at the initial stages of designing, it will increase the potential even further. Utilizing prototyping only at later stages may limit its potential by using it to improve a specific prototype within the limits of an executed and functioning design (Buxton, 2007).

System developers may work on projects to identify systems features and requirements and/or to evaluate the usability of the systems. This is why we believe it is important to clearly understand the difference between software requirements engineering and usability engineering. Software requirement engineering consists of three main elements: identification, analysis, and communication (Hooper and Hsia, 1982). Usability engineering consists of prototyping, empirical user testing, and iterative design (Nielsen, 1992, Wogalter et al. 1999). The methodological framework for software requirements engineering definition was developed and published by Hooper and Hsia in 1982 to guide requirements identification by end users (Hsia, 1982). Tohidi et al. conducted a study to compare a single interface against three interfaces, all sharing the same functionality (Tohidi et al., 2008). The only difference between the interfaces was the style presented to the users. Their results suggest that users in the single design group

rated the proposed single design significantly higher compared to the three designs group. The single design also received less criticism. Tohidi et al. recommended not limiting the participants to one option or functioning prototype.

This review focuses on work based on three criteria:

1. Projects with PFS research context, in which the proposed systems were intended to be used by end users.
2. Projects that considered developing new systems (prototypes), and
3. Projects that considered stakeholders (service providers and end users) in the design process.

The objective of this review was to describe how end users' (patients) involvement is considered in the design process. These projects (see Table 1) are illustrative of the literature, in which PFS projects start by developing prototypes among the system designers and healthcare providers without involving the patients at the very initial prototyping/designing stages. The healthcare providers are approached by the developers to involve them in feature elicitations activities or to initiate ethnographic evaluations that lead to functioning prototypes or mock-ups. At a later stage, patients are approached to evaluate the prototypes and suggest improvements (Yang & Asan, 2016, Piper & Hollan, 2013, Ni et al., 2011, Nystorm et al., 2018, Honekamp & Ostermann, 2011, Gonzales & Riek, 2012, Wilcox et al., 2010, Martinez al., 2018, Idowu et al., 2014). In these projects, researchers started the design process by talking to the service provider to elicit the systems' features and main design elements. Although involving the end user is recommended, we believe that limiting the initial discussions to healthcare providers may be acceptable as a starting point for the project. However, it is important to involve end-users to elicit features and general borderlines for the system before developing the first prototype. Participants may agree on whatever is presented to them, which may limit their ability and willingness to suggest additional features. We also noted that only one project considered the competencies of their participants, although it is recommended to always measure the competencies of participants in PFS projects. This is to ensure that

the participants are a good representation of the targeted population and to ensure that the proposed system will accommodate end users with different levels of competencies.

Title	End users time of Involvement	End users stimulation/evoking	Task for Usability Testing	Observations
Supporting medical communication for older patients with a shared touch-screen computer, 2013	Late involvement/post prototype development	No stimulation/evoking techniques were implemented during end users involvement	Completed 7 pre-defined tasks for usability testing	• No thorough documentation on how tasks were defined. • Prototype was developed without end users involvement. • No consideration of participants health literacy. • No consideration of operational complexities.
AnatOnMe: Facilitating Doctor-Patient Communication Using a Projection-Based Handheld Device, 2011	Late involvement/post prototype development	No stimulation/evoking techniques were implemented during end users involvement	Completed 6 pre-defined tasks for usability testing	• Thorough documentation on how tasks were defined (based on discussions with healthcare providers and thematic analysis). • Prototype was developed without end users involvement. • Consideration of participants' health literacy (3 levels of health literacy low, medium and high). • No consideration of operational complexities.
Dependable online appointment booking System for NHIS outpatient in Nigerian Teaching hospitals, 2014	Early involvement/prior prototype development	No stimulation/evoking techniques were implemented during end users involvement	NA	• No documentation on what end users did during the data collection phases. • No documentation on how features were elicited. • Physician and patients were involved in the early design phases.
Methods for Patient-Centered Interface Design of Test Result Display in Online Portals, 2018	Late involvement/post prototype development	No stimulation/evoking techniques were implemented during end users involvement	Completed 3 pre-defined tasks for usability testing	• No thorough documentation on how tasks were defined. • Prototype was developed based on features listed in literature. • No consideration of participants' health literacy. • No consideration of operational complexities.

Table 1 PD studies in PFS (Observations Summary)

Title	End users time of Involvement	End users stimulation/evoking	Task for Usability Testing	Observations
Application of the FITT framework to evaluate a prototype health information system	Late involvement/post prototype development	No stimulation/evoking techniques were implemented during end users involvement	Completed one task that was defined be experts and based on literature	• No consideration of participants' health or electronic literacy. • Evaluated a prototype using a framework that considered 3 factors: technology, user and task. All participates were well-informed university students and employees. • No consideration of operational complexities. • No thorough documentation on how tasks were defined.
A Shared Interface to Improve Oncologist-Patient	No involvement	NA	NA	• No prototype was developed, conceptual design was proposed based on literature and contextual inquiry discussions with the physicians. • No patient involvement, although the proposed system was intended for use by patients and physicians.
Designing Patient-Centric Information Displays for Hospitals	Late involvement/post prototype development	No stimulation/provoking techniques were implemented during end users involvement	Semi-structured interviews with end-users for high level feedback and features elicitation	• No consideration of participants' health or electronic literacy. • No consideration of operational complexities. • Prototype was developed without end user involvement. • Iterative design and features elicitations with physicians.
A Patient-Facing Diabetes Dashboard Embedded in a Patient Web Portal: Design Sprint and Usability Testing	One end user was involved during early design and the rest of end users were involved later for usability testing	No stimulation/provoking techniques were implemented during end users involvement	NA	• Thorough documentation of methods. • Only one patient was involved in the design sprint. • Usability testing tasks were built based on "typical user" needs. • Numerical and health literacy measurements tools were considered for recruitment.

Table 1 PD studies in PFS (Observations Summary) (continued)

From this list of eight projects, we will now highlight the study that provided the most detailed review of end user engagement in the design process. The study was conducted to design and develop an online-based PFS within the context of diabetes (Martinez et al., 2018). The core feature of this PFS was to involve patients in managing their medical conditions through a plug-in dashboard that can be used with an established patient portal. The researchers applied the "design sprint" methodology (Banfield et al., 2015, Knapp, 2016) followed by usability testing activities to design and evaluate the proposed PFS (Martinez et al., 2018). The design sprint was conducted over two phases, 4 days for design (phase one) and a dedicated day for usability testing (phase two). In phase one they identified a set of literature-based challenges within the context of diabetes self-management and reviewed existing design solutions across different domains, including banking and education. Based on the existing design solutions, they developed a mock-up prototype for the proposed system. In phase two, 14 participants (diabetes patients) were invited to the usability testing activity. Upon arrival, participants were asked to complete a short questionnaire consisting of basic demographic questions, a health literacy measurement tool (Sarkar et al., 2011), and a numeracy literacy measurement tool (Fagerlin et al., 2007). Personal medical information for each participant was extracted from their main medical chart. The participants were verbally introduced to the prototype by a researcher and were instructed to "think-aloud" during the session. After completing the introductory session, participants were asked to complete five tasks using the prototype. The tasks were created by the researchers based on what they believed was a representation of tasks that may be performed by any "typical user" while using the application.

Since researchers involved only one patient during the design sprint, the design population sample did not represent a wide range of patients who could use the PFS in future. Another issue noted is the selection of tasks that were used to test the PFS. The tasks were built based on "typical user" needs. This approach may lead to false expectations about the users' ability to use the PFS in the future because not all end users

are “typical” users. Testing and designing phases must accommodate a wide range of users, to ensure a system that can be used in extreme situations (Junior & Filgueiras, 2005). The researchers relied on a health literacy measurement tool, that consisted of questions related to literacy and the ability understand medical forms, as well as a numeracy literacy measurement tool. We believe that both tools may be suitable measurement tools for different research contexts but not for their proposed PFS, because end-users are expected to interact with health-related data (health literacy) presented in the context of computer system (e-literacy).

The eight studies varied in how the system developers utilized prototyping methods and techniques to explore design features that may be proposed in the final systems designs. Prototyping was used for features elicitation and systems usability testing, but the justification for the choice of prototyping methods was not clear. Therefore, it was important to explore the factors that may be used to identify the proper prototyping method based on the research context.

1.4.2 Prototyping Methods and Dimensions

This section explores and reviews commonly used prototyping methods. The design space is considered as a canvas that can be used to explore different viable solutions for a specific issue, this exploration can be done through prototyping (O'Raghallaigh & Adam, 2017). Prototyping is considered as a design tool that can be used to understand and elicit future system requirements, and to result in a domain-specific design or domain-general design (Rodriguez-Calero et al., 2020). Domain-general design is the design that can serve multiple purposes across a wide range of fields and research contexts (Rodriguez-Calero et al., 2020, Daly, Adams, & Bodner, 2012; Goel & Pirolli, 1992; Visser, 2009; Zimring & Craig, 2001). On the other hand, domain-specific design is the design that serves a specific purpose within a specific discipline (Rodriguez-Calero et al., 2020, Visser, 2009). It is important to know what problem is being solved by applying prototyping methods during system development (Litcher, 1994). Prototyping

approaches can be categorized, based on the goals and problems being solved, as: exploratory, experimental, and revolutionary prototyping (Litcher, 1994, Floyd, 1984). The exploratory approach which is the focus of this study, is usually adopted by developers when the problem and its boundaries are not clearly defined (Litcher, 1994, Floyd, 1984). It can be utilized at the initial stages of system development to foresee the potential challenges to be considered in more mature prototypes at later stages of development. Some prototyping methods are cost- and time-consuming but support the successful interaction of end users with the system and increase their sense of ownership of the final product. Rapid Prototyping (RP), which is a less time-consuming approach, consists of four dimensions: form, fidelity, scope, and interactivity. Understanding each dimension will help in the identification of suitable prototyping methods for different information system projects, see Table 2 (O'Raghallaigh & Adam, 2017, Floyd et al., 2007, Jones et al., 2007, Beaudouin & Mackay, 2003).

Dimension	**Level**
Form (representation)	• Less evolved: Quick, inexpensive and does not support real-time interactions, such as paper sketches • More evolved: Slow, expensive, and supports real-time interactions, such as software codes
Scope (extent)	• Horizontal: shallow only shows chosen functions at the interface level • Vertical: deeply explores functions starting at the interface level to the system level
Fidelity (accuracy and level of details)	• Low fidelity: Quick, inexpensive and does not show how the final product works • High-fidelity: Slow, expensive, and the final product can be predicted
Interactivity (the extent to which prototype can be functional)	• Static: observational, quick, inexpensive and no deep insight can be gathered from the prototype • Dynamic: interactional, slow, expensive, and deep insights can be gathered from the prototype

Table 2 Prototyping Dimensions

Prototyping dimensions are used by developers to guide the process of selecting the proper prototyping method based on resources, objectives, and available time. Therefore, developers can identify the suitable prototyping method that enables them to reach their design goals. It is important to note that there is no perfect prototyping method and that trade-offs must be made to fulfill the final goal (O'Raghallaigh & Adam, 2017, Floyd et al., 2007). Developers can balance between the dimensions based on their needs.

The Plastic Interface for Collaborative Technology Initiatives (PICTIVE) is a mock-up participatory design prototyping technique that employs low-technology methods and video recording to support/record prototyping tasks (Muller, 1991). PICTIVE enables potential end users to experiment with the design space in the initial stages of system development through static, low-fidelity, course-grained, and less-evolved system mock-ups (Muller, 1991, Bodker et al., 1987, Bodker et al., 1988). PICTIVE is a simple, yet powerful, method that provides equal design opportunities to end users by utilizing simple office materials that can be used and manipulated by non-experts to build mock-ups (Muller et al., 1993). The concept of equality is obvious when participants apply their ideas without relying on a design team or other powerful stakeholders (Muller, 1991, Thoresen, 1990). Muller (1991) defined two design objects that can be used for prototyping: simple office tools like, “highlighters, papers, Post-It™ notes of many sizes, stickers and labels, and paper clips — all in a range of bright colors”, and paper-based icons that represent interface commands like drop-down menus, command bars, menu bars, text boxes, etc., which are prepared by researchers or designers based on the nature of the project (Muller, 1991). Utilizing the dimensions and fidelity of prototyping enables systems developers to identify the right prototyping methods based on their needs and resources (O'Raghallaigh & Adam, 2017, Floyd et al., 2007, Jones et al., 2007, Beaudouin & Mackay, 2003). Dimensions may also enable developers to identify the prototyping method that allows proper end user engagement in the design process by choosing the method that matches end user skills.

1.4.3 End User Involvement in Prototyping

Prototyping can be utilized to aid in developing the front-end and back-end design of systems (Rodriguez-Calero et al., 2020). The back-end represents the backbone of the system and usually, it is limited to systems developers, while the front-end, referred to as the client-end design, includes all interface elements that are used directly by the clients, (Rodriguez-Calero et al., 2020, Dorst & Cross, 2001). The challenge is to anticipate the problem faced by end users and provide the solution to them while ensuring this solution meets the expectations of the client (Rodriguez-Calero et al., 2020, Dorst & Cross, 2001). Therefore, front-end prototyping and main user engagement may be the solution to overcoming this challenge (Rodriguez-Calero et al., 2020). Prototyping can be initiated by developers at any stage during system development (Lauff et al., 2018, Rodriguez-Calero et al., 2020, Coughlan, Suri, & Canales, 2007). It can be applied during the initial stages without the wait for the system to mature for testing (Coughlan, Suri, & Canales, 2007, Rodriguez-Calero et al., 2020). Utilizing prototyping methods at the initial stages of system design may yield system requirements and specifications that meet end user expectations (Jensen et al., 2017, Rodriguez-Calero et al., 2020, Cooper, 2018).

The level and timing of end user involvement in the prototyping differ between the American and the European prototyping schools. The Americans prefer a rapid style of prototyping that gets the prototype to the functional stage as soon as possible for testing by the end users, while the Europeans tend to be more user-focused (Litcher, 1994). In other words, the American style of prototyping is more end user-independent compared to the European which is more end user dependent (Litcher 1994). However, as Privitera et al. argue, challenges are expected when engaging end-users in system development (Privitera et al., 2017). In their study, they evaluated the encounters between 18 medical device firms in the U.S and end users at the hospitals where they identified 11 challenges associated with end user involvement (Privitera et al., 2017). The identified challenges were: user familiarity with system development, Research Ethics Board approvals to exchange information with users, ability to express needs by users,

time coordination to meet with users in groups, users' personas, users clash during groups activities, cost, legal obligations, initiating the first contact with the user, motivating users to optimum innovation and artifacts analysis (Privitera et al., 2017). Privitera et al. believe that utilizing end user thoughts and expertise in the system development process, outweighed the challenges imposed by their participation (Privitera et al., 2017). Therefore, system developers should involve end users in the development cycle (Privitera et al., 2017). They also suggest developing guidelines for end user engagement to address challenges and ensure a high level of end user engagement.

End users' early involvement in prototyping activity is described in the HCI and PD literature (Sanders & Stappers, 2014, Rodriguez-Calero et al., 2020, Houde & Hill, 1997). It is also described in the literature within the context of design engineering (Rodriguez-Calero et al., 2020). However, these descriptions are either high-level accounts or focus on usability testing at later stages (Viswanathan & Linsey, 2009, Yang & Epstein, 2005, Rodriguez-Calero et al., 2020, Dieter & Schmidt, 2013, Pietzsch et al., 2009, Zenios et al., 2010). This lack of available descriptions of engagement strategies at the initial stages of prototyping motivated Rodriguez-Calero et al. to explore methods of engagement used by healthcare device designers (Rodriguez-Calero et al., 2020). They conducted semi-structured interviews with 22 designers from 16 medical device companies in the United States. The 16 companies varied from major firms with 10,000+ employees to small firms with less than 50 employees. The companies' services cover the entire globe (Rodriguez-Calero et al., 2020).

The interviews with the designers revealed a total of 17 strategies that were used by the designers to engage their stakeholders. The interviews also revealed that the engagement strategies were not consistent among the designers, with less than 50% of the designers indicating that they used the same strategies. The core principles for the strategies to engage the participants varied across the designers. For example, some of the designers relied on varying the number of prototypes presented to participants, while

others relied on modifying the prototypes during the session across the participant groups. Some designers (7 out of 22) stated that they evoke participant insight and feedback by simulating a use case scenario and asking the participants to interact with the prototype. Rodriguez-Calero et al. indicate that the identified strategies may be used by system designers to improve communication with the stakeholders and reach designs that meet their needs and expectations as well (Rodriguez-Calero et al., 2020). They also concluded that further research is needed within the context of end user engagement to develop guidelines and documented them in the literature used by the designer's community (Rodriguez-Calero et al., 2020).

End user involvement strategies are not clearly described and their influence on system designs is not verified through research in the literature. There are different involvement strategies that are listed briefly that were identified through discussions with system developers. We believe that involvement strategies require rigorous testing and validation to identify their influence on the final systems designs. The previously explored literature has led us to identify a research gap that formed the scope of our study. The research gap and research question are discussed in the following chapter.

Chapter Three: Research Gap And Question

2.1 Research Gap

Computer systems design and development literature recognizes the importance of using prototyping as a method to involve end users in the design process. Recognized end user involvement strategies include early involvement in the design process, intentional stimulation, and the consideration of the operational competencies. However, the literature lacks a clear and detailed description of how to evoke/stimulate end users during early design stages and the impact of this stimulation on design outcomes within the context of PFS. The published descriptions are mainly focused on usability testing at a later stage of prototyping, and within domains that do not necessarily generalize to PFS. In my work, therefore, I analyze the influence on design decisions of intentionally evoking/exposing patients to operational complexities of online PFS booking using extreme characters and scenario methodologies during a participatory design activity.

2.2 Context

All Canadian provinces support organized breast screening programs that provide screening services to women of appropriate age and risk. The Nova Scotia Breast Screening Program (NSBSP) was established in 1991, and since that time, the program has relied on a central booking office that books all screening appointments. Screening patients are self-referred and must contact the program during regular business hours to book an appointment. We partnered with the NSBSP to explore and gain deeper insight into the interaction between patients and the booking system to investigate the considerations of moving to a patient-facing booking system. In the interest of simplicity, this research focused on booking previously screened patients (i.e., re-screening patients) who already have demographic and history/eligibility information on file with the NSBSP.

2.3 Research Question

The study started with the preliminary research objectives of understanding how re-screening appointments were handled by booking clerks, exploring the current re-screening booking process to inform an alternative e-booking method, and identifying complexities associated with online booking systems with the goal of defining extreme personas and related scenarios. This primary objective led to a research question that formed the basis for the second phase of the study. The second phase aimed to explore the interaction between e-Health Literacy and patients' exposure to booking complexities and how this interaction may influence the way Patient-Facing Systems (PFS) are designed by patients. The question that guided the research is:

How do e-Health Literacy and exposure to operational complexities influence comprehension of complexities underlying Patient-Facing Systems design, as measured by requirements fulfillment, scenario-based walkthrough, and thematic analysis of design decisions?

Chapter Four: Methods

3.1 Overview

This study utilized a mixed-methods approach to investigate the influence of exposing end users to operational complexities on their design decisions during the prototyping stage of systems within the context of healthcare online booking systems. We used a mixture of quantitative and qualitative research methods (Schoonenboom & Johnson 2017) based on relevant literature (Martinezet al., 2018, Rodriguez-Calero et al., 2020, Privitera et al., 2017, Muller, 1991, Karnoe at al., 2018).

User Centered Design (UCD) and Participatory Design (PD) principles were considered while creating the data collection methods. Following requirements elicitation techniques from UCD, we identified PFS challenges from the literature and used discussions with the booking clerks to inform scenarios and extreme characters (Karnoe et al., 2018). Then we utilized challenges, scenarios and extreme characters to inform the PD activity with the end users. The main principle considered is the involvement of the main stakeholders (patients, booking clerks, and management staff) that have a direct relationship with the online booking system at all phases. We involved the service providers (booking clerks and management) and end users (re-screening patients). The prototyping approach adopted is the Scandinavian approach, where we directly interacted and evoked the stakeholders during the data collection phase (Spinuzzi, 2005). This contrasts with the North American approach that relies more on observing the stakeholders with limited direct interaction (Spinuzzi, 2005). We chose the Scandinavian approach because it aligns with our research question that focused on the “intentional” exposure and stimulation of our participants, which allowed us to interact directly with the end users instead of observing them remotely. This experimental approach was followed through prototyping to establish clear communication with all stakeholders and to identify the system’s requirements, features, and boundaries (Floyd, 1984).

3.2 Study Phases

The study was conducted in two phases: phase one involved exploring booking complexities and phase two involved exploring the impact of complexities on design decisions.

3.2.1 Phase One

We initiated our exploration by communicating directly with the senior booking clerks and management team at the NSBSP.

The goals of this phase were to understand how re-screening appointments were handled by the booking clerks, explore the current re-screens booking process to inform an alternative e-booking method, and explore complexities associated with online booking systems. Individual and group semi-structured interviews were conducted with the booking clerks of the NSBSP. Data from the interviews were analyzed using inductive coding (Miles et al., 2014) which was guided by the inductive thematic analysis adopted from HCI literature (Jacobs et al., 2015, Andersen et al., 2017, Pfeifer et al., 2012, Mishra et al., 2018). For detailed data collection and analysis methods see chapter 5.

3.2.2 Phase Two

Data from both the phase one interviews and the focus group activity with the senior clerks provided us with insight into the clerks' perspective about online booking, which informed the creation of online booking scenarios that represent users with unique needs while booking screening appointments and encountering operational complexities at the same time. The complexities within the context of online booking systems refer to the obstacles that the end user might face while booking an appointment. Such obstacles may affect the entire booking experience and may lead to seek alternative booking such as phone-based booking systems. The goal for phase two was to explore how exposure to operational complexities may influence design decisions by end users. Therefore, we used

the scenarios from phase one as the core of the exposure activity. Phase two consisted of two stages:

- Stage One – Survey: involved distributing the e-Health Literacy Assessment toolkit (e-HLA) and supplementary assessment questions survey at two NSBSP screening sites. This tool measures the e-Health Literacy for re-screening patients. To our knowledge, the e-HLA is the only validated and published literacy measurement tool that considers both technology/operational and health literacy skills (Karnoe et al., 2018).

Collected surveys were used to calculate the total e-HLA score for each participant for sample formation for the next stage of the study. The responses to the supplementary questions were used to generate descriptive statistics. A Spearman correlation coefficient test was performed to measure the strength of relationships among the supplementary questions and e-HLA scores.

- Stage Two – Prototyping: this involved a set of activities with a subgroup of survey respondents who completed the survey as well as booking clerks at the NSBSP. We applied a modified PICTIVE technique during the prototyping sessions (see Chapter Six).

Each artifact from the prototyping session was analyzed using requirement fulfillment, scenario-based walkthrough, and thematic analysis of design decisions. As with phase one, we employed an inductive coding process to analyze this data. For detailed data collection and analysis methods see Chapter Six.

Chapter Five: Phase One – Exploration Of Complexities – Methods And Results

This chapter describes the research methods used for phase one and presents the results that were used to develop scenarios of usage complexities. Each scenario represents an extreme fictional character (patient) who is trying to book an appointment using an online booking system. Scenarios and extreme characters were utilized to inform the design of phase two of the study.

4.1 Population

The targeted population was senior booking clerks at the Nova Scotia Breast Screening Program (NSBSP). The reason for targeting senior clerks is their extensive experience in dealing with patients on a daily basis.

4.2 Recruitment

In collaboration with the NSBSP, the program management team identified 3 senior booking clerks for recruitment (based on knowledge and experience) to provide information about the booking process.

4.3 Ethical Considerations

No specific quotes and comments were attributed to individual booking clerks nor were communicated to the manager. Results were anonymized, referring to the ID number only.

4.4 Procedure (Interviews & Focus Group)

This phase involved working directly with the booking clerks at the NSBSP. The researcher interviewed the three senior clerks at the NSBSP during regular business hours.

The clerks were interviewed individually, for the following reasons:

- Avoid bias: in group interviews, it is common to have individuals who can monopolize responses and influence responses of others.
- Insight into Individual experience: individual interviews provide the opportunity to focus on individual experiences and discuss them in more detail.
- Explore disconcerting encounters: talking to patients on a daily basis might lead to disconcerting situations. Individual interviews may make the clerk more comfortable to share such encounters.

The individual semi-structured interviews lasted for approximately 45 minutes. A set of questions was used to guide the discussion (see Appendix A). After analysing the individual interviews, a group interview was conducted lasting 90 minutes. We used the same set of questions used during the individual interviews to guide the discussion. The goal of the group interview was to cover any missed points and to further investigate points of consensus and divergence. We used a set of questions to maintain the flow of discussion that started with patients' needs and the factors to be considered while designing an online booking system. The final discussion focused on the clerks' expectations from the future online booking system. A set of guiding questions was utilized to prompt the interview (see Appendix A).

4.5 Analysis

Interviews were transcribed and a qualitative-inductive analysis approach was used to synthesize the learnings from the senior clerks to identify potential online booking complexities that might be encountered by patients when using online portals. Our approach was inductive, and all codes/categories were derived from the data itself. This iterative process was intentional to avoid any bias that might be generated due to the direct interaction between the researcher/data analyst and the participants. This approach was adapted from Miles et al. (Miles et al., 2014). To guide our analysis, we applied the steps of "Inductive Thematic Analysis", a technique commonly used in HCI

research studies (see for example Jacobs et al., 2015, Andersen et al., 2017, Pfeifer et al., 2012, Mishra et al., 2018). This was performed as follows (Miles et. al, 2014).

1. Transcribe all data.
2. Read the data multiple times to get familiar with the raw text.
3. The long text will be summarized and condensed into short sentences (while keeping interesting quotes).
4. Create labels (codes).
5. Iteratively identify broad categories/themes that group similar codes.
6. Review the identified categories/themes from steps 4 and 5 (this is to ensure the connection with the data).
7. Create a definition for each category/theme.
8. Create a title/category for each theme.
9. Write a comprehensive text including quotes that represent participants' opinions to support the discussion.

The resulting themes were discussed in relation to online booking complexities. Themes were supported by direct quotes by the clerks.

4.6 Results

We had a total of 3 participants, all senior booking clerks, for our interviews and focus group sessions. Data was analyzed by applying the thematic analysis protocol.

We identified five themes in total, where four themes involved the interaction between potential future users and an online booking portal. The fifth theme represented the impact of an online booking portal on the clerical workflow. Note that all themes were derived from the perspective of the booking clerks who participated in the study.

In the following we present each theme and associated codes from the interviews (for examples of supporting quotes for each theme please see Appendix B):

4.6.1 Theme One: User/Patient Empowerment

Definition

This theme refers to the ability of patients to gain better control over access to the online booking service at their convenience. Patients feel that they control and book their appointments with the flexibility and ease of online booking system. The clerks reflected on the difficulties faced by patients when making phone calls, such as wait times, matching their availability with the available appointments and calling during working hours. Such difficulties if addressed by the online booking system, would result in patients feeling empowered.

Associated Codes

- Convenience
- Take responsibility
- Empowerment

4.6.2 Theme Two: Online Portal Usability

Definition

This theme refers to the extent to which online booking portals can be used by patients, without external guidance, to book screening appointments with satisfaction and error-free. The usability of online booking systems for healthcare purposes was not limited to the ease of use or the ability to book an appointment without guidance. The clerks were concerned about the correctness of the appointment in terms of matching the patients' special needs, such as time slots required to complete the screening and overcoming complexities related to medical terms. In general, the clerks assumed that

the online booking system should behave as if it a real booking clerk is interacting and responding to the patients' needs over the phone.

Associated Codes

- Medical terms ambiguity
- Online booking complexity
- Booking requirement
- Booking correctness
- Time slots
- Users with special needs

4.6.3 Theme Three: Generation Gap

Definition

This theme refers to how different generations embrace online booking, where older users are less comfortable using online portals, compared to younger users. Clerks were concerned about the online tool being too advanced for most of their patients. The women who visit the clinic are between 41 and 75 years old, with a wide diversity of knowledge, education, health literacy, and computer skills. A portion of the clients could use the online system with no issues and may prefer it over the phone-based booking system, but the concern is about the other portion of the patients. The clerks expect the online system to accommodate a wide range of preferences and abilities.

Associated Codes

- Older users' preferences
- Younger users' preferences
- Familiarity with technology
- Methods of interaction

4.6.4 Theme Four: Eligibility

Definition

This theme refers to the users' eligibility for a screening appointment. Not all women are eligible to book an appointment for screening, for example, women experiencing symptoms, require physician referral for diagnostic evaluation and are considered ineligible for screening. Therefore, the clerks were concerned about the eligibility of women using the online booking system. They were concerned about how the system will determine patients' eligibility and, if they are not eligible, how it will direct the patient. The proposed system is expected to determine the eligibility and direct the patient to the right route if she is not eligible. This requires the system to be connected to the main health information system at the province for eligibility confirmation.

Associated Codes

- No symptoms
- Eligibility check-up
- Screening Due date
- Intervention

4.6.5 Theme Five: Administrative And Clerical Duties

Definition

As discussed above, this was the only theme that highlighted the impact of an online booking portal on the clerical workflow – it arose out of the interviews and focus group discussion with the clerks. This theme refers to the clerks' daily workflow with regard to screening booking. Whenever there is a new technology that automates a function or service, there is a human concern about being replaced by this technology. Clerks expressed concern about being replaced by online booking systems. However, the advantages of such technology have mitigated their concern and their attention was

directed to how online booking system might improve their workflow, for example, using the online booking system to deal with mainstream cases that do not require special attention and leaving more complicated cases for the clerks to manage.

Associated Codes

- Job security
- Better workflow
- Focus on other tasks

The interviews and the focus group activity with the senior clerks provided us with insight into the clerks' perspective about online booking. The categories and the associated codes indicated a concern by the clerks about online booking systems. Our discussion identified the complexities associated with the booking process. During interviews, it was clear that the clerks were concerned about the future of booking if the online portals become active and are operated by the patients without guidance. This was the basis for considering how extreme scenarios of patients could be managed by the system. Extreme scenarios of usage require non-typical users to complete the picture. From this we created online booking scenarios that represent users with unique needs while booking screening appointments and encountering booking complexities. The scenarios and associated personas were developed based on Nielsen's model of Personas and Scenarios (Nielsen, 2003).

After defining the personas, Nielsen (2003) recommends placing each persona in a relevant scenario that includes a set of actions. This will transform the persona from being a static character into an interactive character with motivations to perform a set of actions. Every scenario should reflect a persona with goals within a situation to perform an action to achieve the goal. The situation should reflect obstacles that must be addressed by the character to reach a solution (Neilsen, 2003).

Incorporating extreme characters into the usage scenarios may lead to the development of systems that are able to accommodate and mitigate usage complexities. However, we were concerned that limiting the design process only to extreme characters without the consideration of mainstream and basic usage scenarios, may lead to systems designs that would be overly complicated and overwhelming for mainstream users. In our approach, we helped mitigate this limitation by creating a set of extreme characters that were validated by the senior booking clerks at the NSBSP.

After generating and defining themes from interviews with the clerks, these themes were used to generate several personas based on the model by Nielsen (2003). Each persona had to accommodate the following elements (Neilsen, 2003):

1. A clear figure that reflects gender, age, and style.
2. A specific set of motivations behind the intended actions.
3. A context that defines family, education, geographical location, culture, and job.
4. Goals and needs define the emotional state.
5. Contradictory characteristics that reflect the reality in the persona, which helps in contrasting the flat and rounded character. This character shows serotype traits yet has features of a round character with all its details and emotions that enable it to deal with a complex situation.

We applied the steps 1 to 5 to define each persona. Each booking scenario and associated persona was assessed for realism with the senior booking clerks at NSBSP.

4.7 Online Booking Complexities: Extreme Characters

In the following, we have created five booking scenarios and associated elements using the themes informed by the interviews and focus group discussion with the booking clerks. Each scenario represents an imaginary booking process completed by an extreme character. The main issues that are presented in the scenarios are as follows:

1. Scenario 1: Medical terms presented on the user interface.
2. Scenario 2: Updating family history and demographics if needed.

3. Scenario 3: Updating the medical chart if needed.
4. Scenario 4: Users with special needs (accessibility).
5. Scenario 5: Eligibility and navigation without external guidance.

Scenario ONE

Kristy is a 60-year-old female. She is a resident of Halifax Regional Municipality, Nova Scotia, Canada. She works as a social worker between 7:30 am and 5 pm. Recently, she is having busy days at work, where she always forgets to call the NSBSP during working hours to book an appointment. This evening she decided to book the appointment through the new online booking website, but she feels hesitant about it due to her limited computer skills and bad past experiences using such websites. For example, Kristy always calls to book flights because she doesn't feel confident dealing with online flight booking. This is due to a mistake she made 3 years ago when she booked an international flight, where she forgot to change her title from Mr to Mrs (which indicated gender for the airline). This mistake caused a delay and cost her $200 to change the booking information. When opening the NSBSP booking website her apprehension worsened when she read confusing medical terms on the booking portal (for example, she was unaware that breast biopsy is considered a surgery).

This scenario represents two themes, the *generation gap, and online usability*. The associated codes are familiarity with technology, medical terminologies, and booking complexities. This can be seen in the scenario, where Kristy is not confident using the portal due to the medical terms that she might encounter during the booking process. This confidence issue is worsened by her previous negative experience with online services.

Scenario TWO

Sarah is a 52-year-old-old female. Sarah is a resident of Dartmouth, Nova Scotia, Canada. Recently she visited her family physician for a medical follow-up, where her physician informed her that he was moving to BC and would transfer her file to different family practice. A couple of days later she got a phone call from her sister informing her that she was diagnosed with breast cancer. That evening she remembered that she needed to book an appointment at the NSBSP and decided to use the new online booking website. While using the website and filling in the appointment information, she realized that she still needed to update her family physician contact information.

This scenario represents the *online portal usability* theme. The associated codes are, booking correctness and booking requirements. This is reflected in Sarah's experience with her family physician who is moving to a different province. This incident requires Sarah to update her chart. The complexity also has increased when she received the unfortunate news about her sister's medical condition that also requires her to update her chart.

Scenario THREE

Ashanti is a 42-year-old female. Ashanti is a resident of Bedford, Nova Scotia, Canada. Nine months ago, she had breast augmentation surgery. Recently her mother was diagnosed with breast cancer. Now she wants to book her next screening using the new web portal. Note: It is mandatory to book the appointment through her family physician due to her change in her medical history related to breast augmentation.

This scenario represents the *eligibility* theme and the associated codes are due date re-screen, symptoms, and eligibility check-up. The other theme that is also represented in the scenarios is online portal usability and the associated codes are booking correctness and booking requirements. Ashanti is expected to encounter

different complexities in the form of updating her chart to report her new surgery and her family history update.

Scenario FOUR

Deborah is 57 years old with vision difficulties. Looking at the computer screen is not a comfortable option for her. Therefore, she asked her niece, Samantha, to book her an appointment with NSBSP through the new website. She left her medical ID card at home for her niece to book the appointment.

This scenario represents *online portal usability*, and the associated code is users with special needs. The other theme is the generation gap and the associated code is methods of interaction. Deborah has vision issues that prevent her from using the computer, which forced her to ask someone else to book the appointment for her. This situation might impose a confidentiality issue due to the sensitive personal data on the medical chart.

Scenario FIVE

Jennifer works with the NSBSP team and she was appointed to work on the online booking system design. She worked closely with some of the NSBSP clients to get their feedback on the design. Her clients are worried about the patients using the system without external guidance. Now she is worried about the future of the new online portal. In particular, she is concerned about patients being rejected by the system because they are not eligible. This rejection might stop patients from using the system.

This scenario represents the theme *eligibility* and the associated code eligibility check-up. Another represented theme is user empowerment, and the associated code is taking responsibility. Here it is clear that the clerk is concerned about the patients taking responsibility and operating the system without external guidance which imposes booking correctness and eligibility issues.

Chapter Six: Phase Two – Impact of Complexities on Design Decisions – Methods and Results

Phase two of the study was informed by phase one which involved direct discussions with the senior booking clerks at the NSBSP. Phase two involved direct discussions and prototyping activities with the patients and senior booking clerks at the NSBSP. This phase was conducted in two stages: survey (for recruitment and e-HLA measurement) and prototyping activity (to evaluate the influence of exposure on the design decisions made by the clerks and patients).

5.1 Stage One

5.1.1 Population

The targeted population for this phase was female patients who visited NSBSP for screening (ages 40 and over).

5.1.2 Recruitment

After the completion of their screening visit at one of two sites (Halifax Shopping Centre and Cobequid Health Centre) patients were approached by the registration clerk and asked if they were willing to complete the survey (see Appendix C). Survey respondents also had the option of providing contact information to enable recruitment for stage two.

5.1.3 Procedure

A total of 200 surveys were distributed at the screening sites (Halifax Shopping Mall site and Cobequid Health Centre). The survey consisted of the e-HLA toolkit (Karnoe et al., 2018), which consists of two parts (health literacy measurement tools and computer skills measurement tools). In addition to the e-HLA tool kit, a supplementary set of questions was used as a part of the survey. The supplementary questions and what they are intended to explore are as follows:

1. How often do you use the internet for booking (hotels, flights, government services…etc.)?

This question was added to explore the familiarity with online booking in general.

2. How often do you use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)?

This question was added to explore the familiarity with online-based health services.

3. I am interested in booking my re-screening appointment at the NSBSP using the online booking website

This question was added to explore the interest in future online booking services at the NSBSP among their clients.

4. To my knowledge, the term "Biopsy" means:

This question was added to explore the familiarity with the most confusing medical term for the patients, according to the senior booking clerks at the NSBSP.

To maintain the integrity of the e-HLA tool kit, the supplementary questions were separated.

5.1.4 Analysis

The e-HLA score was calculated for each participant. Descriptive analysis (frequency, proportions) was carried out for the supplementary questions. A Spearman correlation coefficient test was performed to measure the strength of relationships between the supplementary question responses and the e-HLA score.

5.1.5 Results

A total of 185 surveys were completed by the patients yielding a response rate of 92.5%. A total of 18 participants did not complete the entire survey resulting in a final study sample of 167 for analysis do not include their survey responses in this analysis. A subset of 45 (24%) respondents agreed to be contacted regarding the next phase of our research.

5.1.5.1 Survey Section-One (Supplementary Questions)

Table 3 provides the summary of the responses to the first e-HLA Supplementary question "How often do you use the internet for booking (hotels, flights, government services…etc.)?" Approximately half (51.5%) of respondents indicated that they always use the internet for booking.

Q1 How often do you use the internet for booking (hotels, flights, government services…etc.)?	
Answer	Freq (%)
Always	86 (51.5)
Sometimes	65 (38.9)
Never	16 (9.6)

Table 3 Question 1: Interest and Knowledge (e-HLA Supplementary Questions)

Table 4 provides the summary of the responses to the second e-HLA Supplementary question, "How often do you use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)?" The most common response (43.7%) indicated that respondents never use internet health services.

