eHealth Literacy Research – Quo vadis?

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Abstract

The concept of eHealth literacy evolved from the social and information sciences, and describes competencies necessary to use electronic health services. As it is a rather new topic, and as there is no current overview of the state of the art in research, it is not possible to identify research gaps. Therefore, the objective of this viewpoint article is to increase knowledge on the current state of the art of research in eHealth literacy, and to identify gaps in scientific research which should be focused on by the research community in the future. The article provides a current viewpoint of the concept of eHealth literacy and related research. Gaps can be found in terms of a missing ‘gold standard’ regarding both the definition and the measurement of eHealth literacy. Furthermore, there is a need for identifying the implications on eHealth developers, which evolve from the measurement of eHealth literacy in eHealth users. Moreover, a stronger inclusion of health professionals, both in the evolving concept and in the measurement of eHealth literacy, is needed in the future.
**eHealth literacy – the background**

eHealth literacy is a rather broad topic that can be viewed from a number of different perspectives by diverse research disciplines. These disciplines reach from social scientists who are interested in human and social factors associated with eHealth literacy, to health professionals who are facing an increasing patient empowerment, to programmers and information scientists, who want to know how the eHealth literacy of consumers can be mirrored when designing eHealth services.

According to the definition of Eysenbach, eHealth (alternative spelling: e-health), encompasses health services and health information, which are provided via the Internet, and related technologies. Moreover, this definition includes a special way of thinking: “the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology” (1).

Over time, the concept of eHealth has had many definitions and a review conducted in 2005 found 51 unique definitions for eHealth (2).

The consumer is commonly the focus of eHealth strategies and services – the layperson who has no medical background should be enabled to manage his or her own health (3). eHealth strategies and services enable patients to be active participants in the process of medical decision-making by providing information. This may lead to a better understanding of their health and wellbeing (1, 4, 5). An analysis of eHealth strategies in Nordic countries, conducted by the Nordic eHealth Research Network, showed that the strategies in 2010-2013 were explicit regarding the citizen’s perspective, whereas the strategies in 2014-2016 were implicit in this respect (6).

There is a wide range of consumer-focused eHealth services. Telemedicine, first used in the 1920s, is the oldest form of eHealth (7). More recently, the mobile health sector (mHealth or m-Health) has been offering a huge amount of services for diverse user groups and with diverse objectives (8, 9). There are internet-based services such as patient forums, health information pages, electronic patient records or self-tracking systems that can be used along with fitness wristbands or smart watches. In this dynamic environment the eHealth consumer
needs to be self-reliant and able to actively participate in his or her health management. When we examine the literature for the so-called digital divide, it is clear that this gap is widening in western civilizations. This is not only due to a lack of access (first level digital divide) but also due to a lack of use (second level digital divide) (10-12). Individuals might therefore be excluded from the potential advantages of eHealth services. There is a gap in the population as to whether people are able to make use of eHealth services or not (13, 14).

In this context, eHealth literacy has become a central issue of research in international health informatics. While some people are eHealth literate and access eHealth services to enhance their health and communication with healthcare services, others are eHealth illiterates and are not knowledgeable about eHealth. The term eHealth literacy was first defined by Norman and Skinner in 2006 as the “ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem”(15). eHealth literacy is by definition a meta literacy that comprises six different subtypes of literacies:

