The Transactional Model of Electronic Health (eHealth) Literacy

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Abstract

**Background:** Electronic health (eHealth) literacy was conceptualized in 2006 as the ability of Internet users to locate, evaluate, and act upon online health information. eHealth advancements have cultivated transactional opportunities for patients to access, share, and monitor health information. However, empirical evidence shows that existing models and measures have limited theoretical underpinnings that reflect the transactional capabilities of eHealth. The current manuscript describes a conceptual model based on the Transactional Model of Communication (TMC), in which eHealth literacy is conceptualized as dynamic, cyclical, and shaped by contextual factors.

**Objective:** This study systematically examined eHealth literacy definitions, models, and measures to propose a refined conceptual and operational definition based on the TMC.

**Methods:** An adapted version of Walker and Avant’s concept analysis method was used to guide the systematic review of eHealth literacy definitions (N = 10), rating scales (N = 6), models (N = 4), and peer-reviewed model applications (N = 16). An inductive cluster analysis was conducted to identify salient themes across definitions. Dimensions, antecedents, and consequences within models and measures were extracted, deductively analyzed based on codes consistent with the TMC.

**Results:** A disconnect remains between operational skills in definitions and the literacies within models and measures. Theoretical underpinnings of eHealth literacy remain dismal, although recent measures incorporate tenants of the social cognitive theory. Despite the transactional capabilities of eHealth, the role of “communication” remains underdeveloped and limited to the physical and cognitive processing of two-way interactions that occur in eHealth.

**Conclusions:** The Transactional Model of eHealth Literacy (TMeHL) and a corresponding definition is proposed. eHealth literacy is a hierarchical and multidimensional intrapersonal skillset that mediates the cyclical effect of contextual factors (i.e., user-oriented, task-oriented) on factors related to patient activation. The intrapersonal skillset is comprised of four eHealth literacies, which correspond with operational behaviors central to defining eHealth literacy: functional (i.e., locate, understand), communicative (i.e., exchange), critical (i.e., evaluate), and translational (i.e., apply). As posited by the model and consistent with the TMC, this four-dimensional intrapersonal skillset counteracts the negative effect of noise produced by preceding contextual factors, to ultimately influence patient activation and expectations of future eHealth experiences.

**Keywords:** eHealth literacy; transactional model of communication; interpersonal communication; social media
Introduction

Electronic health (eHealth) is increasingly engrained within the healthcare system and patient engagement experience. eHealth facilitates collaborations among informed patients, proactive health care professionals, and responsive health care systems to coordinate care for positive health outcomes [1,2]. Alongside the evolution of eHealth, patients can now interact with health information available on the Internet and synchronously and asynchronously exchange ideas, thoughts, and health-related data with other users through multimedia on computer-mediated platforms (e.g., health information portals, personal health records, telemedicine applications, support groups or forums) [1,2]. Shaw and colleagues [2] identified three overlapping domains of eHealth, including users’ interaction with technology, interaction with other users through mediated platforms, and use of information gained from these interactions to advance their health and well-being. As such, a core aspect of eHealth includes not only the use of technology, but also the computer-mediated transaction of information among its users.

The transactional model of communication (TMC) [3] posits that communication between two or more entities is dynamic, process-oriented, and adapted or appropriated according to the context of the transaction. This context is shaped according to the channel of communication (e.g., telephone, email, letter), the source of communicators (e.g., interpersonal or impersonal), language (e.g., native or second), and the type of message (e.g., mode of transmission, whether image, video, text, or other). In the TMC, entities are not assigned roles as message “senders” or “receivers;” rather, their roles are interdependent, meaning that they are simultaneously message senders and receivers, or simply communicators. Any person within a social situation is a communicator, whether or not their interaction is synchronous or asynchronous, verbal or non-verbal, and intentional or unintentional. In this model, communication extends beyond a simplistic view of message creation; it is also about processing information to construct community and personal identity and impression management within the context surrounding the transaction (e.g., source, channel, message, language) [3-5]. The TMC functions under the assumption that interpersonal communication exists within a fluid state, and that the transaction among communicators is constantly changing and influenced by one another.

Within the context of eHealth, the TMC can be extended to interpersonal computer-mediated communication (I-CMC). I-CMC occurs remotely with technology (e.g., computer, smartphone, tablet, laptop) through diverse channel forms (e.g., text, video, image) and sources (e.g., personal friends and family, impersonal provider or peer) [6]. I-CMC notoriously fosters ambiguous communication, as the traditional in-person social and contextual cues that assist people in understanding the pragmatic meaning of messages are less salient across computer-mediated platforms [5,7]. With such cues filtered out, I-CMC can disrupt the accurate and smooth transmission of messages among communicators using diverse channels [5]. Similar to in-person communication, there are factors beyond contextual and social cues in the TMC that can exacerbate the ambiguity of message transmission.
Noise-inducing factors interfere with the information transmission and accessibility among communicators, ultimately hindering their ability to access, understand, and transmit meaning to one another [8]. Noise-induced factors can be categorized as physical (i.e., external factors), psychological (i.e., mental and emotional belief-systems), physiological (i.e., physical conditions, including auditory and verbal limitations, medication effects), and semantic (i.e., systems of meaning do not correspond) [6]. In I-CMC, these noise-inducing factors include technological usability challenges, stress or worry related to a recent disease diagnosis, scientific medical jargon, and physical limitations due to a health condition, to name a few. The high volume and constant flow of health information created and shared on the Internet coupled with the regular presence of noise-inducing factors has the potential to exacerbate the capacity of users to effectively and appropriately engage in the transmission of communication. Therefore, an essential aspect of successful transactional communication within computer-mediated contexts is the users’ capacity to counteract the negative effects of noise.

