Chapter

2

Defining Usability and User Experience in Healthcare

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Unpacking and defining usability can be challenging. The domain of healthcare adds another layer of complexity.

In this section, we review definitions of usability and user experience (UX). After reading this chapter, you should be able to define usability and select dimensions of analysis that are important for a product, use-case, or business goal.

The International Standards Organization (ISO) defines usability as "the extent to which a system, product, or service can be used by specified users to achieve specified goals with **effectiveness**, **efficiency**, and **satisfaction**"(International Standardization Organization, 2018). Stated more plainly, usability is the ability to get things done without difficulty or frustration(Sauro & Lewis, 2016). While ISO usability measures are foundational, others dimensions may by equally important in high-stakes fields like health care. For example, Peter Morville defines UX as a function of seven dimensions including **usefulness**, **ease-of-use**, **desirability**, **value**, **detectability**, **accessibility**, and **credibility**(Morville & Rosenfeld, 2006). Healthcare practitioners also need to know that products **safe**, **credible**, **reliable**, and **trustworthy**(Albert & Tullis, 2013; McKnight, Choudhury, & Kacmar, 2002).

The complexity of terms and definitions can seem overwhelming. However, try to remember: *not all dimensions are important for every project or assessment.* For example, it may be important for a smart phone to be satisfying or desirable, whereas, it is important for

a medication order dialog to be easy to use and error tolerant. Therefore, as we define terms, we will identify stakeholders and situations where specific metrics are appropriate.

Usability, UX, Human Factors, and Human-Computer Interactions

There is some ambiguity in the literature about the differences between **usability**, **user experience (UX)**, **human factors**, and **human-computer interactions**. This ambiguity may arise from the fact that human factors is a new interdisciplinary field drawing from related fields of design, systems engineering, cognitive science, software development, and anthropology.

Tullis and Albert assert that **UX** has three main characteristics: (1) users are involved; (2) users interact with products, systems, or artifacts; and (3) the experience is of interest and measurable(Albert & Tullis, 2013). **Usability** focuses upon the interaction between user and tool, whereas **UX** considers the entire context of interaction, including user thoughts, organizational culture, and physical environment. From this perspective, user values, organizational behavior, and the context of use can all influence perceptions of usability and adoption(Holahan, Lesselroth, Adams, Wang, & Church, 2015).

Human-computer interactions and **human factors** are disciplines that include UX principles. Card and Moran popularized the term "human-computer interaction", describing it as the intersection between cognitive psychology, design, and computer science(Card & Moran, 1983). The Interaction Design Foundation (IDF) currently defines **human-computer interactions** as a discipline concerned with the design and use of computer technology and the interface between user and machine(Interaction Design Foundation, 2020). By contrast, the Human Factors and Ergonomics Society (HFES) takes a broader view, stating that **human factors** applies "knowledge of human abilities and limitations to design systems, organizations, jobs, machines, tools, and consumer products for safe, efficient, and comfortable human use"(Human Factors and Ergonomics Society, 2005).

The key relationship between usability, UX, human-computer interactions, and human factors is that each concept centers on the interaction between user, task, and tool to optimize performance and experience. However, each concept approaches user perceptions at different levels of abstraction. Usability and UX are attributes, whereas human-computer interactions and human factors are disciplines. The former focuses upon computer technologies and the latter embraces a larger scope including users and the context of implementation.

Key Stakeholders and Organizations

The **International Organization for Standardization** (ISO) is a non-governmental body representing over 700 technical committees and subcommittees from over 160 countries. The ISO does not certify or regulate products; it provides specifications for products, services, and systems to ensure quality, safety, and efficiency(International Standardization Organization, 2018). The ISO definition of usability emphasizes the effective functioning of a device (i.e., task success). However, Harrington emphasizes in her text that the ISO definition does not address the complexity of the device (i.e., cognitive burden)(Harrington & Harrington, 2014). In healthcare, an overwrought

design can increase task complexity, cognitive dissonance, and user error. Therefore, it is important to consider design complexity, even if the interface supports user tasks.

The **National Institute of Standards and Technology** (NIST) is a non-regulatory agency within the United States Department of Commerce. Its mission is "to promote innovation by advancing measurement science, standards, and technology in the US to improve market competitiveness and quality of life"(National Institute of Standards and Technology, 2020). NIST emphasizes educating the health IT community about usability and promotes standards for best-practice EHR.

The **International Electrotechnical Commission** (IEC) is a Swiss-based, quasi-governmental association that publishes technology standards and certifies equipment, systems, and components(International Electrotechnical Commission, 2020). The IEC includes vendors, users, trade-groups, and over 60 governmental organizations. It publishes consensus-based guidelines for a wide range of digital health technologies. Acknowledging the rapid pace of evolution in the healthcare ecosystem, the IEC authors standards for the safety and performance of analytic tools, artificial intelligence, cybersecurity, and the Internet of Things (IoT)(Price, 2019).

