User Experience Theories, Models, and Frameworks: A Focused Review of the Healthcare Literature

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**Abstract.** User experience (UX) theories, models, and frameworks (TMFs) help scope user-centered design activities, aid in the selection of constructs and measures, and contextualize findings within a larger knowledge base. However, the fragmentation of literature across disciplines and the inconsistent use of TMFs makes integrating concepts and selecting UX tools challenging. Therefore, we conducted a focused review of the healthcare literature to identify a succinct list of UX-specific TMFs for academic UX researchers and industry practitioners alike.

**Keywords and MeSH terms.** Human-Computer Interface, Theoretical Models, Ergonomics, human factors, usability, frameworks, user experience.

# Introduction and Problem Statement

User experience (UX) encompasses user perceptions and responses resulting from the use or the anticipated use of a product, system, or service [[1](#_ENREF_1)]. Because UX research in healthcare is a high-stakes endeavor, questions arise concerning methods and instrumentation. For example, “what methods best suit the context?” and “how will we know if a technology is effective”? Practitioners can use theories, models, and frameworks (TMFs) to answer these questions. Using Nielsen’s definitions, we define “theory” as a set of statements that explain observable phenomena, “model” as a descriptive simplification of those phenomena, and framework as the lexicon to organize constructs [[2](#_ENREF_2)].

Collectively, TMFs scaffold UX work by organizing concepts, aiding in method selection, and contextualizing results [[3](#_ENREF_3)]. Because it can be challenging to stay abreast of the literature, we offer a focused review of relevant TMFs reported in healthcare. Our goals were to (1) provide a succinct list of UX TMFs used to study health information technology (HIT); (2) describe several general models that can meet a wide array of UX research needs; and (3) identify theory-research and theory-practice gaps and opportunities.

# Methods

We completed a PubMed search from 1946 through to 2019 using the following medical subject headings (MeSH) terms and keywords: “Human-Computer Interface OR Ergonomics OR human factors OR usability OR technology acceptance OR user experience” AND “Models, Theoretical OR Models, Psychological OR Information Theory or Systems Theory OR frameworks”. We restricted the results to manuscripts applying a theory, model, or framework to healthcare and limited output to “human subjects” and “English language”. We excluded articles of methods without TMFs.

# Results

We identified 4369 article titles, selected 307 for abstract review based upon relevance (i.e., if they described technology development or implementation), and 104 for full text review. We identified 101 unique articles speaking to UX and related disciplines including implementation science, software development, and cognitive psychology[[2]](#footnote-2). Of those articles retrieved, 36 TMFs expressly addressed user experience, interface design, or interface usability.