To understand the capacity of patients to successfully use and benefit from eHealth, the concept of eHealth literacy was initially coined in 2006. eHealth Literacy was defined as the ability to locate, evaluate, understand, and act upon health information from electronic sources [9-10]. Despite its continued widespread use over the past decade, researchers have argued that its seminal model and corresponding eHealth Literacy Scale (eHEALS) is outdated because neither consider the evolving dynamic and social nature of eHealth [2,11-13]. In an attempt to synthesize eHealth literacy research and recommendations for its conceptual advancement, Griebel and colleagues [14] posit that new concepts of eHealth literacy do not build upon the assumptions and structure of existing models; rather, these models function in isolation and do not extend from existing literature. Moreover, empirical evidence shows that eHealth literacy definitions and models have limited theoretical underpinnings to serve as a blueprint for developing an updated definition, model, and corresponding measure [14]. This perpetuates challenges in advancing the understanding of eHealth literacy in the social era of eHealth, specifically in regard to evidence for its valid operationalization and measurement.

The purpose of this study is to systematically review how eHealth literacy has been conceptualized in the transactional era of eHealth. As such, this study aims to operationalize eHealth literacy as an intrapersonal skillset to counteract the effect of noise within transactional interactions across computer-mediated platforms. This study applies a concept analysis methodology, a rigorous method where empirical literature is systematically surveyed to refine the operationalization of a construct [15-16]. Findings of will have important implications for developing an operational definition and model of eHealth literacy based on the TMC, a fundamental aspect of eHealth [2].

**Concept Analysis Methods**

**Sample and Procedures**
A series of keywords were combined with Boolean operator (“AND”) and entered into three electronic databases (i.e., PubMed, CINAHL, PsycINFO). In each search query, a combination of three terms were entered to reflect (1) **purpose** (i.e., “concept,” “model,” “definition,”
“framework,” “theory,” “measure,” “instrument,” “scale,” “survey”), (2) context (i.e., “eHealth,” “social media,” “web 2.0,” “social network,” “digital health”), and (3) ability (i.e., “skill,” “literacy). The same queries were conducted in Google Scholar to identify grey literature. The final sample consisted of articles that: (a) were published after 2006, the year that the seminal eHealth literacy definition and model was published; (b) in the English language; (c) included the terms “eHealth,” “social,” “media,” “web 2.0,” or “digital health” in the title or abstract; and (d) presented information on the concept, definition, or measurement of skills related to social media, digital health, electronic health record use. Figure 1 presents the literature review extraction procedures.

![Figure 1. Literature extraction procedures](Image)

Walker and Avant’s [16] concept analysis methodology was adapted to guide the data extraction and analysis procedures. First, literature presenting definitions, antecedents, consequences, and attributes (i.e., dimensions) of eHealth literacy was extracted. Articles that presented explicit definitions and conceptual models of eHealth literacy were considered. Moreover, the original sources of eHealth literacy empirical referents (i.e., measurement instruments) were included in the final sample. Peer-reviewed empirical articles that included at least one of the models reviewed in the analyses were perused to identify information about antecedents and consequences of eHealth literacy.
Data Analysis
An inductive analysis of eHealth literacy definitions was conducted to identify thematic clusters [17]. The attributes (i.e., content areas) of eHealth literacy conceptual models and measurement instruments were extracted and entered into a descriptive table where congruent components were identified. Antecedents, noted as independent variables in analyses, and consequences, the dependent variables within analyses, associated with conceptual models were extracted from peer-reviewed and grey literature.

Concept Analysis of eHealth Literacy Definitions, Models, and Measures

Existing Definitions of eHealth Literacy
Table 1 presents ten eHealth literacy definitions developed since 2006. Seminal definitions were solely focused on intrapersonal skills to access and use health information obtained from electronic sources [9,18]. The interaction of individual and technological factors became more salient in later definitions of eHealth literacy [12,19]. Chan & Kaufman [20], for example, posit that eHealth literacy is not solely dependent on cognitive processing; rather, it is influenced through interactions between cognition and technology. More recent definitions of eHealth literacy state that eHealth skills function within the context of social, individual, and technological factors [11,14,21]. The interaction between diverse contextual factors and the technological constraints influence eHealth skills, and the ultimate capacity to improve health and wellness. Although implied by all definitions, one explicitly stated that eHealth literacy is comprised of a “hybrid of two other concepts,” including health literacy and technology literacy [22]

Table 2 presents the definitions of eHealth literacy into clustered themes. Competence is characterized as a set of skills and knowledge, predominantly referred to as “the ability.” Influential Factors that determine the said ability are characterized as the interplay between contextual factors (i.e., individual, social) coupled with situational factors (i.e., type of health problem, type of technology). Actions are operational skills, including the capacity to locate, understand, evaluate, communicate/create, evaluate, and apply. The Object of Interest, or the purpose of carrying out the actions, includes obtaining knowledge from high quality health information. And, finally, the Objective of obtaining the object of interest is generally for the purposes of health, or to maintain or improve the quality of health across the lifespan.
<table>
<thead>
<tr>
<th>Article</th>
<th>Year</th>
<th>Author</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2006</td>
<td>Norman &amp; Skinner</td>
<td>“The ability to seek out, find, understand and appraise, integrate, and apply what is gained in electronic environments toward solving a health problem” (pg. 2).</td>
</tr>
<tr>
<td>2</td>
<td>2008</td>
<td>Bodie &amp; Dutta</td>
<td>“… not just the ability to use the Internet to find answers to health-related questions; it also entails the ability to understand the information found, evaluate the veracity of the information, discern the quality of different websites, and use the quality information to make informed decisions about health” (pg. 193).</td>
</tr>
<tr>
<td>3</td>
<td>2011</td>
<td>Chan &amp; Kaufman</td>
<td>“A set of skills and knowledge that are essential for productive interactions with technology-based health tools, such as proficiency in information retrieval strategies, and communicating health concepts effectively” (pg. 2).</td>
</tr>
<tr>
<td>4</td>
<td>2011</td>
<td>Norman</td>
<td>“A foundational skill set that underpins the use of information and communication technologies for health” (pg. 1).</td>
</tr>
<tr>
<td>5</td>
<td>2012</td>
<td>Neter &amp; Brainin</td>
<td>“The ability of people to use emerging information and communication technologies to improve or enable health and health care” (pg. 1).</td>
</tr>
<tr>
<td>6</td>
<td>2012</td>
<td>Paek &amp; Hove</td>
<td>“… a hybrid of two other concepts, eHealth and health literacy, [in which] skills must be appropriate for the informational text people need to understand in their efforts to treat various health concerns” (pg. 728).</td>
</tr>
<tr>
<td>7</td>
<td>2013</td>
<td>Werts &amp; Hutton-Rogers</td>
<td>“The ability to gather and appropriately process health information retrieved online” (pg. 115).</td>
</tr>
<tr>
<td>8</td>
<td>2014</td>
<td>Gilstad</td>
<td>“The ability to identify and define a health problem, to communicate, seek, understand, appraise, and apply eHealth information and welfare technologies in the cultural, social and situational frame and to use the knowledge critically in order to solve the health problem” (pg. 69).</td>
</tr>
<tr>
<td>9</td>
<td>2015</td>
<td>Bautista</td>
<td>“The interplay of individual and social factors in the use of digital technologies to search, acquire, comprehend, appraise, communicate, and apply health information in all contexts of healthcare with the goal of maintaining or improve the quality of life throughout the lifespan” (pg. 43).</td>
</tr>
<tr>
<td>10</td>
<td>2017</td>
<td>Griebel et al.</td>
<td>“… a dynamic and context-specific set of individual and social factors, as well as consideration of technological constraints in the use of digital technologies to search, acquire, comprehend, appraise, communicate, apply, and create health information in all contexts of healthcare with the goal of maintaining or improving the quality of life throughout the lifespan” (p. 10).</td>
</tr>
</tbody>
</table>
### Table 2. Five Clusters of eHealth Literacy Definitions from the Literature