Q2 How often do you use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)?	
Answer	Freq (%)
Always	25 (15.0)
Sometimes	69 (41.3)
Never	73 (43.7)

Table 4 Question 2: Interest and Knowledge (e-HLA Supplementary Questions)

Table 5 provides the summary of the responses to the third e-HLA Supplementary question, “I am interested in booking my re-screening appointment at the NSBSP using the online booking website”. The majority (70%) either agree or strongly agree with the provided statement about using online booking for re-screening appointments.

Q3 I am interested in booking my re-screening appointment at the NSBSP using the online booking website	
Answer	Freq (%)
Strongly agree	65 (38.9)
Agree	52 (31.1)
Neutral	38 (22.8)
Disagree/Strongly Disagree	12 (7.2)

Table 5 Question 3: Interest and Knowledge (e-HLA Supplementary Questions)

Table 6 provides the summary of the responses to the last e-HLA Supplementary question, “To my knowledge, the term “Biopsy” means”. The majority (69.5%) of respondents indicated that the term Biopsy means surgical procedure.

Q4 To my knowledge, the term “Biopsy” means	
Answer	Freq (%)
Surgical Procedure	116 (69.5)
Non-surgical Procedure	43 (25.7)
Neither	8 (4.8)

Table 6 Question 4: Interest and Knowledge (e-HLA Supplementary Questions)

5.1.5.2 Survey Section-Two (e-HLA Toolkit)

The e-HLA scores ranged from a low of 19 to a high of 45 out of a possible 45 on a sample of 167. The descriptive analysis of the distribution of e-HLA scores appears in Table 7 and Figure 1.

Mean	37
Median	38
Range	26
Minimum	19
Maximum	45
Standard Deviation	5.8
Standard Error	0.45
Kurtosis	0.87
Sample Size	167

Table 7 e-HLA Summary of Descriptive Analysis

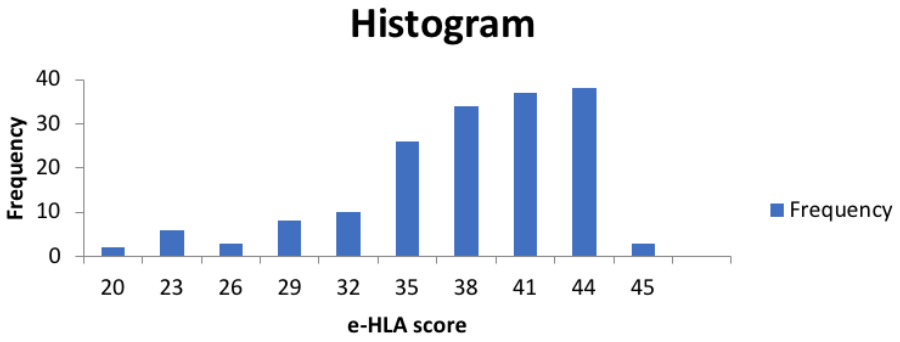


Figure 1 e-HLA Score Distribution (n=167)

5.1.5.3 Supplementary Questions and e-HLA scores

Three supplementary questions were selected for the comparison to the e-HLA scores using Spearman correlation. Results indicated that there was a significant positive correlation between the responses to the questions and the e-HLA scores, where people with higher e-HLA were more likely to report that they used online based services (see Table 8).

Supplementary Questions	e-HLA Scores	
	Spearman *p*	*p*-value
Q3 Interest in booking a re-screening appointment at the NSBSP using the online booking website	0.365	$p < .001$
Q2 How often participants use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)	0.389	$p < .001$
Q1 How often participants use the internet for booking (hotels, flights, government services…etc.)	0.414	$p < .001$

Table 8 Spearman rank correlation analyses for associations between supplementary questions and total e-HLA scores

Three supplementary questions were selected for the comparison among each other. Results of the Spearman correlation indicated that there was a significant positive correlation between the responses, where people with high interest in re-screening online booking are more likely to report that they use online health services (see Table 9).

Supplementary Questions	Q2 How often participants use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)		Q3 Interest in booking a re-screening appointment at the NSBSP using the online booking website	
	Spearman *p*	*p*-value	Spearman *p*	*p*-value
Q1 How often participants use the internet for booking (hotels, flights, government services…etc.)	0.431	$p < .001$	0.565	$p < .001$
Q2 How often participants use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)	--	--	0.402	$p < .001$

Table 9 Spearman rank correlation analyses for associations among supplementary questions

5.1.5.4 Supplementary Questions and e-HLA Technology Tool

Three supplementary questions were compared to the e-HLA (technology tool only). Results of the Spearman correlation indicated that there was a significant positive correlation between the responses (see Table 10).

Supplementary Questions	Technology e-HLA	
	Spearman *p*	*p*-value
Q1 How often participants use the internet for booking (hotels, flights, government services…etc.)	0.432	$p < .001$
Q2 How often participants use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)	0.324	$p < .001$
Q3 Interest in booking a re-screening appointment at the NSBSP using the online booking website	0.351	$p < .001$

Table 10 Results of Spearman rank correlation analyses for associations between supplementary questions and Technology e-HLA

In general, the results indicate that patients are willing to use online booking as an alternative to the traditional phone-based booking method. The correlation between the supplementary questions and e-HLA scores indicates the readiness of the patients to use the online booking system if implemented in the future.

5.2 Stage Two

5.2.1 Population

The targeted population for this phase was female patients who completed the survey in stage one and agreed to be contacted for future research. We also targeted the same senior booking clerks who participated in phase one of this study.

5.2.2 Recruitment

After the completion of the survey, the researcher scored the e-HLA portion of the survey and used the scores to group respondents into three equal-sized groups based on the scores (low, medium, high). Six participants were randomly sampled from each of the medium e-health literacy group (score: 34-40) and high e-health literacy group

(score:40-45). It was decided to exclude participants with low e-health literacy scores. Phase 2 of the study was conducted remotely due to COVID-19-related restrictions barring in-person data collection, and we were concerned that participants might find it challenging to complete the task and interact with the researcher using online tools. Using such online tools require a minimum level of e-literacy, which may make it a challenging task for participants with low e-HLA scores, affecting their performance during the online design session.

The 6 medium e-HLA participants were randomly assigned into 2 groups (3 participants in each group: exposed to complexities and not-exposed to complexities). The 6 high e-HLA participants were similarly randomly assigned into 2 groups. In addition to patients, the 3 senior booking clerks who participated in phase one were invited to participate in this stage, only 2 clerks consented to participate.

5.2.3 Procedure

All participants, including the booking clerks, were invited to the online design activity as a member of one of the following groups:

- Exposed participants design activity: The plan was to expose only the group of 6 participants to the booking scenario complexities. This was achieved by introducing the participants to the booking scenarios that were generated from our discussion with the booking clerks at the NSBSP (see section 5.6).
- Non-exposed participants design activity: The plan was to generate artifacts by 6 non-exposed participants without any exposure to booking complexities. The participants followed the same protocol as the exposed group except that they did not went through the exposure activity.
- Booking clerks design activity: The plan was to generate 3 artifacts by 3 clerks without any exposure to booking complexities. They were not exposed because we wanted to rely on their experience to build the artifacts without being exposed to the scenarios.

A total of 14 online prototyping sessions were conducted as follows:

- 3 exposed mid e-HLA.
- 3 unexposed mid e-HLA.
- 3 exposed high e-HLA.
- 3 unexposed high e-HLA.
- 2 unexposed senior clerks.

The researcher worked directly with each participant through an online whiteboard to build the interface and sequence of interactions between the client and PFS. The researcher was available to answer any questions during the session. To guide this activity, Muller's PICTIVE prototyping guidelines were used to inform our modified PICTIVE protocol (Muller, 1991). Muller defined two design objects that can be used for PICTIVE prototyping: simple office tools like, "highlighters, papers, Post-It™ notes of many sizes, stickers and labels, and paper clips — all in a range of bright colors" (Muller, 1991), and paper-based icons that represent interface commands like drop-down menus, command bars, menu bars, text boxes, etc., which are prepared by researchers or designers based on the nature of the project (Muller, 1991). Before starting the actual PICTIVE activity, Muller recommends the following:

- That participants must be aware of the purpose of the system that they will work on. There will be no leader in the group, but it is recommended to assign a participant to make sure that the group is covering the agenda/tasks list during the activity. Each participant will bring to the activity his/her personal expertise. They must be reminded that they are the experts during the activity and they can suggest or change whatever they want.
- That designers/researchers prepare the system components in advance. Components are considered as building blocks and include widgets and icons that represent functions and features of the proposed system. The components and system elements are based on the nature of the project and its environment.

PICTIVE was chosen to inform our modified approach, explained in detail in this section, because it is categorized as a static, low-fidelity, coarse-grained, and less-evolved

prototyping method. It is a method that is easy to implement and can be handled by non-expert end users (patients) that have no experience in prototyping (Muller, 1991).

In addition, the "Think aloud" technique was employed to find out the justification behind decisions made by the participants (Vardoulakis et al., 2012). This approach was inspired by Vardoulakis et al. During the session, the researcher asked the participants about their justification for every decision made by the participant, for example placing an icon, suggesting a feature, writing a note, and creating a new page. We followed the low fidelity prototyping techniques to involve our participants in the activity (Muller, 1991, Bodker et al., 1987, Bodker et al., 1988). As an alternative to the tangible design artifacts "PICTIVE prototyping elements" (e.g., icons, colored text boxes, drawing tools), we used online whiteboard elements for the design session. The whiteboard design elements were obtained from User Interface (UI) mock-ups Kits that are used to build UI prototypes. The selected elements represent different functions as follows:

a. Social media communication,
b. Print,
c. Copy,
d. Support,
e. User profile,
f. Log-in,
g. Calendar, and
h. Navigation and confirmation (proceed and back).

In order not to limit the participants to the pre-identified elements, a set of blank widgets and sticky notes mock-ups was provided. The selection of the design elements was inspired by different online services like online banking, travel booking and restaurants reservations. Figure 2 shows a screenshot of the online whiteboard that we used to facilitate the design session.

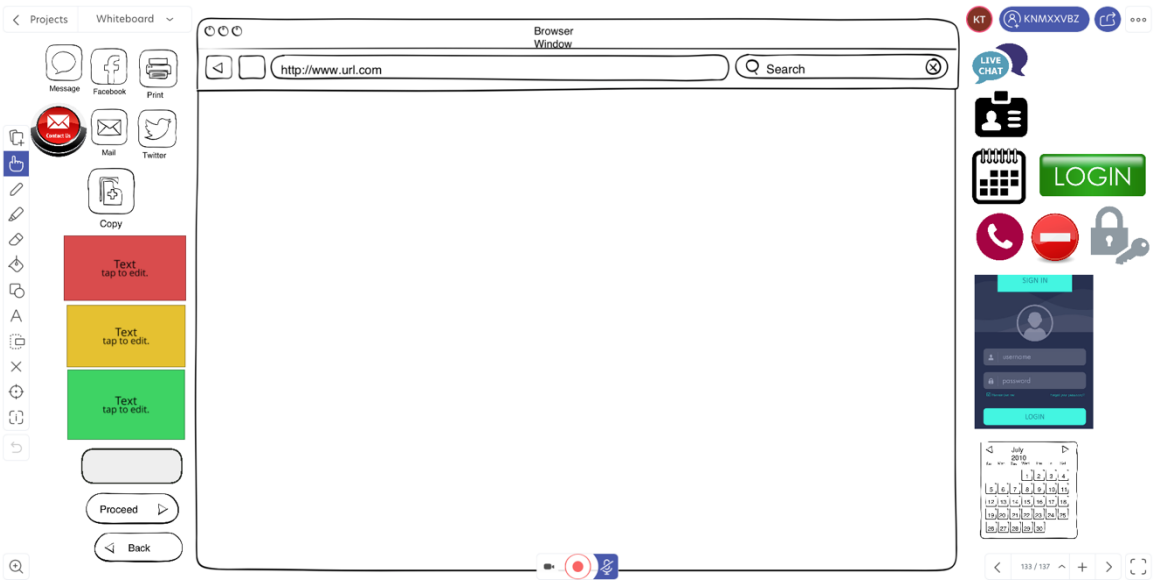


Figure 2 online whiteboard and design icons

On both sides of the whiteboard were placed icons that could be used by the participant to design the online booking portal. Participants were informed that they were not limited to the icons on the screen, as they could draw any icon or shape if needed. We also informed them that if they encountered any difficulties during the session, the researcher was available to take control of the pointer and draw based on their instructions.

5.2.4 The Prototyping Day

In the following, we list the protocol that was followed during the prototyping session.

- On the meeting day, the researcher sent an email that included an invitation link that took the participant to the design session.
- The researcher greeted the participant and asked her if she had any questions.
- The researcher informed the participant that the meeting would be audio- and screen-recorded.
- The researcher introduced the concept of online booking to the participant by providing common examples like Expedia.com and restaurant reservations.

- (exposed groups only) The researcher presented the scenarios to the participant. Each participant had the chance to read the scenarios from the screen in front of her.
- The researcher explained how to draw and sketch the design following the principles of PICTIVE prototyping. Each participant had the chance to watch the researcher drawing and sketching few basic elements like arrows, boxes and write notes inside the boxes.
- The researcher played a tutorial video on how to use the online whiteboard. The purpose of this step was to make sure that participants were comfortable to complete the designing activity.
- The researcher asked the participant to perform a mini design task where the participant was asked to drag icons, place icons on the whiteboard, draw icons and write notes.
- Once comfortable with the technique and controls, the participants were asked to design an online booking interface for a re-screening appointment while considering the following criteria (i.e., minimum requirements):

1. Successfully book a screening appointment,
2. Confirm the appointment, and
3. View the medical chart.

The minimum requirements were selected to guide the prototyping session and keep the flow of the activity. The researcher informed the participant that she was not limited to the previously mentioned requirements, as she could add any feature/function she wanted. The researcher also started each design activity by stating “you have a powerful computer with unlimited resources that enables you to do whatever you want; there is no limit”. It was stressed that these were the minimum requirements to complete the design session and participants were welcome to suggest any additional features/functions that might be helpful for future users. It was also stressed that they should not hesitate to suggest any features/functions, even if they appeared unrealistic,

as there was no right or wrong when it comes to prototyping. Each participant was constantly reminded that she was expected to think aloud during the session.

Each design session was followed by a short audio-recorded semi-structured interview. The interviews were semi-structured, using a set of questions to guide the discussion to ensure we did not deviate from the main purpose of the interview. The main goal was to explore the willingness of the participants to use the online booking systems. We also wanted to explore the values associated with the concept of PFS systems in general and online booking systems. We followed the same order of our questions to maintain the flow of discussion. We used a set of questions to guide the semi-structured interview and engage the participant (see Appendix D).

5.2.5 Impact of COVID-19 on Methods

It should be noted that our methods went through significant changes due to the **Co**rona **Vi**rus Disease of 20**19** (COVID-19) outbreak. The local government and health authorities in NS suspended all studies that required physical contact with patients. The suspension occurred after the completion of stage one of phase two of the study. In order to resume our research and to ensure the safety of our participants and research team members, we had to redesign stage two of phase two to ensure safe research practices that consider social distancing policies. We were planning to contact 24 participants, 12 low e-health literacy participants, and 12 high e-health literacy, and invite them to meet with the researcher in pairs. Participants were to be randomly assigned to one of the study groups as follows:

- Exposed & High e-health literacy (3 groups, 2 participants in each group): patients with high e-health literacy score and completed the booking scenarios complexities focus group activity.
- Exposed & Low e-health literacy (3 groups, 2 participants in each group): patients with low e-health literacy score and completed the booking scenarios complexities focus group activity.

- Non-exposed & High e-health literacy (3 groups, 2 participants in each group): patients with high e-health literacy score and did not participate in the booking scenarios complexities focus group activity.
- Non-exposed & Low e-health literacy (3 groups, 2 participants in each group): patients with low e-health literacy score and did not participate in the booking scenarios complexities focus group activity.
- Booking clerks (3 clerks): senior booking clerks at the NSBSP.

All participants, including the booking clerks, were to be invited to the designing session over three days as follows:

- Day One: Exposed participants will complete the focus group activity and followed by the designing session.
- Day Two: Non-exposed participants will complete the designing session.
- Day Three: Booking clerks will complete the designing session.

The researcher was to work closely with each group of participants to build the interface and sequence of interactions between the client and PFS. Participants were to be provided with tools for task completion and were video recorded (hands only) during the activity. We also planned to employ the "Think aloud" technique to find out the justification behind decisions made by the participants. During the session, tangible artifacts such as "PICTIVE prototyping elements" (e.g., blank posters, sticky notes, pens) were to be used to allow users to express their vision and demands while designing the interface. After the completion of the designing session, the researcher was to start an open-ended discussion, to gain insight into the design decisions made by the users.
The impact of these changes are discussed in section (see section 7.4.2).

5.2.6 Ethical Considerations

Senior booking clerks were identified by the NSBSP and asked to share their knowledge and experience with the researcher. Results were anonymized, referring to

the ID number only. No specific quotes and comments were attributed to individual booking clerks nor communicated to the manager.

The study focused only on the patients' opinions and feedback about online booking systems and technology solutions – no personal health information was collected. Patients were provided with an overview of the project as a part of the consent process over the phone.

We made it clear and informed all participants about using the audio recorders during the designing session. Individuals also were informed that their participation was voluntary and they could leave the study at any time without any impact on the quality of healthcare that they receive from the NSBSP. Results were anonymized, referring to the ID number only.

To acknowledge the time and effort that was provided in participating in our study. The participants were offered a total of $45. Phase two was conducted into two stages, part one which involved the design activity, and part two which involves the designing group debriefing, ($20 for part one and $25 for part two).

5.2.7 Analysis

To analyze the data that emerged from the artifacts, we applied 3 common HCI approaches as follows:

Requirements fulfillment: *This is a*n approach used to assess the completeness of the design by checking whether the proposed design accommodates the suggested requirements. Each artifact was evaluated against the suggested design requirements which were used to guide the designing session. In addition, new requirements and features were identified in each artifact through video analysis. Each artifact was examined to identify icons and widgets that represented functions. The video recordings were also used to identify functions suggested by the participant during the design

session. The additional functions were clustered by purpose. This approach enabled us to compare the artifacts among all groups in terms of both requirements fulfillment and new requirements.

Scenario-based walkthrough: A scenario-based walkthrough was conducted to determine whether the proposed design addressed the complexities embedded in the pre-defined scenarios. Each artifact was evaluated against the pre-defined scenarios to determine if the design features addressed any of the complexities. This enabled us to compare the artifacts among all groups in terms of whether scenario complexities were accommodated.

Thematic analysis of design decisions: A qualitative and inductive analysis approach was used to gather more insight into the decision-making process by the users. To identify the rationale behind design decisions, the comments from the artifacts and comments from the video recordings were transcribed. This approach was adapted from Miles et al. in which the transcribed data were analyzed by performing "Inductive Coding" (Miles et al., 2914). To guide our analysis, we applied the steps of "Inductive Thematic Analysis", which was inspired by multiple HCI research studies (Jacobs et al., 2015, Andersen et al., 2017, Pfeifer et al., 2012, Mishra et al., 2018). This was performed as in the same manner as for the booking clerk interviews (see section 5.5).

The resulting themes were discussed in relation to e-health literacy groups' exposure to the operational complexities. Themes were also supported by direct quotes by the participants and the condensed sentences were used for discussion.

5.2.8 Results

We analyzed each prototype using the following HCI qualitative analysis methods defined above: requirements fulfillment, scenario based walkthrough, and thematic analysis.

An example of artifacts produced by using the online PICTIVE is shown in Figures 3 and 4. (see Appendix E for the full set of artifacts).

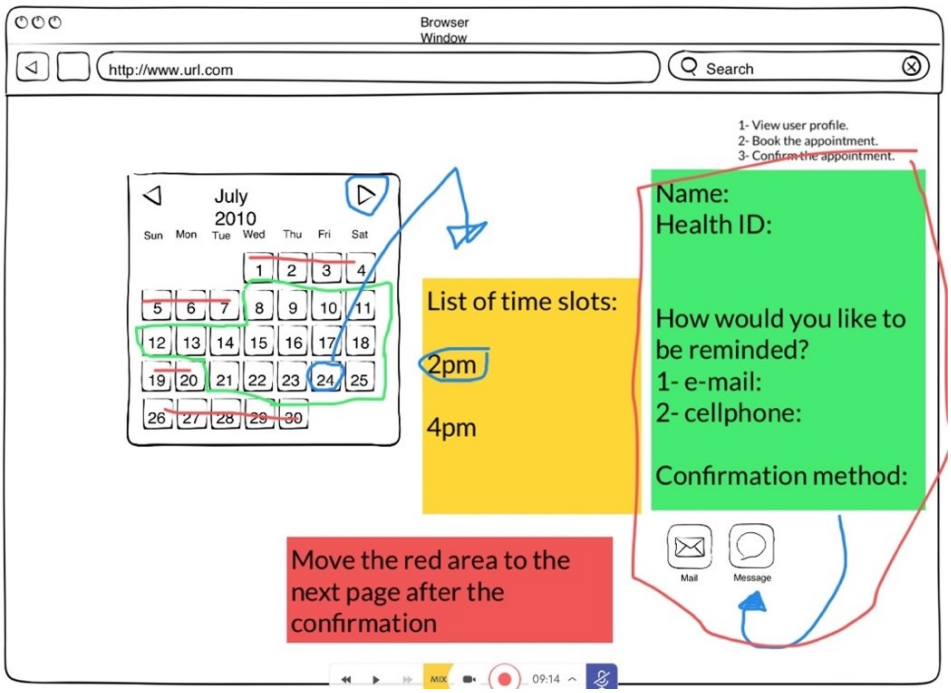


Figure 3 Sample prototype - appointment selection using a calendar

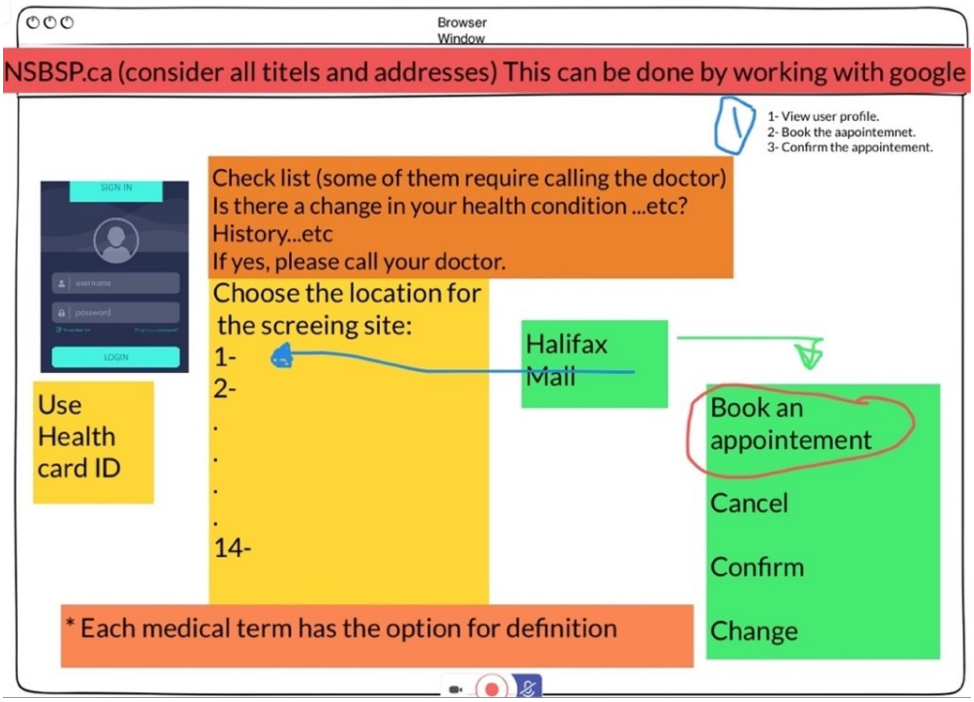


Figure 4 Sample prototype - log-in page

5.2.8.1 Requirements Fulfillment

We evaluated each prototype against the basic design requirements used to motivate the prototyping activity. Data from the requirements fulfillment analysis were grouped into three different groups based on exposure status and populations (exposed patients, un-exposed patients, and clerks). Tables 11, 12, and 13 show the results of requirements fulfillment for the exposed, un-exposed groups and clerks.

Participant	Requirement 1	Requirement 2	Requirement 3
P-38	✓	✓	X
P-42	✓	✓	✓
P-22	✓	✓	X
P-10	✓	✓	✓
P-34	✓	✓	✓
P-2	✓	✓	✓

Table 11 Requirements Fulfillment (Exposed)

Participant	Requirement 1	Requirement 2	Requirement 3
P-31	✓	✓	✓
P-4	✓	✓	✓
P-7	✓	✓	X
P-6	✓	✓	✓
P-24	✓	✓	✓
P-9	✓	✓	X

Table 12 Requirements Fulfillment (Un-exposed)

Participant	Requirement 1	Requirement 2	Requirement 3
Clerk 1	✓	✓	✓
Clerk 2	✓	✓	✓

Table 13 Requirements Fulfillment (Clerks)

During the requirements fulfillment analysis exercise, we noticed that our participants suggested features to address different issues that might be faced by online booking users. Suggested features were in the form of functions that would allow potential users to avoid complexities associated with online booking.

The proposed features were grouped based on functionality as follows.

1. Reminder: Features in this category refer to website services that aim to remind the user about their upcoming appointment (see Figure 5). Features include calendar auto-sync-mail, automated phone call, mail, and text.

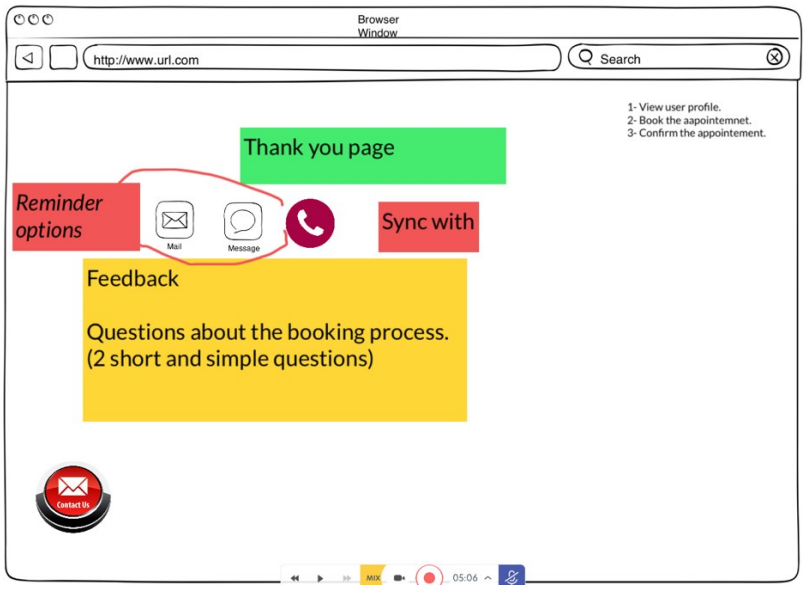


Figure 5 Sample prototype - two reminder options (mail and message)

2. Confirmation: Features in this category refer to website services that aim to confirm the booked appointment (see Figure 6). Features include print/Mail, e-mail, text, and on-screen.

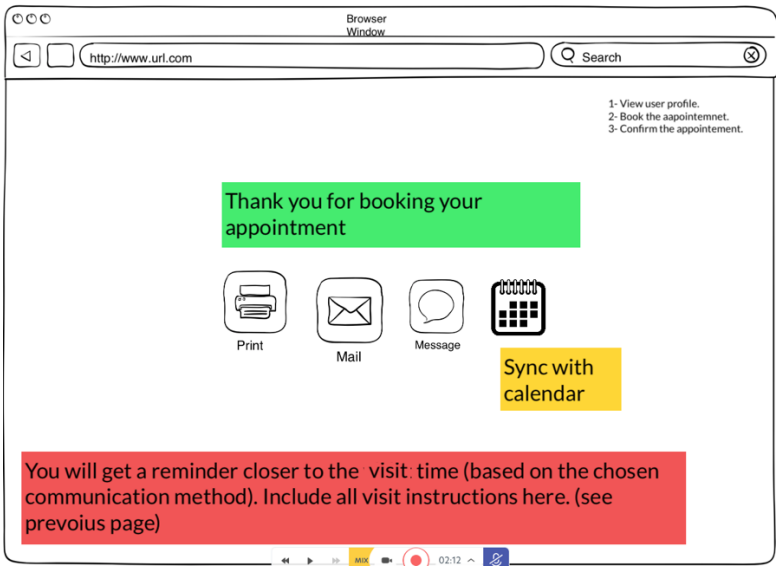


Figure 6 Sample prototype - three appointment confirmation options (mail, message and print)

3. Assistance: Features in this category refer to website services that aim to aid users with special needs and users who require clarifications regarding their appointments (see Figure 7). Features include audio support, font size, medical terms tooltip, live chat, FAQ, and call us.

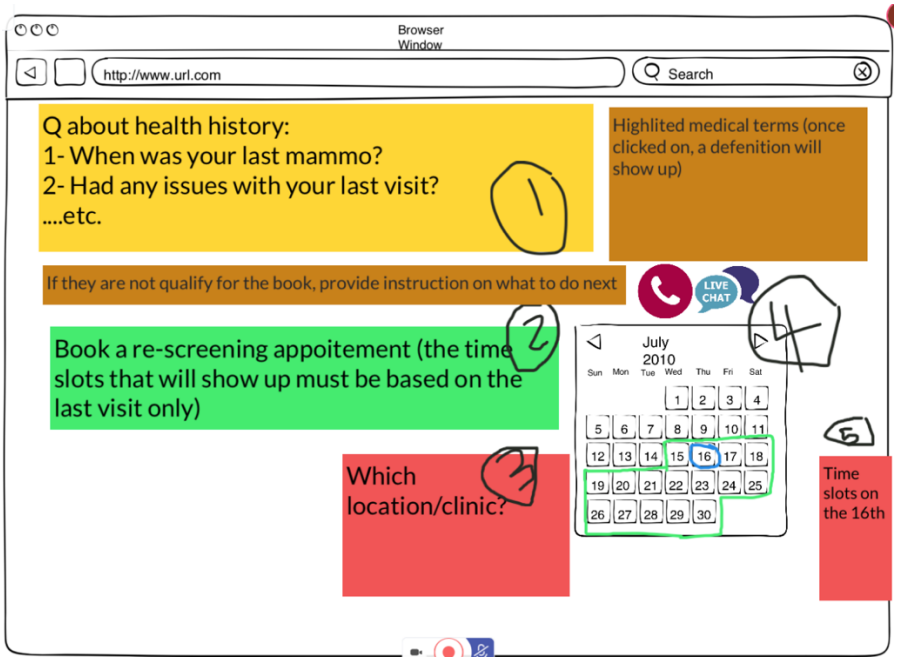


Figure 7 Sample prototype - two assistance options (phone call and live chat)

4. Social Media: Features in this category refer to website services that provide users with the ability to connect/sync with social media services (see Figure 8). Features are, Facebook and Twitter.

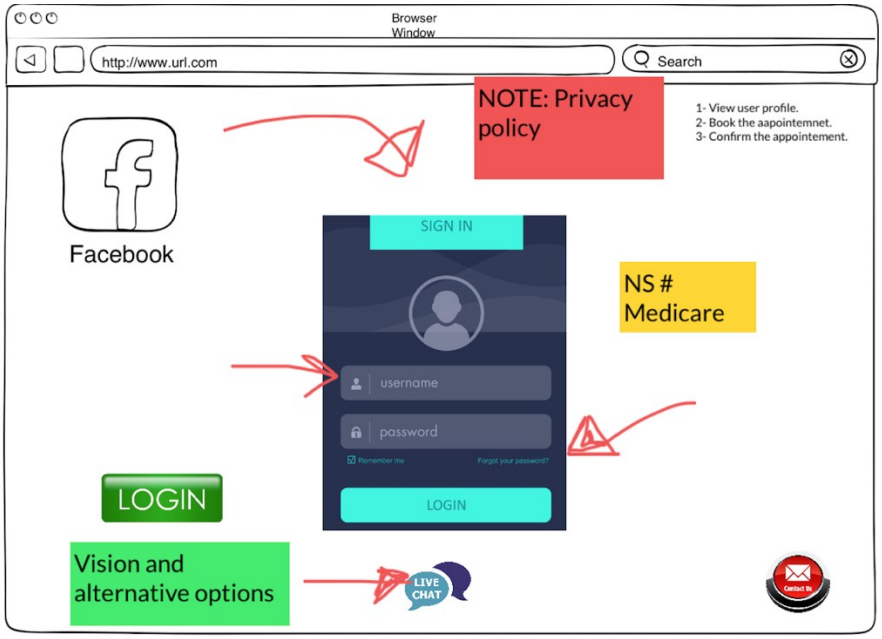


Figure 8 Sample prototype - social feature (Facebook)

5. Management: Features in this category refer to website services that allow the user to manage their accounts and appointments (see Figure 9). Features include secure Log-in, calendar, and medical chart.

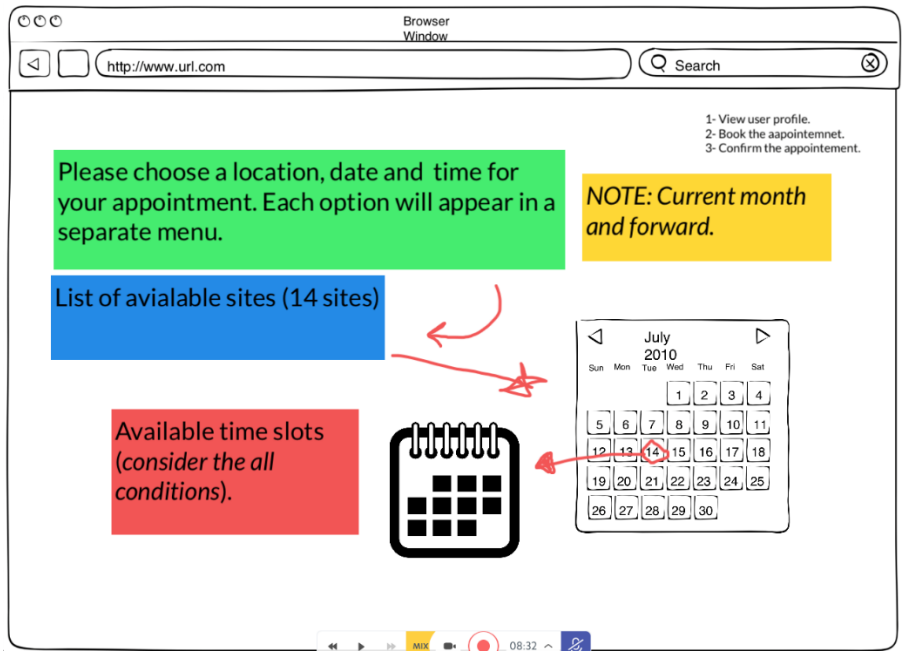


Figure 9 Sample prototype - calendar options

Tables 14, 15 and 16 list additional suggested features by the participants.

	Feature	P-38	P-42	P-34	P-10	P-2	P-43
Reminders	Calendar auto-sync	✔		✔	✔		✔
	e-mail	✔	✔	✔	✔	✔	
	Auto phone call		✔	✔	✔	✔	
	Mail	✔	✔	✔	✔	✔	✔
	SMS		✔	✔	✔	✔	
Confirmation	Print/Mail	✔	✔			✔	
	e-mail	✔		✔	✔		✔
	SMS					✔	✔
	On-Screen	✔	✔	✔	✔	✔	✔
Social Media	Facebook		✔				
	Twitter		✔				
Management	Secure log-in	✔	✔	✔	✔	✔	
	Medical Chart		✔	✔	✔	✔	
	Calendar	✔	✔	✔	✔	✔	✔
Assistance	Audio Support			✔		✔	
	Font Size			✔			
	Medical Terms Tooltip	✔	✔				✔
	Live Chat	✔	✔		✔	✔	
	Call Us/Contact Us	✔	✔	✔	✔		✔
	FAQ			✔			✔

Table 14 Additional features proposed by participants during prototyping (Exposed)

	Feature	P-6	P-24	P-9	P-31	P-4	P-7
Reminders	Calendar auto-sync						
	e-mail	✔					
	Auto phone call						
	Mail						
	SMS	✔					
Confirmation	Print/Mail	✔					
	e-mail						
	SMS						
	On-Screen						
Social Media	Facebook						
	Twitter						
Management	Secure log-in	✔	✔	✔	✔	✔	✔
	Medical Chart						
	Calendar	✔	✔	✔	✔	✔	✔
Assistance	Audio Support						
	Font Size						
	Medical Terms Tooltip						
	Live Chat						✔
	Call Us/Contact Us						
	FAQ						

Table 15 Additional features proposed by participants during prototyping (Un-exposed)

	Feature	Clerk 1	Clerk 2
Reminders	Calendar auto-sync		
	e-mail		✔
	Auto phone call		✔
	Mail		
	SMS		
Confirmation	Print/Mail	✔	
	e-mail	✔	
	SMS		
	On-Screen	✔	
Social Media	Facebook		
	Twitter		
Management	Secure log-in	✔	✔
	Medical Chart	✔	✔
	Calendar	✔	✔
Assistance	Audio Support		
	Font Size		
	Medical Terms Tooltip		
	Live Chat		
	Call Us/Contact Us	✔	✔
	FAQ	✔	✔

Table 16 Additional features proposed by participants during prototyping (Clerks)

5.2.8.2 Scenario-Based walkthrough

We evaluated each prototype against the pre-defined scenarios to determine whether the proposed design addressed the issues in the scenarios.

Tables 17, 18, and 19 outline whether the proposed prototype address the complexities associated with each of the scenarios (scenario-based walkthrough). Results from the unexposed patients and the clerks indicate that their proposed designs do not accommodate the pre-defined complexities scenarios. On the other hand, results from the exposed group suggest that their proposed designs were more likely to address the pre-defined complex scenarios.

Participant	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Total
P-31						0/5
P-4		✔	✔			2/5
P-7						0/5
P-6		✔	✔			2/5
P-24						0/5
P-9						0/5

Table 17 Scenario complexities addressed (Unexposed)

Participant	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Total
P-2	✔	✔		✔	✔	4/5
P-34		✔	✔	✔	✔	4/5
P-10	✔	✔	✔	✔	✔	5/5
P-38	✔		✔	✔	✔	4/5
P-42	✔	✔		✔	✔	4/5
P-22	✔	✔	✔		✔	4/5

Table 18 Scenario complexities addressed (Exposed)

Participant	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Total
Clerk 1		✔	✔			2/5
Clerk 2		✔	✔			2/5

Table 19 Scenario complexities addressed (Clerks)

5.2.8.3 Thematic analysis of design decisions

We analyzed the prototypes that were produced using the thematic analysis protocol. Two main themes and 9 sub-themes were identified based on the codes that emerged from the transcribed video recordings. Table 20 describes the counts of codes, stratified by participant group.