- Traditional literacy & numeracy: the ability to understand text and numbers
- Health literacy: the ability to process and understand health information
- Computer literacy: the ability to use computer hardware and software
- Science literacy: the ability to understand scientific texts, facts and correlations
- Media literacy: the ability to process media content and assess its quality
- Information literacy: the ability to process information, to know how knowledge is organized and how to use the gained information

eHealth literacy can occur on different levels. The lower level requires operational and navigational skills, while the higher level requires the ability to choose and critically evaluate available information. Each of these levels contributes to the ability to find and assess the quality of health information online. Therefore, a deficiency in any may result in inadequate health literacy and prevent individuals from accessing eHealth resources of high quality (12). A high level of eHealth literacy is argued to be directly connected with the intention to use eHealth services (16). eHealth literacy, as with other literacies, is not a static set of skills but can change over time (15). If the level of eHealth literacy can be identified, services and information can be tailored specifically to the needs of the target group. Therefore, if eHealth services are bespoke to the consumer, they may benefit from the potential advantages (17, 18). In line with the eHealth literacy concept, Norman and Skinner provided the eHealth
literacy scale (eHEALS) to measure the individual’s literacy level (19). Currently there are papers that mention problems with the existing concept of eHealth literacy or with measurement methods (20-24). In 2011, Cameron Norman provided a guest editorial for the Journal of Medical Internet Research concerning eHealth literacy. In this editorial he mentioned the problem that the original eHealth literacy concept had been developed for the first generation of eHealth services and thus does not include social media. He reasoned that skills and tasks, including, for example, the confidence in expressing oneself clearly in social interactions online, should be part of a measurement instrument of eHealth literacy (23). Since this editorial paper from 2011 there, indeed, has been a lot of work on the topic of eHealth literacy but it remains unclear where the research community in this area is standing at the moment and if the problems with the measurement of such a dynamic concept have been solved.

Therefore, this viewpoint paper aims to provide an overview – it does not intend to give a systematic review of the literature but aims to address the following two questions:

- Question 1: What is the current state of the art of eHealth literacy research?
- Question 2: Which research gaps should the scientific community focus on more in the future?

**Question 1: What is the state of the art of eHealth literacy research?**

The number of the articles using the concept “eHealth literacy” has risen over the years. Having a closer look at the current literature, several findings are revealed, that are presented below.

**Finding No. 1: There is a lot of research that deals with eHealth literacy but uses other terms.**

Although eHealth literacy is the term most widely used by authors when they are referring to literacies linked to the use of electronic health services, there are numerous articles that used other terms but probably mean the same thing. This, of course, was expected because the concept of eHealth literacy (or e-health literacy) has been launched quite recently and has been mainly used in the fields of research where the concept of health literacy has a strong background, such as in health sciences. In the fields of research where information literacy, health information literacy, and digital or media literacy are the focus, the concepts relating to them are more popular when speaking about the issues related to eHealth literacy.
Other terms used include “Internet health literacy” (25), “e literacy” (26), or “digital health literacy” (27). Other researchers do not state the term “eHealth literacy” but describe combinations of different literacies, such as online health literacy, digital literacy, health literacy (28) or talk just about health literacy or health information literacy, even when they indicate competencies relevant for searching for health information on the Internet (29-32). Furthermore, it must be remembered that there is a lot of research done on the research areas of information seeking and information behavior that do not necessarily use the concept of literacy in the context of seeking, understanding and using online health information.

Finding No. 2: There are several models to describe eHealth literacy.

As Norgaard et al. describe in their work, first came the well-known Lily Model by Norman and Skinner (22). This model describes eHealth literacy as a meta literacy consisting of six other competencies (15).

This is the most commonly cited model of eHealth literacy. Nevertheless, over the years this model has been critically commented on. As mentioned above, Cameron Norman, one of the pioneers of the eHealth literacy concept, argued that the Lily Model does not describe contexts of use and does not fully fit with interactive Web 2.0 contents where other competencies might be necessary as well (23). Therefore, he points out that researchers, such as Xie (33) and van der Vaart and colleagues (24) have continued to develop the concept further.

In 2013 Griebel et al. (34) placed the eHealth literacy model by Norman and Skinner in a wider context by linking it with the Unified Theory of Acceptance and Use of Technology (35).

Gilstad took another approach to widen the eHealth literacy concept in 2014 by combining it with contextual factors, such as cultural context, institutional context or the type of eHealth technology (36).