<table>
<thead>
<tr>
<th>Competence</th>
<th>Contextual Factors</th>
<th>Action</th>
<th>Object of Interest</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Ability&lt;sup&gt;1,2,5,7,8&lt;/sup&gt;</td>
<td></td>
<td>* To locate</td>
<td>* Knowledge&lt;sup&gt;1,8&lt;/sup&gt;</td>
<td>* For health&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>* Skills&lt;sup&gt;6&lt;/sup&gt;</td>
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<td></td>
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<tr>
<td>* Set of skills &amp; knowledge&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
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<tr>
<td>* Foundational skillset&lt;sup&gt;4&lt;/sup&gt;</td>
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<td></td>
<td>O Contextual</td>
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<tr>
<td></td>
<td>• Contextual</td>
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<tr>
<td></td>
<td>• Cultural, social, and situational frame&lt;sup&gt;8&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Interplay between social and individual factors in using technology&lt;sup&gt;9&lt;/sup&gt;</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>• Dynamic and context-specific individual and social factors, and technological constraints&lt;sup&gt;10&lt;/sup&gt;</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• To use information and communication technologies&lt;sup&gt;4,5&lt;/sup&gt;</td>
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<td></td>
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<tr>
<td></td>
<td>• To locate</td>
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<tr>
<td></td>
<td>o Find&lt;sup&gt;1,2&lt;/sup&gt;</td>
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<td></td>
<td>o Seek&lt;sup&gt;1,8&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>o Search&lt;sup&gt;9,10&lt;/sup&gt;</td>
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<td></td>
<td>o Retrieve&lt;sup&gt;3&lt;/sup&gt;</td>
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<td></td>
<td>o Gather&lt;sup&gt;7&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>o Acquire&lt;sup&gt;9,10&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>• To understand</td>
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<tr>
<td></td>
<td>o Comprehend&lt;sup&gt;9,10&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>o Understand&lt;sup&gt;1,2,6,8&lt;/sup&gt;</td>
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<td></td>
<td>o Process&lt;sup&gt;7&lt;/sup&gt;</td>
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<td></td>
<td>• To evaluate</td>
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<tr>
<td></td>
<td>o Appraise&lt;sup&gt;1,8,9,10&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>o Evaluate the veracity&lt;sup&gt;2&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>o Discern the quality&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• To communicate&lt;sup&gt;3,8,9,10&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• To create&lt;sup&gt;10&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>• To translate</td>
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<tr>
<td></td>
<td>o Integrate&lt;sup&gt;1&lt;/sup&gt;</td>
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<td></td>
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<tr>
<td></td>
<td>o Apply&lt;sup&gt;1,8,9,10&lt;/sup&gt;</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>o Use knowledge&lt;sup&gt;8&lt;/sup&gt;</td>
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</tbody>
</table>

*Note. Superscripts correspond with numbers in Table 1.*
Dimensions of eHealth Literacy
Since 2006, four eHealth literacy models and six measurement instruments have been published. Table 3 presents their purpose, guiding theoretical framework (if applicable), and the dimensions used in the concept and measurement.

Conceptual models (N = 4)
Norman and Skinner’s [9] Lily Model posits that eHealth literacy is comprised of analytic skills that are central to the online health information seeking experience, as well as context-specific skills that vary according to situational contexts. In this model, health science, and computer literacies are context-specific skills, whereas information traditional/numeracy, and media literacies are analytic-specific. As such, a high degree of eHealth literacy exists when context- and analytic-specific skills work in concert and allows an individual to successfully carry out an eHealth goal.

Gilstad [21] adapted Norman & Skinner’s [9] Lily Model to describe how eHealth literacy mediates the effect of diverse contextual factors (or literacies) on productive patient-provider communication. This model posits that contextual “literacies” (i.e., propositional, cultural, social, propositional, procedural) coupled with situational factors (i.e., type of health question, type of eHealth technology) directly impact context- and analytic-specific aspects of eHealth literacy as posed in Norman & Skinner’s Lily Model. In Gilstad’s model, the outcome associated with eHealth literacy is communicative expertise (i.e., the capacity to discuss a personal or family concern with an offline healthcare provider).