Codes	Exposed	Un-Exposed	Un-Exposed Clerks
Design Reference	4	3	0
e-Literacy	4	0	0
Values	7	3	2
Core feature	5	2	0
Engagement	3	0	0
Rationale for Functional Choices	7	1	2
Considerations	4	4	2
Flow	5	1	2
Web purpose	5	2	0

Table 20 Prototyping design decisions – thematic analysis codes by participant group

In the following subsections, we describe each theme and associated codes from the prototyping sessions (see Appendix F for examples of supporting quotes for each theme).

5.2.8.3.1 Influence by Individual Approach

Five sub-themes were identified that describe the impact on the design decisions by individual influential factors.

1. **Design Reference:** This refers to participants using a functioning system or an experience as a reference to influence their design. The associated codes were *features reference* and *design flow reference*.
2. **e-Literacy:** This refers to participants stating that they are having difficulty during the session. Every time the participant paused for a while without saying anything or thinking aloud, this was an indication of a struggle. In addition, the coding was triggered when the participant verbally expressed struggle or finding the activity hard to complete. The associated codes were *self-confidence, ability to deal with the task,* and *familiarity with online services.*
3. **e-Booking Values:** Values describe how e-booking may be a better alternative to phone booking. The associated codes were *personal values, e-service advantages,* and *e-booking in contrast to phone booking.*

4. Core Attribute (personal perspective): This refers to participants emphasizing the importance of a design element or feature. The associated codes were *emphasis on simplicity, emphasis on potential users' age,* and *emphasis on interface language.*

5. Engagement: This refers to the level of personal engagement that influences the overall designing experience. The associated codes were *direct statement, side talk,* and *prototype review.*

5.2.8.3.2 Influence by Exposure and Activity

Four sub-themes were identified that represent the influence on the design decisions by the designing task.

1. Rationale for Functional Choices: This describes the rationale behind the key features proposed by the participant to address the basic requirements or/and complexities. The associated codes were *basic features, complexities-related features,* and *beyond complexities features.*

2. Design Considerations: This refers to participants making a design decision to accommodate their needs and/or potential users' needs. The associated codes were *self-oriented approach* and *the other-oriented approach.*

3. Design Flow: This refers to the proposed interaction flow between the user and the system to accommodate the basic requirements and complexities. The associated codes were *log-in to Log-out, location-day-time,* and *when to check eligibility.*

4. Website Purpose: This refers to the participants' approach to defining the website purpose, which could have multi-faceted purposes with one or many different goals and objectives. The associated codes were *online booking, educational website + Booking,* and *educational + health Portal + booking.*

In general, the results revealed a connection between exposing the participants to operational complexities and their comprehension of complexities underlying the

online booking system, as shown in the artifacts produced by the exposed group. The produced artifact were more comprehensive and rich, in terms of features to address usage complexities.

Chapter Seven: Discussion

This study was conducted to evaluate/identify the influence of exposing end users to operational complexities on their design decisions in the context of Patient-Facing System (PFS) Design. We have evaluated how e-Health Literacy and exposure to operational complexities influence comprehension of complexities underlying PFS design, as measured by requirements fulfillment, scenario-based walkthrough, and thematic analysis. The results revealed a difference between the artifacts produced by the exposed group and un-exposed groups in terms of the features and rationale underlying the design decisions. This indicates the influence of the exposure technique on the design decisions made by the exposed participants. Our results demonstrate that exposing end users to operational complexities yielded design artifacts that were more comprehensive in terms of features and design rationale. In addition, artifacts produced by the exposed end users, independent of their electronic health literacy, were richer in terms of features that have the ability to accommodate operational complexities as compared to experienced designers (booking clerks) and un-exposed participants.

Results from phase one indicate that senior booking clerks were concerned about the operational complexities underlying online booking systems. In particular, they were concerned about the interaction between the patients (end users) and the online booking system without external guidance. Results from phase two revealed that involving exposed/aware users in the design process yielded comprehensive design decisions and features that can be used by developers to guide the system development. Contrary to our expectations, exposing end users to operational complexities gave them this advantage regardless of their electronic-health knowledge. The results from phase one and phase two will be discussed with a focus on the influence of exposing end users (patients) to the operational complexities underlying online booking systems.

7.1 Service Provider Engagement in the Design Process

The study results revealed that online booking systems as PFS are subject to operational complexities. This was based on discussions with the senior booking clerks that enabled us to explore and learn about the clerks' perspective about online booking services for breast screening. The complexity related categories, and the associated codes that were identified from the interviews, indicated a consistent concern by the clerks. Engaging the booking clerks at the initial phase of the system design, before developing the first prototype, informed the methodology of the following study phases. Through this process, we identified a set of operational complexities based on the obstacles that may be encountered by the clerks and callers (patients) on daily basis. The complexities were specific to online booking systems for breast screening and not available in the literature. The impact of these complexities on the design, derived from the knowledge of the main service providers, demonstrated the importance of involving service providers in the process. This involvement is consistent with the recommendations to initiate an exploratory phase to identify the boundaries of the proposed system (Litcher, 1994, Floyd, 1984).

7.1.1 *PFS and Operational Complexities*

In comparison with non-healthcare sectors, we believe that adopting online booking services in the context of healthcare is more complicated, due to the underlying operational complexities and related challenges. The main challenge is the operation of the system by the patients with little to no external guidance. This was clear from the senior clerks' responses, in which they were concerned about patients operating the system on their own. For example, one of the clerks (P1) was concerned about the correctness of booking. She said, "the downsides I can see is if the system doesn't work the way it should, and someone gets booked early or get booked inappropriately". This also was reflected in another clerk's (P3) statement, "if you are breastfeeding, then you can't have a mammogram". Their concern aligned with the literature that classify online

booking systems as PFS, which should be operated by the end users with little to no external support (Fox & Jones, 2009, Weingart, 2006).

Unlike commercial services, a second complication of online booking of healthcare services is related to the eligibility of patients to book appointments. As one of the clerks (P2) stated, “The only downfall for ladies booking online is that we ask eligibility questions to certainly make sure they are eligible for the screening appointments”. Another clerk was concerned about the complexity of cases that requires special attention, (P3) “if we have ladies with Down Syndrome, they can go to the mobile, it’s fine, but they just need two appointments”.

Finally, the last concern was related to the e-health literacy of patients and their ability to operate online portals without external guidance, which aligns with findings by Karnoe et al. (2018), as clerks believed it is essential to evaluate health- and technology-related competencies to ensure the optimum operation of health systems. This was observed in the clerks’ responses: clerk (P2) said, “Some ladies will say no, but I had a mole removed. Which to them could be surgery” ; and clerk (P3) said, “if the biopsy is fine, we don’t consider it a surgery either. So, there are a lot of medical terms and I don’t understand all medical terms, and when you ask, have you ever had any breast surgery, well I will question what you mean by breast surgery”. In the past and before relying on computer systems, healthcare providers relied on paper based medical forms to collect data from their patients. If any ambiguity encountered by the patients, they could easily ask the clerks or nurses in the clinic. Medical forms (paper-based) underlying complexities are likely limited to the comprehension of medical data presented on the forms. Therefore, forms designers/developers relied on health literacy measurement tools to anticipate the targeted population’s knowledge and ability to complete the forms with little to no external guidance. However, due to the rapid advancement and implementation of computer technology in healthcare, it is important to consider patients’ technology literacy (e-literacy) as a competency to operate healthcare computer

systems. This aligns with the recommendation to consider the relationship between patients' health literacy and e-literacy while developing healthcare systems (Karnoe et al., 2018).

7.1.2 *Operational Complexities: Extreme Characters*

PFS are designed to be operated by end users, without external guidance, at the point of service. Users are required to make decisions with minimal assistance from the system while interacting with it. It is important, therefore, to know or predict who will be using the system. During our interviews, it was clear that the clerks were concerned about how a future booking system would be operated by patients without guidance. Our interviews identified an opportunity to create extreme users with special needs and expectations. This observation aligns with findings by Djajadiningrat et al. (2000), who indicates that creating user profiles with extreme characters, unusual needs, and expectations may lead to the identification of usage scenarios that are usually harder to discover (Djajadiningrat et al., 2000). Extreme scenarios of usage require non-typical users to complete the picture. This aligns with the literature (Djajadiningrat et al., 2000, Junior & Filgueiras, 2005).

7.2 Patients (end users) Engagement in the Design Process

Considering end users during design is essential to User-Centered Design. The design must encompass the main users by considering their requirements and expectations (Junior & Filgueiras, 2005). However, it is not just about considering their needs and meeting their expectations, but also about involving them in the design process. In the PFS literature, end user engagement in design is discussed, however, it is either presented at a high level or is focused on usability testing at later stages (Viswanathan & Linsey, 2009, Yang & Epstein, 2005, Rodriguez-Calero et al., 2020, Dieter & Schmidt, 2013, Pietzsch et al., 2009, Zenios et al., 2010). Further research is recommended within the context of end user engagement in design to develop guidelines

and explore alternatives to the current approaches (Rodriguez-Calero et al., 2020, Privitera et al., 2017). Thus, we will discuss how we involved our participants in the design cycle and how this involvement revealed design factors that we recommend to be considered by PFS developers.

7.2.1 *Electronic Health Literacy and Patient-Facing System Users*

The relationship between patients' health literacy and computer-related skills (e-literacy) must be considered to ensure the best possible practice of using electronic health systems (Karnoe et al., 2018). We utilized the e-HLA toolkit to evaluate both health literacy and e-literacy (i.e., e-health literacy). We wanted to understand the distribution of e-health literacy in our population and to explore the role of e-health literacy on design decisions. The distribution of e-HLA scores for the participants (see section 5.3.2) tended towards the higher end of the possible scores. It should be noted that it is accepted that screening patients tend to be of higher social status (self-referred and well-informed patients) as compared to other women of their age. Therefore, we expected to find a higher e-HLA score distribution among this population. This might also explain the correlation between the e-HLA score and the patients' responses to our supplementary questions about the usage of online based services and their high acceptance of future online booking systems (see section 5.3.3). For example, there was a statistically significant positive correlation between the interest in booking their re-screen appointments at the NSBSP using the online booking website and the e-HLA score, ($r(167) = 0.365$, $p < .001$). However, it is important to consider the nature of the survey; this is a self-rated survey and it is common among participants to give themselves high ratings (Short et al., 2009). This finding also aligns with the literature that criticizes this type of measurement tool because it focuses on operational skills, which does not indicate the real performance in completing tasks using online systems by the end user (Van Deursen & Van Dijk, 2009). The correlation results also indicated a significant positive correlation between how often participants use the internet (including mobile applications) for

health services (pharmacy, family clinic…etc.), and the interest in booking screening appointment using the online booking website.

We focused on the impact of exposure on design decisions made by participants. Exposure was the main controlled variable, but it is important to look at other variables related to the electronic health literacy of the participants, in particular, the variables associated with the questions in the e-HLA measurement toolkit (Karnoe et. al, 2018). The toolkit is made up of seven tools that measure different aspects of e-HLA. The toolkit was not developed to measure the competency associated with each tool independently, but there may be a connection between the design decisions and some of the sub-tools.

7.2.2 **Influential Factors On Design Decisions**

We provided participants scenarios of complexities (exposed group), basic design requirements to motivate the activity, and a low fidelity design tool. The following statement was used to motivate each participant, “you have a powerful computer with unlimited resources that enables you to do whatever you want, there is no limit” and whenever the participant asked “Can I do this?” or “Can I suggest this feature?”, our response was “it is your system, your decision, you can do whatever you want, there is no right or wrong”. This was to allow them to feel that they have no restrictions and have the final say on design decisions. In the following, we will use examples from the design sessions to discuss the factors we believe influenced the end users in the design process.

7.2.2.1 Influence by Individual Attributes

Each participant approached the design session with individual factors that resulted in unique artifacts. One of these individual factors was experience with other online systems as a reference in their design decisions. For example, participant (P42) said, “when I do my taxes online and whenever I face something that I don’t understand, they have a little look up thing that explain things … a basic dictionary appears when you press

on a word". The participant was clearly influenced by her experience with a tax portal, thus suggesting the addition of the dictionary function for her proposed design. Thus, the more the participants are familiar with online services, the more sophisticated design decisions were made during the design session. Because they were exposed to other online services, they wanted similar features, such as auto-sync calendar, secure log-in, and auto-reminder. Another example, participant (P7) asked for, "this has to be a drop-down menu if this is like HRM, so you will have many options to choose from". It is noted here that it is not only the features/functions that are influenced by the external reference online system but also how to navigate within the interface. It is important to note that it was expected that our participants would be familiar with online services, in general. They were self-referred patients and therefore likely to be of higher social status, which was reflected by their high e-HLA score and the high-positive correlation between their scores and their use of online services ($r(167) = 0.565$, $p < .001$).

Another important individual factor that was noted was the participants' familiarity with computer systems (e-literacy) and the impact on their acceptance and willingness to use e-health systems, an observation which is consistent with the literature (Karnoe et al., 2018). Being familiar with computers and technology, in general, has an impact on the interaction between humans and computer systems. When it comes to design decisions, we found that there was in fact no connection between them. We noticed that the comments about hesitation and struggle with the design tool (online whiteboard) were made by the participants who provided the richest designs in terms of features. For example, participant (P42) said, "this is nerdy stuff; I had to ask my husband to activate the code for the session". Although this participant faced issues with using her computer to complete seemingly simple tasks such as joining the design session, she provided one of the most comprehensive artifacts. This may be related to the desire of the participants with low e-literacy to propose a system that accommodates users who share the same level of expertise in dealing with computer systems. On the other hand, senior clerks proposed systems with fewer features, which we believe may be related to

their high level of expertise. They wanted to propose simple systems, likely thinking that simple systems are easier to operate, while less experienced participants proposed more complex systems to accommodate complex situations.

An additional individual factor that was observed was that personal values about online booking influenced design decisions. On many occasions during the design sessions, our participants emphasized attributes such as timeliness, accuracy, convenience, and accessibility. Whenever there is a value that is held and believed by a participant, we noticed that she wanted to implement it. This aligns with the principles of PD by Robertson & Simonsen (2013) and Leong & Robertson (2016), who believe that engaging the participants in the design process enables them to inject their values and needs as main users.

7.2.2.2 Exposure to Operational Complexities

One of the groups was exposed to the operational complexities through the booking scenarios before starting the design session. It was clear that this exposure influenced the content of the final artifacts. In terms of interactivity, all of the resulting artifacts were non-interactive in nature; this is expected due to the nature of the design tasks and the design tool provided (basic whiteboard and widgets). The difference between artifacts generated by the exposed versus and the un-exposed groups can be associated with the prototyping dimensionality of scope (O'Raghallaigh & Adam, 2017, Floyd et al., 2007, Jones et al., 2007, Beaudouin & Mackay, 2003). The artifacts produced by the un-exposed group were deemed to be horizontal in nature with no details and only addressed functions at the interface level. However, the artifacts that were produced by the exposed group showed some degree of vertical level of scope with features that were connected to the database at the NSBSP or the main hospital. The exposed participants proposed functions at the level of the human-computer interface as well as those connected to the level of the back system (connection between the online portal and other main health systems such as the health information system at the province/country level). For

example, participant (P4) stated, “once their chart info is available, they should be able to verify the info and check the contact info and all normal things; it will let us do it like how things are checked when you call the clinic to book an appointment” and participant (P9) who said, “why not connect it to the major health systems in the province to view charts and prescriptions?”. The number of features that were suggested by the exposed participants surpassed what was suggested by the non-exposed in terms of number, the complexities addressed, and the overall artifact sophistication. This aligns with the findings by Privitera et al. who note it is challenging to evoke the end users and make them identify what they may need from the proposed system (Privitera et al., 2017). For example, features like auto-calendar synchronization, automated phone call, social media connection, live chat, FAQs, and many more are not seen on the artifacts produced by the non-exposed group. This was not true only for exposed versus non-exposed groups; when we compared the artifacts by the senior clerks against what was produced by the exposed group, there were substantially more features suggested by the exposed participants as compared to the un-exposed participants and the clerks (see Table 21).

Group	Features	Total
Exposed	auto-calendar synchronization reminder, e-mail reminder, Auto phone call reminder, Mail reminder, SMS reminder, Print/Mail confirmation, e-mail confirmation, SMS confirmation, On-screen Confirmation, Facebook, Twitter, Secure log-in, Medical Chart, Calendar, Audio Support, Font Size, Medical Terms Tooltip, Live Chat, Call Us/Contact Us, FAQ	20
Un-Exposed	e-mail reminder, SMS reminder, Print/Mail confirmation, Secure log-in, Calendar, Live Chat	6
Clerks	e-mail reminder, Auto phone call reminder, Print/Mail confirmation, e-mail confirmation, On-screen Confirmation, Confirmation, Secure log-in, Medical Chart, Calendar, Call Us/Contact Us, FAQ	10

Table 21 Unique Features Proposed During Prototyping, By Participant Group

It was noted that the exposed participants proposed a list of rich features while the features proposed by the clerks were comparable to the features proposed by the un-exposed group. Although the clerks were administrative healthcare professionals who deal with booking complexities on a daily basis, they suggested fewer features to address

complexities compared to exposed participants. We identified unique and interesting features among the artifacts by the exposed group. We noticed that proposed features considered the needs of other potential users, which indicates that the participants were engaged in the activity. For example, participant (P2), said “I think we need something on the page where users can chat with a clerk but add it to the login page because if people cannot book an appointment, they can chat with someone. We do not want them to leave the website without booking so they can ask for help if needed”. Another example of the thoughtful features, participant (P34) asked, “I would like to add an option to update the information at any time. Say you moved or changed phone number or your doctor, you need an option or tap that is available on all pages to update your info”.

We noticed that the exposed participants also considered other users in their decision making, resulting in their artifacts being more reflective of different users’ needs and challenges (theme – Design Considerations). This was reflected in the number and type of features that were suggested by the participants. For example, one of the participants admitted that she is an “old school” and has a flip phone. She also said, “I hate texting”, but yet she suggested features to accommodate younger women who prefer email reminders.

It was noted that only a few participants suggested having an online booking tool without being connected to any other central system, such as the main hospital health information system or the Nova Scotia Medical Services Insurance (MSI) system. Some participants suggested the inclusion of health education resources alongside the online booking portal. For example, participant (P2) suggested, “while I am on the website, I want to learn about self-breast exam and learn about new breast screening options. I want it to be an educational website not just for online booking” and participant (P42) asked, “why not connect it to the major health systems in the province to view charts and prescriptions?”. It is worth mentioning that the suggestions about the website's purposes are prevalent among the exposed participants (see Table 20).

Participants suggested having an appointment booking portal because such systems avoid complications and maintain the ease of use. We believe that participants who were exposed to operational complexities wanted to keep the design easy to operate among all types of potential future users. This was mentioned by one of the exposed participants (P34) who said “It should be only for booking screening appointments, keep it simple”.

It was noted that the interaction between the researcher and the participant during the design session influenced the reasoning and logic of some design elements. Although we tried to be quiet during the session, to avoid any indirect impact on the participants, there were moments when we could not avoid interacting with the participant. For example, when one of the participants completed designing the FAQ page and moved to the next page, we had to interfere, not to alter the design, but to extract more ideas from the participant. Our conversation was triggered as follows, researcher- ”what if they are not eligible based on their answers? what will happen?” To which participant (P38) said, “I think an option to talk to someone would be great”. The participant suggested talking to someone, referring to the “contact us” feature. She could have suggested any other feature, but suggested talking to the NSBSP clerk over the phone. Sometimes the participants felt stuck and hesitant to take actions,. For example, participant (P7) said “the next thing … here is where … I don’t know…… I don’t know what to do to book an appointment mmmm”. The researcher replied, “take your time, maybe try to think of any other booking website that you used in the past”. We did not tell her what to do exactly, but rather tried to encourage her by triggering her experience with other systems. Some participants were engaged with the activity and expressed their excitement. We noticed that the more they started side discussions and expressed their excitement, the more comprehensive their design was in terms of addressing the booking complications. For instance, participant (P22) stated, “there was a major health information project in the province and it was a waste of resource, they should have done it this way”. This indicates a high level of engagement which was reflected in her artifact in terms of features and rationale. This behaviour is in line with the literature that recommends PD as a medium

to involve participants and empower them, which in return will yield a higher level of engagement (Robertson & Simonsen 2013, Leong & Robertson 2016).

7.3 Strengths

7.3.1 Sample Selection

Our participants were self-referred and well-informed patients who attended NSBSP for breast screening. This sample allowed us to evaluate the influence of the exposure technique among the potential end users of an online booking tool/PFS.

7.3.2 Researcher and Data Collection

Qualitative data collection was conducted by one researcher. A sole collector was used, which eliminated any inter-rater reliability related to data collection inconsistency, but may have increased the risk of observer bias.

7.3.3 Qualitative Approach

A qualitative approach was selected because it provides insight into the justification behind the design decisions made by the end users. The qualitative research approach provides evidence that the end users' feelings, behaviours, expectations, justifications and personal features may influence their design decisions. This data cannot be easily obtained by a quantitative approach.

7.3.4 Research Gap and Research Question

To our knowledge, this study is the first study to investigate the influence of exposing end users to operational complexities on subsequent design decisions within the context of PFS.

7.4 Limitations

7.4.1 *Design Platform*

The design activity was framed in a way that may have limited our participants in terms of design freedom. To be more specific, providing the participants with a pre-defined set of basic requirements and a set of widgets, might have resulted in participants working only within those boundaries. They would create the most straightforward and simple implementation of each requirement and then conclude the activity. This could be avoided by providing several options of each widget or function, a practice in line with Tohidi et al., (2008) who recommend not limiting the participants to one option during the design activity.

This limitation may be associated with the un-exposed group, as they were not exposed to the operational complexities like the exposed group. It is unlikely to affect the validity of the study because we took different measures to mitigate this issue. These include reminding the participants on many occasions that the provided requirements are the minimum requirements, and they were free to suggest any other features. We also started each session with an opening statement to encourage and motivate the participants, saying “you have a powerful computer with unlimited resources that would enable you to do whatever you want; there is no limit”. In addition, we reminded each participant that their proposed design will serve a wide range of users with different needs. So, a universal design is expected to cover a wide range of needs. It is true we did provide a pre-defined set of widgets to be used as design elements, we also did provide blank widgets and informed the participants that they could propose anything to be placed inside the widgets.

7.4.2 *Online Remote Prototyping*

Due to the COVID-19 outbreak, we had to change our data collection protocol to accommodate social distancing rules. It was necessary to conduct the design session using an online whiteboard as a platform. This approach has limitations in the form of the lack

of direct communication with participants. We were hoping to meet with participants in person and monitor their reactions during the design session.

Distancing restrictions also limited the PICTIVE technique that we were planning to apply. Participants did not have the chance to use PICTIVE tools for designing (e.g. color, sticky notes, widgets etc.), which may have limited their ability to fully express their thoughts. The use of the online tool forced us to recruit participants with high e-HLA scores because low-score participates might face difficulties in dealing with the online tool. We were hoping to get design feedback from low e-HLA participants. The online tool did not allow us to facilitate group design sessions. We were hoping to have groups of 2 participants to enable the opinion and idea exchange during the session. This could have led to more rich artifacts. Utilizing the online tools as a design canvas, instead of the traditional paper-based PICTIVE, was unlikely to alter the study findings, as all groups were provided the same online tool and yet artifacts were different among the exposed and unexposed groups.

7.4.3 *Technical*

Due to unknown technical difficulties, the online tool did not allow the participants to fully control the design space. Accordingly, we had to take verbal commands from the participants and control the design space on their behalf in some instances. We believe that this may have affected the freedom of our participants to fully express themselves during the design sessions. It is unlikely that the study's validity is affected, because all participants faced this difficulty

7.4.4 *European e-HLA Toolkit*

The e-HLA toolkit is one-of-a-kind evaluation tool that is used to evaluate electronic health literacy for patients (Karnoe et. al, 2018). We are not aware of any other tool that has the features of the e-HLA. However, the kit is comprised of questions that were published and validated in Denmark, which may be more suitable for the European

patients (medications that are used for the health literacy questions are European-branded medications that Canadian patients are not familiar with). We could have used two different published and validated tools, the e-literacy tool and health literacy. However, we wanted to use a tool that was validated within a healthcare setting.

Chapter Eight: Medication Adherence Reminder Mobile Application

8.1 Introduction

This chapter presents and discusses the Medication Adherence Reminder (MAR) mobile application, which is a different PFS research project supervised and executed by Dr. Derek Reilly and myself. My role in the MAR is as follows:

- designed the MAR application,
- designed the study methods
- obtained the approvals from the Dalhousie and Health authority REBs.
- recruited study participants.
- collected data for phase one and two, and
- analyzed data gathered from phase one.

This project was designed and conducted prior to the PFS online booking exposure project. This chapter will introduce the MAR study, compare it with the online booking exposure study, and summarize reflections on the MAR project, given the findings from the exposures study, all within the context of end user involvement in the design process of PFS. The application was programmed by M.Sc. student Aqib Mohammed. Fatimah Alshammari, an MSc student was involved in phase two of the study (data-logs management, recruitment and data analysis). The project led to a master's dissertation (Alshammari, 2018), masters project report (Aaqib, 2016), conference poster (Tearo et al., 2015), and conference paper (Alshammari et al., 2020).

8.2 What is MAR?

The Medication Adherence Reminder (MAR) application was designed and developed to supplement traditional time-based reminders and other mechanisms like pillboxes to promote medication adherence among patients. MAR began as a collaboration project between the Graphics and Experiential Media (GEM) Lab, Dalhousie University, and HealthQR Technology company. The MAR application was developed as a

standalone application with the intention that its features would be integrated at a later date into an existing HealthQR (HQR) application and database. The HQR application was developed by health solutions company HealthQR to provide patients with access to personal pharmacy information to make informed decisions about medication consumption and refills. The HQR user interface provides patients with access to the pharmacy database to view prescriptions online, share information with family members/healthcare professionals, set reminders when to refill medications, and order refills online.

Three configurations of MAR were developed to assess the impact of reward and/or penalty as potential features to promote medication adherence among patients on long-term prescriptions. The first configuration was a reward-based system in which points are won when the medication is taken on time. The second configuration was a penalty-based system in which points are subtracted when the medication is taken late or not-taken at all. The third configuration had neither feature, and was included as a control. All three MAR configurations included a reminder feature, which utilized time and other contextual information (location, participant profile data) to generate reminders for taking medication, and a history of medications taken. The penalty and reward configurations built on theory from persuasive computing to encourage positive behaviours (Oliveira et al., 2010, IJsselsteijn, et al., 2006, Orji et al., 2017).

8.3 User Motivation

Smartphones are readily available as they provide platforms for applications that are convenient and cost effective personal assistance tools (Dayer et al., 2013). Hence it was decided to explore the use of smartphone applications as a medication adherence aid tool for long-term prescription patients. Dayer et al. (2013) assessed medication adherence using 160 different mobile applications to evaluate their features that aim to improve the adherence level among users. The evaluation revealed that the available adherence applications rely on generic and basic reminder functions like text messages

and push notifications. Only six applications provide the user with the function to track taken and missed doses. It was noted that the Dayer et al. (2013) review did not indicate that any of the applications aim to adapt the patients' behavior in relation to medication adherence. We believe that the medication adherence issue is strongly related to the patient's individual behavior, habits, and values. Therefore, suggesting any solution to overcome the adherence issue may be more effective if human factors (behavior, habits, and values) are considered.

We find persuasive methods may be effective in changing behavior because they rely on ubiquitous techniques to change the users' behaviour (Oliveira et al., 2010, IJsselsteijn, et al., 2006, Orji et al., 2017). For example, context-aware systems that are always connected to the internet and continuously monitoring the environment around the user can utilize environmental cues such as location and time to evoke the user, which may lead to a behavior change over time. However, we think that behavior change requires more fundamental strategies that target the core values of the users for an effective and long-lasting behavior change (Consolvo et al., 2006). Persuasive methods utilize motivation strategies and indirect persuasion to change the users' behavior at a deep-rooted level which is different from temporally and instant changes that rely on environmental cues like time and location. We believe that a hybrid style that merges persuasive and ubiquitous methods may lead to a behavior change. For example, a hybrid approach that utilizes environmental cues (time and location) and motivational strategies (rewards) may be more effective because it works at both levels of cognition. This was the rationale behind MAR research study as we wanted to investigate the impact of persuasive and ubiquitous methods on medication adherence through the integration of existing strategies for medication compliance and persuasive strategies. The concept and techniques of persuasive behavior change, are the core concepts of MAR. MAR in comparison to basic reminders did show a better adherence level. Our findings align with literature that suggests the effectiveness of persuasive behavior change techniques in

improving medication adherence (Oliveira et al., 2010, IJsselsteijn, et al., 2006, Orji et al., 2017).

8.4 MAR and Exposure (Online Booking System) Research Projects

In the following, we subjectively compare and contrast MAR and Exposure studies with a focus on the design methodologies and end user involvement in the design process. The goal of this exercise is to explore how MAR and Exposure may complement each other in terms of the PFS design approach.

8.4.1 Resemblances

8.4.1.1 PFS

In both research studies, the systems are PFS and intended for operation by patients without external guidance. The online booking system in the Exposure framework study provides end users with the ability to book their own breast screening appointment without the direct support of the booking clerks and MAR also provides end users the ability to access their medication database and report and monitor medication consumption patterns over time. Both systems rely on the end users' competencies (electronic and health literacy) to successfully complete specific tasks.

8.4.1.2 User-Centered Design

UCD is the main and shared design principle between the MAR and Exposure studies. An iterative design process was used for MAR and considered end users needs and expectations as the main design principle. It was important for the research team, system owners, and healthcare service provider (pharmacy) to ensure that MAR was usable by the targeted end users. Users' needs and expectations were elicited through focus group activities and discussions with the system owners and healthcare service provider (pharmacy). In addition, end users were directly involved in usability testing to evaluate key features of MAR. The same consideration was taken while designing the

Exposure study. However, in that study end user needs and expectations were elicited through focus group activity and discussions with the booking clerks at the NSBSP. End users also were involved in the prototyping activity to elicit the system's features and functions.

8.4.1.3 Health Care Context

The shared principal function between both research studies is serving patients by providing them with tools that aid them in managing their health condition. Both systems are health information systems that provide a key foundation to assist patients in making informed decisions about their health conditions.

8.4.2 Distinctions

8.4.2.1 Underlying Principles

Both studies were experimental in nature, but for different purposes. MAR evaluated the influence of persuasive techniques on the users' medication adherence. The Exposure study provided a design to access a booking systems created through features elicitation by the end users. The underlying principle of MAR was persuasive technology that influences users' behaviour over time through persuasion techniques (reward/penalty system). When the medication was taken on time, MAR rewarded the patient with points that accumulated over time and that could be redeemed for special rewards at the sponsoring pharmacy; if the medication was missed or taken late, the system would penalize the end user by subtracting points from the users' profile. We wanted to assess the reward/penalty system on the patients' medication adherence over time.

In contrast, the online booking system (Exposure study), relied on the values and beliefs of the end users as a motivation to use the system for online booking if implemented in the future. In addition, Exposure study involved participants who are willing to be part of a study on online booking which may indicate that they were already

motivated. End users were asked to design an online booking system able to mitigate different operational complexities that may be encountered by the end users.

8.4.2.2 End users Involvement in the Design Process

It is typical in UCD process to carry PD activities early in the design process by proposing a system, building a prototype, and finally conducting a user study to compare different approaches of the proposed system. This is the approach that was implemented during MAR study, where we developed three versions of MAR and had a group of patients compare the designs. Consequently, the end users were involved after developing the first prototype to complete usability and comparative study. In the Exposure study, end users were involved in developing the first prototype of the online booking system.

8.5 Discussion

8.5.1 Potential End Users

The process of designing and developing the MAR application took place alongside direct discussions with the HealthQR team and some meetings with a chain of local pharmacies in Nova Scotia, Canada. The MAR development team met with the stakeholders on multiple occasions to identify application requirements and to gain a deeper insight into the user population. Similar to MAR, the online booking system's requirements and potential end users were explored through direct discussions with the booking clerks at the NSBSP. In both studies we started by addressing two questions: who are the users and what are their key tasks. This was achieved by performing a contextual inquiry in the form of a series of discussions with the service providers (HealthQR team and NSBSP clerks). Our approach in investigating the population relevant to design aligns with the "understanding users" phase of a phased UCD process model (Greenberg, *Task-Centered System Design*, n.d).

The elicited requirements and user information was utilized differently in the MAR and Exposure research studies. During MAR development we prioritized progress to a functional prototype over consideration of underlying operational complexities that may be encountered by end users.

On the other hand, in the Exposure study the goal was to achieve effective PFS designs that would address extreme use cases. The discussions with clerks revealed how concerned they were about the use of online booking systems by patients without assistance. Therefore, we relied on the extreme characters and scenarios to uncover complexities that might be encountered by patients when booking an appointment.
We believe that the exploration phase with the service provider (booking clerks in the Exposure study and HealthQR in the MAR study) played a major role in guiding requirements elicitation. While the HealthQR team raised issues that some patients might encounter, we did not use these with participants during design. The MAR development may have looked different had the Exposure technique been applied. For example, if the HealthQR team were concerned about patients with vision complications and their ability to interact with MAR, we might have engaged potential users in a design activity, first exposing the participants to scenarios of users with impaired vision (among other extreme scenarios) and find out how they propose addressing this complication. For example, they may suggest to modify the MAR interface by utilizing a voice-controlled virtual assistant to facilitate the interaction between MAR and the patient.

8.5.2 Exposure-Based Features Vs Features Grounded in Theory

MAR users were involved at a later stage of the study to evaluate the influence of penalty and reward on adherence: they were provided with a fully functioning prototype with which to interact. Usability feedback was only collected as supplemental information, and so the study was not a true usability test in UCD terms, however, it was comparable to usability tests like those conducted in later phases of a design project. Based on what we have learned from the Exposure study, it may have been advantageous

to integrate theory-based design with PD design into MAR by involving end users in the design process during medium and high fidelity design activities as well. For example, end users may suggest designs that would minimize the psychological impact of the penalty feature by emphasizing the positive impact of the penalty system on medication adherence. The Exposure research suggests that exposing participants to extreme scenarios relevant to using the penalty feature (for example, negative responses including non-use, adverse psychological effects) might have encouraged more nuanced and inclusive approaches to integrating that persuasive technique into a design.

A closer look at the features that were suggested by the exposed participants in the Exposure study shows that some features may have been missed if the participants were not involved through the exposure technique. For example, the feature of appointment auto-synchronization across all personal calendars was only suggested by the exposed group; not by the un-exposed group or the clerks. On the other hand, there are other key features that are recognised by the medical booking systems developers like the compliance with the Health Insurance Portability and Accountability Act (HIPA) and no-show tracking (Couey, 2021). Another example from the MAR study is the penalty and reward motivation, particularly penalty, which is unlikely to emerge organically by end users through PD sessions due to the concept of "loss aversion" that is not admirable by users (Hannan et. al, 2005). This shows that Exposure in isolation will not typically ensure a comprehensive or effective design. It is worth mentioning that the design features that were suggested by the participants in the Exposure study did not contradict with the suggestions made by the booking clerks nor the literature. In this case we believe that an iterative prototyping and evaluation would still be necessary after the PD activity.

Personas, scenarios, and the underlying operational complexities are not design features of the online booking system. In addition, it is not expected that end users will suggest design features to accommodate complex scenarios. Therefore it was critical to discuss situational complexities with the senior clerks to elicit a list of scenarios and then

use them to evoke end users during design sessions. In the case of MAR, however, it may not be likely that end users would suggest a penalty function as a method of behaviour change and thus a more traditional prototype/test approach had to be used for MAR. Comparing and contrasting the methodologies of both research studies allows us to contribute to the collective knowledge regarding involvement of end users in the design process. This comparison provides knowledge about involving end users in the development of PFS the benefits of an evoking strategy (Exposure) to increase the chances of producing rich prototypes yielding features to accommodate usage complexities. We believe that PD is only one part of a comprehensive human-centered design process. Hence, an integrative approach would meet the expectations of both end users and developers.

Chapter Nine: Implications and Conclusion

Research implications and recommendations to PFS developers are presented in this chapter, followed by opportunities and directions for subsequent research.

The aim of this research was to address the gap in the literature on the value of involving end users early in the design process of PFS and the influence of this involvement through exposure to operational complexities on the design decisions. This was achieved by stimulating the end users before they started designing the first prototype of the PFS (online booking system). The results revealed a difference between the artifacts produced by the exposed group and un-exposed groups in terms of features and rationale behind design decisions. This indicates the influence of the exposure technique on the design decisions made by the exposed participants. The results suggest that involving patients in the design process and intentionally evoking them through the exposure technique yield PFS designs that are rich and comprehensive in terms of both the features and rationale underlying design decisions. The process is believed to also yield systems that meet the needs expectations of a wider range of end users.

The “exposure” strategy may be integrated with available end users engagement strategies and validated through future research to build conceptual end users engagement framework for PFS design and development.

9.1 Exposure: A Conceptual Framework for Complexities-Driven Patient-Facing System Design

Based on our findings, we propose a conceptual framework describing engagement of end users in designing and building PFS. The core of our proposed framework to evoke end user engagement (exposure), which aligns with the literature that proposed further research to develop guidelines for end user engagement (Rodriguez-Calero et al., 2020, Privitera et al., 2017). The following subsections led to the proposed conceptual framework.

9.1.1 How to Engage Service Providers?

Service providers, such as healthcare providers, are important stakeholders when it comes to developing HIT systems or PFS. Their input is crucial for requirements elicitation and overall design flow. The majority of HIT systems and PFS commence discussing system requirements with the service providers to build the initial prototype that can be used through an iterative prototyping cycle among service providers and end users. Our approach contrasts with this in the way and timing of involving the service providers in the design cycle. Our approach suggests involving the service providers not to identify the requirements and main design lines, but to identify all possible complications based on their interaction with patients over the years. This is done to prepare a list of complications in the form of usage scenarios that can then be used to involve the end users at a later stage is prepared. Our approach aligns with the principles of "getting the right design" (Tohidi et al., 2006).

9.1.2 How to Engage End Users?

End users are the focus of any system that is designed based on PD principles. It makes sense to involve them at the early stages of development, but how and what should their role be. This approach contrasts with the common approach among PFS developers which is to approach patients with a prototype, of low or high fidelity, based on the discussions with the service providers and to have them evaluate the prototype and/or to suggest improvements (Yang & Asan, 2016, Piper & Hollan, 2013, Ni et al., 2011, Pedersen & Wolff, 2008, Nystorm et al., 2018, Honekamp & Ostermann, 2011, Gonzales & Riek, 2012, Wilcox et al., 2010). It is likely to minimize the negative impact on end users' design creativity by involving them in the design process before developing the first prototype. Providing end users with a pre-developed prototype and asking them to use it as a reference for their design may limit their creativity and the ability to suggest unique features. Therefore, it was important for us to consider involving end users in the design process without biasing their design decisions with a pre-developed prototype. We also suggest exposing participants to operational complexities to achieve a higher level of

engagement and inspiration. Our approach aligns with the findings of Tohidi et al., (2006) on how to get “the right design”.