In the same year (2014), Koopman, Petroski, Cansfield, Stuppy and Mehr developed the PRE-HIT instrument which was based on a widened understanding of eHealth literacy: they included further variables, including, for example, computer anxiety, computer expertise, or health information, and validated them in focus groups of patients with chronic diseases.

In 2015 Monkman and Kushniruk published the Consumer Health Information System Adoption Model (37). They argued that the consumers’ eHealth literacy level and the
demands, which a system has for eHealth literacy are moderating the adoption and the successful use of a consumer-oriented eHealth system. eHealth literacy was placed into context with usability and usefulness of eHealth services and described as a moderating variable between the usefulness and usability of a system and the adoption, value and successful use of it.

Also in 2015, Norgaard, Furstrand, Klokker, Karnoe, Batterham, Kayser, and Osborne provided the “framework for characterizing e-health users and their interaction with e-health systems” (22). They performed workshops with patients and medical professionals, identified eHealth literacy domains and divided them in an eHealth literacy framework (eHLF). The eHLF includes not only individual factors (e.g. the ability to process information) necessary to use eHealth systems but also system relevant factors (e.g. digital services that suit individual needs) and user-system interaction aspects (e.g. the motivation to engage with digital services). Therefore, the eHLF provides a broad picture of viewpoints that need to be taken into account when creating eHealth tools that fit with the intended users’ eHealth literacy.

To conclude, in the described models, eHealth literacy has been looked at under the following perspectives:

- What sub-competencies are included in the idea of eHealth literacy?
- What context or user-specific factors might influence the users’ eHealth literacy?
- What role does the eHealth system play when regarding the individuals’ eHealth literacy?
- What role does eHealth literacy play when it comes to the adoption and use of eHealth services?

Finding No. 3: The eHealth Literacy Scale (eHEALS) was mostly used but there are also other measurement approaches.
Mostly the eHealth Literacy Scale (eHEALS) by Norman and Skinner was used (19) to measure the eHealth literacy of diverse study groups. The scale has been translated from English into at least six languages:

- Italian (38, 39)
- Chinese (40)
- Japanese (41)
- Spanish (42)
- German (43)
Exploring the literature over the years it is clear that there have been numerous critical voices regarding the eHEALS. In general, Hargittai stated that measurements based on self-assessment show problems of validity (44).

More specifically, in his 2011 article, Norman explains that the Lily Model and the subsequent eHealth literacy scale were developed before the rise of social media and Web 2.0 (23). So the concept and the scale do not consider the use of digital interaction via social media (e.g. Facebook) or specific Internet forums where people share their medical experience with others and exchange best-practice examples. To use such interactive media, Norman states that other competencies are needed and that maybe a social media interactive subscale should be included into eHEALS. This extension of eHEALS should be possible as eHealth literacy is an integrative model of diverse skills and it subsequently can evolve over time.

Additional to Norman’s thoughts, Van der Vaart et al. found only a weak correlation between eHealth literacy measured by eHEALS and the Internet use of a person and mentioned that this correlation was high when eHEALS was developed (17). They, similar to Norman, concluded that this change evolved from the fact that electronic media has changed over time: Social media and mobile web are common today and are viewed as a dynamic, multifaceted form of media – there is more interaction and not only static health information on the Internet. The skillset that eHEALS should measure has not changed over time, however, the context in which the skills are needed has become more dynamic regarding social media and mobile health.

Besides all critical voices, some literature describes eHEALS as a valid and reliable tool to measure patients’ eHealth literacy (45). Nevertheless, there are several articles that mention other measurement approaches (e.g. (17, 20, 22, 24, 46-57).