Unlike Norman & Skinner [9] and Gilstad [21], Bautista [11] developed a model to posit that eHealth literacy is a process-oriented concept. In this model, Bautista states that eHealth literacy is cyclical, meaning that it has a reciprocal relationship with diverse contextual and ecological factors. As such, Bautista [11] defines eHealth literacy as comprising intrapersonal actions (i.e., search, acquire, comprehend, appraise, communicate, apply), the type of digital technology (i.e., PC, mobile devices) and online environment (i.e., social media vs. informational website), as well as the goal of using eHealth technologies (i.e., maintenance, treatment) in particular healthcare contexts (i.e., promotion, prevention, curative, rehabilitation) across the lifespan.

Kayser and colleagues [23] applied an informatics approach to conceptualize eHealth literacy through a multidisciplinary lens. This model applies a user-task-context matrix, adapted from Kushniruk & Turner [24]. The model functions under the assumption that eHealth literacy is the degree of harmony between healthcare consumers’ needs and skills, as well as the capacity of the technology to address those skills and needs within the greater healthcare context. The user-task-context matrix is grounded in health and digital literacy, and it is comprised of seven dimensions from three domains (i.e., user, task, user-task).
### Table 3. Dimensions (Content Areas) of eHealth Literacy Conceptual Models and Measures

<table>
<thead>
<tr>
<th>Background Information</th>
<th>Dimensions (Content Areas) and Operational Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conceptual Models</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Author:</strong> Norman &amp; Skinner [9]</td>
<td>Context-Specific Literacies</td>
</tr>
<tr>
<td><strong>Name:</strong> Lily Model</td>
<td>- Health literacy <em>(i.e., basic literacy in the context of the healthcare system)</em></td>
</tr>
<tr>
<td><strong>Purpose:</strong> To develop a model that accounts for the unique attributes of health literacy in an electronic/networked world.</td>
<td>- Science literacy <em>(i.e., understand the scientific process)</em></td>
</tr>
<tr>
<td><strong>Guiding Framework:</strong> Consumer eHealth</td>
<td>- Computer literacy <em>(i.e., use computers to solve issues)</em></td>
</tr>
<tr>
<td><strong>Author:</strong> Gilstad [21]</td>
<td>Analytic-Specific Literacies</td>
</tr>
<tr>
<td><strong>Name:</strong> A comprehensive model of eHealth Literacy</td>
<td>- Traditional literacy/numeracy <em>(i.e., basic or prose literacy)</em></td>
</tr>
<tr>
<td><strong>Purpose:</strong> To develop a comprehensive model of eHealth literacy that accounts for the competencies and analytic notions of what makes a user “eHealth literate.”</td>
<td>- Information literacy <em>(i.e., resource awareness)</em></td>
</tr>
<tr>
<td><strong>Guiding Framework:</strong> Extends from Norman &amp; Skinner’s Lily Model; Self-Efficacy Theory</td>
<td>- Media literacy <em>(i.e., critical thinking)</em></td>
</tr>
<tr>
<td></td>
<td>Contextual Factors</td>
</tr>
<tr>
<td></td>
<td>- Propositional literacy <em>(i.e., learning through facts, theory)</em></td>
</tr>
<tr>
<td></td>
<td>- Cultural literacy <em>(i.e., cultural knowledge)</em></td>
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<tr>
<td></td>
<td>- Social literacy <em>(i.e., norms, values, rules, and regulations)</em></td>
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<td></td>
<td>- Procedural literacy <em>(i.e., experiential or physical learning with a computer)</em></td>
</tr>
<tr>
<td></td>
<td>- Contextual literacy <em>(i.e., understanding the social and health situation)</em></td>
</tr>
<tr>
<td></td>
<td>Situational Factors</td>
</tr>
<tr>
<td></td>
<td>- Type of health question</td>
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<tr>
<td></td>
<td>- Type of eHealth technology</td>
</tr>
<tr>
<td></td>
<td>Context-Specific Literacies</td>
</tr>
<tr>
<td></td>
<td>- Health literacy <em>(i.e., basic literacy in the context of the healthcare system)</em></td>
</tr>
<tr>
<td></td>
<td>- Science literacy <em>(i.e., knowledge of the scientific method)</em></td>
</tr>
<tr>
<td></td>
<td>- Computer literacy <em>(i.e., knowledge about using a computer and social media)</em></td>
</tr>
<tr>
<td></td>
<td>Analytic-Specific Literacies</td>
</tr>
<tr>
<td></td>
<td>- Traditional literacy/numeracy <em>(i.e., understanding, communicating text &amp; numbers)</em></td>
</tr>
<tr>
<td></td>
<td>- Information literacy <em>(i.e., using information to identify and solve a problem)</em></td>
</tr>
<tr>
<td><strong>Author:</strong> Bautista [11]</td>
<td><strong>Author:</strong> Kayser et al. [23]</td>
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<tr>
<td><strong>Name:</strong> N/A</td>
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<td><strong>Framework:</strong> User-Task-Context Matrix</td>
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<tr>
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**Measurement Instruments**

<table>
<thead>
<tr>
<th><strong>Author:</strong> Bautista [11]</th>
<th><strong>Author:</strong> Kayser et al. [23]</th>
<th><strong>Author:</strong> Norman &amp; Skinner [10]</th>
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<tr>
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<td><strong>Purpose:</strong> To assess knowledge, comfort, and perceived skills at finding, evaluating, and applying electronic health information to</td>
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</table>

- Media literacy (i.e., analyze visual and audio information)
- Communicative Expertise (i.e., interaction with an offline healthcare provider)
- Contextual factors (i.e., social and individual factors)
- Lifespan (i.e., age group)
- Quality of life (i.e., maintenance and improvement)
- Healthcare context (i.e., health promotion, prevention, cure, rehabilitation)
- Actions (i.e., search, acquire, comprehend, appraise, communicate, apply)
- Use of technologies (i.e., PC, mobile device, Internet, social media)

- Health and digital literacy
- Health care context
- User Domain
  - Knowledge about one’s health
  - Ability to interact with information
  - Ability to engage with technology
- Task Domain
  - Access to technologies that work
  - Access to technologies that suit individual needs
- User-Task Domain
  - Feel that using technology is beneficial to address a health need
  - Feel in control and secure in using a technology to address a health need

- Locate electronic health information
- Evaluate electronic health information
- Apply knowledge gained from electronic health information
health problems.