9.2 Exposure: A Conceptual Framework

Exposure is our proposed conceptual framework for complexities-aware PD for PFS, which is built on three literature supported pillars and a fourth pillar that we controlled in our research. All pillars are inter-related (see Figure 10) that support the initial stages of PFS development. This conceptual framework helps to address the need identified in the literature for guidelines on how to engage the end users “intentionally” at early design stages (Rodriguez-Calero et al., 2020; Privitera et al., 2017).

The pillars of Exposure are defined as follows:

1. Operational Complexities (control variable): This pillar is the focus of this study. It relates to the process of exposing the end users (designers) to potential operational complexities that were identified from discussions with the service providers. The exposure must be completed before approaching the design activity. The exposure activity should highlight real-life encounters between different personas and operational obstacles.
2. End Users (literature-supported) (Rodriguez-Calero et al., 2020): End users empowerment maybe increased through involving them in the design process of PFS.
3. E-HLA (literature-supported) (Karnoe et al., 2018): This pillar relates to the Electronic Health Literacy of the end users. We recommend selecting a wide range of Electronic Health Literacy (low to high), to accommodate the population that will use the intended system in the future.
4. Initial Stage (literature-supported) (Jensen et al., 2017, Rodriguez-Calero et al., 2020, Cooper, 2018): This pillar relates to the proper timing of end users’ involvement in the designing activity. Early involvement in the design process is recommended by the literature.

The exposure activity is intended to be carried out at early stages of the design process. Engaging the end users after the development of the first prototype and asking them to test it, will limit their choices given the boundaries of a functioning prototype.

Another pillar is the electronic health literacy of the participants who will complete the exposure and designing activity. Including participants with a good representation of electronic health literacy will increase the chances of producing artifacts with rich design elements. It is fundamental to involve the end-users in the exposure activity followed by the design session. PFS researchers are advised to investigate the integration of exposure techniques with other literature based design practice recommendations.

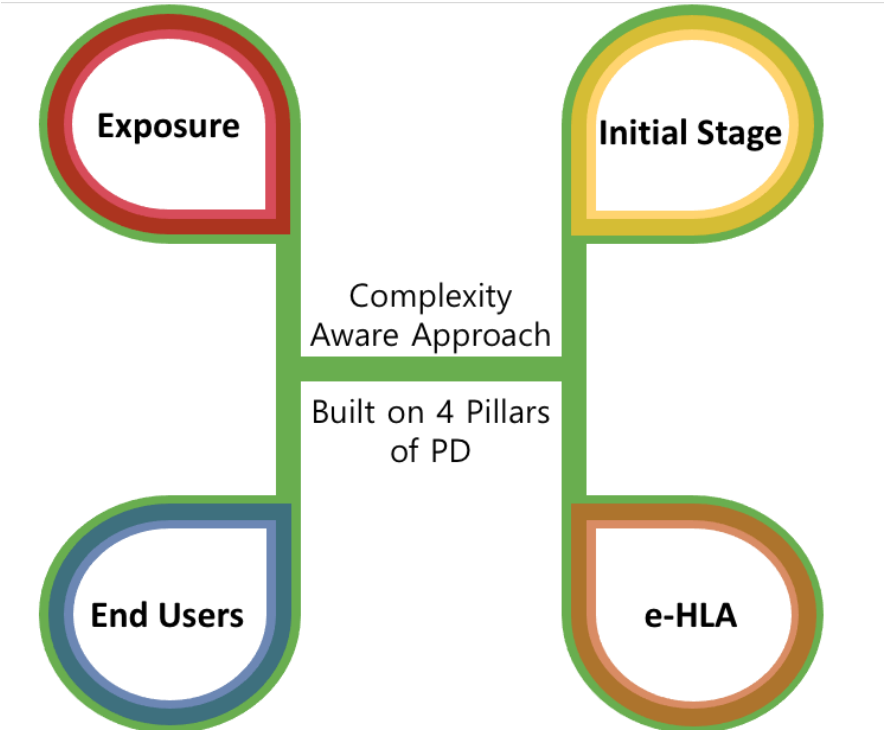


Figure 10 Exposure: A Conceptual Framework

9.3 Conclusion

Healthcare organizations can provide patient access and control of health-related data to patients through Patient-Facing Systems with little to no external guidance. If the external guidance and support are completely absent, the interaction between end-users and the PFS is susceptible to operational complexities that may negatively impact the end-users. For example, a patient who wants to book an appointment for breast screening through the online booking portal may face difficulties in comprehending medical terms presented on the user interface. This difficulty may hinder the patient's experience in interacting with the online portal and may discourage the patient from using the online portal in the future (Karnoe et al., 2018, Parker et al., 1995, Murphy et al., 1993). Therefore, it is important to consider operational complexities and patient associated competencies that may enable end-users to overcome these complexities while designing PFS. The literature suggests involving end-users in the design process of computer systems, which leads to systems that meet the needs and expectations of the end-users. The literature also suggests considering end-users operational skills and competencies, like health literacy and electronic literacy, while designing PFS (Karnoe et al., 2018). End-user involvement in the design process of PFS varies in terms of timing, strategy, and methods. Prototyping techniques can be utilized as tools to aid the design and development of computer-based systems (Rodriguez-Calero et al., 2020, Norman, 1993, Kirsh, 2010). Our investigation into the influence of exposing end-users to the underlying operational complexities on their design decisions during the prototyping stage of PFS, has provided us several insights. Design artifacts produced by the exposed end-users, independent of their electronic health literacy, were richer in terms of features that may accommodate operational complexities, as compared to experienced designers (booking clerks) and un-exposed participants. Our results imply that end-users when involved in the design process are influenced by internal/individual factors and external/activity-related factors. To visualize the factors and have the opportunity to see the bigger picture, we created the following diagram that describes the factors (themes and subthemes) that influence design decisions during design sessions (see Figure 11).

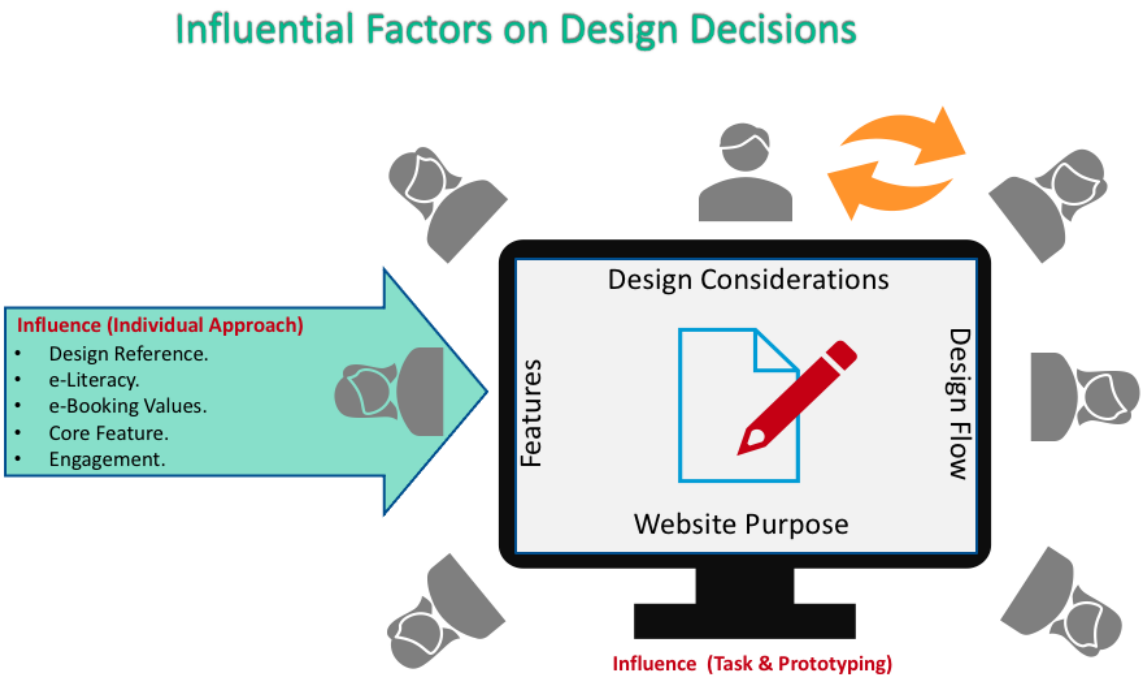


Figure 11 Summary of Influential Factors on Design Decisions

These factors, if taken into consideration by the developers, may lead to better understanding of the special needs of the intended end-users of the system they are developing. Based on the "exposure" factor and the other three literature-supported factors we develop a conceptual framework for end-user involvement in PFS design. We call the framework "Exposure" which is a complexities-aware PD framework for PFS. The conceptual framework is built on four inter-related pillars, exposure, end-user, initial design stage, and electronic health literacy. The core feature of the proposed framework is end-user exposure to operational complexities. The exposure will yield well-informed and comprehensive design decisions (in terms of features and rationale). The framework addresses the need for a set of guidelines on how to engage the end-users at the initial stages of system design.

In the following, we provide a use case example to provide more details on how to use the proposed conceptual framework.

A typical scenario: a healthcare provider wishes to provide their clients with an online portal for online appointment booking. The healthcare provider approaches a PFS developer for design suggestions and implementation. The developer arranges a series of discussion sessions with the senior booking clerks who are in direct contact with patients. The goal is to gain a deeper insight into the operational complexities that are faced by the patients and clerks. Based on the discussions with the clerks, the developer prepares a set of personas and scenarios (using Nielsen's model of personas and scenarios) (Nielsen, 2003).

Following the completion of personas and scenarios, the developer approaches the booking clerks to review the scenarios. The developers may also provide the healthcare provider with the e-HLA tool kit to be distributed among the clients. The goal is to gain insight into the population in terms of electronic and health literacy. The e-HLA tool kit would also be utilized as a recruitment tool, by scoring the completed forms, to identify a set of clients that represent a wide range of electronic and health literacy. The developer splits the scores into thirds (low, medium, and high), and then identifies and contacts patients from the three groups. The identified participants may be contacted to arrange the designing activity. The activity starts by introducing the concept of online booking to the participants by providing common commercial examples of online services.

The developer then introduces the scenarios to the participants. Each participant will read the scenarios and ask questions if needed. The developer plays a tutorial video of an acting participant completing a basic design task. This step makes sure that the participants are comfortable completing the design activity. At this point, the participants are asked to design an online booking interface for a healthcare appointment using a low fidelity prototyping technique. The developer may use a set of basic requirements to be used by the participants to keep the activity flowing. Here we provide an example of such basic requirements: successfully book an appointment, confirm the appointment, and

view the medical chart. The developer may inform the participants that they are not limited to the basic requirements, as they can add any features/functions they want.
It is critical to stress that these are the minimum requirements to complete the designing session and they are welcome to suggest any additional features/functions that might be helpful for future users. Participants must be reminded that they are expected to think aloud during the session. Each design session is followed by a short audio-recorded, semi-structured interview. The goal of this step is to explore the willingness of the participants to use the online booking systems and the associated core values with using online booking. The identified core values may be incorporated into future proposed systems by PFS developers. The core feature of the proposed framework is the exposure activity where end-users are exposed to operational complexities in advance. Exposing end-users prior to the design process increases the awareness of potential complexities, which likely will yield more comprehensive design features.

The above-mentioned example on how to implement the "Exposure" framework, reflects the ideal situation of implementation. We believe it is ideal to involve the service provider as early as possible to generate the complexities and then utilize the complexities to generate personas and scenarios. It is also ideal to involve the end users in the exposure activity by providing them with a blank design canvas without relying on a pre-defined prototype or any design constrains. We believe that there are only a few situations where this framework should not be used. For example, when developers do not have a set of complexities that are derived from a contextual inquiry with the service provider. We recommend against relying on the literature to identify a set of complexities and then generate the scenarios and personas from these complexities. We believe that every health information system project has a unique usage context, therefore it is important to communicate directly with the stakeholders to identify the constraints and boundaries of the project. Another example would be a situation where developers are being asked to prioritize progress to a functional prototype over consideration of underlying operational complexities that may be encountered by end users. Finally, we recognize

that it may be difficult for developers to use this framework if the work is constrained by a limited budget, given that accommodating extreme usage scenarios is associated with both higher cost and a longer development time.

In our study, “Exposure” was the only pillar that we controlled. Therefore, it is important to consider the unknown factors in relation to the Exposure framework. We relied on recommendations from the literature and service providers to build the framework and test it while controlling only exposure, but we don’t know how the other pillars may impact the efficacy of exposure. For example, one of the pillars is early involvement of end users in designing the first prototype. However, we don’t know whether exposure is may be valuable to layering the design decisions. There may be other opportunities for developers and service providers to build a basic prototype and then apply any refinements, before the early involvement of end users in the design activity. Another pillar is the involvement of end users, but what if we use the concept of exposure with other individuals that are indirectly invested in the project? In fact, developers themselves may benefit from the activity. This leads to the question ‘is exposure important only for end users?’. Therefore, further research is required to determine the impact of any variation of the pillars and the relationships between the pillars.

Designers should not provide end-users with a blank canvas and expect them to generate features and design suggestions that accommodate underlying usage complexities. Designers are recommended to frame the underlying complexities for end-users (designing participants), without placing boundaries that restrict what they can do. Our contribution suggests framing the problem through evoking the end-users by exposing them to usage complexities at the same time provide them with a blank design canvas that they can use to suggest features that may address the complexities from the end-user perspective. We believe that the advantage of this approach is the ability to design systems that accommodate PFS underlying complexities from the perspective of the patients who are the end-users of the proposed systems.

Bibliography

Ahern, D. K., Woods, S. S., Lightowler, M. C., Finley, S. W., & Houston, T. K. (2011). Promise of and potential for patient-facing technologies to enable meaningful use. American journal of preventive medicine, 40(5), S162-S172.

Alpert, J. M. (2014). Evaluating the Content of Family Physician Websites in the United States. Journal for Healthcare Quality.

Altexsoft (Ed.). (2019, November 11). History of Flight Booking: CRSs, GDS Distribution, Travel Agencies, and Online Reservations. Retrieved March 22, 2020, from https://www.altexsoft.com/blog/travel/history-of-flight-booking-crss-gds-distribution-travel-agencies-and-online-reservations/

Andersen, Tariq O., et al. "Understanding patient experience: a deployment study in cardiac remote monitoring." Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare. ACM, 2017.

Banfield R, Lombardo CT, Wax T. Design Sprint: A Practical Guidebook for Building Great Digital Products. Sebastopol, CA: O'Reilly Media, Inc; 2015.

Beaudouin-Lafon, M. and Mackay, W. Prototyping tools and techniques. Human Computer Interaction- Development Process2003), 122-142.

Bell, H., and N.K.H. Tang (1998). “The Effectiveness of Commercial Internet Web Sites: A User’s Perspective.” Internet Research: Elec- tronic Networking Applications and Policy, 8 (3): 219-28.

Bertelsen, O. W. (1996, November). The Festival Checklist: design as the transformation of artefacts. In Blomberg, J., Kensing, F. & Dykstra-Erickson (eds.). PDC'96, Proceedings of the Participatory Design Conference. Palo Alto: Computer Professionals for Social Responsibility (pp. 93-101).

Bertot, J. C. (2003). The multiple dimensions of the digital divide: more than the technology'haves' and'have nots'. Government Information Quarterly,2(20), 185191.

Bill Buxton. Sketching User Experiences: Getting the Design Right and the Right Design. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2007.

Bodker, S., Ehn, P., Kammersgaard, J., Kyng, M., and Sundblad, Y. (1987). A UTOPIAN Experience On Design of Powerful Computer-Based T ools for Skilled Graphic Workers. In Bjerknes, G., Ehn, P., and Kyng, M. (Eds.), Computers and Democracy: A Scandinavian Chllenge. Brookfield, VT: Gower, 251-278.

Bodker, S., Ehn, P., Knudsen, J., Kyng, M., and Madsen, K. (1988). Computer support for cooperative design. In CSCW88: Proceedings of the Conference on Computer-Supported Cooperative Work. Portland OR: ACM, 377-393

Brooks, R., & Grotz, C. (2010). Implementation of electronic medical records: How healthcare providers are managing the challenges of going digital. Journal of Business & Economics Research (JBER), 8(6).

Brusilovsky, P. (1998). Methods and techniques of adaptive hypermedia. In Adaptive hypertext and hypermedia (pp. 1-43). Springer, Dordrecht.

Buntin, M. B., Burke, M. F., Hoaglin, M. C., & Blumenthal, D. (2011). The benefits of health information technology: a review of the recent literature shows predominantly positive results. Health affairs, 30(3), 464-471.

Canada Health Infoway, C. (n.d.). About Us: Canada Health Infoway. Retrieved January 19, 2021, from https://www.infoway-inforoute.ca/en/about-us Carey, J. M., & Currey, J. D. (1989). The prototyping conundrum. Datamation, p.p 29-33.

Chou, D. C., & Chou, A. Y. (2000). A guide to the Internet revolution in banking. Information Systems Management, 17(2), 51-57.

Christensen, Bente, et al. "The biography of participation." Proceedings of the 13th Participatory Design Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium papers, and Keynote abstracts-Volume 2. ACM, 2014.

Clement, J. (2020, February 3). Global digital population 2020. Retrieved March 22, 2020, from https://www.statista.com/statistics/617136/digital-population-worldwide/

Consolvo, S., Everitt, K., Smith, I., & Landay, J. A. (2006, April). Design requirements for technologies that encourage physical activity. In Proceedings of the SIGCHI Conference on Human Factors in computing systems (pp. 457-466). ACM.

Constantine, L. L., & Lockwood, L. A. (1999). Software for use: a practical guide to the models and methods of usage-centered design. Pearson Education.

Cooper, A., Reimann, R., Cronin, D., & Noessel, C. (2014). About face: the essentials of interaction design. John Wiley & Sons.

Cooper, A.,The Inmates Are Running the Asylum, Macmillan Computer Publishing (1999).

Cooper, R. G. (2018). The drivers of success in new-product development. Indus- trial Marketing Management, 76, 36e47. https://doi.org/10.1016/ j.indmarman.2018.07.005.

Couey, C. (2021, May). Most Popular Free Medical Scheduling Software Systems. https://blog.capterra.com/top-7-free-medical-scheduling-software-systems/.

Coughlan, P., Suri, J. F., & Canales, K. (2007). Prototypes as (Design) tools for behavioral and organizational change: A design-based approach to help orga- nizations change work behaviors. The Journal of Applied Behavioral Science, 43(1), 122e134. https://doi.org/10.1177/0021886306297722.

D. Scott McCrickard, C. M. Chewar, and Jacob Somervell. 2004. Design, science, and engineering topics?: teaching HCI with a unified method. In Proceedings of the 35th SIGCSE technical symposium on Computer science education (SIGCSE '04). ACM, New York, NY, USA, 31-35. DOI: https://doi.org/10.1145/971300.971314

Daly, S. R., Adams, R. S., & Bodner, G. M. (2012). What does it mean to design? A qualitative investigation of design professionals' experiences. Journal of En- gineering Education, 101(2), 187e219. https://doi.org/10.1002/j.2168-9830.2012.tb00048.x.

Dayer, L., Heldenbrand, S., Anderson, P., Gubbins, P. O., & Martin, B. C. (January 01, 2013). Smartphone medication adherence apps: Potential benefits to patients and providers. Journal of the American Pharmacists Association: Japha, 53, 2, 172.

Deursen, A. V., & Dijk, J. V. (2008). Measuring digital skills: Performance tests of operational, formal, information and strategic Internet skills among the Dutch population (Paper Presented at the 58th Conference of the International Communication Association.). In ICA Conference, Montreal, 22-26 May 2008.

Diefenbach, R. (1998). "The World Wide Web Can Answer Travelers' Wishes." South Florida Business Journal-Miami [Online]. Available: Dow Jones News Retrieval Service (October 22)

Dieter, G. E., & Schmidt, L. C. (2013). Engineering design. Engineering design (5th ed.). New York, NY: McGraw-Hill.

DiMaggio, P., & Hargittai, E. (2001). From the 'digital divide'to 'digital inequality': Studying Internet use as penetration increases. Princeton: Center for Arts and Cultural Policy Studies, Woodrow Wilson School, Princeton University, 4(1), 4-2.

Djajadiningrat, J. P., Gaver, W. W. and Frens, J.W. Interaction Relabelling and Extreme Characters: Methods for Exploring Aesthetic Interactions. Proceedings of the conference on Designing interactive systems. New York City, New York, United States, (2000) pp. 66 – 71.

Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-evolution of problem-solution. Design Studies, 22(5), 425e437. https://doi.org/10.1016/ S0142-694X(01)00009-6.

Fagerlin A, Zikmund-Fisher BJ, Ubel PA, Jankovic A, Derry HA, Smith DM. Measuring numeracy without a math test: development of the Subjective Numeracy Scale. Med Decis Making 2007;27(5):672-680. [Medline: 17641137]

Fatimah Alshammari, Khalid Tearo, Rita Orji, Kirstie Hawkey, and Derek Reilly: MAR: A Study of the Impact of Positive and Negative Reinforcement on Medication Adherence Reminders. 2020 IEEE 8th International Conference on Serious Games and Applications for Health (SeGAH).

Fatimah Alshammari, Khalid Tearo, Rita Orji, Kirstie Hawkey, and Derek Reilly: MAR: A Study of the Impact of Positive and Negative Reinforcement on Medication Adherence Reminders. 2020 IEEE 8th International Conference on Serious Games and Applications for Health (SeGAH).

Floyd, C. (1984). A systematic look at prototyping. In Approaches to prototyping (pp. 105-122). Springer, Berlin, Heidelberg.

Floyd, I. R., Jones, M. C., Rathi, D. and Twidale, M. B. Web mash-ups and patchwork prototyping: User-driven technological innovation with web 2.0 and open source software. IEEE, City, 2007.

Fox S, Jones S. The social life of health information: Americans' pursuit of health takes place within a widening network of both online and offline sources. Pew Internet & American Life, 2009. Report, available online. http://www.pewinternet.org/Reports/ 2009/8-The-Social-Life-of-Health-Information.aspx.

García-Vázquez, J. P., Rodríguez, M. D., Andrade, Á. G., & Bravo, J. (2011). Supporting the strategies to improve elders' medication compliance by providing ambient aids. Personal and Ubiquitous Computing, 15(4), 389-397.

Goel, V., & Pirolli, P. (1992). The structure of design problem spaces. Cognitive

Gonzales, M., & Riek, L. (2012, January). A shared interface to improve oncologist-patient communication. In Proceedings of the 6th International Conference on Pervasive Computing Technologies for Healthcare (Vol. 10).

Greenberg, S. (n.d.). Task-Centered System Design. University of Calgary . https://pages.cpsc.ucalgary.ca/~saul/hci_topics/pdf_files/task_centered.pdf.

Hargittai, E. (2001). Second-level digital divide: Mapping differences in people's online skills. arXiv preprint cs/0109068.

Hargittai, E. (2002). Beyond logs and surveys: In-depth measures of people's web use skills. Journal of the American Society for Information Science and technology, 53(14), 1239-1244

Hartson, R., & Pyla, P. S. (2019). Chapter 19/Background: Design. In The UX book: Agile UX deisgn for a quality user experience (pp. 497-401). Cambridge: MK, Morgan Kaufmann.

Honekamp, W., & Ostermann, H. (2011). Evaluation of a prototype health information system using the FITT framework. Journal of Innovation in Health Informatics, 19(1), 47-49.

Hooper, J. W., & Hsia, P. (1982, April). Scenario-based prototyping for requirements identification. In Proceedings of the workshop on Rapid prototyping (pp. 88-93).

Houde, S., & Hill, C. (1997). What do prototypes prototype?. In Handbook of human-computer interaction (pp. 367e381) Elsevier. https://doi.org/10.1016/ b978-044481862-1/50082-0.IDEO.org. (2015). The field guide to human-centered design (1st ed.). San Fran- cisco, CA.

Houston TK, Sands DZ, Jenckes MW, Ford DE. Experiences of patients who were early adopters of electronic communication with their physician: satisfaction, benefits, and concerns. Am J Manag Care 2004;10(9):601– 8.

https://www.cdc.gov/ehrmeaningfuluse/introduction.html

https://www.interaction-design.org/literature/topics/human-computer-interaction

Interaction Design Foundation. (n.d.). Artifact. https://www.interaction-design.org/literature/book/the-glossary-of-human-computer-interaction/artifact.

Irizarry T., DeVito Dabbs A., Curran C.R., 23 June 2015 “Patient Portals and Patient Engagement: A State of the Science Review”, JMIR, doi: 10.2196/jmir.4255

Jacobs, Maia, James Clawson, and Elizabeth D. Mynatt. "Lessons learned from a yearlong deployment of customizable breast cancer tablet computers." Proceedings of the conference on Wireless Health. ACM, 2015.

Jensen, M. B., Elverum, C. W., & Steinert, M. (2017). Eliciting unknown un- knowns with prototypes: Introducing prototrials and prototrial-driven cul- tures. Design Studies, 49, 1e31. https://doi.org/10.1016/j.destud.2016.12.002. Kelley, T. (2001). The art of innovation: Lessons in creativity from IDEO, Ameri- ca's leading design firm. Broadway Business.

Jones, M. C., Floyd, I. R. and Twidale, M. B. Patchwork prototyping with open source software. Handbook of Research on Open Source Software: Technological, Economic, and2007), 126.

Junior, P. T. A., & Filgueiras, L. V. L. (2005, October). User modeling with personas. In Proceedings of the 2005 Latin American conference on Human-computer interaction (pp. 277-282).

Karnoe, Astrid, et al. "Assessing competencies needed to engage with digital health services: development of the eHealth literacy assessment toolkit." Journal of medical Internet research 20.5 (2018): e178.

Khalid W. Tearo, Aaqib Mohammed, Derek Reilly (2015). When The Reward Is Great, The Effort To Adhere Is Great: Medication Adherence Reminder (MAR). Graphics Interface 2015, Halifax.

Khalid W. Tearo, Aaqib Mohammed, Derek Reilly (2015). When The Reward Is Great, The Effort To Adhere Is Great: Medication Adherence Reminder (MAR). Graphics Interface 2015, Halifax.

Kirsh, D. (2010). Thinking with external representations. AI & Society, 25(4), 441e454. https://doi.org/10.1007/s00146-010-0272-8.

Knapp J, Zeratsky J, Kowitz B. Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days. New York, NY: Simon and Schuster; 2016.

Lauff, C. A., Kotys-Schwartz, D., & Rentschler, M. E. (2018). What is a proto- type? What are the roles of prototypes in companies? Journal of Mechanical Design, Transactions of the ASME, 140(6). https://doi.org/10.1115/1.4039340. Leifer, R., Lee, S., & Durgee, J. (1994). Deep structures: Real information re- quirements determination. Information & Management, 27(5), 275e285.

Lavsa, S. M., Holzworth, A., & Ansani, N. T. (2010). Selection of a validated scale for measuring medication adherence. Journal of the American Pharmacists Association: JAPhA, 51(1), 90-94.

Law, R., & Leung, R. (2000). A study of airlines' online reservation services on the Internet. Journal of Travel Research, 39(2), 202-211.

Levey, N. N. (2009, March 17). Shot in the arm for digital health. Chicago Tribune. Retrieved June 8, 2009, from http://www.chicagotribune.com/news/nationworld/chi-health-techmar17,0,7364529

Leysia, P & Stinne, A., Proceedings of the 2006 20th anniversary conference / Computer supported cooperative work (CSCW '06). (2006). Of pillboxes and piano benches. ACM, 2 Penn Plaza, Suite 701, New York, NY 10121-0701, USA.

Lichter, H., Schneider-Hufschmidt, M., & Zullighoven, H. (1994). Prototyping in industrial software projects-bridging the gap between theory and practice. IEEE transactions on software engineering, 20(11), 825-832.

Lim, Y. K., Stolterman, E., & Tenenberg, J. (2008). The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. ACM Transactions on Computer-Human Interaction (TOCHI), 15(2), 1-27.

Maeder, A. J., & Martin-Sanchez, F. J. (2012, July). Patients' perceptions of web self-service applications in primary healthcare. In Health Informatics: Building a Healthcare Future Through Trusted Information: Selected Papers from the 20th Australian National Health Informatics Conference (HIC 2012) (Vol. 178, p. 242). IOS Press. Chicago.

Martinez, W., Threatt, A. L., Rosenbloom, S. T., Wallston, K. A., Hickson, G. B., & Elasy, T. A. (2018). A patient-facing diabetes dashboard embedded in a patient web portal: design sprint and usability testing. JMIR human factors, 5(3), e9569.

Miles, M., Huberman, A., Saldana, J. (2014). Qualitative Data Analysis: A Methods Sourcebook. Third Edition. Arizona State University. SAGE Publications, Inc.

Mishra, K K et al. "Recent advancements in computer & software technology." TheScientificWorld Journal vol. 2014 (2014): 609512. doi:10.1155/2014/609512

Mishra, Sonali R., et al. "Supporting Collaborative Health Tracking in the Hospital: Patients' Perspectives." Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems. ACM, 2018.

Mishra, Sonali R., et al. "Supporting Collaborative Health Tracking in the Hospital: Patients' Perspectives." Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems. ACM, 2018.

Muller, M. J., Wildman, D. M., & White, E. A. (1993). “Equal opportunity” PD using PICTIVE. Communications of the ACM, 36(6), 64.

Muller, Michael J. "PICTIVE-An exploration in participatory design." (1991).

Munson, S. A., & Consolvo, S. (2012, May). Exploring goal-setting, rewards, self-monitoring, and sharing to motivate physical activity. In Pervasive Computing Technologies for Healthcare (PervasiveHealth), 2012 6th International Conference on (pp. 25-32). IEEE.

Murphy PW, Davis TC, Long SW, Jackson RH, Decker BC. Rapid Estimate of Adult Literacy in Medicine (REALM): a quick reading test for patients. J Read 1993 Oct;37(2):124-130

Nasr, R. 2015. Online travel industry is booming: Report. Available at http://www.cnbc.com/2015/07/01/online- travel-industry-is-booming-report.html

Neustaedter, C., & Sengers, P. (2012, June). Autobiographical design in HCI research: designing and learning through use-it-yourself. In Proceedings of the Designing Interactive Systems Conference (pp. 514-523).

Ni, T., Karlson, A. K., & Wigdor, D. (2011, May). AnatOnMe: facilitating doctor-patient communication using a projection-based handheld device. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 3333-3342).

Nielsen, L. (2002, June). From user to character: an investigation into user-descriptions in scenarios. In Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques (pp. 99-104).

Nielsen, L. (2003). A model for personas and scenarios creation. Roskilde, Denmark, 71.

Norman, D. (1993). The power of representation. In Things that make us smart (pp. 43e76). Reading, MA: Addison-Wesley Publishing Company.

Nutbeam D. World Health Organization. 1998. Health Promotion Glossary URL: http://www.who.int/healthpromotion/about/HPR%20Glossary%201998.pdf?ua=1 [accessed 2018-04-04] [WebCite Cache ID 6yQbR9grS]

Nystrom, D. T., Singh, H., Baldwin, J., Sittig, D. F., & Giardina, T. D. (2018). Methods for patient-centered interface design of test result display in online portals. eGEMs, 6(1).

O'Raghallaigh, P., & Adam, F. (2017, August). Scenario Based Prototyping: When Open Source meets the Video Star. In Proceedings of the 13th International Symposium on Open Collaboration Companion (p. 2). ACM

Paré, G., Trudel, M., & Forget, P. (2014). Adoption, use, and impact of e-booking in private medical practices: mixed-methods evaluation of a two-year showcase project in Canada. JMIR Med Inform. 2014; 2 (2): e24. doi: 10.2196/medinform. 3669.

Parker RM, Baker DW, Williams MV, Nurss JR. The test of functional health literacy in adults: a new instrument for measuring patients' literacy skills. J Gen Intern Med 1995 Oct;10(10):537-541. [Medline: 8576769]

Pedersen, E. R., & Wolff, G. (2008, February). Paper interface to electronic medical records: a case of usage-driven technology appropriation. In Proceedings of the 7th ACM conference on Designing interactive systems (pp. 40-49).

Pfeifer Vardoulakis, Laura, et al. "Using mobile phones to present medical information to hospital patients." Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, 2012.

Pietzsch, J. B., Shluzas, L. A., Pate-Cornell, M. E., Yock, P. G., & Linehan, J. H. (2009). Stage-gate process for the development of medical devices. Journal of Medical Devices, 3(2). https://doi.org/10.1115/1.3148836. 021004.

Pikkarainen, T., Pikkarainen, K., Karjaluoto, H., & Pahnila, S. (2004). Consumer acceptance of online banking: an extension of the technology acceptance model. Internet Research, 14(3), 224–235. https://doi.org/10.1108/10662240410542652

Piper, A. M., & Hollan, J. D. (2013). Supporting medical communication for older patients with a shared touch-screen computer. International journal of medical informatics, 82(11), e242-e250.

Privitera, M. B., Evans, M., & Southee, D. (2017). Human factors in the design of medical devices e approaches to meeting international standards in the Euro- pean Union and USA. Applied Ergonomics, 59, 251e263. https://doi.org/ 10.1016/j.apergo.2016.08.034.

R. de Oliveira, M. Cherubini, and N. Oliver, “MoviPill: Improving Medication Compliance for Elders Using a Mobile Persuasive Social Game,” in Proceedings of the 12th ACM International Conference on Ubiquitous Computing, New Y ork, NY , USA, 2010, pp. 251–260.

R. L. Hannan, V. B. Hoffman, and D. V. Moser, “Bonus versus Penalty: Does Contract Frame Affect Employee Effort?,” in Experimental Business Research, Springer, Boston, MA, 2005, pp. 151–169.

R. Orji, L. E. Nacke, and C. D Marco, “Towards Personality-driven Persuasive Health Games and Gamified Systems,” in Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, New York, NY, USA, 2017, pp. 1015–1027.

Raghupathi, W., & Tan, J. (2002). Strategic IT applications in health care. Communications of the ACM, 45(12), 56-61.

Rich, E. User Modeling via stereotypes. Cognitive Science. v. 3, 1979, pp. 329-354.

Rizal, H., Amin, H., Suddin, L., Sondoh Jr, S. L., & Ku, C. J. (2020). Relationship Quality and E-Loyalty towards Online Travel Agency (OTA): Social Exchange Theory Perspective. Jurnal Pengurusan (UKM Journal of Management), 58.

Robertson, T. and Simonsen, J. (2013) Participatory Design – an Introduction, in Simonsen, J. and Robertson, T. (eds) (2013) Routledge International Handbook of Participatory Design. New York: Routledge, pp. 1-17.

Robertson, T. and Wagner, I. (2013) Ethics. Engagement, representation and politics-in-action, in Simonsen, J. and Robertson, T. (eds) (2013) Routledge International Handbook of Participatory Design. New York: Routledge, pp. 64-85

Rodriguez-Calero, I. B., Coulentianos, M. J., Daly, S. R., Burridge, J., & Sienko, K. H. (2020). Prototyping strategies for stakeholder engagement during front-end design: Design practitioners’ approaches in the medical device industry. Design Studies, 71, 100977.

Ruddy, K., Mayer, E., & Partridge, A. (January 01, 2009). Patient adherence and persistence with oral anticancer treatment. Ca: a Cancer Journal for Clinicians, 59, 1.)

Sanders, E., & Stappers, P. J. (2014). Probes, toolkits and prototypes: Three ap- proaches to making in codesigning. CoDesign, 10(1), 5e14. https://doi.org/ 10.1080/15710882.2014.888183.

Sarkar U, Schillinger D, López A, Sudore R. Validation of self-reported health literacy questions among diverse English and Spanish-speaking populations. J Gen Intern Med 2011 Mar;26(3):265-271 [FREE Full text] [doi: 10.1007/s11606-010-1552-1] [Medline: 21057882]

Schoonenboom, J., & Johnson, R. B. (2017). How to construct a mixed methods research design. KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie, 69(2), 107-131.

Science, 16(3), 395e429. https://doi.org/10.1016/0364-0213(92)90038-V.

Gupta, A. K., & Wilemon, D. L. (1990). Accelerating the development of technology-based new products. Journal of Product Innovation Management, 7(4), 323e335.

Seybert, H., & Lööf, A. (2010). Internet usage in 2010–Households and Individuals. Eurostat, data in Focus, 50-2010.

Short, M. E., Goetzel, R. Z., Pei, X., Tabrizi, M. J., Ozminkowski, R. J., Gibson, T. B., Dejoy, D. M., & Wilson, M. G. (2009). How accurate are self-reports? Analysis of self-reported health care utilization and absence when compared with administrative data. Journal of occupational and environmental medicine, 51(7), 786–796. https://doi.org/10.1097/JOM.0b013e3181a86671

Siddiqui H. Keynote Animation – How To Prototype UI. Freiburg, Germany: Smashing Magazine; 2015. URL:https://www. smashingmagazine.com/2015/08/animating-in-keynote/[WebCite Cache ID 70v0mIyCA]

Simonsen, J. and Robertson, T. Routledge Handbook of Participatory Design. Routledge 2012.

Spinuzzi, C. (2005). The methodology of participatory design. Technical communication, 52(2), 163-174.

Szopiński, T. S. (2016). Factors affecting the adoption of online banking in Poland. Journal of business research, 69(11), 4763-4768.

Thoresen, K. (1990). Prototyping Organizational Changes. In PDC90: Conference on Participatory Design. SeattleWA ComputerProfessionals forSocialResponsibility, 22-33.

Tohidi, M., Buxton, W., Baecker, R., & Sellen, A. (2006, April). Getting the right design and the design right. In Proceedings of the SIGCHI conference on Human Factors in computing systems (pp. 1243-1252).

Tuck Wah Leong and Toni Robertson. 2016. Voicing values: laying foundations for ageing people to participate in design. In Proceedings of the 14th Participatory Design Conference: Full papers - Volume 1 (PDC '16), Claus Bossen, Rachel Charlotte Smith, Anne Marie Kanstrup, Janet McDonnell, Maurizio Teli, and Keld Bødker (Eds.), Vol. 1. ACM, New York, NY, USA, 31-40. DOI: https://doi.org/10.1145/2940299.2940301

Van Deursen, A. J., & van Dijk, J. A. (2009). Improving digital skills for the use of online public information and services. Government Information Quarterly, 26(2), 333-340.

Van Dijk, J. A. (2005). The deepening divide: Inequality in the information society. Sage Publications.

Van Dijk, J. A. (2006). Digital divide research, achievements and shortcomings. Poetics, 34(4-5), 221-235.