- The research group around Furstrand, Kayser, Norgaard et al developed the so-called eHealth Literacy Assessment Toolkit (eHLA) (50). It is based on a framework by Noorgard et al (22) which took both the user and the system perspectives into account.
- Koopman et al developed the PRE-HIT instrument to measure the patient’s readiness to engage in health information technology (55).
- Sekcin et al examined a new 19-item eHealth literacy measurement (e-HLS) and found that it consisted of three factors: communication, trust, and action (56).
- Ivanitskaya et al used an interactive 56-item online assessment – the Health Research Readiness Self-Assessment (Health-RRSA) for measuring readiness to receive health information. They describe the Health-RRSA as a combination of an electronic survey and an electronic test (52, 53).

- Ashurst et al criticized eHEALS as a self-assessment tool and used other self-efficacy items. (20).

- Britt et al used the eHEALS in combination with items from Ajzen’s planned behavior theory (46).

- Chan et al proposed the combination of the eHealth literacy model and Bloom’s Taxonomy – a classification of intellectual behavior in learning that includes six cognitive process dimensions which differ in regard to their complexity (47, 48).

- Van der Vaart et al. performed observation studies on how users solved eHealth-related tasks (17, 24). As well as Ashurst et al. they criticized the self-assessment character of eHEALS (20).

- Chew presented a new eHealth literacy scale based on six components of eHEALS (49).

- Hanik and Stellefson investigated the perceived and actual eHealth literacy of students using the Research Readiness Self-Assessment (RRSA-h) instrument (51).

- Stellefson, together with Hanik, Chaney and Tennant, used a Q-technique factor analysis to identify students’ perspectives of personal eHealth search practices and linked it with the participants’ eHealth literacy (57).

- Jones developed the “Patient eHealth Readiness Scale” (PERQ), which includes competency-related items as well as contextual factors such as Internet use, support by other persons and demographics such as age or gender (54).

- Most recently Van der Vaart and Drossaert published a new Digital Health Literacy Instrument – the DHLI which takes Health 1.0 as well as interactive Health 2.0 aspects into account (58). This self-assessment tool should be tested in the future among diverse population groups.

Overall, it appears that researchers who developed new measurements did not take previous work by other researchers into account. Therefore, currently it appears that the research community in eHealth literacy is providing numerous “stand-alone tools” that are not used or reworked by others.
Finding No. 4: There are several definitions of eHealth literacy.
Norman and Skinner, pioneering in the field of eHealth literacy, provided the definition of eHealth Literacy that is widely used: eHealth literacy is “the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem” (15).

In 2015 Bautista performed a literature review on eHealth literacy definitions and, besides the one by Norman and Skinner cited above, found three definitions (59):

- Chan and Kaufman: “A set of skills and knowledge that are essential for productive interactions with technology-based health tools” (47).
- Koss: “The ability of consumers (directly or with assistance) to use computers and other communication technologies to find, read and understand health information to make personal decisions” (59). It has to be noted that, for us, it was not possible to find the definition Bautista cited in his article on the Internet or elsewhere - the source might have been removed.
- Gilstad: “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” (36).

Furthermore, Bautista found seven definitions of “health literacy” and three of “digital literacy” and subsequently condensed all found definitions in a new one. According to him, eHealth literacy can be defined as follows:

“eHealth literacy involves 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 improving the quality of life throughout the lifespan” (59).

This definition might be supplemented by the following definition by Klecun, Lichtner, and Cornford:

“[eHealth literacy is] a dynamic and context-specific ensemble of the skills, attitudes and understandings necessary and appropriate for working with digital tools and systems (including computers, smart phones and other devices) in order to perform
health care related tasks both individually and as part of a team, and to participate in processes of (technology-led) change within institutional settings” (26).

Furthermore, the eHealth literacy concept by Kayser et al (21) possibly adds further aspects to a definition of eHealth literacy. The researchers defined seven eHealth literacy domains including:

- Knowledge about one’s own health
- Ability to interact with information
- Ability to engage with technology
- Access to technologies that work
- Access to technologies that suit individual needs
- Feel that using technologies is beneficial
- Feel in control and secure when using technologies

Moreover, the ability to search, acquire, comprehend, appraise, communicate and apply health information should not be the only part of a definition of eHealth literacy. The creation of health information is an additional aspect relating to the recent “Framework for Information Literacy for Higher Education by the Association of College & Research Libraries“ (60) that highlights the role of the individuals’ ability to create information as a key element for information literacy.