**Framework:** Reflects the Lily Model, but items do not correspond with model literacies.

| **Author:** Koopman and colleagues [25] | • Health information need  
| **Name:** Patient Readiness to Engage in Health Internet Technology (PRE-HIT) | • Internet experience  
| **Purpose:** To measure readiness or motivation, a key aspect of “competence,” to use eHealth. | • Computer anxiety  
| **Framework:** Dimensions were derived from focus groups with chronic disease patients | • Preferred mode of interaction  
| | • Relationship with doctor  
| | • Cell phone expertise  
| | • Online privacy  
| | • “No news is good news”

| **Author:** Chew & Yuqian [26] | • Health literacy  
| **Name:** eHealth Literacy | • Science literacy  
| **Purpose:** To measure eHealth literacy as the ability to use information technology to search, locate, process, and understand health information to improve health and healthcare. | • Media literacy  
| **Framework:** Included items from the Health Information National Trends Survey (HINTS) that align with core literacies of the seminal Lily Model. | • Computer literacy  
| | • Traditional literacy/numeracy  
| | • Information literacy
Author: Bhalla and colleagues [27]
Name: eHealth Readiness Scale
Purpose: To assess user preparedness to engage in eHealth interventions.
Framework: Bandura’s Social Cognitive Theory (SCT)

- Self-motivation and self-regulation in eHealth task completion

Author: Seckin et al. [28]
Name: e-Health Literacy Scale (e-HLS)
Purpose: To develop an eHealth literacy scale that assesses how well people provided digital health content can discern high quality from low-quality information.
Framework: eHealth literacy is grounded in the concept of health literacy, thus dimensions were derived from a review of the literature

- Cognitive literacy (i.e., trust in the credibility of online health information)
- Interactional literacy (i.e., communication with offline health care providers)
- Behavioral literacy (i.e., action related to evaluating and appraising online health information)

Author: van der Vaart & Drossaert [29]
Name: Digital Health Literacy Instrument (DHLI)
Purpose: To develop and measure a self-reported and performance-based measure Web 1.0 and Web 2.0 skills.
Framework: Dimensions were derived from formative research examining the eHealth performance of patients with rheumatic diseases

- Operational skills (i.e., to use the computer and Internet)
- Navigation skills (i.e., to navigate and orient on the Internet)
- Information searching skills (i.e., to use correct search strategies)
- Evaluation skills (i.e., to evaluate the reliability and relevance of online information)
- Self-creation skills (i.e., to add self-generated content to web-based apps)
- Privacy protection skills (i.e., to protect and respect privacy while using the Internet)
Conceptual models have attempted to extend Norman & Skinner’s [9] Lily Model depicting the intrapersonal skillset of eHealth literacy, to depict how contextual factors that influence these skills. Gilstad [21] identified a number of situational, technological, and cultural factors that can influence the intrapersonal literacies outlined by the Lily Model. Kayser and colleagues [23], who did not consider the Lily Model in their conceptualization of eHealth literacy, roughly defined influential contextual factors as user- and task-domains, positing that eHealth skills are dependent on both the situation and person. Only Bautista’s [11] model depicts operational skills that correspond with the core components of existing definitions, which includes “communication” as a central skill. Bautista’s model also depicts eHealth literacy as a cyclical process and posits that these intrapersonal skills have a reciprocal relationship with contextual factors, the type of technology, the age of the patient, and finally the purpose of the eHealth experience. Synthesized, these four models suggest that eHealth literacy is an intrapersonal skillset that is shaped by diverse contextual factors related to the user and the situation.

**Measurement instruments (N = 6)**

Table 3 also presents the results of six self-administered eHealth literacy rating scales, including their purpose, guiding framework, and dimensions. Norman & Skinner’s [10] eHealth Literacy Scale (eHEALS) was the seminal eHealth literacy measurement instrument, developed as a unidimensional scale grounded in self-efficacy to reflect the Lily Model [10]. Research refuting that the eHEALS reflects dimensions of the Lily Model, Chew & Yuqian [26] identified items from the Health Information National Trends Survey (HINTS) to address each of the literacies within the Lily Model. Unfortunately, evidence to support the scale psychometric properties does not exist.

Other measurement instruments assessed eHealth motivation or readiness. Through formative focus groups with older adults with chronic disease, Koopman and colleagues [25] derived eight dimensions of eHealth motivation, including (but not limited to) the need for health information, preferred mode and channel of the eHealth interaction, and online privacy. Authors did not disclose than these dimensions reflect an existing conceptualization of eHealth literacy. Bhalla and colleagues [27] assessed eHealth readiness by conducting formative research with eHealth end-users to identify themes that reflect constructs of the Social Cognitive Theory, specifically the constructs of self-regulation and self-motivation to use eHealth. Despite being grounded in a behavior change theory, the dimensions included within this measure do not reflect central components of a proposed or existing validated eHealth literacy models.

Most recently, measurement instruments have been developed to account for the social features of eHealth. Seçkin and colleagues [28] identified three important concepts from a systematic literature review of health literacy that appeared to be central to eHealth literacy, including cognitive literacy (trust), interactional literacy (communication with offline healthcare providers), and behavioral literacy (apply learned health behaviors). Additionally, van der Vaart and Drossart [29] developed an instrument to measure digital health literacy through performance-based challenges among rheumatic patients. The items in this scale capture dimensions about the capacity to use technology, navigate online health information, create text messages for other users, and take precautions to protect
the privacy of themselves and other users. These most recent measurement instruments begin to consider the operational skills related to eHealth proficiency; however, these measures are derived from formative research with limited application to existing eHealth literacy definitions or conceptual models.