Van Dijk, J., & Hacker, K. (2003). The digital divide as a complex and dynamic phenomenon. The information society, 19(4), 315-326.

Visser, W. (2009). Design: One, but in different forms. Design Studies, 30(3), 187e223. https://doi.org/10.1016/J.DESTUD.2008.11.004.

Viswanathan, V. K., & Linsey, J. S. (2009). Enhancing student innovation: Phys- ical models in the idea generation process. In Proceedings - Frontiers in Education Conference, FIE. https://doi.org/10.1109/FIE.2009.5350810.

Vurgun, S., Philipose, M., & Pavel, M. (January 01, 2007). A Statistical Reasoning System for Medication Prompting. Lecture Notes in Computer Science, 4717, 1-18.

W. IJsselsteijn, Y. de Kort, C. Midden, B. Eggen, and E. van den Hoven, “Persuasive Technology for Human Well-being: Setting the Scene,” in Proceedings of the First International Conference on Persuasive Technology for Human Well-being, Berlin, Heidelberg, 2006, pp. 1–5.

Warschauer, M. (2004). Technology and social inclusion: Rethinking the digital divide. MIT press.

Waterhouse, D. M., Calzone, K. A., Mele, C., & Brenner, D. E. (January 01, 1993). Adherence to oral tamoxifen: a comparison of patient self-report, pill counts, and microelectronic monitoring. Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology, 11, 6, 1189-97.

Weingart SN, Rind D, Tofıas Z, Sands DZ. Who uses the patient internet portal? The PatientSite experience. J Am Med Inform Assoc 2006;13(1):91–5.

What is Human-Computer Interaction (HCI)? (n.d.). The Interaction Design Foundation. Retrieved February 16, 2021, from https://www.interactiondesign.org/literature/topics/human-computer-interaction.

Wilcox, L., Morris, D., Tan, D., & Gatewood, J. (2010, April). Designing patient-centric information displays for hospitals. In proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 2123-2132).

Yang, M. C., & Epstein, D. J. (2005). A study of prototypes, design activity, and design outcome. Design Studies, 26(6), 649e669. https://doi.org/10.1016/j.destud.2005.04.005.

Yang, Y., & Asan, O. (2016). Designing patient-facing health information technologies for the outpatient settings: a literature review. Journal of innovation in health informatics, 23(1), 185.

Zenios, S., Makower, J., Yock, P. G., Brinton, T. J., Kumar, U. N., Denend, L., et al. (2010). Biodesign: The process of innovating medical technologies (1st ed.). Cambridge University Press.

Zhang, M., Zhang, C., Sun, Q., Cai, Q., Yang, H., & Zhang, Y. (2014). Questionnaire survey about use of an online appointment booking system in one large tertiary public hospital outpatient service center in China. BMC medical informatics and decision making, 14(1), 49.

Zimring, C., & Craig, D. L. (2001). Defining design between domains: An argu- ment for design research a la Carte. In C. M. Eastman, W. M. McCracken, W. C. B. T.-D. K, L. C. In, & D. E. Newstetter (Eds.), Design knowing and learning: Cognition in design education (pp. 125e146). Oxford: Elsevier Science. https://doi.org/10.1016/B978-008043868-9/50007-3.

Appendix A

Phase One – Exploration of Complexities – Guiding questions for Senior clerk interviews

- How do you know if the patient has special needs or mobility issues? (e.g. any condition that may affect the length of the appointment or the need for a second technologist) What words do you use? Please describe in detail the procedure you follow once you identify that.
- How do you know if the patient requires 2 or more time slots for screening? What do you do once you know that?
- How do you make sure that 2 technologists are available at a specific time slot to scan a patient with special needs?
- Do you follow a verification process if somebody is calling on behalf of a patient? Do you find it necessary? Do you add a note to the appointment that somebody is calling on behalf of the patient?
- Can you tell me which patients are better served by calling NSBSP rather than e-booking? Why?
- I know that you ask the patients if they had breast surgery, to my knowledge the definition of the term surgery might not be clear for some patients. For example, a biopsy might not sound like surgery for the patient. My question is, how do you make sure that the patient is clear about the term surgery? Please provide me with a list of all possible surgeries.
- If I am building an e-booking system, how do I incorporate your knowledge into this system? What questions should I incorporate?
- I know that you don't accept symptomatic patients (ex. specific nipple discharge), please tell me about all criteria that you check with patients to ensure eligibility for booking.

Appendix B

(Phase one – Exploration of Complexities – Supporting Quotes for Thematic Analysis)

Supporting quotes for users/patients empowerment theme

P3 “they don’t have to wait on the phone they don’t have to find a time to call”.

P1 “now you can’t reach people here in weekends or evenings. I hope that the uptake of screening would increase by giving people more abilities”.

P2 “I think ladies will be empowered to do that themselves to take care of themselves”.

Supporting quotes for o*nline portals usability theme*

P3 “if we have ladies with Down Syndrome, they can go to the mobile, its fine, but they just need two appointments”.

P2 “Some ladies will say no but I had a mole removed. Which to them could be surgery”.

P3 “if the biopsy is fine, we don’t consider it a surgery either. So, there are a lot of medical terms and I don’t understand all medical terms, and when you ask, have you ever had any breast surgery, well I will question what do you mean by breast surgery”.

P1 “the downsides I can see is if the system doesn’t work the way it should and someone gets booked early or get booked inappropriately”.

P2 “when I ask about surgeries they say no, then I ask about implants they say yes”.

Supporting quotes for generation gap theme

P1 “older patients feel more comfortable when they hear a human voice”.

P3 “Elderly patients, they benefit by calling to book”.

P1 “the older generations would want to speak to someone in person or just don’t feel comfortable using the technology”.

P2 “it depends on the generation you are from, whether you are computer savvy or not a computer savvy, there is a certain age of women who would not even think of going in this route”.

Supporting quotes for eligibility theme

P3 “if you’re not breastfeeding, there is no possibility of pregnancy, but if you are breastfeeding then you can’t have a mammogram for 6 months after a person finish breastfeeding”.

P1 “ensure the patient has not had any kind of intervention between her last exam, so asking questions or reconfirming sometimes they are not a breast cancer survivor or they don’t have got implants”.

P2 “The only downfall for ladies booking online is that we ask eligibility questions to certainly make sure they are eligible for the screening appointments”.

Supporting quotes a*dministrative and clerical duties*

P3 “I had to call 18 ladies for rebooking because the machine was down, but that is different”.

P2 “I don’t know if they would see it as an advantage, they may think that their job might be in jeopardy if a fewer number of ladies were calling, they might think that their job is impaired”.

P1 “the idea of using technology to replace a real person would be a concern”.

P2 “there are other things for them to do if the phones are not busy”.

Appendix C

(Phase Two – Complexities Impact On Design Decisions – Patient Survey)

Ver 3. Nov 26th, 2019

Online Booking Systems for Breast Screening

You are invited to participate in our study by filling out this survey (will take 10 min).

What is Our Project about?

Since 1991, the Nova Scotia Breast Screening Program (NSBSP) has used a central booking office to book all screening appointments. Women have to phone the program during business hours to book an appointment. This project is trying to explore how women could use an online system to book their appointments, and what challenges they may face.

Not all women have the same level of comfort with computers – some may wish to call the program, while others might want the flexibility to contact the program during non-regular business hours to book their screening appointment. In addition, women are asked some questions about their medical history, and we need to understand how practical this would be.

This survey asks women who have had a screening appointment, to answer some simple questions about their comfort with computers and their general health knowledge. You will also be given the choice to find out more about how you can participate in a focus group that will bring women together to talk about how a booking system could be designed to suit their needs. These focus groups will target both women who are comfortable with computers and medical terms as well as those who may be less comfortable.

Your participation will help us in learning about women's needs and expectations about online booking systems. You are being asked to answer the survey questions – your participation is voluntary and you may skip any questions you don't wish to answer. Finally, you will be given the option to learn more about the next step – a focus group discussion – by giving us some contact information (this will be kept separate from your survey answers). If contacted, you will be provided with more information about the focus groups, and you can then consider if you'd like to participate.

If you have questions you may contact the lead researcher, Khalid Tearo (tearo@dal.ca).

1

Survey

Please answer the following questions by selecting the option that corresponds to your answer:

a. How often you use the internet for booking (hotels, flights, government services…etc.)?

Always	Sometimes	Never

b. How often you use the internet (including mobile applications) for health services (pharmacy, family clinic…etc.)?

Always	Sometimes	Never

c. I am interested in booking my re-screening appointment at the NSBSP using the online booking website

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

d. To my knowledge, the term "Biopsy" means

Surgical procedure	Non-surgical procedure	Neither

Tool 1. Functional health literacy

Imagine this is a patient information leaflet on 500mg paracetamol tablets (Panodil similar to Pnadol). Fill in the blanks by choosing from the four options below each blank.

You can _____ Panodil without a prescription.
A. see
B. get
C. is
D. go

Panodil is a painkiller and also _____ your temperature when you have a fever.

A. reuses
B. increases
C. rescues
D. reduces

If your doctor has _____ Panodil for you, always follow your doctor's instructions.

A. properly
B. prescribed
C. orchestra
D. manager

If in doubt, ask your doctor or _____.

A. go to the library
B. use an applet/application
C. ask a pharmacist
D. make a counterclaim

The usual dose for adults is 2 tablets of 500 mg (total of _____ mg) 3-4 times daily

A. 250
B. 1000
C. 3000
D. 4000

and a maximum of _____ tablets (4000 mg total) daily.

E. 2
F. 4
G. 6
H. 8

The maximum dose for children in 50mg/kg/day divided in 3-4 doses per day. E.g. if the child weights 30 kg, the maximum does is _____ mg a day.

A. 500
B. 1000
C. 1500
D. 3000

A _____ dose of Panodil than the recommended one is dangerous and can cause long-term damage.

A. sweeter
B. less
C. higher
D. quantity

It is important that you seek _____ as soon as possible if you suspect an overdose.

E. a away
F. a doctor
G. a dentist
H. a lip

Symptoms of overdose may include vomiting, stomach aches/pains, nausea, jaundice and discoloration of urine and stools. In the worst case, after approx. 3 days patient may lose _____ and die of liver failure.

A. evidence
B. the practice
C. determination
D. consciousness

Tool 2. Health literacy self-assessment

On a scale from very easy to very difficult, how easy would you say it is to:	Very difficult	Difficult	Easy	Very Easy
Find information on treatments of illnesses that concern you?	☐	☐	☐	☐
Find out where to get professional help when ill? (e.g., at the clinic, at the pharmacy)	☐	☐	☐	☐
Understand what your doctor is saying to you?	☐	☐	☐	☐
Follow instructions from your doctor or pharmacist?	☐	☐	☐	☐
Find information on what to do in case of mental health problems such as stress and depression ?	☐	☐	☐	☐
Decide on the basis of information in the media, how do you want to protect yourself against illness? (e.g. newspapers, brochures, internet or other media)	☐	☐	☐	☐
Find information on habits that are good for your mental well-being? (e.g., meditation, exercise, walking, etc.)	☐	☐	☐	☐
Understand advice on health from family members or friends?	☐	☐	☐	☐
Evaluate how your bad habits are affecting your health? (e.g. drinking and eating habits, exercise, etc.)	☐	☐	☐	☐

Tool 3. Familiarity with health and healthcare

Rate on a scale from not at all familiar to completely familiar.

How familiar are you with the following items?	**Not at all familiar**			**Completely Familiar**
	1	2	3	4
Rehabilitation	☐	☐	☐	☐
Spleen	☐	☐	☐	☐
Medical ventilator (respirator)	☐	☐	☐	☐
Withdrawal (symptoms)	☐	☐	☐	☐
Autism	☐	☐	☐	☐
Abstinence	☐	☐	☐	☐

Tool 4. Knowledge of health and disease

Choose the option that you believe is the right one for each of the seven questions.

When you receive a blood test results, what does the term “haemoglobin” mean?

a. ☐ The blood type
b. ☐ Blood platelet
c. ☐ Your blood percentage
d. ☐ I will ask someone else, since I’m unsure about the answer.

What does the term “fracture” mean?

a. ☐ Vomiting
b. ☐ Broken bone
c. ☐ Kidney failure
d. ☐ I will ask someone else, since I’m unsure about the answer.

What other term can be used instead of the term "palsy"?

a. ☐ Paralysis
b. ☐ Fertilization
c. ☐ Scalpel
d. ☐ I will ask someone else, since I’m unsure about the answer.

Which of the following is one of the livers main functions?

a. ☐ Detoxing of the blood
b. ☐ Oxygenate blood
c. ☐ Urine production
d. ☐ I will ask someone else, since I'm unsure about the answer

Nephrology is the doctrine of?

a. ☐ Liver disease
b. ☐ Kidney disease
c. ☐ Nervous disease
d. ☐ I will ask someone else, since I'm unsure about the answer

What is one of the main functions of the pancreas?

a. ☐ To oxygenate the blood
b. ☐ To produce stomach acid
c. ☐ To produce insulin
d. ☐ I will ask someone else, since I'm unsure about the answer

The last three tools concern the use of electronic devices such as computer, tablets, smartphones, smart TV or similar.

If you use other electronic devices than a computer, then base your answers on the electronic device that you use the most in everyday life.

Tool 5. Technology familiarity

Rate on a scale from not at all familiar to completely familiar.

How familiar are you with the following items?	**Not at all familiar**			**Completely Familiar**
	1	2	3	4
Keyboard	☐	☐	☐	☐
Settings	☐	☐	☐	☐
Operating Systems (e.g. Windows)	☐	☐	☐	☐
User Name	☐	☐	☐	☐
Wi-Fi	☐	☐	☐	☐
Copy & Paste	☐	☐	☐	☐

Tool 6. Technology confidence

On a scale from not at all confident to completely confident, rate your use of computers.

How confident do you feel …?	Not at all confident			Completely confident
	1	2	3	4
Using a computer in general?	☐	☐	☐	☐
Using a computer other than your own?	☐	☐	☐	☐
Using touchscreen?	☐	☐	☐	☐
Finding information online?	☐	☐	☐	☐

Tool 7. Incentives for engaging with technology

On a scale from completely disagree to completely agree, rate your experience of computers.

How much do you agree or disagree with the following statement:	Completely disagree			Completely agree
	1	2	3	4
I am interested in using computers.	☐	☐	☐	☐
I am fond of my computer.	☐	☐	☐	☐
I am not afraid to try out new functions on computers.	☐	☐	☐	☐
I am open to new possibilities of using computers.	☐	☐	☐	☐

'Interested in providing more information?'

We are conducting a related study about how online booking systems can be used to book future screening appointments. Your participation is valuable and can help us understand how patients might use computers to book these appointments.

If you are interested in receiving more information about our study, please provide us with the following:

Name (print):

e-mail:

Phone number:

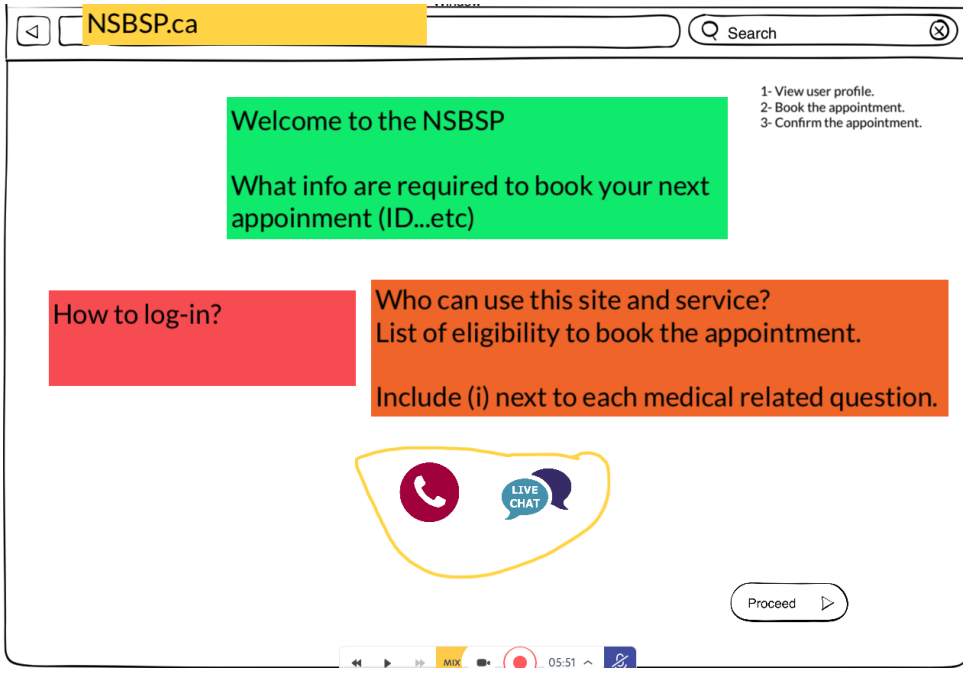
Appendix D

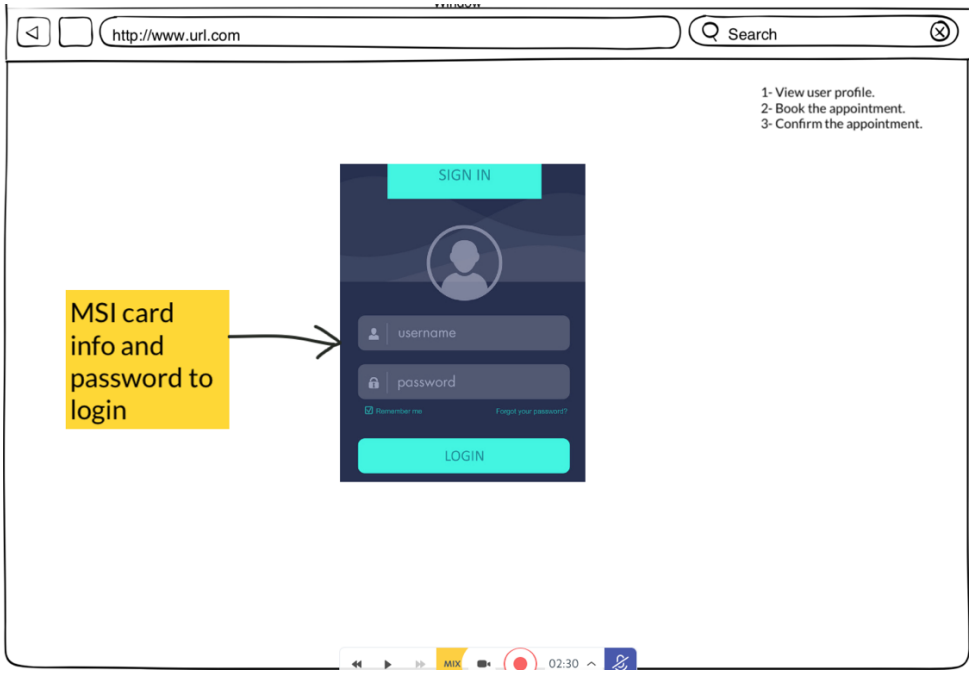
(Phase Two – Impact of Complexities on Design Decisions– Guiding Questions Post-Prototyping Interviews)

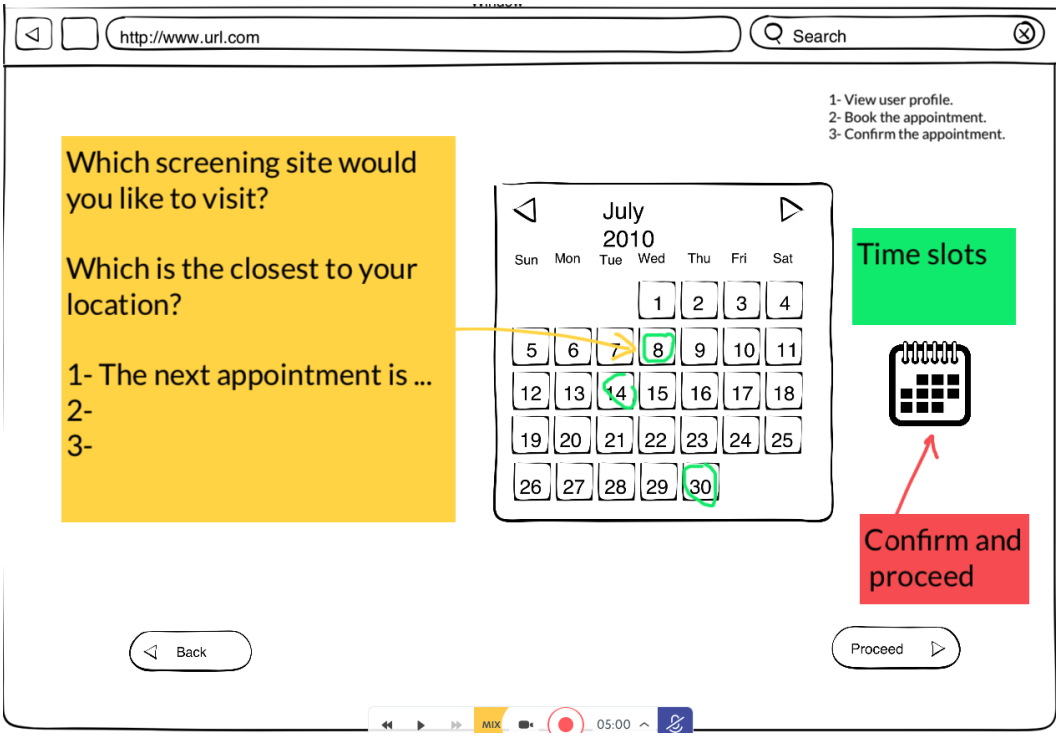
- Am I willing to inject time and effort to use online booking tools?
- What are the circumstances that will make you consider using online booking tools?
- How might online booking tools help me in comparison to phone-based booking?
- What are the most valuable aspects/values of using online booking tools?

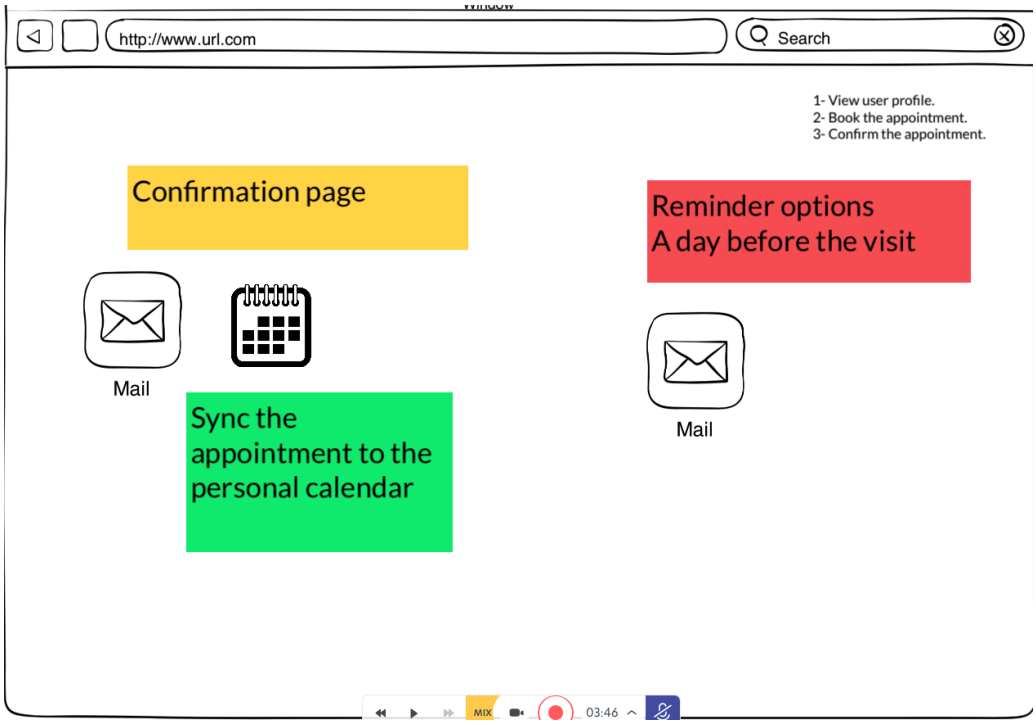
Appendix E

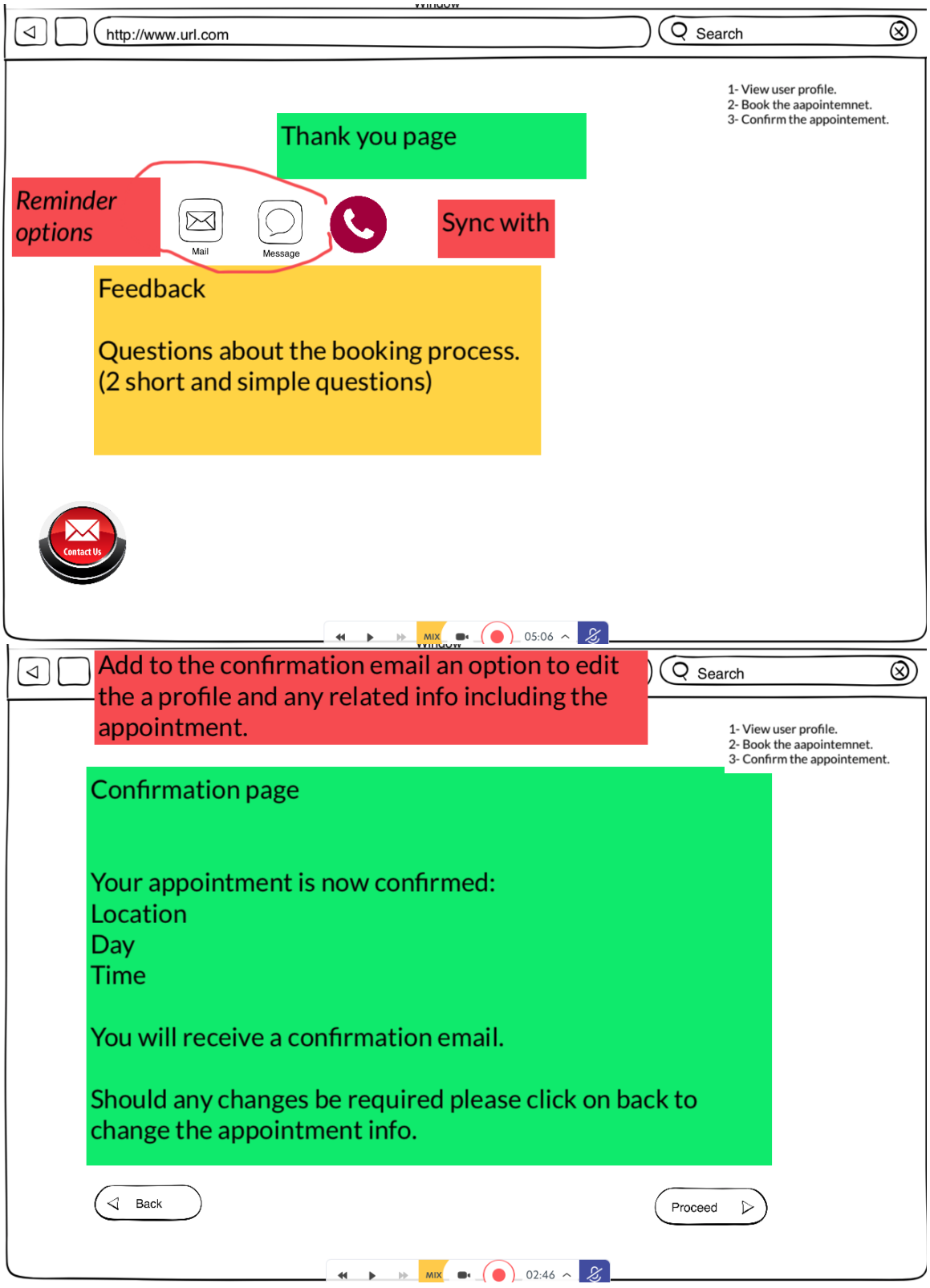
(Phase two – Impact of Complexities on Design Decisions – Artifacts)

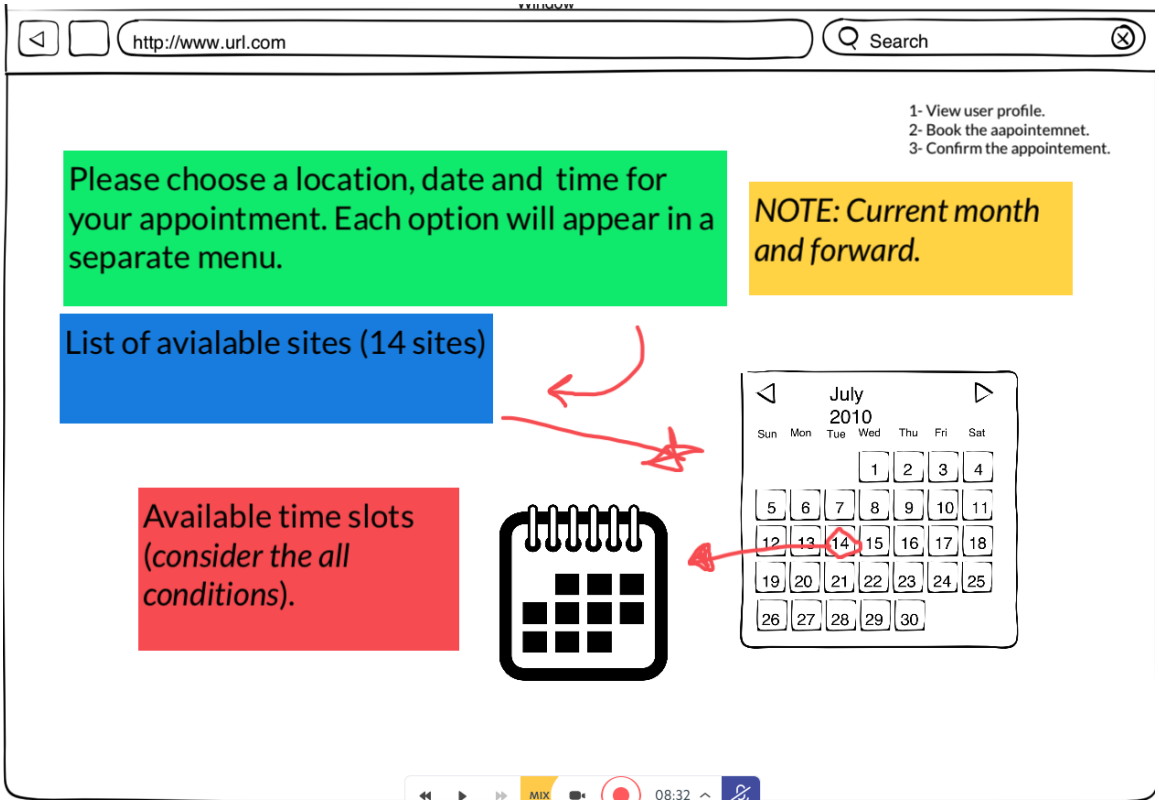


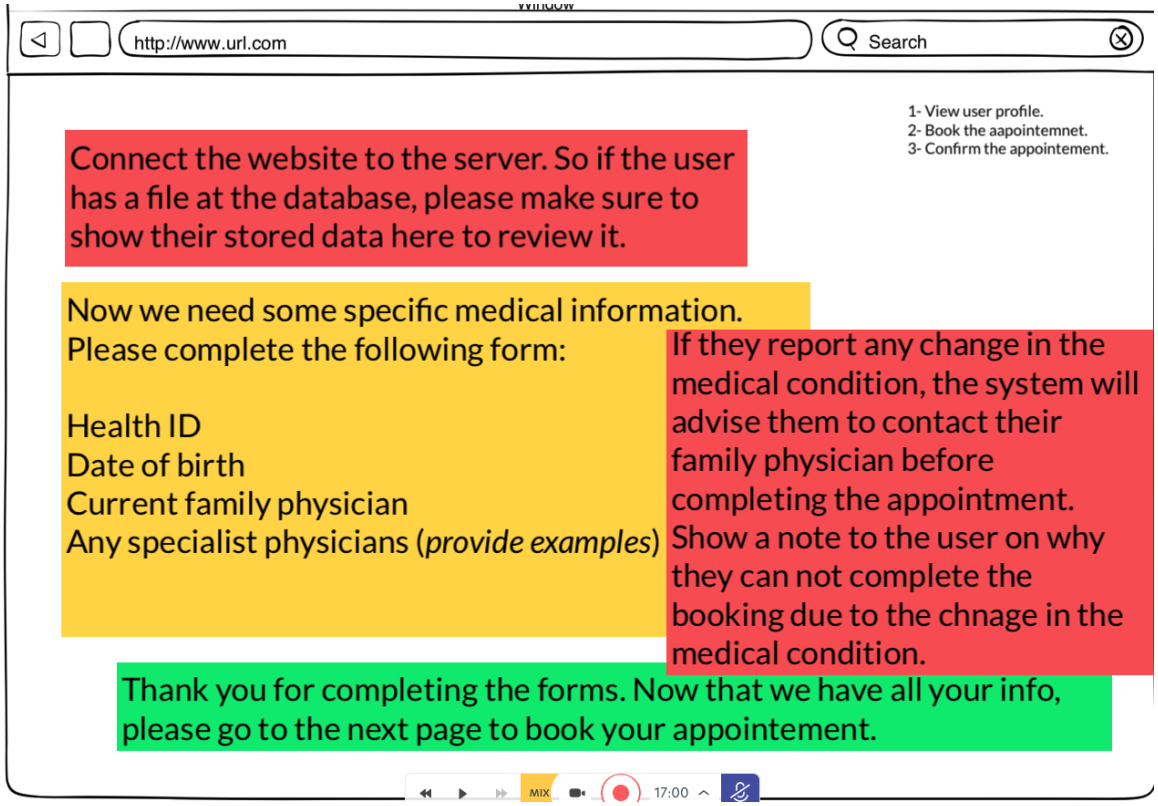


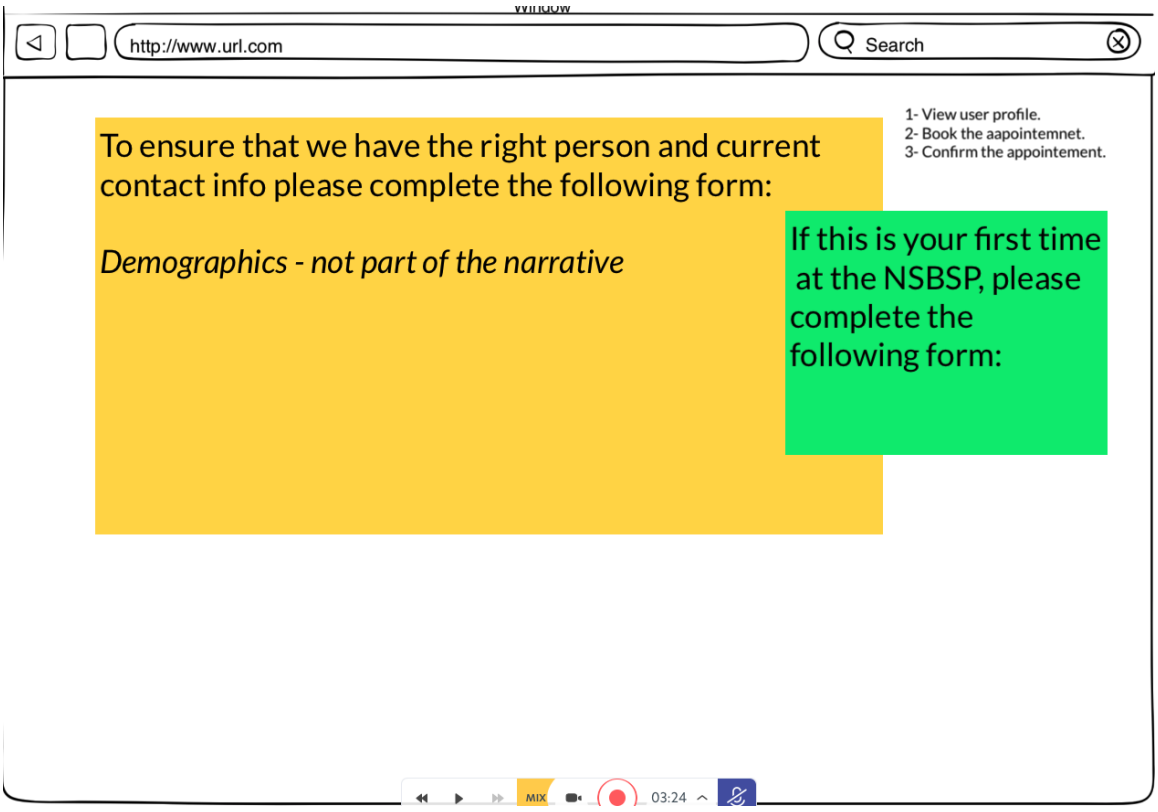

http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Which screening site would you like to visit?
Which is the closest to your location?
1- The next appointment is ...
2-
3-
July
2010
Sun Mon Tue Wed Thu Fri Sat
Time slots
Confirm and proceed
Back
Proceed
05:00

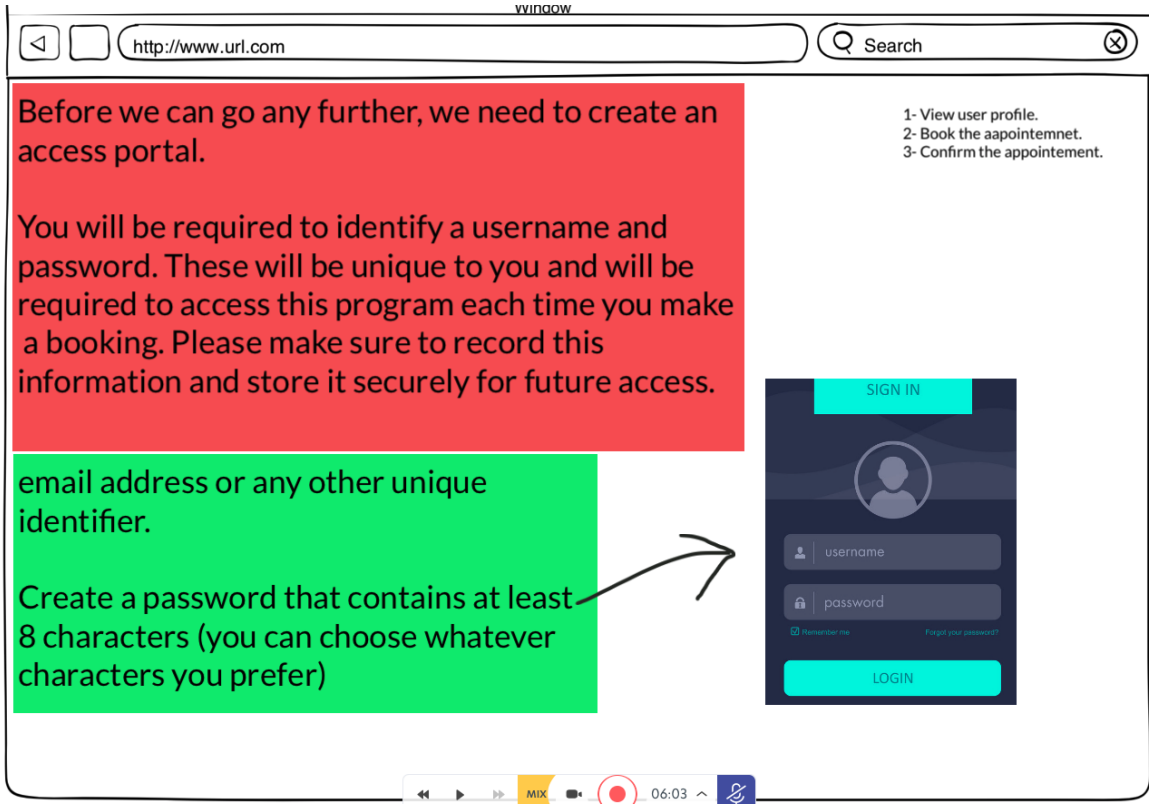

http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Confirmation page
Reminder options
A day before the visit
Mail
Sync the appointment to the personal calendar
Mail
03:46