The Health Information Technology of Economic and Clinical Health Act (HITECH) in 2009 helped establish the **Office of the National Coordinator** for Health Information Technology (ONC)(Office of the National Coordinator for Health Information Technology, 2019). One of the primary roles of the ONC is to promote adoption and meaningful use of EHRs in pursuit of improved healthcare quality. While the ONC neither enforces nor certifies EHR usability, the office sponsors programs that foster industry collaboration, innovation in design, transparency in usability (including reporting of unintended consequences), and continuous quality improvement.

The **Agency for Healthcare Research and Quality** (AHRQ) is an agency within the US Department of Health and Human Services dedicated to funding translational health research. Its mission is to "produce evidence to make health care safer, higher quality, more accessible, equitable, and affordable…"(AHRQ, 2014). The effectiveness and scalability of translational research is often dependent upon the consistent and skilled use of information technologies. Therefore, AHRQ regularly funds research, promotes tools, and disseminates findings related to HIT usability.

The **US General Services Association** (GSA), established in 1949, streamlines federal projects by creating the governance, infrastructures, and specifications for capital asset procurement, management, and reparations. Capital assets typically include government buildings, real estate, equipment, and supplies. While not specific to technology or IT infrastructure, the GSA does provide important guidance over accessibility standards that align with the American with Disabilities Act (ADA). **Section 508 of the Rehabilitation Act of 1973** requires that federal agencies ensure information technology is accessible to people with disabilities(United States Department of Justice and Civil Rights Division, 2018). Standards include specifications for closed-captioning, screen-reading software, and special user configurations.

Dimensions of Usability

Scholars and UX practitioners have organized the determinants of usability in myriad ways. For example, Whitney Quesenbery developed a memorable rubric called the 5Es (i.e., **effective, efficient, engaging, error tolerant, easy to learn**)(Quesenbery, 2014). These dimensions – while practical, understandable, and suitable for a wide range of products – do not explicitly address HIT or patient safety.

Jiajie Zhang and Muhammad Walji, at the University of Texas Health Sciences Center at Houston, define usability as "the extent that users find a system useful, usable, and satisfying"(Zhang & Walji, 2011). **Usable** (i.e., easy-to-use) in this context reflects how easy a system is to learn and use correctly. **Useful** (i.e., relative advantage) is the extent that a system confers an advantage within a work domain. **Satisfying** is "when the end user finds [a technology] pleasing to use and anticipates using it in the future"(Harrington & Harrington, 2014).

There are other factors that may influence users' decision to adopt a new technology, including visual appeal, reliability, ease of navigation, accessibility, speed, and credibility (i.e., trustworthiness)(Albert & Tullis, 2013). Designing to build trust with users is important in healthcare, since healthcare professionals must believe the information is accurate, complete, and current(McKnight et al., 2002; Yarrow, 2018). Otherwise, they may resist abandoning their current solution or workflow or adopting an innovation.

Covering all dimensions of usability is beyond the scope of this text. However, to help you select measures that are relevant to the context-of-use, we have included **Table 2.1** with many dimensions relevant to HIT.

TABLE 2.1. Definitions of usability with examples and suggested methods for measurement(Fogg et al., 2001; Harrington & Harrington, 2014; Holahan et al., 2015; International Standardization Organization, 2018; Lesselroth et al., 2009; McKnight et al., 2002; Morville & Rosenfeld, 2006; Nielsen, 1994; Quesenbery, 2014; Yarrow, 2018; Zhang & Walji, 2011).

Dimension	Definition	Example	Reference
Effective	The accuracy and completeness with which users achieve specified goals. How well the system supports the work. The extent that the device delivers desired outputs.	Determine why only 20% of clinicians are using a suicide risk CDS intervention.	ISO; Zhang
Useful	The extent that a device or technology supports a user's or business' wants or needs. The perceived extent that a tool will enhance job performance.	Identify most visited pages on a reference web site intended to solve design problems.	Zhang; Davis
Efficient	Resources expended in relation to the accuracy and completeness with which users achieve goals. How quickly a task can be complete.	Determine whether the vital signs input meets its predetermined benchmark for data entry times.	ISO, Quesenbery
Engaging	How well the product or service draws the user into the experience and how pleasant it is to use.	Adoption and use of a mobile app dedicated to improving diagnostic skill	Quesenbery

Dimension	Definition	Example	Reference
Error tolerant	How well the product prevents errors and can help the user recover from mistakes that occur.	Count how many times the medication order entry system allowed entry of a toxic dose.	Quesenbery, Nielsen
Easy to learn	Ease in learning or relearning a device. The speed that a user acquires proficiency.	Comparison of two different handoff tools, measuring time for users to acquire proficiency	Zhang; Harrington
Easy to use	Perceived level of difficulty experienced by user or degree of mental effort required to complete a task	Amount of mental effort required to use an online table to convert opiates to morphine equivalents.	Morville
Memorable	How easy a system is to remember, so that a casual user may return to the system after some period of non-use, without having to relearn features and functions.	Patient logging in to a virtual telemedicine portal for annual clinic appointments.	Nielsen
Findable	The device is easy to find. Information is easily found and easy to navigate. Information architecture is intuitive and easily visualized.	Speed and consistency with which a user finds and triggers a health data exchange system to retrieve outside records.	Morville
Satisfying	Freedom from discomfort and positive attitude towards use of the product. The likelihood of using again in the future or promoting use.	Determine if the CDS intervention meets the threshold for acceptable usability (e.g., SUS score of 60 on a scale of 100).*	ISO
Desirable	The extent that a product appeals to a value system, need, or set of social expectations. The aesthetic appeal or degree of minimalism. The likelihood of using again.	Patient requests for an illustrated after-clinic summary.	Morville
Trustworthy	The product, service, information, or agent (i.e., company) is believable, trustworthy, complete, and free from bias.	Determine why clinicians override a medication	Yarrow, McKnight, Fogg
Reliable	The extent that the service is available and responsive.	Determine the extent that patient navigators rely upon a self-service kiosks to collect information from patients.	Holahan, Lesselroth
Accessible	The design provides users with disabilities the same experience.	Confirming visually impaired patients can use the screen reading software on a self-service kiosk.	Morville