**Antecedents and Consequences of eHealth Literacy**

Functional (or basic), health, and technology literacies are fundamental to eHealth skills [9,19,30-32]. Antecedents that influence eHealth skills include personal, relational, knowledge, and technological determinants. **Personal Determinants** influencing eHealth literacy include income, education [10,13,19,31-34], race/ethnicity [33-34], gender [35], age [13,19,35-37], marital status [35], and health status [10,36]. **Relational Determinants** include social influences/norms and alleviated linguistic and cultural barriers to health information [22,30]. **Knowledge Determinants** include the type and amount of health information preferred and the amount of preexisting knowledge about the health concern [9,19,23,35]. **Technological Determinants** include motivation to use technology for health [10,18,19,22,32,37], access to technological devices [21,38], the type and number of technologies used to access health information [9,13], frequency of using eHealth [19,22,36,39], and preference to use eHealth [31].

The consequences of eHealth literacy primarily comprise intrapersonal factors, which have a residual effect across social-ecological contexts. The most salient intrapersonal consequence included a change in the degree of patient activation, or degree of empowerment and informed decision-making [9,30,40]. People with a high degree of eHealth literacy report greater healthcare access [38], improved health-related outcomes [30,32,38], and participating in proactive health behaviors offline, including self-management behaviors [19], patient-provider communication [19], and cancer screenings [35]. Consistent with the central tenants of eHealth literacy, a greater degree of confidence in eHealth skills was associated with higher self-reported comprehension [40], critical evaluation [39,40] and trust in online health information from diverse sources and channels [21,34]. Positive self-reported eHealth skills predicted motivation to continue using eHealth [18,21], particularly because it is perceived as a useful tool to supplement healthcare [39].

**Transactional Model of eHealth Literacy**

This synthesis and review of eHealth literacy definitions, models, and measures posits that the multi-dimensional construct is a cyclical intrapersonal skillset influenced by the interaction between user- and task-oriented factors, which drive patient activation and informed decision-making. This is consistent with the theoretical underpinnings of the TMC [3]. According to assumptions of the TMC [3], information transaction is dependent on the interaction between a series of contextual factors. In synthesizing antecedents of transactions based upon eHealth literacy literature and the TMC, the contextual factors can be categorized as task-oriented features (i.e., message type, source, channel, language) and the user-oriented features (i.e., personal, relational, knowledge, technological). Their interaction produces a degree of physical, semantic, psychological, and physiological noise [3,6,8]. The effect of the noise can either hinder or facilitate the transaction of information. As such, the intrapersonal skillset of eHealth literacy will be integral for a user to benefit
from the eHealth experience. Existing definitions and models do not capture the transactional nature of eHealth literacy. Therefore, a refined definition and model of eHealth literacy to further depict its process is proposed.

Proposed Definition

The following definition of eHealth literacy is proposed:

The ability to locate, understand, exchange, and evaluate health information from online environments in the presence of dynamic contextual factors, and to apply the knowledge gained across ecological levels for the purposes of maintaining or improving health.

This definition builds upon previous eHealth literacy definitions and extends the concept to the context of the TMC. First, the operational skills comprise and correspond with the central aspects of eHealth [2]: (1) interaction with technology (i.e., locate, understand), (2) interaction with other users through mediated platforms (i.e., exchange), and (3) assess (i.e., evaluate) and act upon (i.e., apply) information to advance health. Second, the proposed definition acknowledges that the eHealth skills of a user will vary according to the interplay between diverse contexts, including user-oriented and task-oriented factors. Third, this definition highlights the role of technologies as tools (or bridges) to assist eHealth consumers to access and exchange health information. Based on the synthesis of eHealth literacy literature, proficiency in using a technology or an online environment does not solely define eHealth literacy; rather, it is the capacity of the user to achieve their intended eHealth goals while counteracting noise including technological challenges. Finally, this definition clarifies that “communication” in eHealth literacy is the ability to construct relationships and identities with other online users through health information exchange, consistent with interpersonal communication literature and the TMC [3,5,6].

Proposed Model

Consistent with the definition above, Figure 2 presents the Transactional Model of eHealth Literacy (TMeHL) based on the TMC. This model does not specify encoders (sender) and decoders (receiver); rather, it treats the communication transaction as a continuous process that is constantly modified and appropriated according to diverse eHealth contextual factors. This model consists of three assumptions: (1) Task-oriented and user-oriented factors interact to produce physical, semantic, psychological, and physiological noise during the transaction process; (2) eHealth literacy, a multidimensional and hierarchical intrapersonal skillset, counteracts the effect of noise on the transaction; and (3) Patient activation is cyclical and influences future interactions between eHealth contextual factors and their effect on eHealth literacy. Although the primary consequence associated with eHealth literacy is being an informed and activated patient across diverse social-ecological contexts, there is no “end goal” of eHealth literacy. The capacity of an informed and activated patient to apply knowledge gained from an eHealth transaction across diverse social-ecological factors (i.e., trust in eHealth, productive patient-provider communication, greater eHealth use and perceptions of its usefulness, positive health-related quality of life) will ultimately inform task- and user-oriented factors that drive future eHealth experiences and noise production.
Figure 2. The Transactional Model of eHealth Literacy
Consistent with prior eHealth literacy models [21,23], a series of task-oriented and user-oriented factors comprise the eHealth context. However, these user- and task-oriented factors do not function in isolation and they extend beyond the ability to interact and use technology; rather, these factors interact with one another to shape the transactional process of the eHealth experience, including eHealth intrapersonal skills. Task-Oriented Factors include the channel in which the transaction occurs (e.g., social media, electronic health record, email), the source or identity of the communicators (e.g., peer, friend, family member, healthcare provider), the language used to communicate (e.g., native language, second-language), and the modality of the message (e.g., image, text, video). User-Oriented Factors, however, consist of factors that are central to the user, rather than the situation or task. These factors include personal demographic information, including education, gender, and age. The relational support is described as the amount of support or perceived social norm in using eHealth. The degree of pre-existing knowledge about the health topic and the desire to obtain more information is also a user-oriented factor. Finally, there is a technological user-oriented factor, which is a general assessment of the users’ access, preference, and frequency of its use. Consistent with the TMC [3], the interactions between task- and user-oriented factors will produce external stimuli, or “noise,” that can serve as a hindrance or facilitator to the transaction.