Thus, supplementing Bautista’s meta-definition with the one by Klecun et al. and enriching it with the aspects by Kayser et al., that eHealth literacy also needs to be viewed from a system’s point of view (technologies that work and suit individual needs), and by the Framework for Information Literacy, we might come to a new definition of eHealth literacy. The following definition is proposed. The basis is the definition by Bautista; words in italics are added and include aspects from the definition of Klecun et al., from the extended eHealth literacy view by Kayser et al. and from the Framework for Information Literacy:

“eHealth literacy includes a dynamic and context-specific set of individual and social factors as well as technology constraints (such as the fit of a system to a user) 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.”
Finding No. 5: Most articles on eHealth literacy are patient-/citizen-/user-oriented and do not put eHealth literacy in a broader context.

A large part of articles on eHealth literacy describes the measurement of eHealth literacy and most of the articles are strongly consumer-/citizen-/patient-oriented. This means that they measure the literacy of certain groups, to draw conclusions such as working on appropriate education programs for individuals to enhance their eHealth literacy (61), or to better understand factors that lead to the misunderstanding of electronic health information (62).

Mostly, the eHealth literacy of students (e.g. (31, 46, 51-53, 61, 63-67)), and patients (e.g. (16, 17, 25, 29, 30, 68-75)) have been measured in studies focusing on eHealth literacy. The eHealth literacy of elderly persons has also been investigated (e.g. (69, 76-80)) just like the literacy of adult population groups in general (e.g. (78, 81-85)). The eHealth literacy of parents of ill children was measured in some articles (e.g. (62, 86-88)), and the eHealth literacy level of children has been examined as well (e.g. (28)). Some articles focus on the eHealth competencies of patients regarding genetic testing (e.g. (71, 89)), or they focus on the eHealth literacy of war veterans (e.g. (90)).

There might be a lack of theoretical frameworks in studies which regard the measurement of eHealth literacy. Most of them use measurement instruments (mostly the eHealth literacy scale) and draw conclusions. Nevertheless, there is only a weak foundation on theoretical aspects such as the fact that eHealth literacy consists of several sub-literacies as found by Norman and Skinner (15). The finding is supported by the work of Mackert et al. which states that more than 90% of all published studies on eHealth literacy or health literacy are not based on theories (91).

Furthermore, the conclusions drawn are often rather vague and do not provide specific recommendations e.g. for eHealth developers on how to process the finding that, for example, the majority of people analyzed have a low or medium eHealth literacy.

Nevertheless, there are a few articles with a more context-oriented focus on eHealth literacy, such as the paper by Chen and Lee that describes the finding that eHealth literacy has a direct effect on eHealth behavior (64). Another example of more context-oriented work is the paper by Diviani et al. – the authors had a closer look at the relationship between health literacy and the evaluation of online health information (81). Furthermore, Suri et al. found that eHealth literacy was associated with the use of the Internet for obtaining information on a healthy lifestyle (31). Another general approach to see eHealth literacy in a broader context is
represented by the paper by Xesfingi and Vozikis, who used a large sample of citizens to explore factors that contribute to their eHealth literacy (92). Klecun, Lichtner and Cornford also explored eHealth literacy in a multi-dimensional way and even provided suggestions for third persons (in this case policy makers and managers) on how to factor the eHealth literacy of citizens in their decisions (26). Monkman and Kushniruk also provided suggestions for third parties by enhancing the online guide on health literacy of the U.S. Department of Health and Human Services (93) by mobile health applications (94). Park, Cormier and Glenna have recently published a study that aimed to link the self-assessed eHealth literacy of citizens to implications on healthcare professionals as to best communicate with their patients (85).