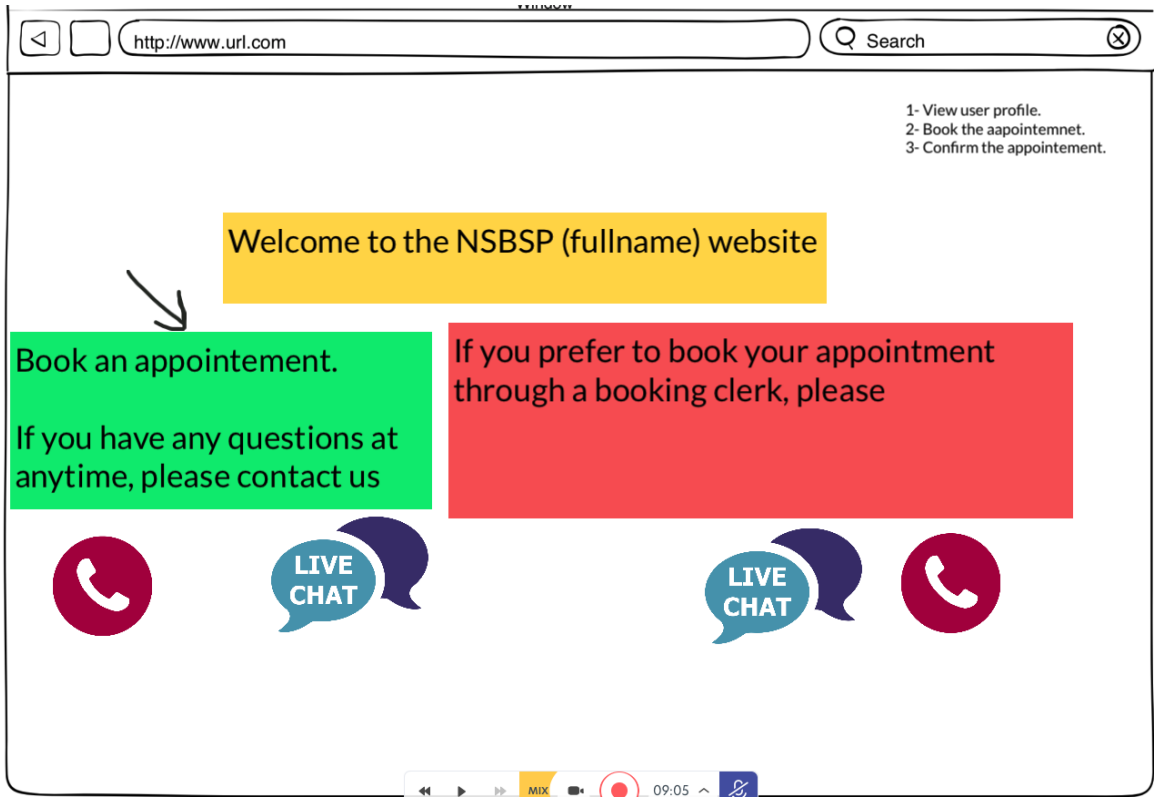

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Thank you page
Reminder options
Mail
Message
Sync with
Feedback
Questions about the booking process.
(2 short and simple questions)
Contact Us
05:06
Add to the confirmation email an option to edit the a profile and any related info including the appointment.
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Confirmation page
Your appointment is now confirmed:
Location
Day
Time
You will receive a confirmation email.
Should any changes be required please click on back to change the appointment info.
Back
Proceed
02:46

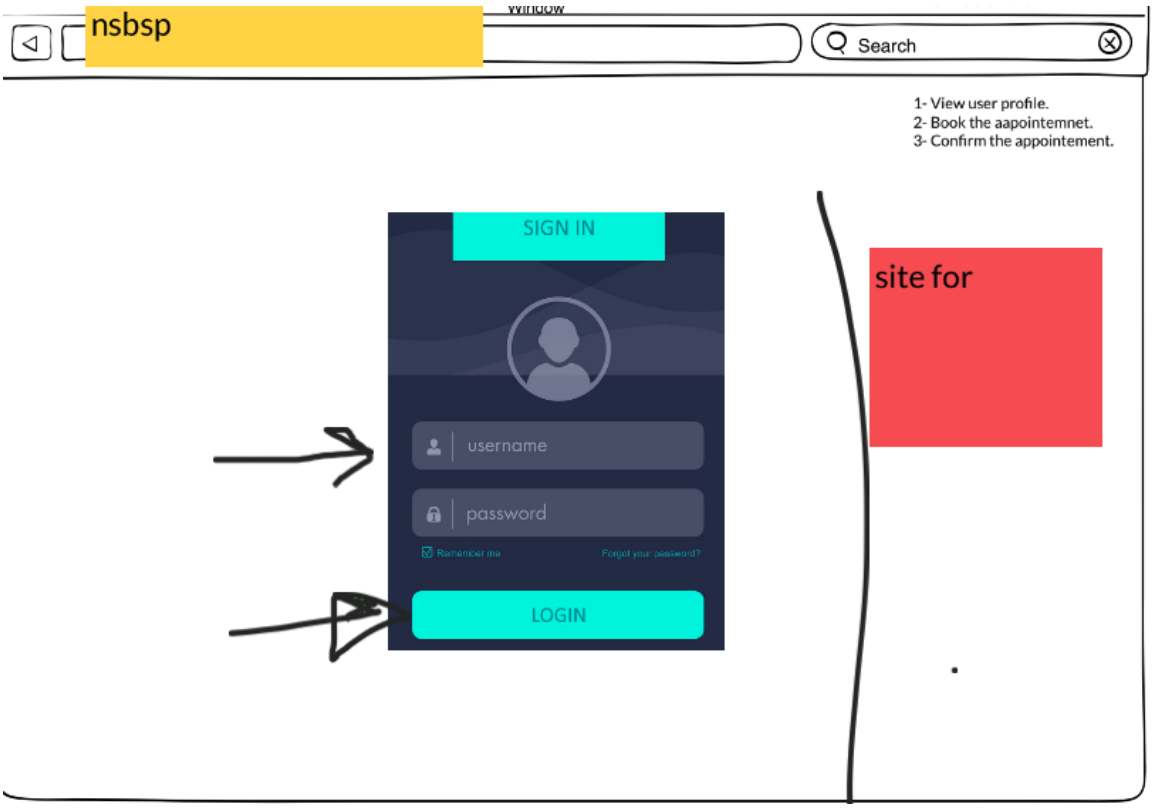

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Please choose a location, date and time for your appointment. Each option will appear in a separate menu.
NOTE: Current month and forward.
List of avialable sites (14 sites)
Available time slots (consider the all conditions).
July 2010
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30
08:32

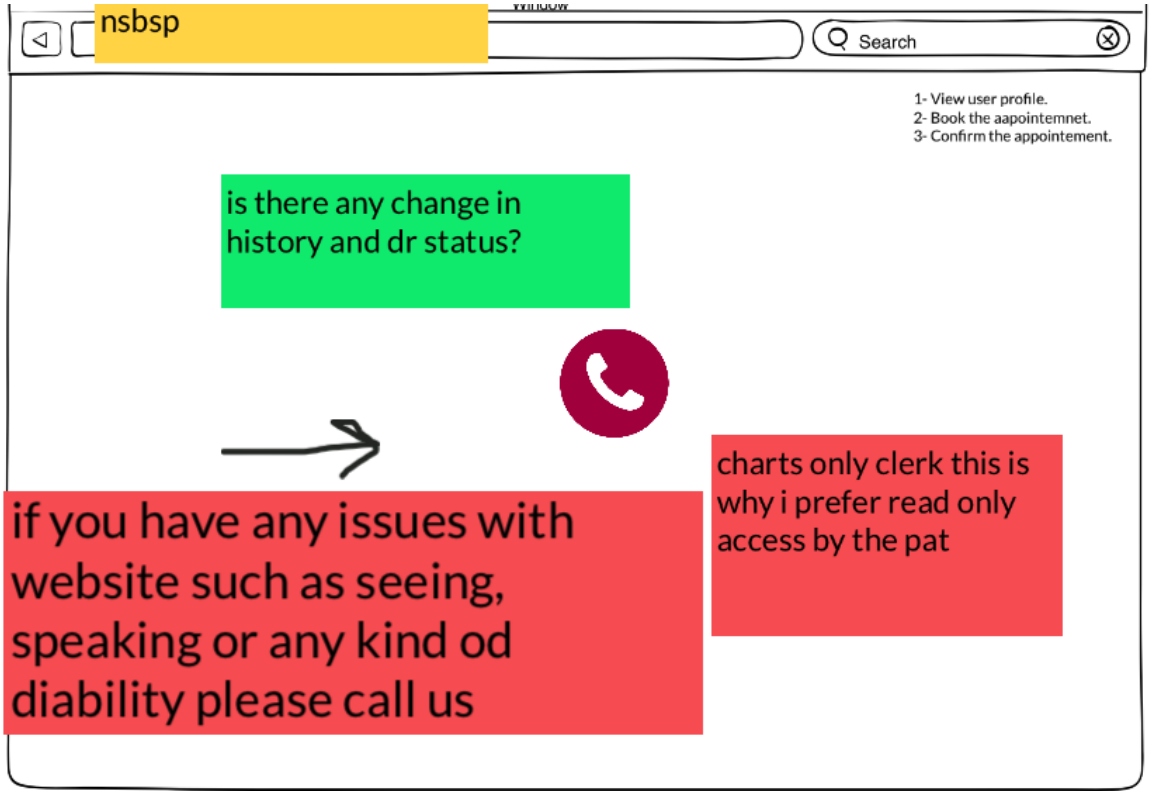

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Connect the website to the server. So if the user has a file at the database, please make sure to show their stored data here to review it.
Now we need some specific medical information.
Please complete the following form:
Health ID
Date of birth
Current family physician
Any specialist physicians (provide examples)
If they report any change in the medical condition, the system will advise them to contact their family physician before completing the appointment.
Show a note to the user on why they can not complete the booking due to the chnage in the medical condition.
Thank you for completing the forms. Now that we have all your info, please go to the next page to book your appointement.
17:00

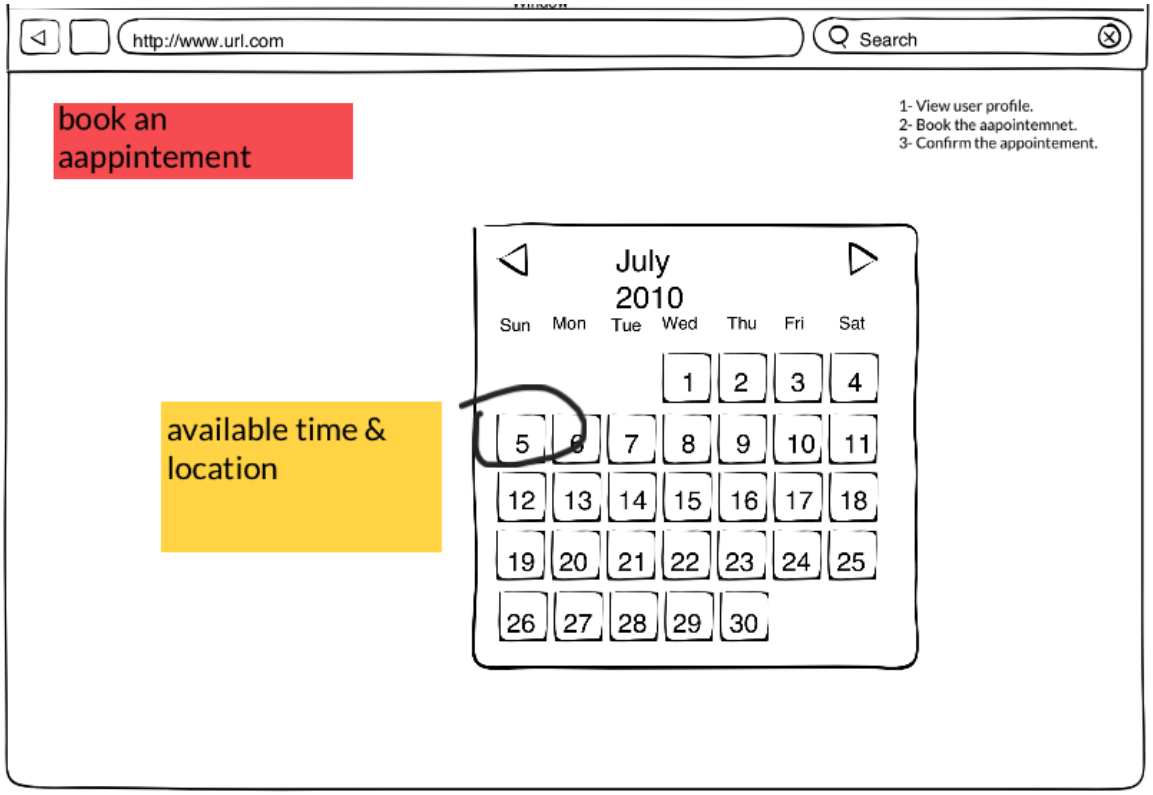

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
To ensure that we have the right person and current contact info please complete the following form:
Demographics - not part of the narrative
If this is your first time at the NSBSP, please complete the following form:
03:24

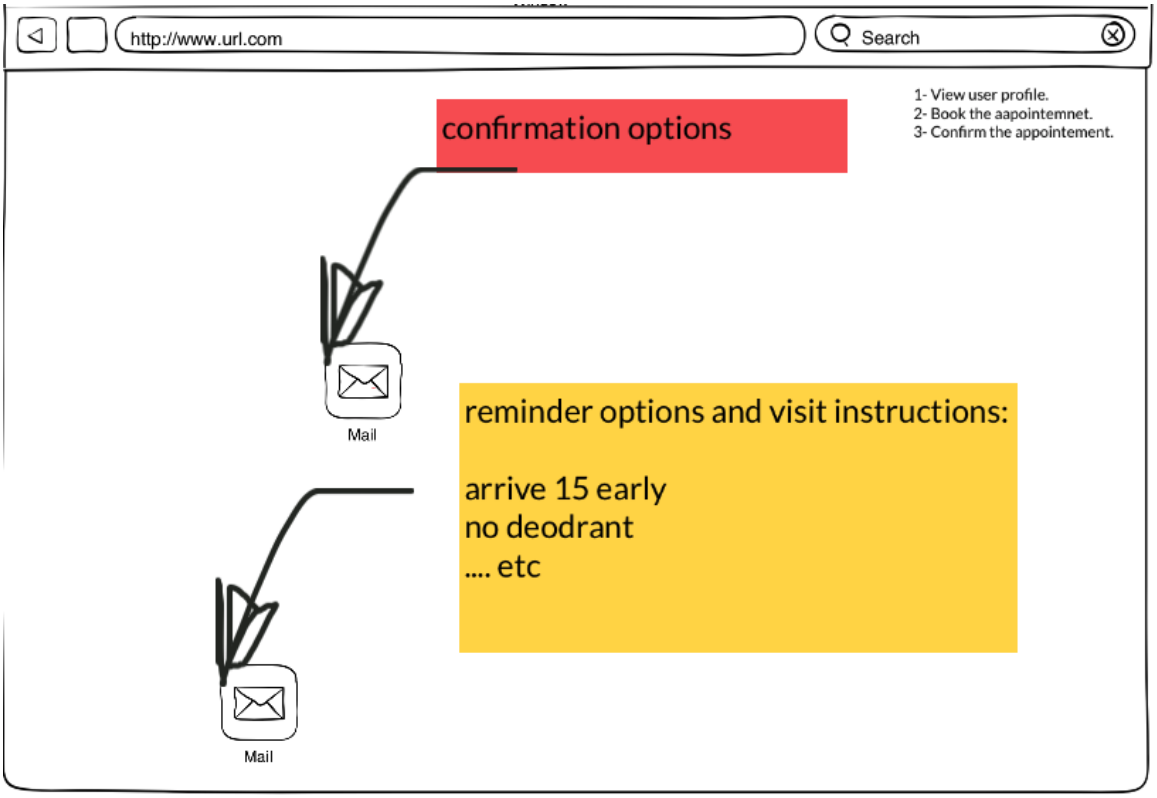

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Before we can go any further, we need to create an access portal.
You will be required to identify a username and password. These will be unique to you and will be required to access this program each time you make a booking. Please make sure to record this information and store it securely for future access.
email address or any other unique identifier.
Create a password that contains at least 8 characters (you can choose whatever characters you prefer)
SIGN IN
username
password
LOGIN
06:03


http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Welcome to the NSBSP (fullname) website
Book an appointement.
If you have any questions at anytime, please contact us
If you prefer to book your appointment through a booking clerk, please
LIVE CHAT
LIVE CHAT

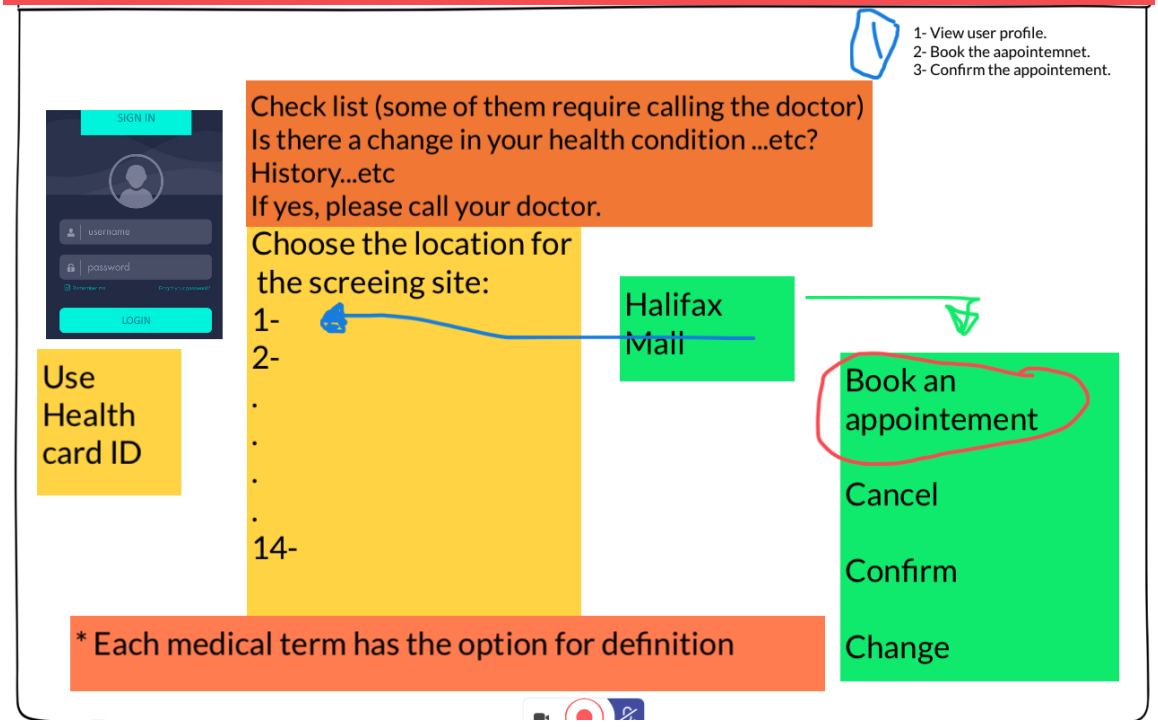

nsbsp
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
SIGN IN
username
password
LOGIN
site for

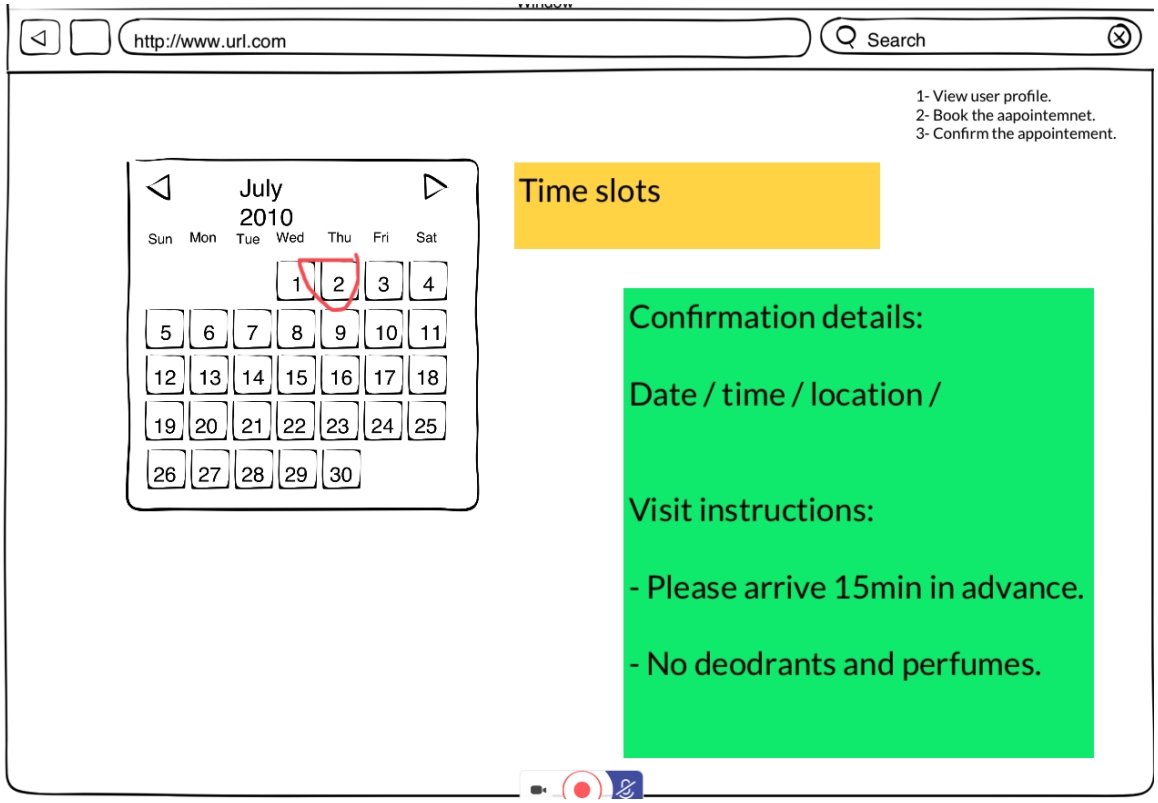

nsbsp
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
is there any change in history and dr status?
charts only clerk this is why i prefer read only access by the pat
if you have any issues with website such as seeing, speaking or any kind od diability please call us

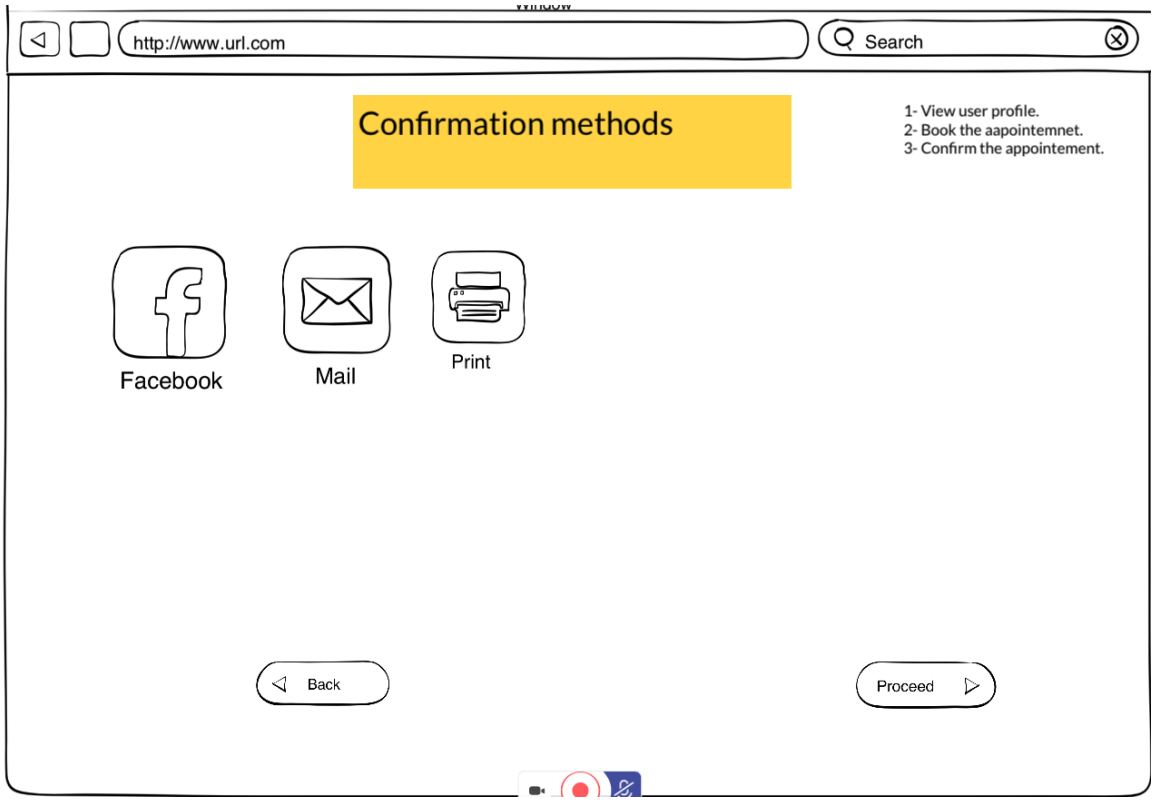

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
book an aappintement
available time & location
July 2010
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30

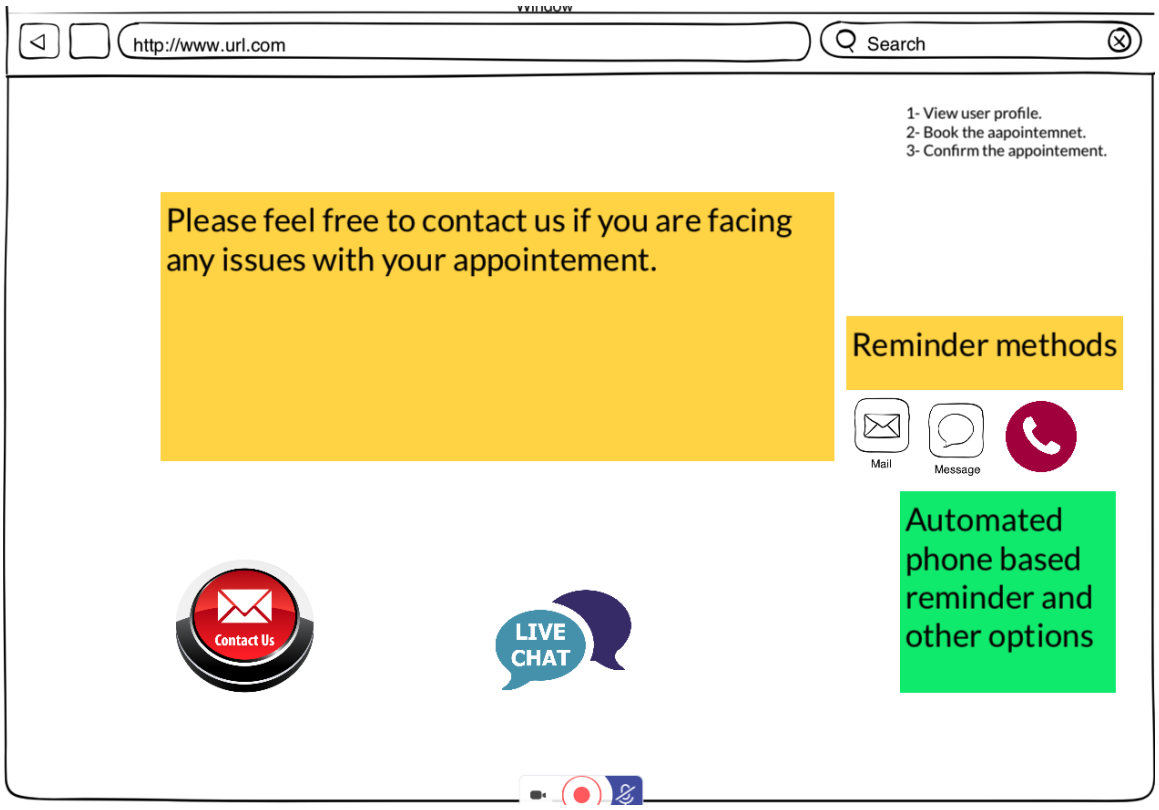


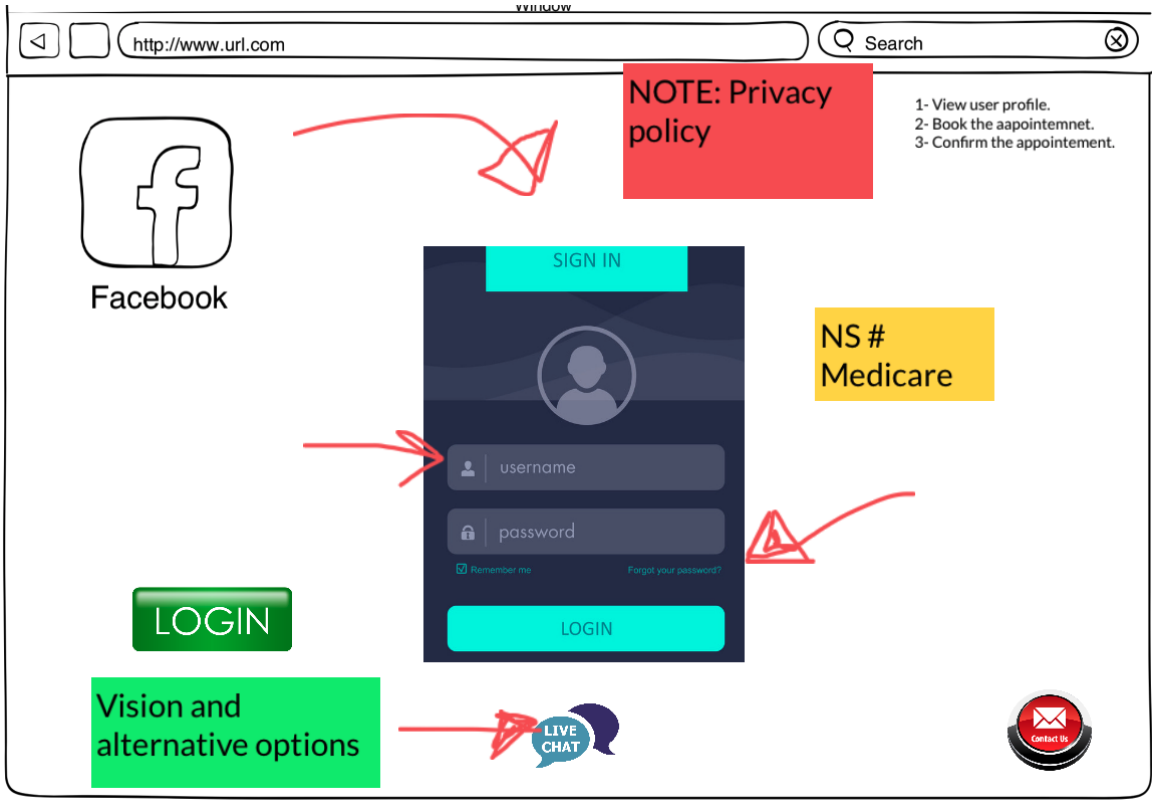
NSBSP.ca (consider all titels and addresses) This can be done by working with google

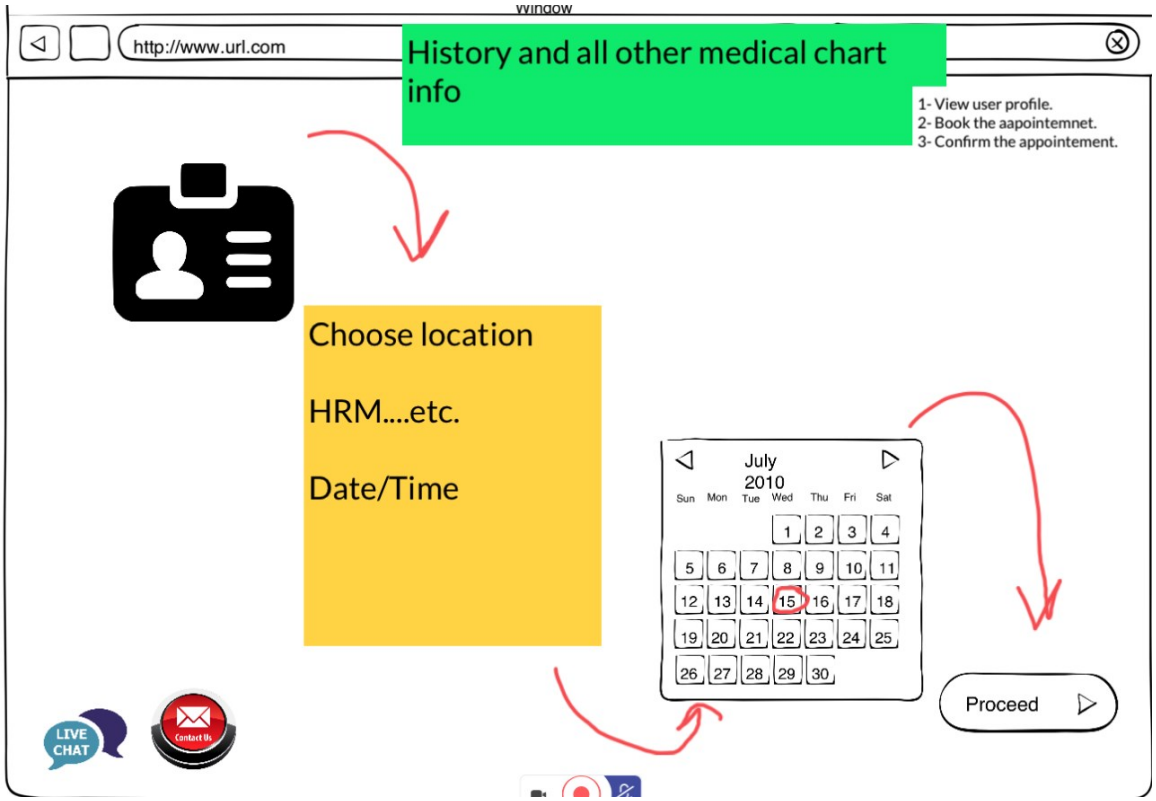


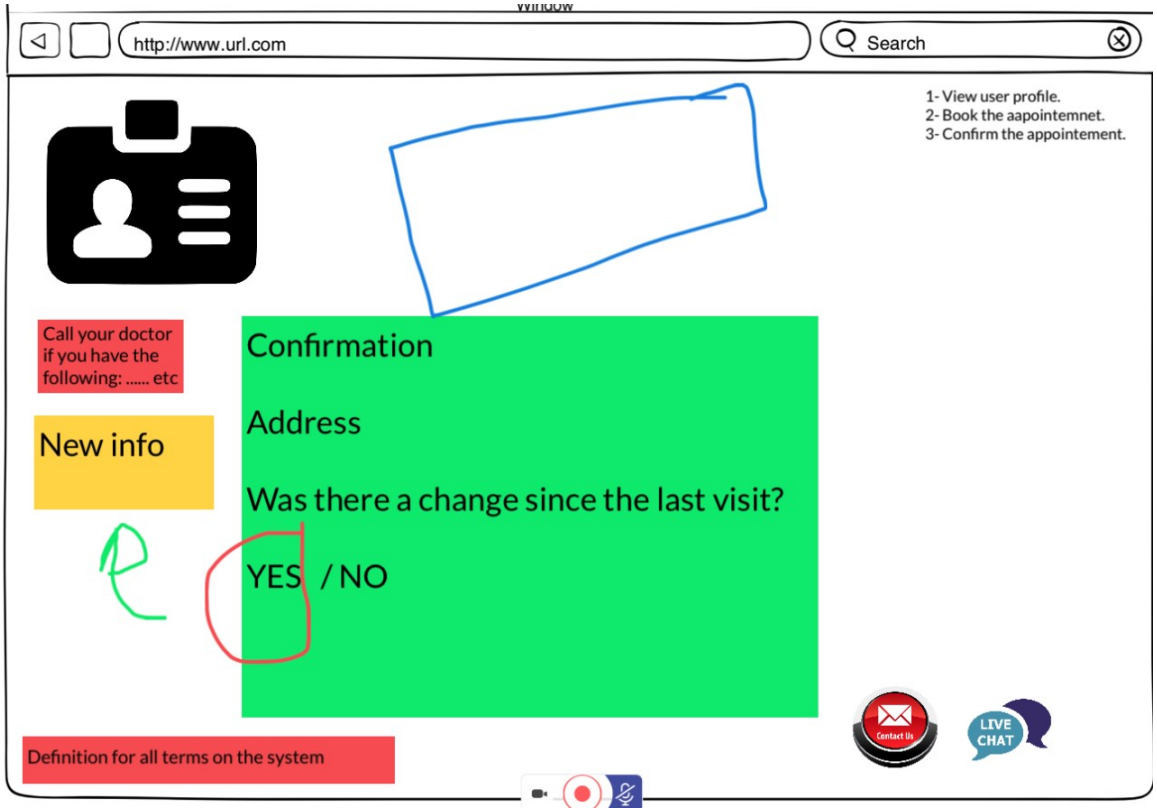

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
July
2010
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30
Time slots
Confirmation details:
Date / time / location /
Visit instructions:
- Please arrive 15min in advance.
- No deodrants and perfumes.