Noise-inducing factors in the TMC, as well as other interactional communication models, are comprised of physical, psychological, physiological, and semantic factors [3]. Although there is evidence that diverse internal and external factors hinder and facilitate the capacity of eHealth users to successfully carry out their intended goals on the Internet [41-43], no other eHealth literacy model or measurement instrument reviewed in this study considered the concept of “noise” as being part of the eHealth experience, beyond contextual eHealth factors. Physical Noise can include external factors that hinder the eHealth experience, including cognitive or information overload due to a wide variety of multimedia or physical challenges with the technology used (e.g., screen size is too small or not bright enough, keyboards are too small). Psychological Noise includes the affective response to the eHealth experience, including the urgency for the information or the nature of the search (e.g., cancer clinical trials versus physical activity information). Physiological Noise can be either temporal or permanent, meaning that it could be dexterity limitations due to a health condition or pain from a briefly debilitating migraine. Finally, Semantic Noise is the disagreement between meaning systems, including excessive use of scientific or wordy jargon from one or more communicator, as well as the use of emojis or emoticons to transmit information. Ultimately, the degree of noise in a computer-mediated transaction is produced by the interaction between these task- and user-oriented factors.

The intrapersonal eHealth literacy skillset mediates the relationship between the effect of noise on eHealth contextual factors and the degree that an eHealth consumer is informed and activated. Theoretically, eHealth literacy skills have an inverse relationship with the negative effect of noise. In other words, greater eHealth literacy skills will negate the detrimental effects of noise produced from the eHealth contextual factors and promote a positive eHealth experience. This is consistent with evidence suggesting that greater frequency in using eHealth improves proficiency in online health information seeking [19],
as users become more familiar with their information needs, the technology, and the usefulness of the Internet for health.

The intrapersonal skillset of eHealth literacy is grounded in three foundational elements: Functional Literacy, Health Literacy, and Technology Literacy. Functional Literacy, or the basic skills in reading and writing [44], is a basic predecessor of both health and technology literacy. Together, health and technology literacy are central to eHealth skills [45]. The most recent definition of Health Literacy posits that it is “linked to literacy and entails people’s knowledge, motivation, and competence to access, understand, appraise, and apply health information in order to make judgments and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course” (p. 3) [17]. Technology Literacy is more concretely defined as, “the ability to use, manage, assess, and understand technology” (p. 9) [46]. Without proficiency in functional literacy, eHealth users would not be able to successfully function within a healthcare context, let alone navigate a technological device or computer-mediated environment for a health inquiry.

Health and technology literacies shape the multidimensional and hierarchical intrapersonal skillset, including four eHealth literacies. These literacies represent an adapted version of the gold-standard health literacy model [47-48] to include Functional, Communicative, Critical, and Translational eHealth Literacies. A significant limitation that was noted in review of existing eHealth literacy definitions, models, and measurement instruments is that they include a high volume of literacies with minimal insight to their relationship to underlying skillsets. As such, this model classifies literacies to what skills they allow an eHealth consumer to carry out.

The eHealth literacies presented in Figure 2 capture a hierarchical depiction of these unique yet related skills, which align with the operational skills proposed in the refined definition. Consistent with health literacy literature [47-48], functional eHealth literacy is a foundational skill that precedes the remaining literacies. This literacy comprises lower-level operational skills, including the ability to locate and understand health information. Translational eHealth literacy is located at the highest level, as being proficient in this top-tier literacy requires a degree of proficiency across all lower-level literacies. This hierarchical depiction shows that the lower-level literacies and operational skills are the building blocks to achieve optimal proficiency in the higher-level literacies and operational eHealth skills. Stated differently, an eHealth consumer must be able to have basic skills in reading and writing/typing, in order to successfully exchange, evaluate, and apply health information from the Internet. Each of these literacies are described and operationalized below, alongside the corresponding behaviors outlined in the proposed definition.

**Functional eHealth Literacy (Operational behaviors: To locate and understand)**
According to Nutbeam [47-48], the definition of functional health literacy, which was adapted by Freebody & Luke [49], is having, “sufficient basic skills in reading and writing to be able to function effectively in everyday situations” (p. 263). Considering the technological context of functional health literacy, it is important to determine how well an individual can successfully read and write about health via a technological device.
Therefore, Functional eHealth literacy is defined as basic skills reading and writing (typing) about health to effectively function on the Internet.

**Communicative eHealth Literacy (Operational Behavior: To exchange)**

Communicative literacy as, “advanced cognitive and literacy skills, which together with social skills, can be used to participate in everyday activities, to extract information and derive meaning from different forms of communication, and to apply new information to changing circumstances” (p. 264) [48]. In its original conceptualization, communicative literacy was intended to assess patients’ communication skills when engaging with offline healthcare professionals [47-48]. eHealth is a computer-mediated form of communication with limited salience given to social and non-verbal cues [6]. According to Spitzberg & Cupach [50], success in achieving instrumental, self-presentation, and/or relational goals are determined based on the degree that interpersonal communication is appropriate and effective. Appropriate communication is consistent with social norms and relationships (stranger/close friend) among communicators. Effective communication achieves the desired goal of the health information seeking experience and interaction. There are three fundamental interpersonal communication skills that guide the degree to which someone is communicating appropriately and effectively [50]: (1) **control**, effectiveness managing a situation to negotiate interpersonal problems and achieve a communicative goal; (2) **collaboration**, adhering to social norms to achieve an interaction goal; and (3) **adaptability**, acclimating to challenges by improvising communicative styles based on contextual and social cues. In our new model, **Communicative eHealth Literacy** is defined as the ability to collaborate, adapt, and control communication about health with users on social online environments with multimedia.

**Critical eHealth Literacy (Operational behavior: To evaluate)**

Critical literacy is defined as, “advanced cognitive skills, which together with social skills, can be applied to critically analyze information, and to use this information to exert greater control over life events and situations” (p. 264) [48]. Through the lens of the TMC, critical eHealth literacy includes being aware of the type of health information that is communicated to and from online users, as well as the source from which this information is presented. This includes not only source and information credibility, but also evaluating the relevance of sharing information and the risks of sharing this information to online sources through diverse channels. In this model, **Critical eHealth Literacy** is defined as the ability to evaluate the credibility, relevance, and risks of sharing and receiving health information on the Internet.