**Table 1** User experience theories, models, and frameworks in healthcare (n=36)2.

|  | **Theory, model, framework** | **Brief description** | **Reference** |
| --- | --- | --- | --- |
| **Human-computer interfaces and design** | | | |
| 1 | Health Human Computer Interactions Framework | Identifies the major components of human-computer interaction and disambiguates user roles. | Staggers et al., 2001 |
| 2 | Ecological Interface Design Framework | General approach to interface design to simplify information processing and improve cognition. | Effken, 2002 |
| 3 | Human Centered Distributed Information Design Model | Analysis of human computer interaction at four levels of abstraction. | Zhang et al., 2002 |
| 4 | Benefits Evaluation Framework | A framework of three quality, two system usability, and three net benefits dimensions. | Lau et al., 2007 |
| 5 | Formative Evaluation in Instructional Design | A decision-making template for developing formative evaluation strategy. | Street et al., 2007 |
| 6 | Elements of User Experience | Stratifies dimensions of usability according to the product timeline or information abstraction. | Crutzen et al., 2009 |
| 7 | Usability Analysis Framework for Healthcare Information Technology | A usability analysis framework designed for inspection of health information technology that identifies and prioritizes potential errors. | Sarnikar et al., 2009 |
| 8 | Cognitive-sociotechnical Framework | Organizes usability and work into levels of user interaction from individual to group interactions. | Borycki et al., 2010 |
| 9 | User Centered Design Development Lifecycle | Organization of UX activities according to software development lifecycle. | Yen et al., 2011 |
| 10 | Technology User Representativeness Functions framework (TURF) | A comprehensive framework that can support a multi-dimensional usability evaluation of HIT to predict safety and impact. | Zhang et al., 2011 |
| 11 | Usa-Design Model© | A model consisting of four phases in the software design lifecycle. | Merino et al., 2012 |
| 12 | Health IT Usability Evaluation Model (Health-ITUEM) | A usability evaluation model designed specifically for evaluating the usability of mobile health technologies. | Brown et al., 2013 |
| 13 | Senior Technology Acceptance Model (STAM) | Adaptation of the TAM to elderly target users. | Chen et al., 2014 |
| 14 | Use of Technology for Adaptation by Older Adults and Those with Limited Literacy (USABILITY) | A model based upon the Technology Acceptance Model and the Theory of Planned Behavior to predict technology adoption by elderly patients. | Caboral-Stevens et al., 2015 |
| 15 | Health Information Technology Frustration Incidence Model | A holistic approach to understanding users’ frustration with healthcare interfaces, recognizing that safety and patient outcomes are at stake. | Opoku, 2015 |
| 16 | Organization for the Review of Care and Health Applications Framework (ORCHA-24) | A framework for evaluating the quality and risk of health applications based upon observed indicators of information security, clinical efficacy, user engagement, and user experience. | Leigh et al., 2017 |
| 17 | Factors Affecting Safety and Performance in Human-machine Interactions | A framework of activity system components used to inventory and predict factors influencing safety and performance of human-computer interactions. | Stowers et al., 2017­ |
| 18 | Model for consumer use of medical devices | A model that describes four dimensions of a device and a user that promote safe use practices. | Reyes et al., 2018 |
| 19 | MOLD-US Usability Framework for Elders | Aging barriers framework for usability problems encountered by older users. | Wildenbos et al., 2018 |
| **Technology implementation and acceptance** | | | |
| 20 | Technology Acceptance Model (TAM) | A model that characterizes usability determinants predicting attitudes towards technology adoption. | Davis, 1989 |
| 21 | Technology Acceptance Model 2 (TAM2) | An added variables TAM that identifies the system variables mediating technology adoption. | Venkatesh et al., 2000 |
| 22 | Diffusion of Innovation Theory | A theory intended to explain how, why and at what rate innovations spread. | Rogers, 2003 |
| 23 | Human, Organization, and Technology-Fit framework (HOT-Fit) | A model that evaluates how individuals, organizations, and technologies interact to influence HIT adoption. | Yusof et al., 2006 |
| 24 | Contextual Implementation Model | Human-computer interaction model looking at three levels of interaction: user, unit, and system. | Callen et al., 2008 |
| 25 | Combined Technology Assessment Model and Theory of Planned Behavior | Combines TAM and TBP to produce a complete set of determinants influencing technology use. | Duyck et al., 2008 |
| 26 | Normalization Process Theory | Identifies, characterizes, and explains mechanisms that promote or inhibit implementation. | May et al, 2009 |
| 27 | Framework for testing electronic adherence monitoring devices | A conceptual human factors framework that incorporates objective and subjective dimensions of electronic adherence monitoring technology. | DeBleser et al., 2011 |
| 28 | Capability, opportunity, motivation – behavior system (COM-B) | A behavioral-change framework that sits at the ‘hub’ of a behavior change wheel and that seeks to overcome limitations of prior frameworks. | Michie et al., 2011 |
| 29 | Effective Technology Use (ETU) model | An actionable model of technology adoption that identifies five determinants of use behavior. | Holahan et al., 2015 |
| 30 | Consumer Health Information System Adoption Model | Predicts the influence of user characteristics and perceptions of an innovation on informatics adoption. | Monkman et al., 2015 |
| 31 | Unified Theory of Acceptance and Use of Technology (UTAUT) | Explains the internal and external factors including users’ intention to use an information system. | Venkatesh et al., 2016 |
| **Computer science and software engineering** | | | |
| 32 | Model of PC Utilization | Identifies factors influencing computer utilization including complexity and user affect. | Duyck, 2008 |
| 33 | Information System Success Model | Identifies the processes and attributes of represented information mediating system success. | Golob et al., 2008 |
| **Systems engineering** | | | |
| 34 | Fit Between Individuals, Task, and Technology (FITT) | A framework looking at the interaction between system variables and human-computer interactions to optimize technology implementation. | Ammenwerth et al., 2006 |
| 35 | Systems Engineering Initiative for Patient Safety (SEIPS) | An extension of the Structure-Process-Outcome framework for understanding the interactions between people and systems. | Carayon et al, 2006 |
| 36 | Sociotechnical Model for Health Technology | An eight-dimensional model addressing challenges in design and implementation. | Sittig et al., 2011 |