Finding No. 6: There are interventions to improve the eHealth literacy of potential users.

Besides the papers on the measurement of eHealth literacy and the papers which consider eHealth literacy in a more context-oriented or theoretical way, there is a huge amount of articles describing eHealth literacy interventions. These intervention include programs, schedules etc. which have been developed to improve the eHealth literacy of numerous individuals. The researcher group of Watkins and Xie has performed various interventions to improve the eHealth literacy of elderly people (33, 95-97). They have also performed a systematic literature review which found that most intervention studies lacked the measurement of health outcomes (98). According to them, currently there is a need for theory-based and well-planned interventions (98).

Besides Watkins, Xie and other researchers of this group, Manafo and Wong, dealt with the promotion of eHealth literacy in individuals. They also focused on elderly persons (99, 100). We can conclude that there might be a gap in the research on the promotion of eHealth literacy in other groups at the moment.

Similar to articles in which eHealth literacy was measured, a theoretical background is often missing - also in the field of eHealth literacy interventions (98). Furthermore, there still is the question of how to link measured levels of eHealth literacy to the development of eHealth services. How do we as consumers or information providers benefit from the information on the differences of individual eHealth levels?
Question 2: Which are the research gaps on which the scientific community should focus more in the future?

Gap No. 1: Literature on eHealth literacy is mostly focused on the measurement of literacy and does not often take theoretical backgrounds or implications for third parties into account.

It has been shown that patients who want to manage their health status actively can have better health outcomes than patients who act more passively (101-103). That is one reason why the US American Office of the National Coordinator for Health Information Technology (ONC) developed the so-called Blue Pledge program to support providers of eHealth services in enabling patients to easily access their individual health data (104). Furthermore, there are practice recommendations for physicians on how to help the patient understand direct communication (105). There are also recommendations for designers of eHealth services on how to build easy-to-use websites (93). Nevertheless, both approaches do not take different eHealth literacy levels into account.

Moreover, as described above, there are numerous approaches to measure eHealth literacy. A big gap can be found in the conclusions of the articles. Several authors measured the level of eHealth literacy of individuals and they even identified barriers of using eHealth services. Nevertheless, it remains unclear what to do with these findings.

If an eHealth service developer wants to create a tool that is suitable for people with low/medium/high eHealth literacy – what are the next steps? The tailoring of health communication, in other words, health information services and their content, should be taken into account in the design of eHealth services (see e.g. (106)). Tailoring can be based, for instance, on the health literacy level of the user. The user’s health literacy level and his/her preferences, e.g. for a specific presenting style, can be measured by a short questionnaire and/or usability tests (for example eye-tracking) when the user accesses a website for the first time. Then the content is represented accordingly. Individuals who consider their health literacy level to be poorer most probably prefer texts presented in summarized and popularized form, without difficult scientific concepts. They may also benefit by a visualization of information (107).

Ideas like these are linked only weakly to eHealth literacy articles. One example that, indeed, represents practical guidelines for eHealth developers and considers the user’s skill set is the work of the research group of Norgaard, Kayser et al. They provided practical guidance for eHealth designers on how to take eHealth literacy into account by proposing an iterative
framework to assess the needs of the users. Developers should therefore design personas of the intended users and follow the seven eHealth literacy domains (knowledge about one’s own health; ability to interact with information; ability to engage with technology; access to technologies that work; access to technologies that suit individual needs; feel that using technologies is beneficial; feel in control and secure when using technologies) (21).

One can look at this gap from a different point of view as well: The measured eHealth literacy of the user has implications on the design of eHealth services and there is no possibility for existing eHealth services to be assessed according to the level of eHealth literacy their use would require.

As we found during our research, self-assessment is still the state-of-the-art to measure eHealth literacy in terms of its practicability – therefore it would be helpful if a bridge between these measurements and the design of eHealth services could be built.