**Translational eHealth Literacy (Operational behavior: To apply)**

Developing a concept that acknowledges the dichotomy between “what people know” and “what people do” represents a fundamental gap in the health literacy literature [51]. Translating knowledge gained through a health-related interaction is the “process of moving what we learned... to the actual application of knowledge in a variety of practice settings and circumstances” [52]. In public health research, knowledge translation is a systems-level approach to transforming knowledge gained from rigorous research into societies for improved health outcomes [52-53]. Within the context of eHealth, health
information seekers often adopt the role of lay health researchers, as they become exposed to new information including health-related knowledge from diverse sources (e.g., peers, family, providers) and communication channels (e.g., social media, Electronic Health Records, news outlets). Strategies used to determine the applicability of new health information and translate it into our existing knowledge structures are dependent on contextual factors, including personal and situational context [54]. This process is likely dependent on the skills a person has to identify and implement successful strategies to translate the information gained. Based on existing literature on knowledge translation, we propose the dimension “translational eHealth literacy.” *Translational eHealth Literacy* is defined as the ability to apply health knowledge gained from the Internet across diverse ecological contexts. Translational literacy is the highest cognitive level of the eHealth literacy, meaning it is informed and built upon from all previous eHealth literacy dimensions (i.e., critical, communicative, functional).

**Discussion**

This study systematically reviewed literature on eHealth literacy to provide an updated understanding in the transactional era of eHealth. Unlike Griebel and colleagues [14], who suggested that eHealth literacy literature functions in solidarity and does not build upon prior literature, the results of this systematic review suggest that eHealth literacy literature actually has built upon existing definitions and models to extend the construct to account for the evolving nature of eHealth. Unfortunately, these attempts continue to miss the mark in capturing the transactional nature of eHealth, specifically the skills to thrive within online environments where social and contextual cues are limited. Instead, literature over the past decade has explored technological and contextual factors that influence the intrapersonal skillset of eHealth literacy, shedding a dim light on the transactional implications of eHealth literacy. The intrapersonal skillset of eHealth literacy remains underdeveloped, especially in regard to the role of communication. Results provide important implications for extending eHealth literacy to the TMC to develop a refined definition and complementary model to guide future instrument development studies.

Existing eHealth literacy definitions include operational skills required for an eHealth consumer to thrive on the Internet (i.e., locate, understand, evaluate, apply, and most recently communicate/create). However, dimensions of existing models and measures are not intuitively aligned with the intrapersonal operational skills outlined in their corresponding definitions. Norman and Skinner’s [10] eHEALS was intended to serve as a unidimensional scale to capture the Lily Model’s eHealth literacy, or the self-efficacy to locate, understand, evaluate, and act upon online health resources [9]. Over the past decade, strong empirical evidence shows that eHEALS is a 3-dimensional measure that assesses eHealth users’ self-efficacy in their eHealth awareness, information seeking, and evaluation and action related to the online health information [55-56]. This research begins to clarify the relationship between the seminal eHealth literacy definition and its corresponding measurement instruments; however, there remains a fundamental gap in the relationship between the seminal definition, the Lily Model, and the eHEALS. This is not unique to most recent eHealth literacy literature, where limited empirical attention has been paid to the operational skills needed to thrive within the social era of eHealth. The proposed TMeHL fills this fundamental disconnect in the literature, by proposing a
The dimension and role of “communication” is significantly underdeveloped in existing eHealth literacy definitions, models, and measurement instruments. “Communication” was not integrated within definitions until 2011, and it first appeared in a conceptual model in 2014 as an outcome related to high eHealth literacy, not an integral or defining element [21]. In regard to its operationalization, existing measures consider communication, or as it is synonymously referred to in the eHealth literature as “interactivity,” as the ability to talk about findings of an online search to an offline healthcare provider [25,28]. The most recent measurement instrument operationalizes “communication” as the ability to self-create, add, or generate messages on social media with a technological device [29]. Interestingly, the most recent definition, Griebel and colleagues [14] posit that “communicating” and “creating” are two discrete skills. As such, the role of communication appears to have an identity crisis in eHealth literacy literature. In the TMC, particularly in computer-mediated contexts, communication is a vehicle that facilitates the process of co-creating information within diverse contexts among two or more communicators [3,5]. The proposed TMeHL definition and model considers communication a central skill of eHealth literacy that affects critical (evaluative) and translational (application) of the eHealth experience, rather than an end-goal or single act of creating a message.

Limitations
This study is not without limitations. Despite the rigorous extraction procedures and inclusion of grey literature, it is possible that not all eHealth literacy models, definitions, and measures were included. A qualitative approach was used to extract and analyze the literature in this study, which is prone to researcher bias [57]. However, this study applied a concept analysis methodology [15-16], which is a rigorous and well-regarded approach to refine and operationalize an evolving concept, like eHealth literacy. This study proposes a refined definition and model of eHealth literacy to “keep up” with the evolving nature and transactional approaches currently engrained in eHealth. This study does not provide empirical validation evidence; however, this is currently underway.

Conclusion
The purpose of this study was to systematically review eHealth literacy literature in the transactional era of eHealth. This is primarily due to the high-volume of overlapping and inconsistent literacies, as well as the underdeveloped nature of “communication” as an integral component of eHealth literacy. Overall, existing eHealth literacy definitions, models, and measures do not account for the transactional nature of eHealth and function under dismal theoretical underpinnings. A refined eHealth literacy definition and model based on the TMC is proposed to inform a corresponding measurement, which is currently underway.

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Conflicts of Interest
The authors declare no conflict of interest.

Abbreviations
eHEALS: Electronic Health Literacy Scale
HINTS: Health Information National Trends Survey
I-CMC: Interpersonal computer-mediated communication
TMC: Transactional Model of Communication
References