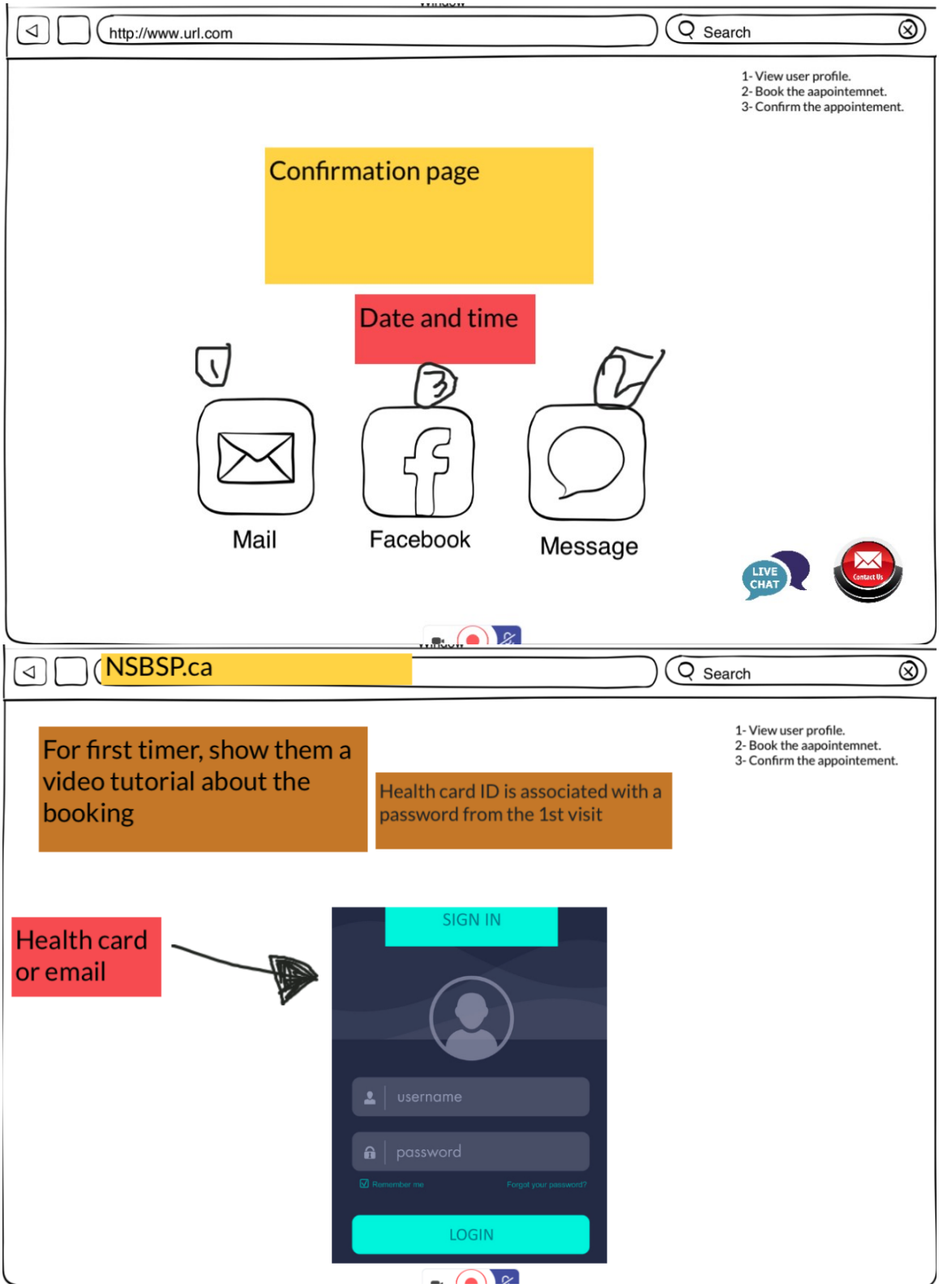

http://www.url.com
Search
Confirmation methods
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Facebook
Mail
Print
Back
Proceed

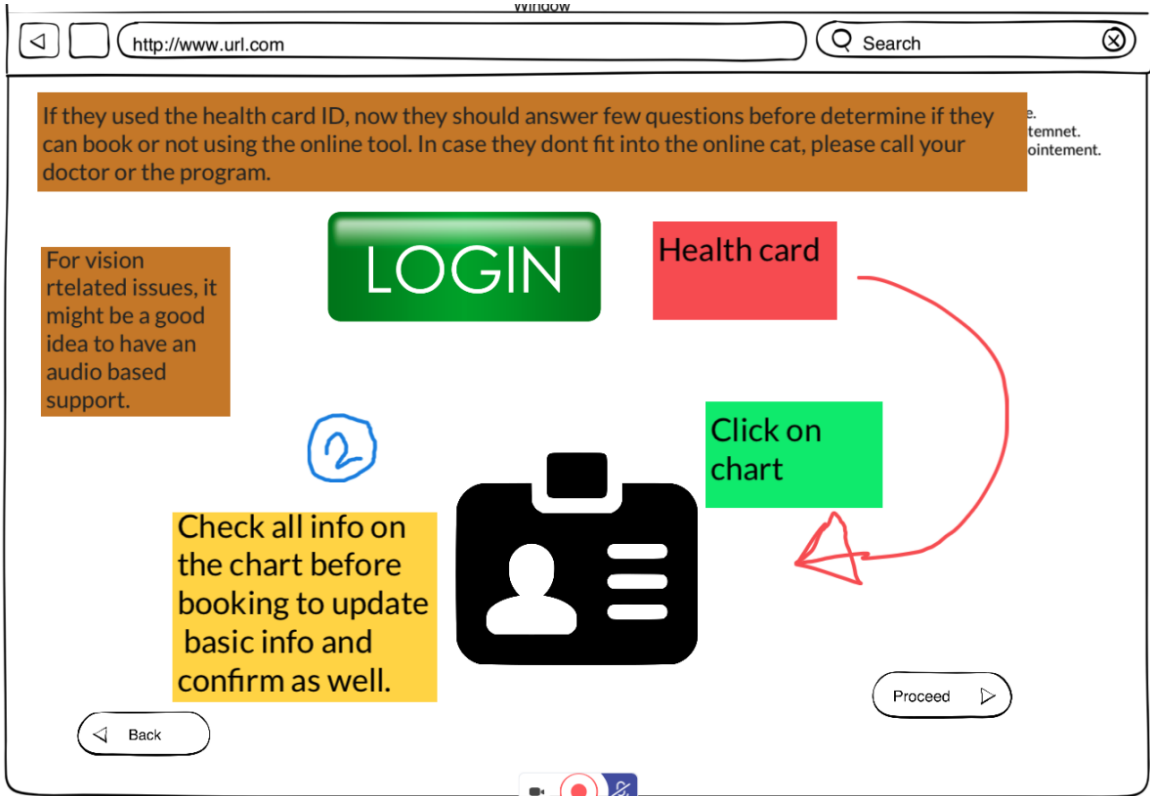

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Please feel free to contact us if you are facing any issues with your appointement.
Reminder methods
Mail
Message
Automated phone based reminder and other options
Contact Us
LIVE CHAT

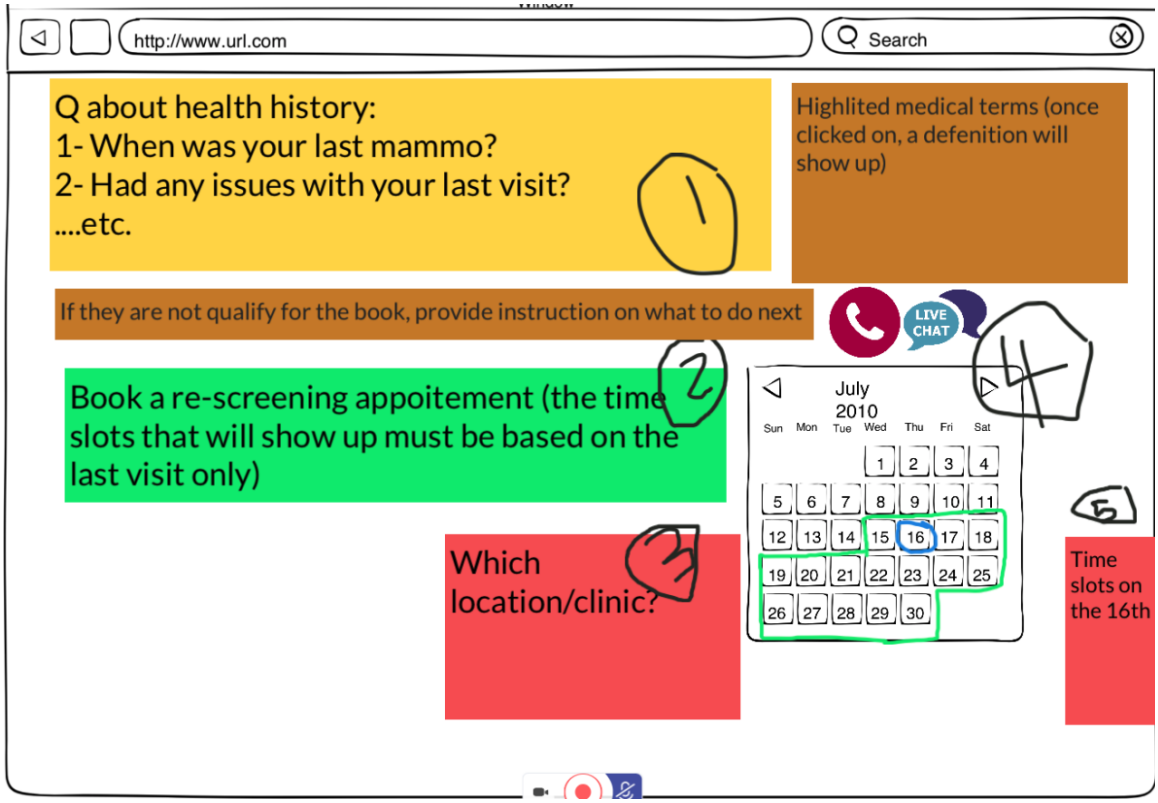

http://www.url.com
Search
NOTE: Privacy policy
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Facebook
SIGN IN
username
password
Remember me
Forgot your password?
LOGIN
NS # Medicare
LOGIN
Vision and alternative options
LIVE CHAT
Contact Us

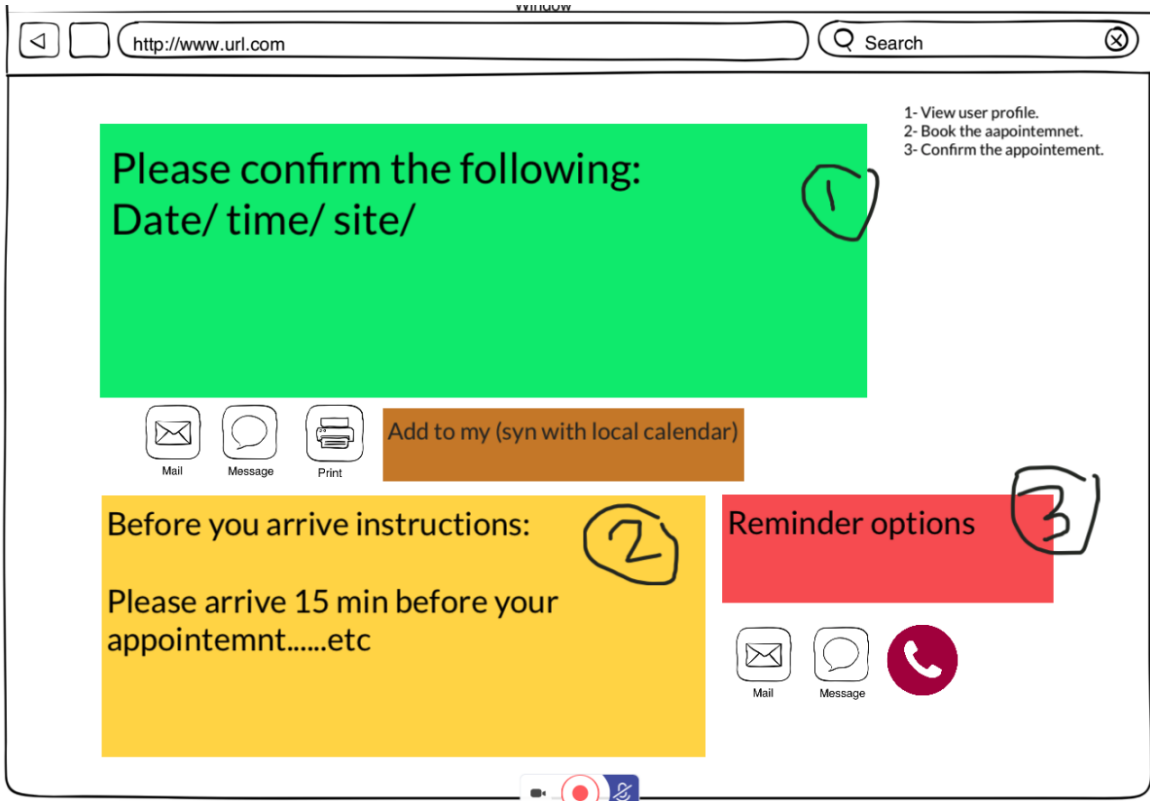

Window
http://www.url.com
History and all other medical chart info
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointemnet.
Choose location
HRM....etc.
Date/Time
July 2010
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30
Proceed
LIVE CHAT
Contact Us

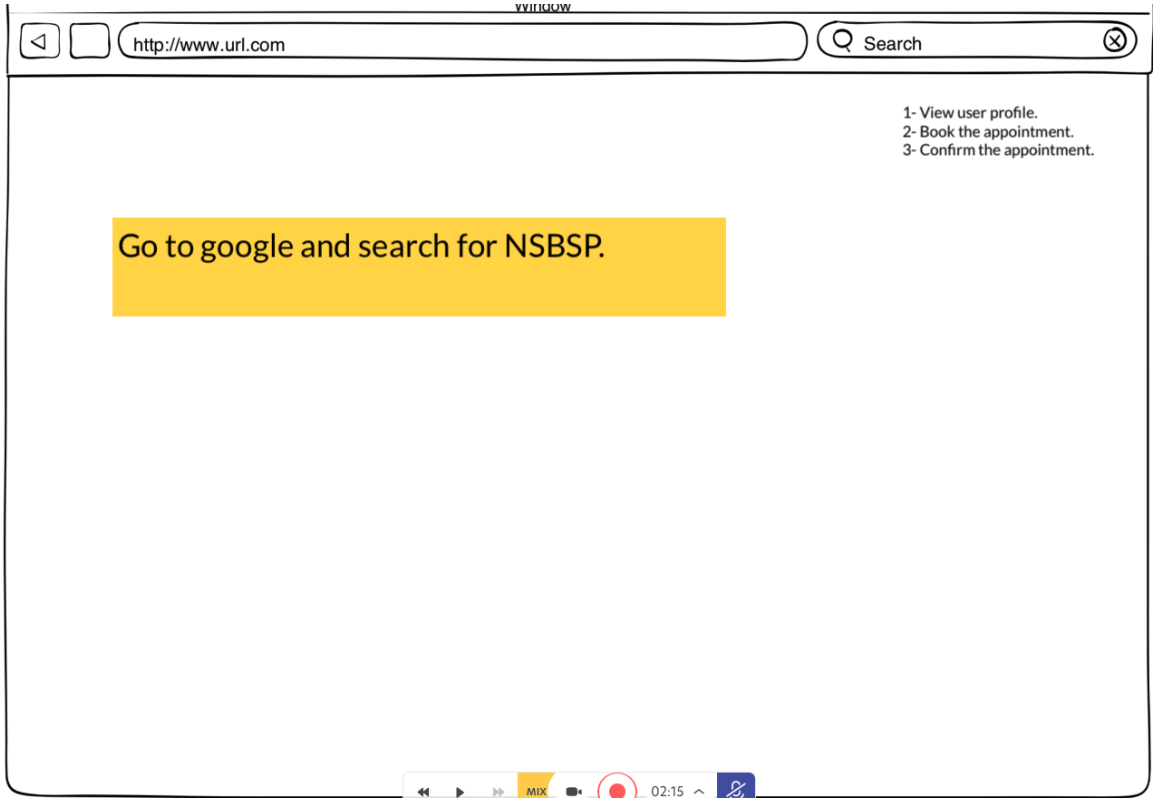

Window
http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointemnet.
Call your doctor if you have the following: ..... etc
New info
Confirmation
Address
Was there a change since the last visit?
YES / NO
Definition for all terms on the system
Contact Us
LIVE CHAT

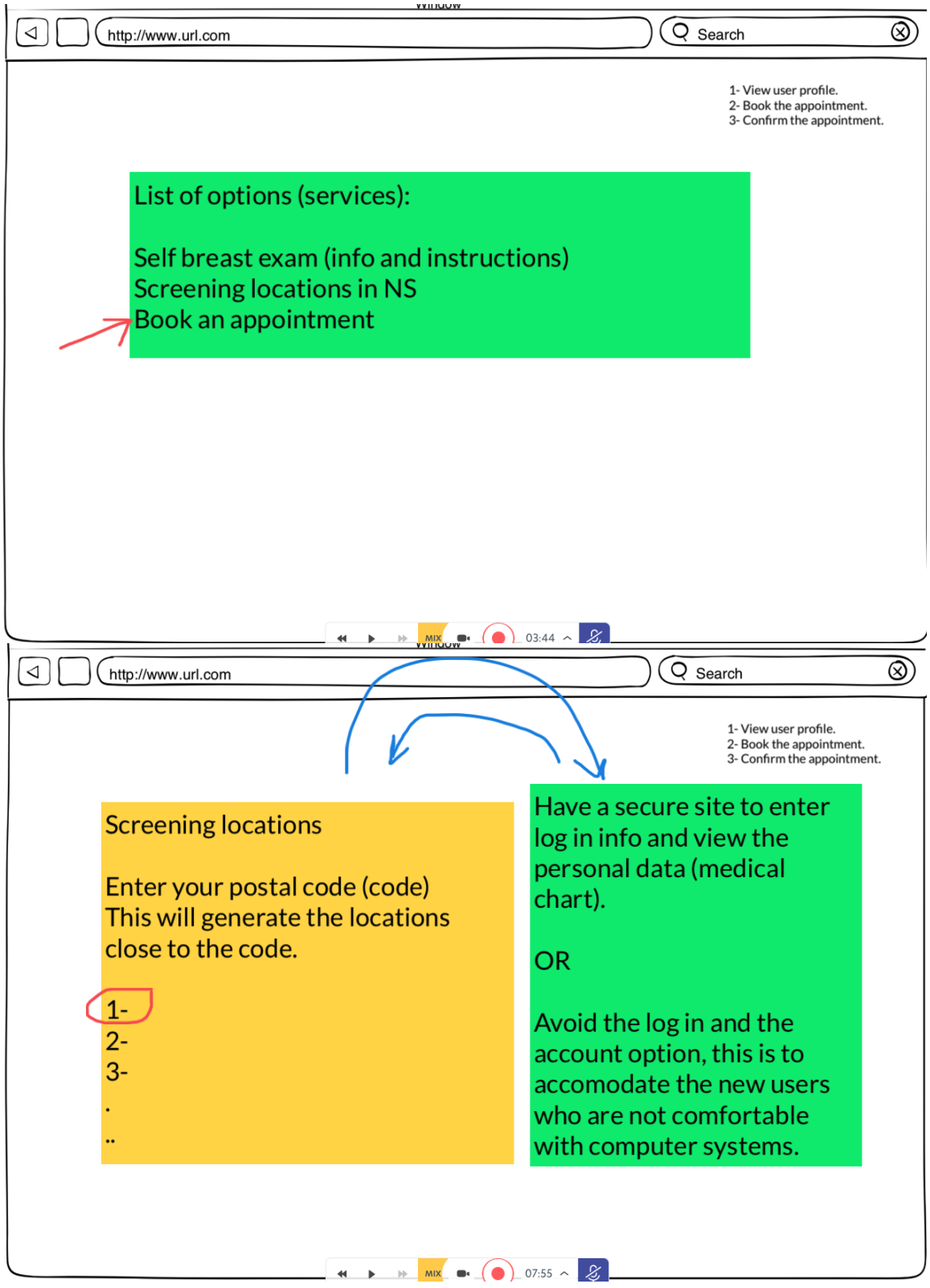

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Confirmation page
Date and time
Mail
Facebook
Message
LIVE CHAT
Contact Us
NSBSP.ca
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
For first timer, show them a video tutorial about the booking
Health card ID is associated with a password from the 1st visit
Health card or email
SIGN IN
username
password
Remember me
Forgot your password?
LOGIN

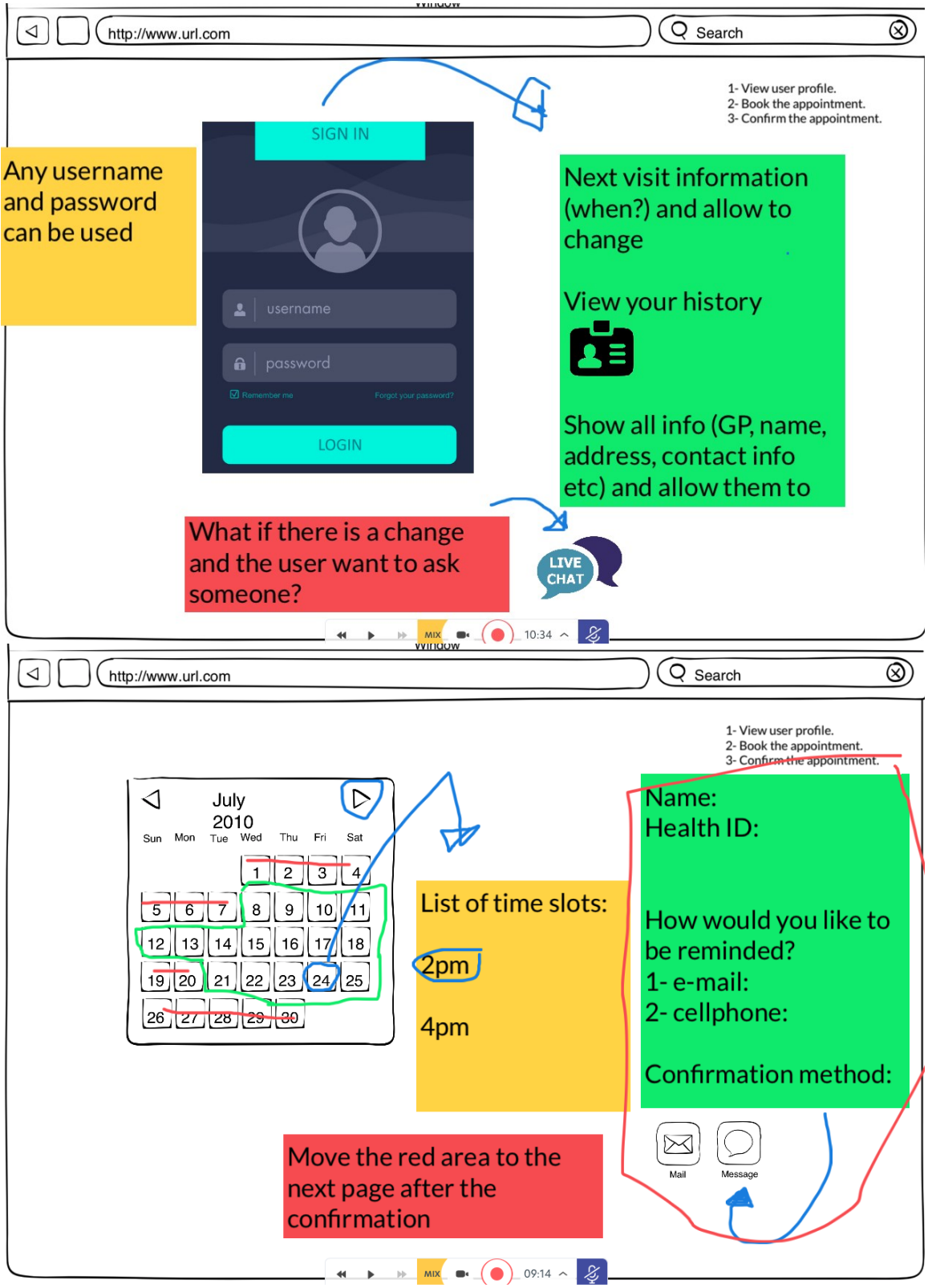

http://www.url.com
Search
If they used the health card ID, now they should answer few questions before determine if they can book or not using the online tool. In case they dont fit into the online cat, please call your doctor or the program.
temnet.
ointement.
For vision rtelated issues, it might be a good idea to have an audio based support.
LOGIN
Health card
Click on chart
2
Check all info on the chart before booking to update basic info and confirm as well.
Proceed
Back

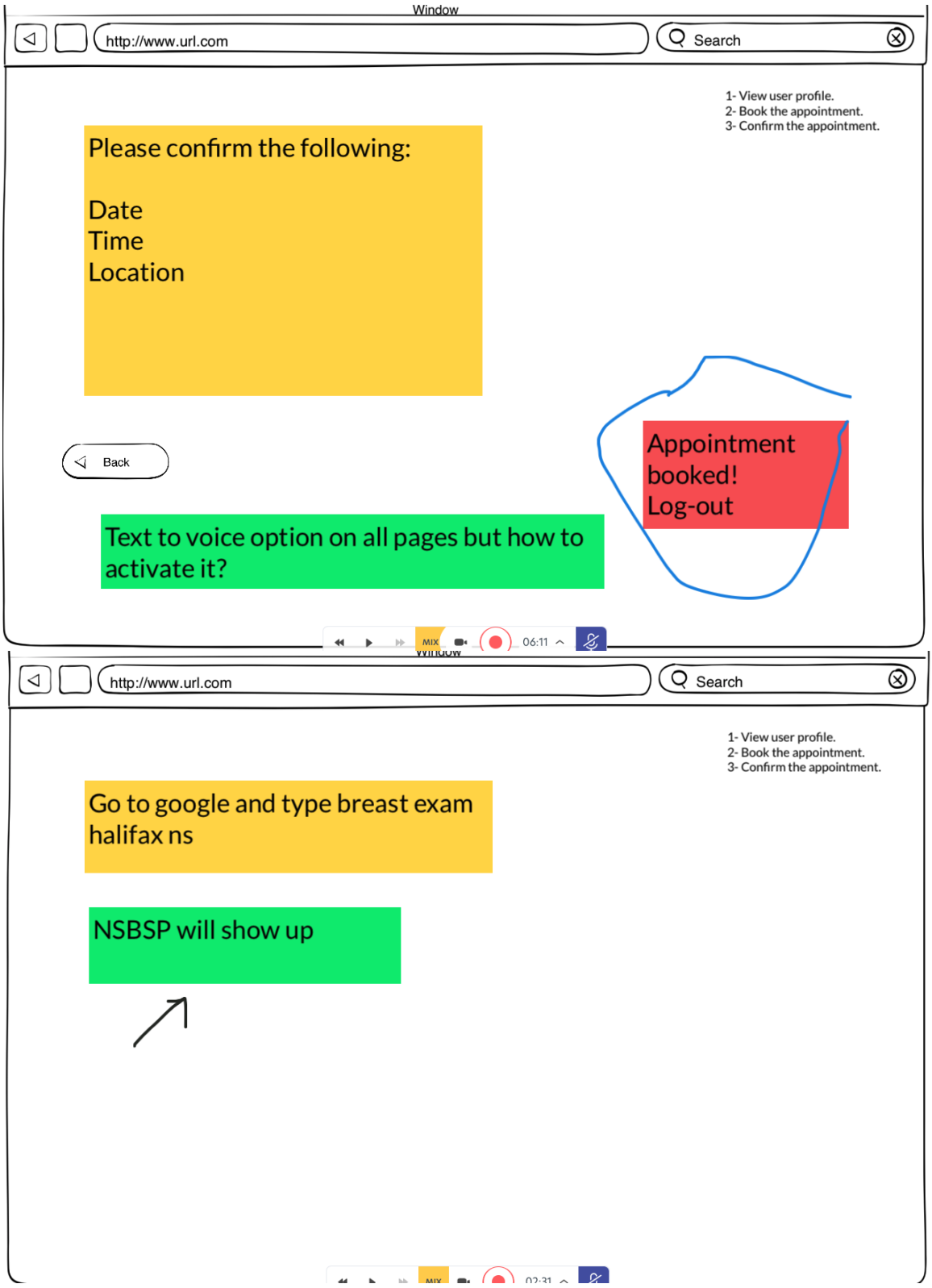

http://www.url.com
Search
Q about health history:
1- When was your last mammo?
2- Had any issues with your last visit?
....etc.
1
Highlited medical terms (once clicked on, a defenition will show up)
If they are not qualify for the book, provide instruction on what to do next
LIVE CHAT
4
2
Book a re-screening appoitement (the time slots that will show up must be based on the last visit only)
July 2010
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30
5
3
Which location/clinic?
Time slots on the 16th

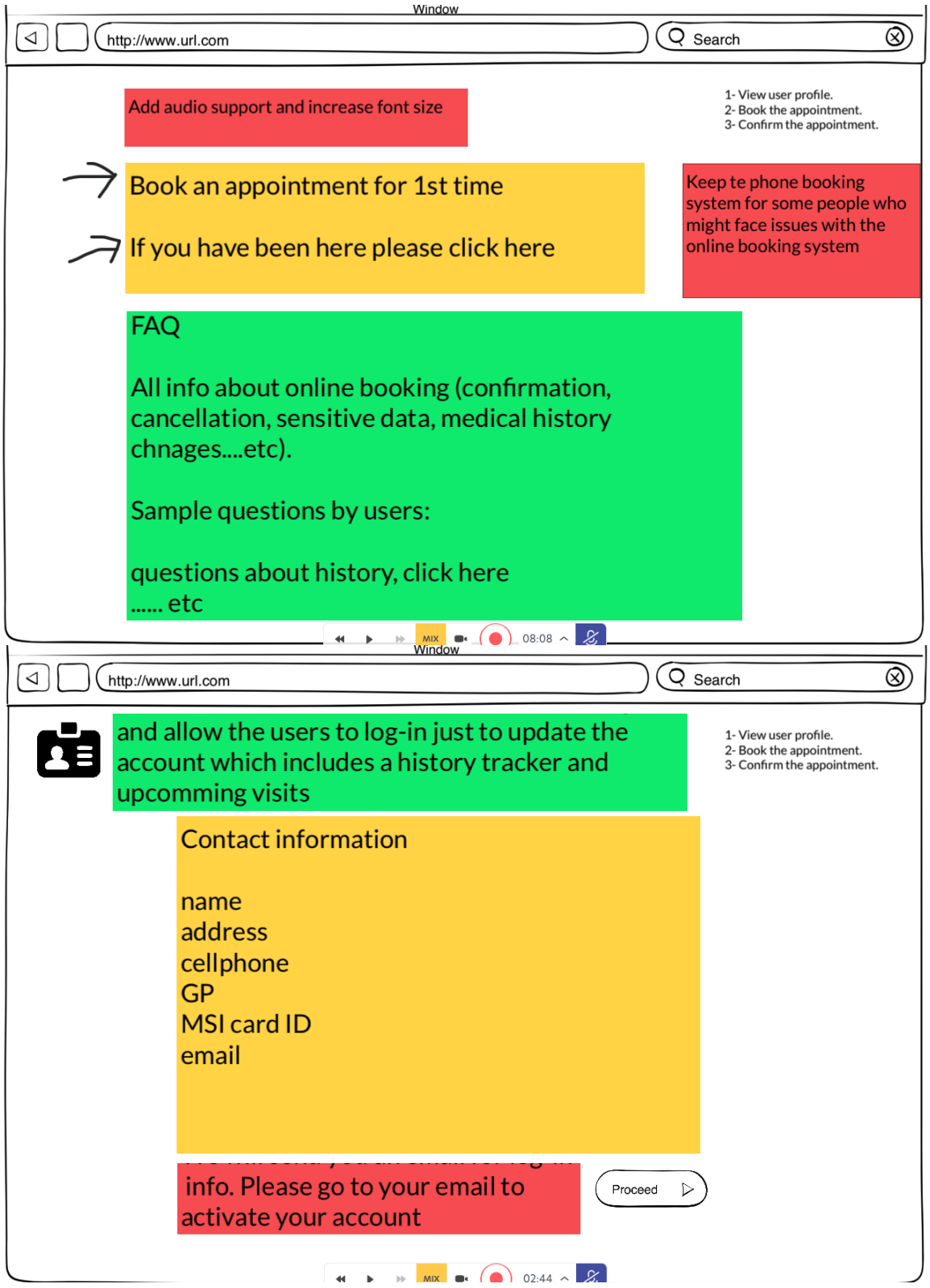

http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Please confirm the following:
Date/ time/ site/
1
Mail
Message
Print
Add to my (syn with local calendar)
Before you arrive instructions:
2
Please arrive 15 min before your appointemnt.....etc
Reminder options
3
Mail
Message

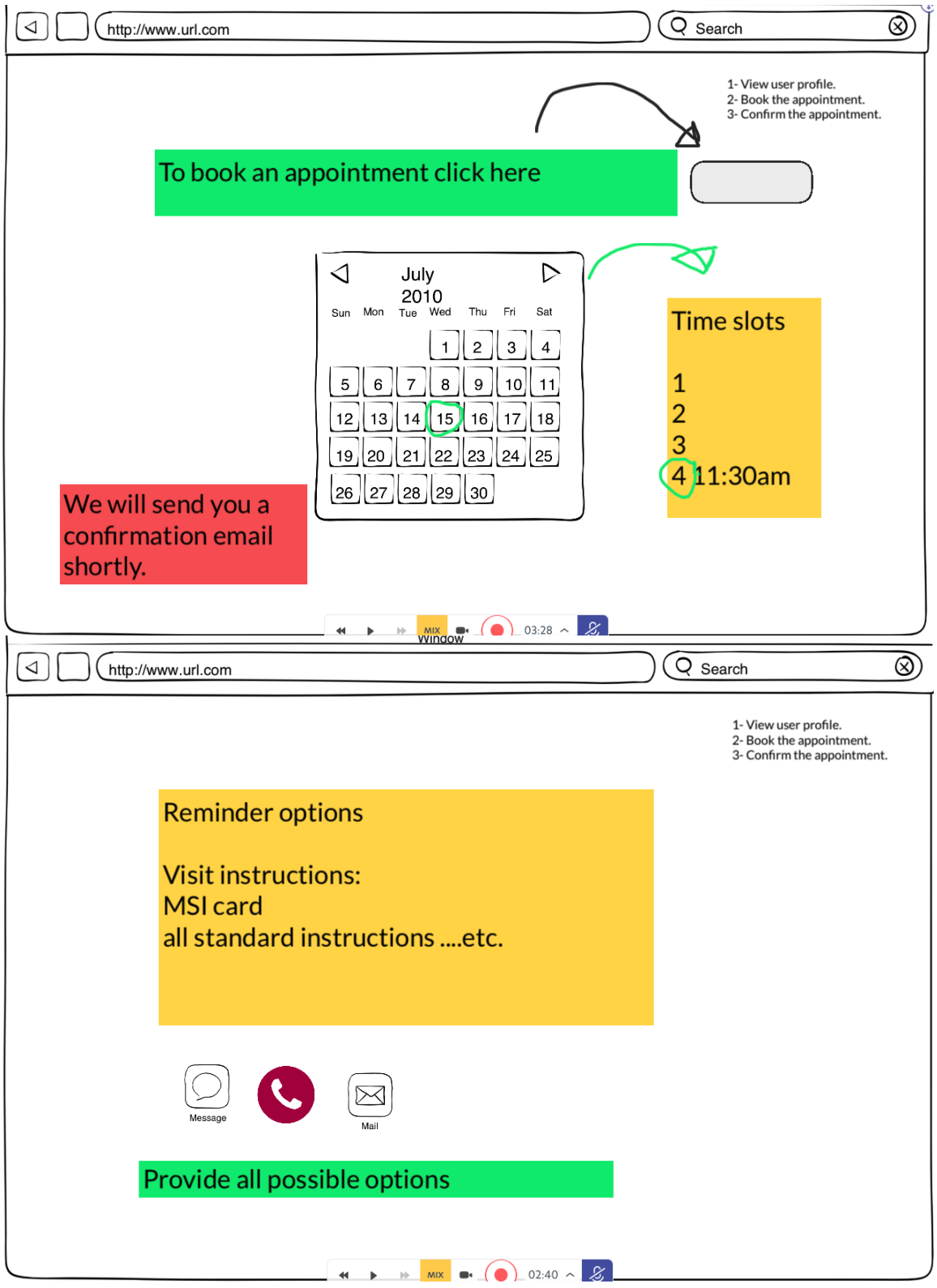

http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Go to google and search for NSBSP.
02:15

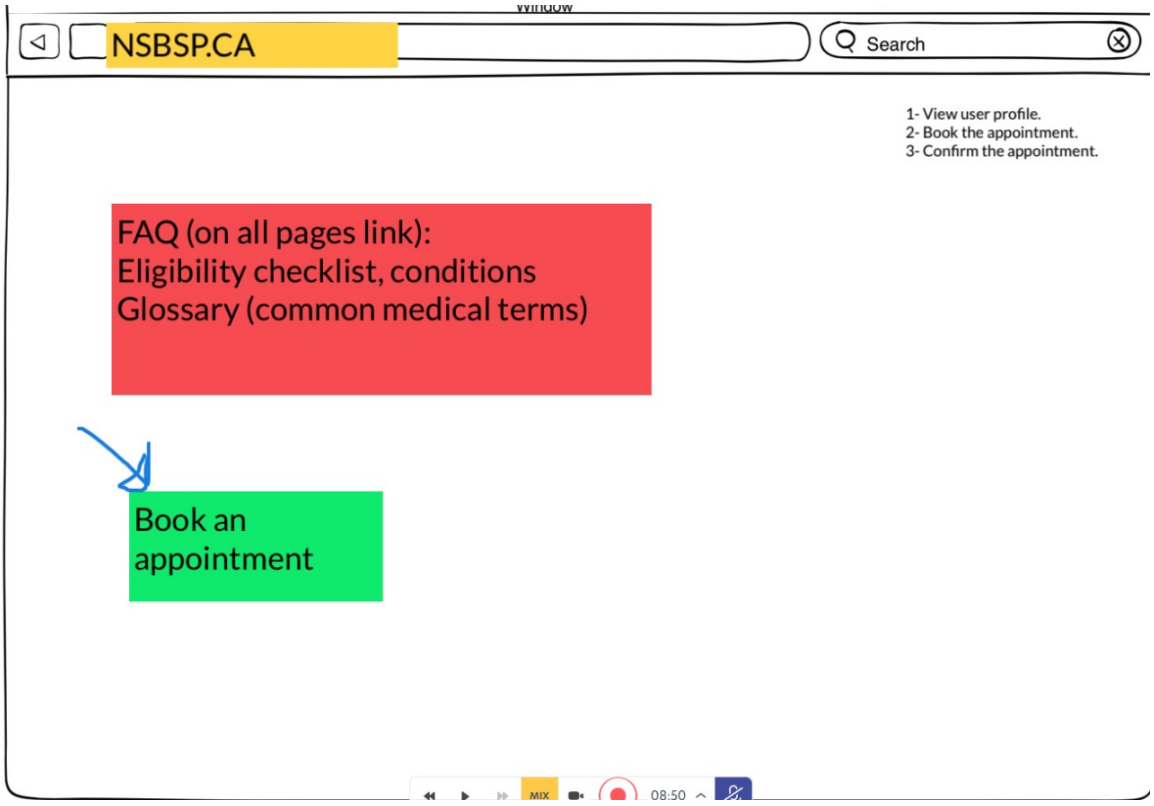

http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
List of options (services):
Self breast exam (info and instructions)
Screening locations in NS
Book an appointment
03:44
http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Screening locations
Enter your postal code (code)
This will generate the locations close to the code.
1-
2-
3-
.
..
Have a secure site to enter log in info and view the personal data (medical chart).
OR
Avoid the log in and the account option, this is to accomodate the new users who are not comfortable with computer systems.
07:55