# Discussion

## Principle Findings and Three Key Models

We identified 36 unique TMFs describing UX studies of HIT. Many articles used TMFs from related fields or pragmatically borrowed constructs without articulating a link to UX theory. We purposefully selected three examples of UX models for further discussion: the User Centered Design Development Lifecycle, the Cognitive Socio-technical Framework, and the Task, Users, Representations, and Functions framework [[3-5](#_ENREF_3)]. These are “general purpose” models (i.e., provide a range of constructs and explanatory interactions) developed expressly to facilitate UX work at any stage of development. Other models may be better tailored to a particular task or context such as app development or designing for the elderly.

The User Centered Design Development Lifecycle, described by Nielsen, is a cycle of activities fusing iterative design-thinking with the software development lifecycle [[6-8](#_ENREF_6)]. Yen adapted this model to healthcare by tracing development stages to evaluation methods and healthcare goals [[3](#_ENREF_3)]. The model describes three phases. The pre-design phase calls for UX instrument preparation during project planning. The design phase includes four steps: (1) specifying user needs; (2) defining requirements; (3) designing components and; (4) combining components. The post-design phase includes two steps: (1) system integration; and (2) routine use (i.e., UX to optimize regular use) [[4](#_ENREF_4), [5](#_ENREF_5), [7](#_ENREF_7)].

Borycki and Kushniruk’s Cognitive Socio-technical Framework (CSF) integrates two complementary characterizations of user interactions: (1) cognitive models describing how humans process information and; (2) sociotechnical models describing how technology affects work [[4](#_ENREF_4)]. The framework suggests UX evaluation methods throughout the technology lifecycle. Initially, researchers should study the interaction between technology and individual. Later, researchers can examine work processes among groups in context.

The Task, Users, Representations, and Functions (TURF) framework developed by Jiajie Zhang is a four-step sociotechnical model that emphasizes the interactions between users, tasks, and functions [[5](#_ENREF_5)]. The first step requires identification of all system users. In the second step, researchers gain an understanding of the work by developing an ontology of activities, interactions, and knowledge. Then, teams can look at software through multiple lenses to identify unmet needs. The third step is a task analysis wherein researchers catalog tasks associated with complex activities to measure complexity and time on task. Finally, the team can study how effectively data displays represent concepts.

## Limitations and Opportunities for Future Research

We only searched PubMed using MeSH terms and keywords; we did not search other bibliographic databases. A future systematic review should include other bibliographic databases (e.g., Scopus, Embase), trade publications, and grey literature.

Future research needs to focus on: (1) schematizing the dimensions of usability; (2) predicting the effect of constructs upon outcomes; and (3) publishing practical guides linking TMFs to use-cases, technology phases, and study methods [[9](#_ENREF_9), [10](#_ENREF_10)].

# Conclusions

Application of UX TMFs can help scope projects, address usability issues, and improve overall system performance. However, the state of the literature makes it difficult to integrate concepts and apply to practical problems. Although we provided a list of generalizable models, we have identified opportunities to close the theory-practice gap.

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2. 2 For search method and a complete bibliography please contact the corresponding author. [↑](#footnote-ref-2)