*System Usability Score (SUS); computerized decision support (CDS)

Usability Assessment Methods

When a publication references "usability testing", the authors are often talking about simulations in which researchers observe users interacting with a device. However, there are many other testing methods. In forthcoming chapters, we will explore several techniques in detail. While, an exhaustive review of all methods is beyond the scope of this text, we provide a list of methods in **Table 2.2** along with suggested references for further study.

TABLE 2.2. Common usability evaluation methods and selected references for practical instruction.

Method	Description	Reference
Heuristic inspection	Expert inspection of an interface using a checklist of agreed-upon usability best-practices.	Zhang (2003)
Cognitive walkthrough	A step-through of the interface with a representative user while analyzing interface cues and prompts.	Harrington (2014)
Simulation	Approximations of environmental conditions, intended to capture real-life user experiences and usability issues. Often coupled with Think-Aloud.	Barnum (2011)
Think-Aloud	A technique where the observer encourages the user to share aloud thoughts, feelings, and questions while using an interface.	Barnum (2011)
Questionnaires and surveys	Instruments designed for collecting self-report information about thoughts, feelings, perceptions, behaviors, or attitudes.	Albert (2013)
Task analysis	An exploration of all user tasks and sub-tasks while interacting with a system to understand goals, workflow, outputs, and interdependencies.	Nielsen (1993)
Ethnography	An immersive approach that includes interviews and field observations to understand users' beliefs, motivations, culture, and activities.	Ash (2008)
Focus groups	Interview of a representative group (typically 3-9 individuals) by a skilled moderator to gain insight into themes, patterns, trends, and beliefs.	Nielsen (1993)
Workflow analysis	Documentation of tasks grouped into chronologically ordered processes. Some documentation format break down actors, artifacts, and sub-routines.	Harrington (2014)
Time-motion study	A specific technique of work observation designed to collect time on task data and physical workflow in a built environment.	Pizziferri (2005)
Agile task analysis	A hybrid testing approach that combines task analysis with simulation testing. This method collects mixed data types including qualitative observations (i.e., usability issues) and quantitative task completion rates.	Lesselroth (2020)
A/B testing or competitive testing	Comparison of two versions of the same design to see which performs better against a pre-determined goal.	Nielsen (2005)
Cognitive mapping	A visualization of people's mental models; a decomposition of mental processes used to make sense of a task or problem.	Martin (2012)
Semi-structured interviews	Interviews with one or more stakeholders using a prepared discussion guide with open-ended questions and probing follow up questions.	Mortensen (2020)
Focus groups	Group interviews designed to capitalize upon the interaction and dialog between respondents.	Halcomb (2007)
Eye tracking	Use of technology to gather detailed information on exactly where and for how long participants look at an interface.	Albert (2013)

Further reading

- **Albert**, W., & Tullis, T. (2013). *Measuring the user experience: collecting, analyzing, and presenting usability metrics*. Newnes.

  A masterclass in usability measurement. Provides details about the selection, instrumentation, and analysis of usability. Less of an introductory text; intended primarily for the dedicated usability professional.

- **Barnum**, C.M. (2011). *Usability testing essentials: ready, set, - test/Carol Barnum*. Burlington, MA: Morgan Kaufmann Publishers.

One of the most accessible texts available. While not specific to healthcare, the author strikes a nice balance between practicality, completeness, and clarity. Includes a nice chapter breaking down terms and definitions.

- **Harrington,** L. & Harrington, C. (2014) Usability evaluation handbook for electronic health records. HIMSS.

  An excellent and accessible introduction to the concept of usability and methods used to evaluate the effectiveness, quality, and safety of electronic health record interfaces. Provides a side-by-side comparison of terms and definitions from different sources. An invaluable addition to the practitioner's library.

- **Nielsen**, J. (1994) *Usability engineering.* Morgan Kaufmann Publishers.

  Arguably one of the most important contributions to the modern profession of usability engineering and user experience. A somewhat dense read for the beginner. However, it furnishes many of the terms and definitions commonplace today.

- **Quesenbery**, W. (2003) "The five dimensions of usability." *Content and complexity: Information design in technical communication,* 81-102.

  An influential monograph deconstructing the concept of usability and introducing a memorable framework. This article is a quick read and an excellent place to start.

References