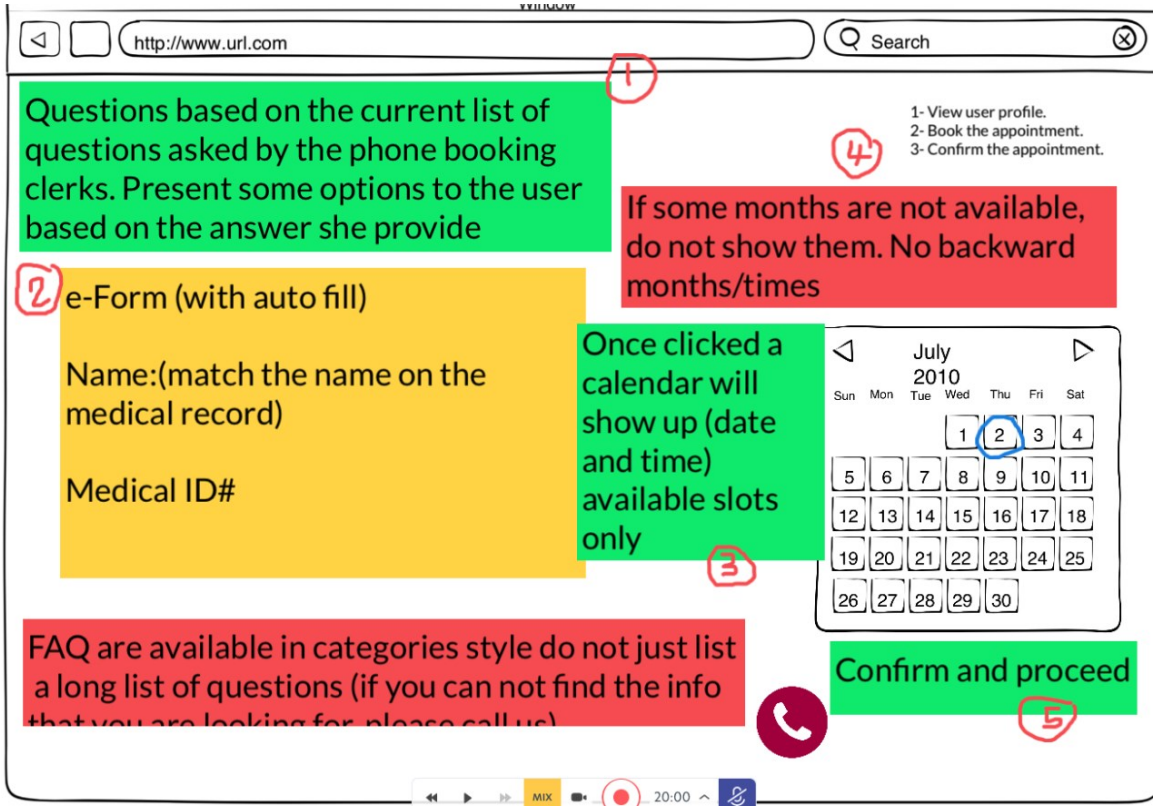

http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
SIGN IN
username
password
Remember me
Forgot your password?
LOGIN
Any username and password can be used
Next visit information (when?) and allow to change
View your history
Show all info (GP, name, address, contact info etc) and allow them to
What if there is a change and the user want to ask someone?
LIVE CHAT
10:34
http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
July 2010
Sun Mon Tue Wed Thu Fri Sat
List of time slots:
2pm
4pm
Name:
Health ID:
How would you like to be reminded?
1- e-mail:
2- cellphone:
Confirmation method:
Mail
Message
Move the red area to the next page after the confirmation
09:14

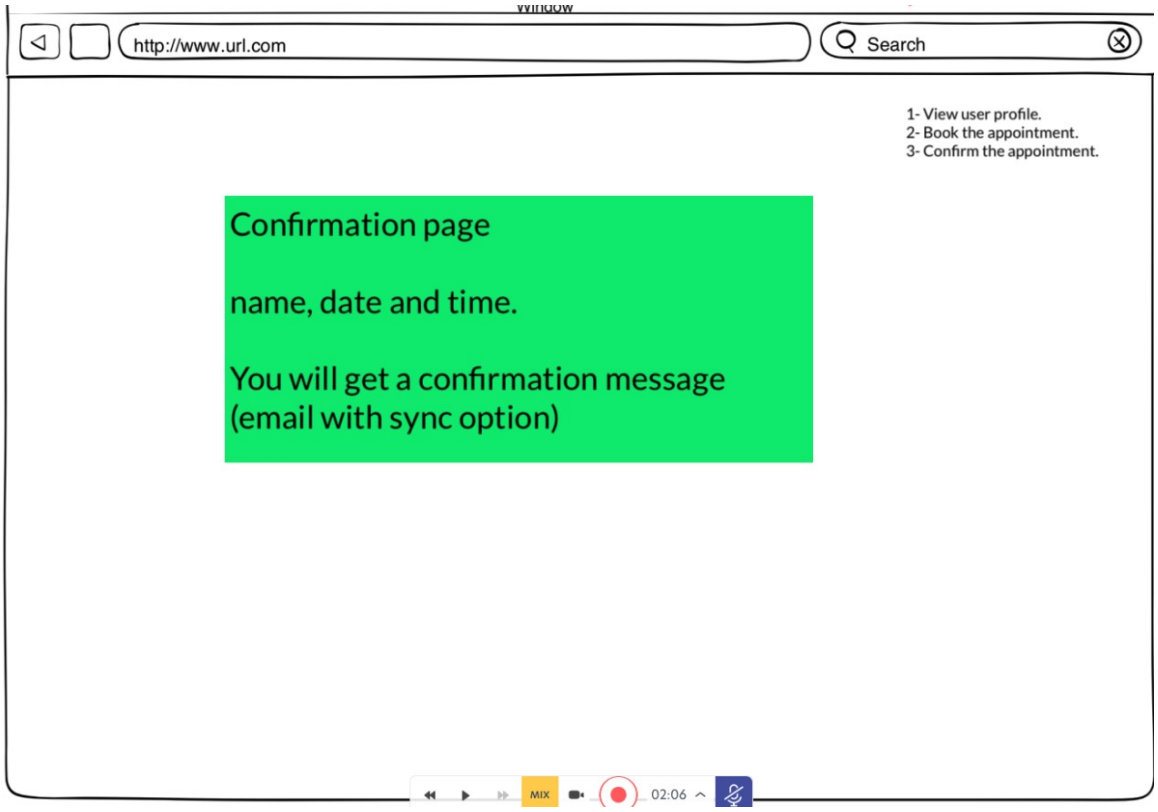

Window
http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Please confirm the following:
Date
Time
Location
Back
Appointment booked!
Log-out
Text to voice option on all pages but how to activate it?
06:11
Window
http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Go to google and type breast exam halifax ns
NSBSP will show up

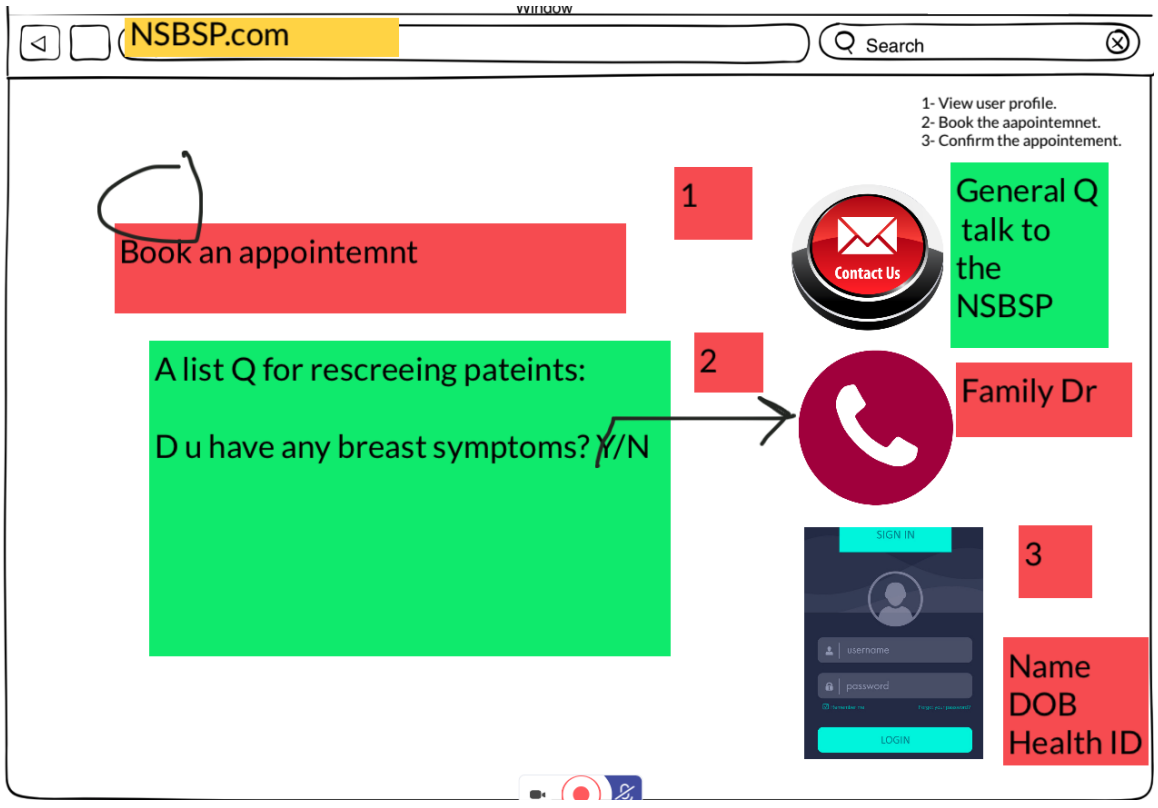

Window
http://www.url.com
Search
Add audio support and increase font size
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Book an appointment for 1st time
If you have been here please click here
Keep te phone booking system for some people who might face issues with the online booking system
FAQ
All info about online booking (confirmation, cancellation, sensitive data, medical history chnages....etc).
Sample questions by users:
questions about history, click here
..... etc
08:08
Window
http://www.url.com
Search
and allow the users to log-in just to update the account which includes a history tracker and upcomming visits
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Contact information
name
address
cellphone
GP
MSI card ID
email
info. Please go to your email to activate your account
Proceed
02:44

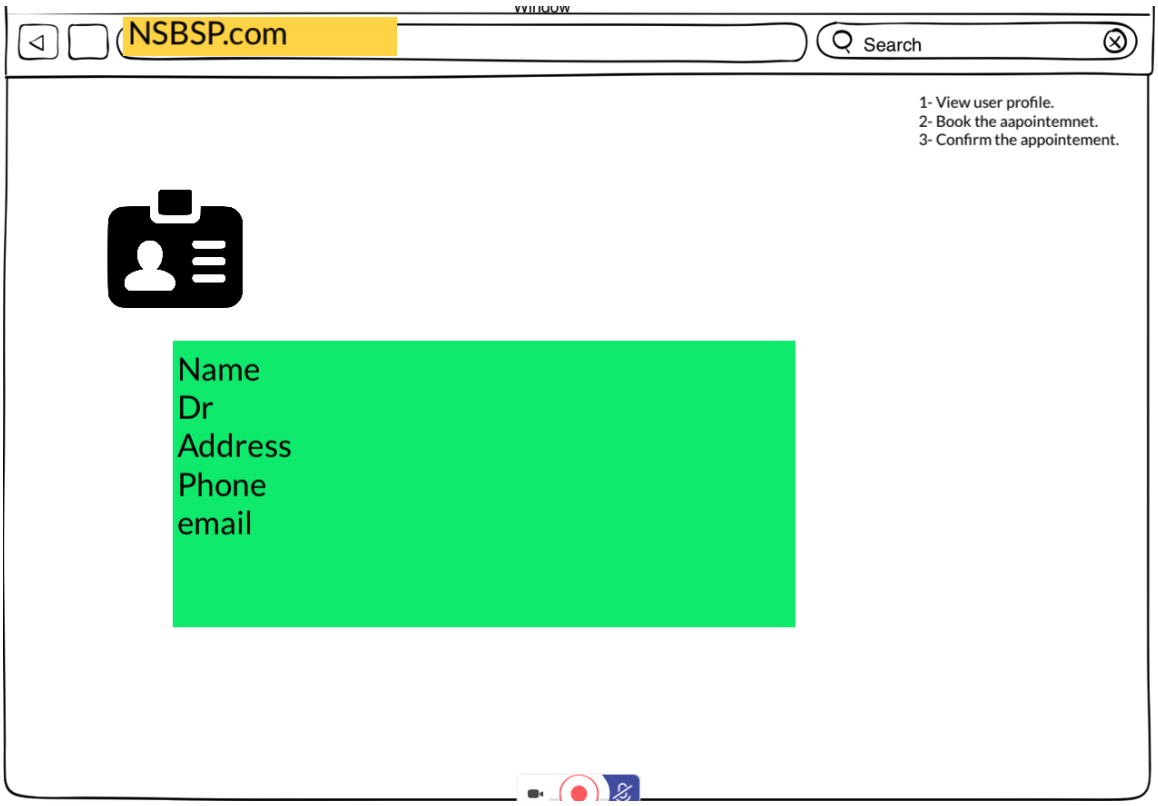

http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
To book an appointment click here
July
2010
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30
Time slots
1
2
3
4 11:30am
We will send you a confirmation email shortly.
03:28
http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Reminder options
Visit instructions:
MSI card
all standard instructions ....etc.
Message
Mail
Provide all possible options
02:40

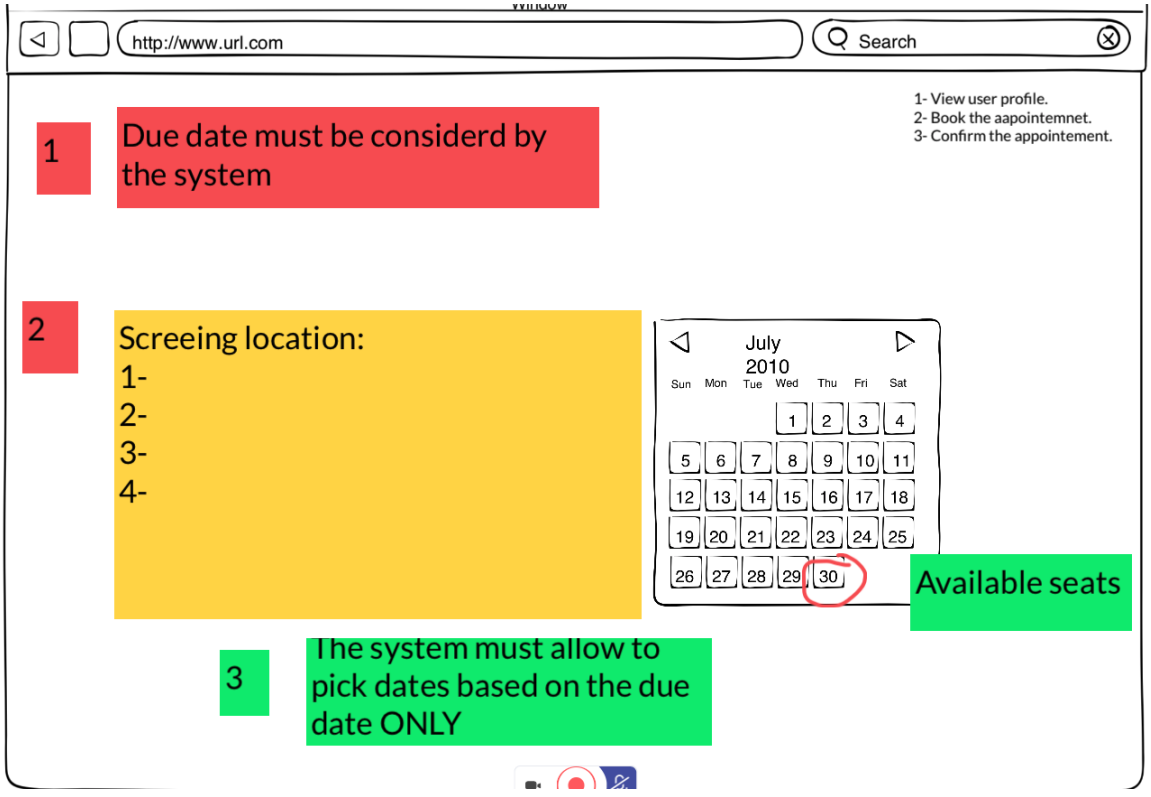

NSBSP.CA
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
FAQ (on all pages link):
Eligibility checklist, conditions
Glossary (common medical terms)
Book an appointment
08:50

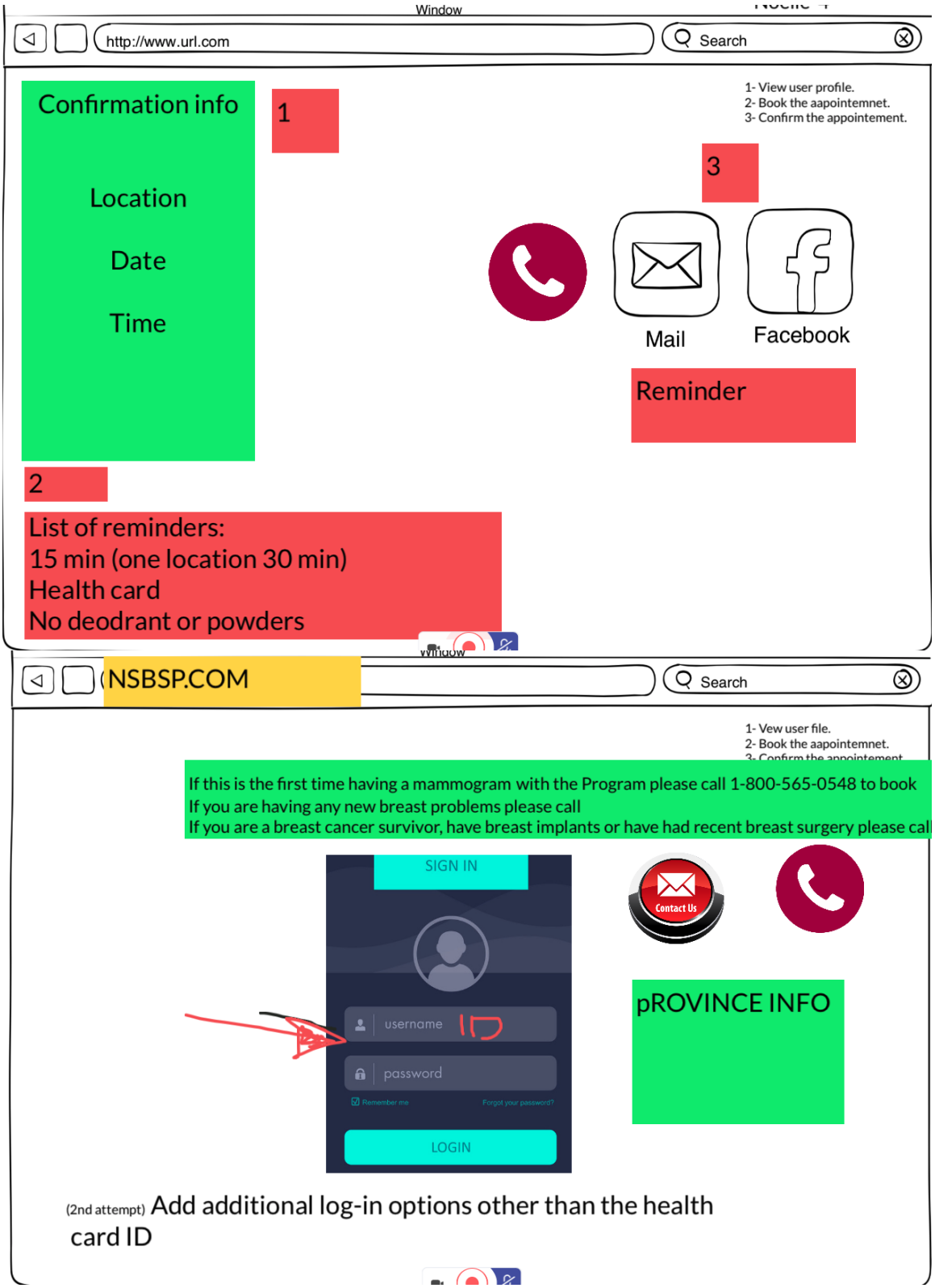

http://www.url.com
Search
1
Questions based on the current list of questions asked by the phone booking clerks. Present some options to the user based on the answer she provide
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
4
If some months are not available, do not show them. No backward months/times
2
e-Form (with auto fill)
Name:(match the name on the medical record)
Medical ID#
Once clicked a calendar will show up (date and time) available slots only
3
July 2010
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30
FAQ are available in categories style do not just list a long list of questions (if you can not find the info
Confirm and proceed
5
20:00

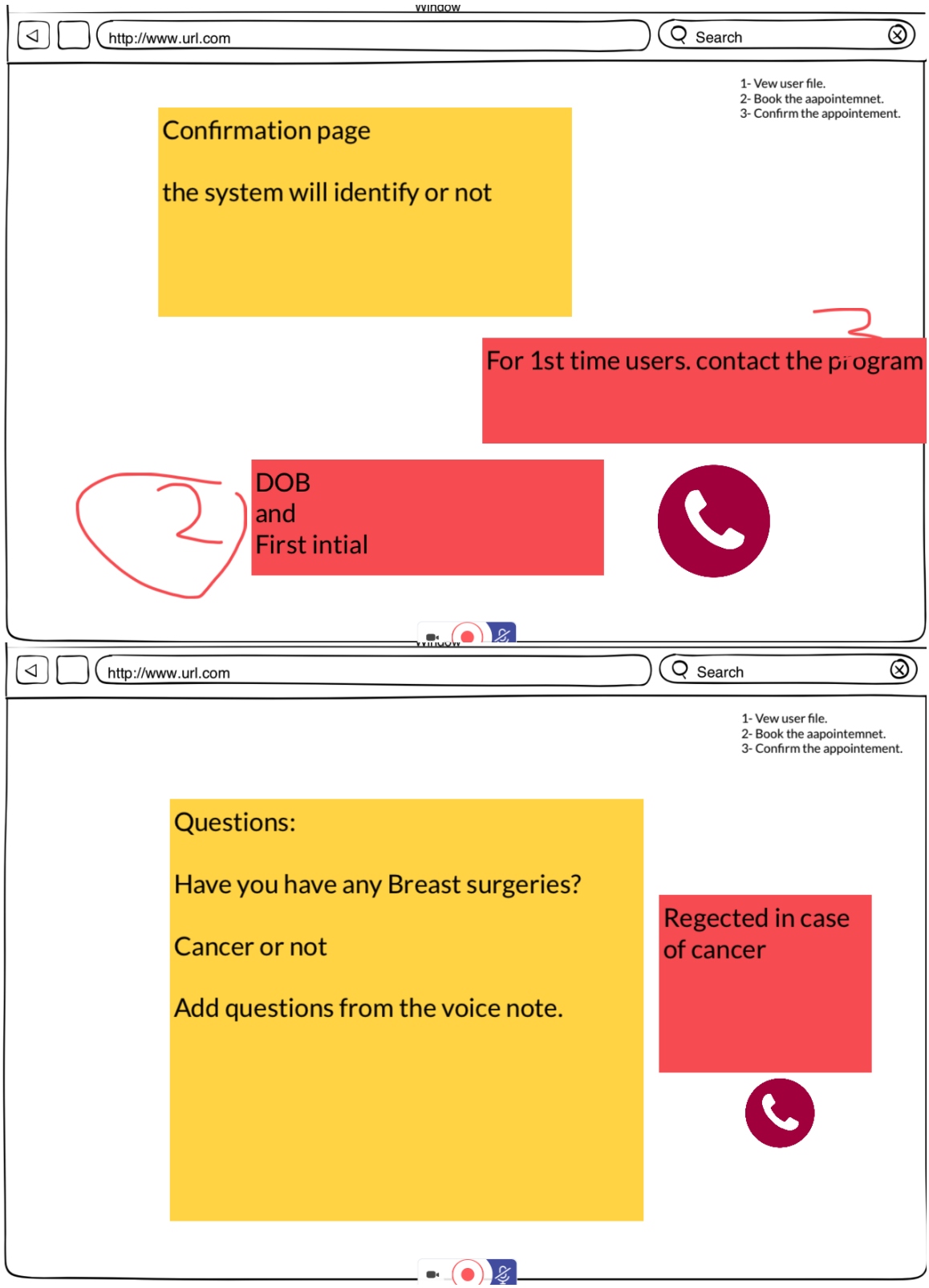

http://www.url.com
Search
1- View user profile.
2- Book the appointment.
3- Confirm the appointment.
Confirmation page
name, date and time.
You will get a confirmation message
(email with sync option)

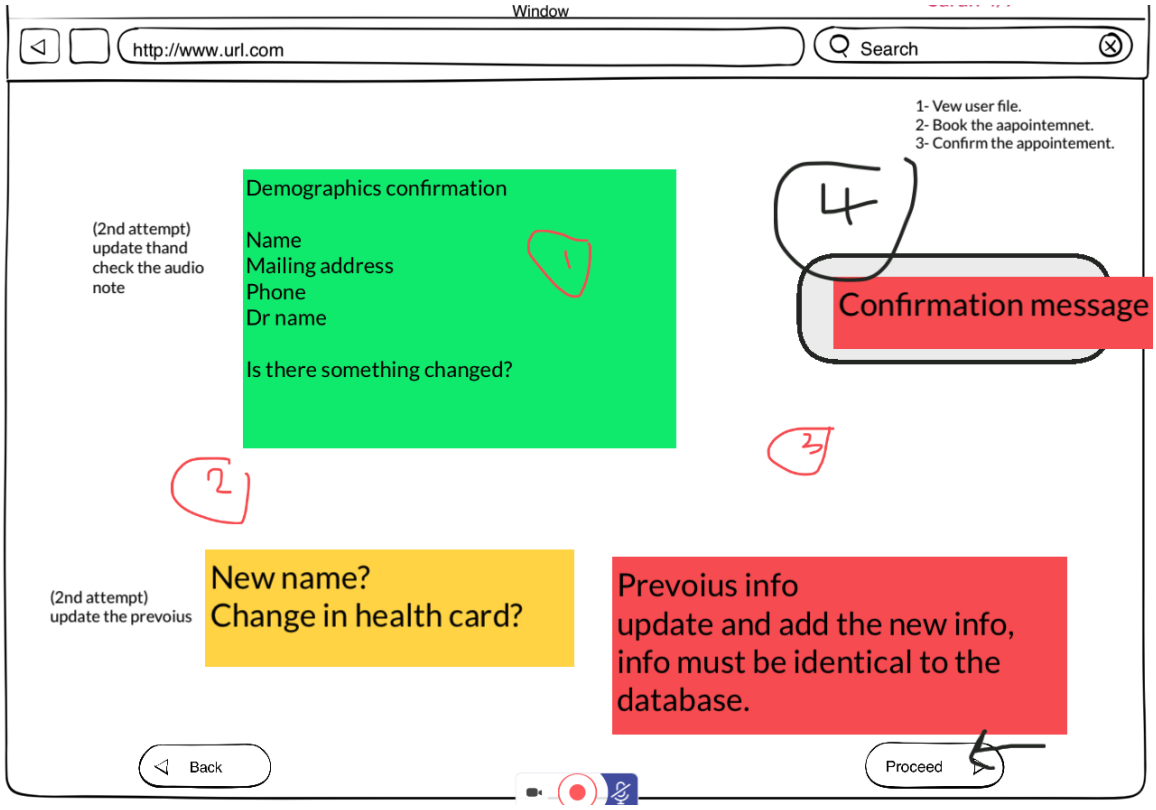

NSBSP.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Book an appointemnt
1
Contact Us
General Q talk to the NSBSP
A list Q for rescreeing pateints:
D u have any breast symptoms? Y/N
2
Family Dr
SIGN IN
username
password
LOGIN
3
Name
DOB
Health ID


NSBSP.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
Name
Dr
Address
Phone
email


http://www.url.com
Search
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
1
Due date must be considerd by the system
2
Screeing location:
1-
2-
3-
4-
July
2010
Sun Mon Tue Wed Thu Fri Sat
Available seats
3
The system must allow to pick dates based on the due date ONLY


Window
http://www.url.com
Search
Confirmation info
Location
Date
Time
1
1- View user profile.
2- Book the aapointemnet.
3- Confirm the appointement.
3
Mail
Facebook
Reminder
2
List of reminders:
15 min (one location 30 min)
Health card
No deodrant or powders
NSBSP.COM
Search
1- Vew user file.
2- Book the aapointemnet.
If this is the first time having a mammogram with the Program please call 1-800-565-0548 to book
If you are having any new breast problems please call
If you are a breast cancer survivor, have breast implants or have had recent breast surgery please cal
SIGN IN
username
password
LOGIN
Contact Us
pROVINCE INFO
(2nd attempt) Add additional log-in options other than the health card ID


http://www.url.com
Search
1- Vew user file.
2- Book the aapointemnet.
3- Confirm the appointement.
Confirmation page
the system will identify or not
For 1st time users. contact the program
DOB
and
First intial
http://www.url.com
Search
1- Vew user file.
2- Book the aapointemnet.
3- Confirm the appointement.
Questions:
Have you have any Breast surgeries?
Cancer or not
Add questions from the voice note.
Regected in case of cancer


Window
http://www.url.com
Search
1- Vew user file.
2- Book the aapointemnet.
3- Confirm the appointement.
4
Confirmation message
Demographics confirmation
Name
Mailing address
Phone
Dr name
Is there something changed?
1
(2nd attempt)
update thand
check the audio
note
2
3
(2nd attempt)
update the prevoius
New name?
Change in health card?
Prevoius info
update and add the new info,
info must be identical to the
database.
Back
Proceed
5

Appendix F

(Phase two – Impact of Complexities on Design Decisions – supporting quotes for thematic analysis)

Supporting quotes for design theme

- P38 “I want the same eligibility questions used by the screening girls”.
- P42 “when I do my taxes online and whenever I face something that I don’t understand, they have a little look up thing that explain things … a basic dictionary appears when you press on a word”.
- P7 “for the profile it should be just like going to a hospital and checking in there at the front desk and report if there any changes”.
- P7 “this has to be a drop-down menu if this is like HRM, so you will have many options to choose from”.
- P4 “once their chart info is available, they should be able to verify the info and check the contact info and all normal things, it will let us do it like how things are checked when you call the clinic to book an appointment”.
- P34 “once that happens an email will be sent to me confirming the appointment much like a restaurant booking system”.
- P22 “I like to pay a ticket webpage where you can do the payment and do different things without login”

Supporting quotes for e-literacy theme

- P42 “this is nerdy stuff; I had to ask my husband to activate the code for the session”.
- P2 “oh this is stressful I don’t know what to do”.
- P34 “Myself I don’t do any online banking and I still have old school calendar that I still use and stick on the wall while my husband is using the electronic one which is always making bing bing bing noise”.
- P22 “I used to help in designing system for the province”.

Supporting quotes for e-booking values theme

- P38 “regarding the control, I can quickly choose the location and look into my calendar and find out what fits me”.
- P42 “when you are booking online you can use the electronic calendar which prevents the issue of forgetting when is the appointment. But you are calling you might write it down somewhere and lose this note. Also when you call from the bedroom and the clerk asks you for the msg number you have to get up and look for the card it is easier and more organized”.
- P7 “You cannot beat the convenience of waking up at 6 am and book your appointment on the iPad while making breakfast”.
- P4 “visual presentation of information I am a very visual person and have that kind of confirmation message or email or what I can print physically that I can see”.
- P2 “when I am looking for something I like to see all the options in front of me it is more accurate”.
- P34 “I think that a lot younger women will prefer online booking option they just don’t want to call so I can say it is more convenient for younger women”.
- P34 “it would be nice if you can update the information on the file while you are in a café for me it should be simple a simple simple”.
- P22 “I am entering my 70’s and getting slower and I like to do my tasks without slowing down others so online booking is about time I like that I can use it on my own time”.
- P10 “I can go back to the system and check my appointment, so I would call it confirmation and certainty”.
- P31 “freedom to do whatever I want at my convivence”.
- Clerk 1 “Accessibility the ease of use as they do it whenever they have time without the need to wait so whenever it pops up your mind you just go online and book it”.

Supporting quotes for core attribute (personal perspective) theme

- P31 “I don’t want them to access the chart and edit it because I want to minimize error and the charts must be mended by professionals only”.
- P42 “It is important to make sure that no matter what the users' background, in the search bar they still get relevant results. They can type the names name or abbreviated names. I might type breast screening others may type Nova Scotia Breast Screening. I don’t know but this is important.”.
- P7 “I don’t want to make it complicated I want it to be simple”.
- P2 “I want it to be reachable and friendly because this is the goal behind such online solutions.”
- P34 “when the homepage for the clinic shows up I would want it to be very basic informational site”
- P22 “Breast screening is not fun, we need an easy experience from start to end”.
- P10 “the main focus should be on avoiding medical terms as much as possible”.

Supporting quotes for engagement theme:

- P42 “I love this stuff I love trying to think of ways to help people that is why I am so grateful for what you are doing and so grateful to be able to help and contribute in improving healthcare online tools” ….. “it is a really important key to understand what people need and provide through the online tools”.
- P10 “I find this activity a huge move forward, I wish if this is a standard approach”.
- P22 “there was a major health information project in the province and it was a waste of resource, they should have done it this way”.

Supporting quotes for rationalization of functional choices theme

- P38 “a live chat option would be great to ask why not eligible”.
- P42 “add contact us and chat options sometimes you need to talk to someone instead of just seeing emails”.

- P42 “when it comes to privacy I don’t think I will be worried and if I needed someone to book on my behalf I will not have any problem showing my account to them. Maybe they can just limit the history on the profile to things related to breast screening only.”
- P4 “now a calendar will pop up with only the dates based on the patient who is booking the appointment the system must consider their medical history to determine the due date”.
- P2 “I think we need something on the page where user can chat with clerk but add it to the login page because if people cannot book an appointment, they can chat with someone. We do not want them to leave the website without booking so they can ask for help if needed”.
- P34 “I would like to add an option to update the information at any time. Say you moved or changed phone number or your doctor, you need an option or tap that is available on all pages to update your info”.
- P22 “I want to sync the appointment with my calendar because I make a lot of appointments and get many emails for confirmation”.
- P10 “if someone is helping the patient in booking the appointment maybe a message shows up at the beginning of the booking process that says (If you have someone who is assisting you, please be aware that this website includes sensitive medical information)”.
- Clerk 1 “Also the system must know when they are due date so the system either will jump the patient to the date and stop them from booking something before this date and show a message that they can not go back this date”.
- Clerk 2 “We do ask specific questions like do you currently have any breast symptoms? if they answer yes, they are not eligible to book an appointment. if they choose yes, the system will tell them why to leave and what to do as a next step”.

Supporting quotes design considerations theme

- P31 “for visual impaired we might offer them to call us instead of booking online because I don’t think we can help them any further”.
- P10 “there should be a pop-up window with a reminder if someone is assisting them, this website includes your personal private medical information”.
- P31 “I am trying to think of the age of the ladies who will be using the website I think social media options will not be a good option for them”
- P42 “mmmm add print icon because I am a paper person and I do like a printed copy what if my phone dies I still need my information.
- P4 “many women have mammograms every year so if you have an annual mammogram it would be important that the available date on the calendar does not come any sooner than the due date based on your last mammogram”.
- P4 “maybe some women might not be comfortable with software confirmation maybe they want a hard copy so let us offer them the option to print the confirmation”.
- P34 “I am an old school and have a flip phone I hate texting maybe younger women may prefer something else and I prefer to be asked about the type of reminder phone call, text or email because some people may have internet and others may have no email at. All younger women and mid-age like me may prefer email but older women I think they will ask for a phone call”.
- P22 “live chat mmmm I don’t know if you want live chat because this means you have to keep clerks working all the time so if they need support it is better to call or send an email unless they are ok to have someone monitoring the website all the time”.
- Clerk 1 “I will add the three questions that if they answer yes, the system wills them to call the program instead of being kicked out later on in the booking process”.

- Clerk 2 “I think they should have an option to contact us in case they face a difficulty or they can send us an email if they have questions or don’t meet the eligibility questions”.

Supporting quotes for design flow theme

- P38 “this is just a booking site, so if I logged in, picked the location, the date-time and confirmed it and asked for a reminder I am done”.
- P10 “Privacy is the responsibility of the user, we should not exaggerate about the privacy issues. This will stop us from moving toward fully automated systems. We don’t hear the same concerns about online banking.”
- P4 “one of the other pieces of information is they have to answer questions about their health history and this is the best time to do it before they proceed to book the appointment”.
- P2 “maybe avoid the log-in and keep it simple and inviting for all users but if there is a log-in there should be a log-out option”.
- P34 “after choosing a date it should be like restaurant reservation options of time would show up and I would see the available time slots on that day what is taken and what is still available for me to choose from”.
- P22 “I think we need a page in between that asks about the medical and family history if the answer is yes then the system should present them few options let us do it in the form checkboxes …you can use the forms by the NSBSP”
- Clerk 1 “I log in to the system the system will tell if I had a screening before and allow me to continue or will not recognize me in which case there should be a question about the name and age because there might be a change in the health card and in this way the system will be able to find the patient file”.
- Clerk 2 “The system must be smart enough to know when the pat is due for the next exam so the calendar should just show the time slots after the due date before doing that the system must check if the patient is on the system or not”.

Supporting quotes for website purpose theme

- P38 “this is just a booking website, there is no need to have an access to the medical chart”.
- P7 “maybe it is better to have a login to the account so the user can see the previous mammogram and all results.”
- P2 “while I am on the website, I want to learn about self-breast exam and learn about new breast screening options. I want it to be an educational website not just for online booking”.
- P34 “It should be only for booking screening appointments, keep it simple”.
- P22 “I don’t want to log in because login is only for major systems that allow accessing any things at the same time”.
- P42 “why not connect it to the major health systems in the province to view charts and prescriptions?”.