**Gap No. 2: A gold standard of measurements of eHealth literacy is missing.**

As mentioned above, several researchers have created new measurement approaches. However, most of the approaches are not based on well-founded theories as they use measurement items that do not cover all aspects of eHealth literacy (but only self-efficacy, for example). Nevertheless, there are some alternative measurement approaches that are well-based and might be used in the future. The eHealth literacy scale (e-HLS) by Seckin et al. could be an interesting approach that takes the three factor groups “communication”, “trust”, and “action” into account and could be viewed as a tool which provides an up-to-date understanding of eHealth literacy and its measurement (56). The new scale by Van der Vaart and Drossaert might also be interesting (58).

To the best of our knowledge, and besides all criticism and the fact that there are other measurement approaches, we found that other measurement tools besides the eHEALS have either not yet been used in practice (like the 2016 approach by Seckin et al. (56)) or have not been used other than in the publication in which the approaches were originally introduced (such as the framework by Chan et al. (47)) .

The eHealth literacy community needs to evaluate the existing measurement possibilities and agree on how to measure eHealth literacy in the future.
Gap No. 3 There is only a weak inclusion of medical professionals in the measurement and definition of eHealth literacy.

Doctors and nurses have been focused in information-seeking studies for a long time and these studies also include the search for and the use of online information (for reviews see e.g. (108, 109)). On the contrary the focus of the articles in which eHealth literacy is measured is mostly on laypersons. Only a few studies - such as a study on an online health platform for physicians, patients and caregivers by Griebel et al. - measured the eHealth literacy of both medical professionals and laypersons (110).

Norgaard et al. performed several workshops, which included patients as well as health professionals and experts in medical informatics to try to identify relevant aspects of eHealth literacy among these various individuals (22). According to these researchers “research in this field [eHealth literacy] has lacked systematic inclusion of users and eHealth professionals in the development of the eHealth literacy concept” (22).

MacLure and Stewart published articles on the digital literacy of pharmacists and pharmacy staff. In one study they found that the self-reported digital literacy of pharmacy staff was at a basic level (111). This finding was supported by a systematic review whose authors found that in Australia, Canada and the US, pharmacy staff in general are lacking digital literacy (112).

The works by Griebel et al., Norgaard et al. and MacLure and Stewart are the only papers on eHealth literacy aspects we have found where other stakeholders than laypersons have been taken into account. In general, there is a weak point considering eHealth literacy research when it comes to health professionals.

Gap No. 4 Concepts of interactive and mobile eHealth services are generally not included in eHealth literacy research.

As Norman criticized in 2011, the Lily Model lacks interactive aspects that might request special types of competencies (23). For example, the use of a smartphone app that enables data upload into a cloud, might require a user who is able to judge if his/her data is safe. More recent measurement approaches like the work done by Seckin et al. provide extended aspects of eHealth competencies – nevertheless, they still focus on webpages (56). The concept of mobile health literacy has recently been introduced in literature (for example (113)).

Gilstad provided an extended model in which context plays an important role (36) – this should be taken as the starting point to broaden the understanding of eHealth literacy.
**Gap No. 5: eHealth literacy is not the only barrier within the use of eHealth.**

There are also other research areas dealing with barriers regarding the use of technology. There are, for example, technology acceptance models (35, 114-116) or research models in the social sciences such as the Theory of Reasoned Action (117) or the Social Cognitive Theory (118).

Technology acceptance models have been tailored to fit with eHealth services. Model extensions like the e-HTAM (119) or the work of Ahadzadeh et al., who combined the Health Belief Model and TAM (120), could be linked to the concept of eHealth literacy.

**Conclusion: eHealth literacy research - Where are we and where to go?**

Although we did not intend to provide a systematic review of the literature in eHealth literacy and might have missed some articles, we can draw several conclusions.

eHealth literacy research includes a large number of articles describing studies where the eHealth literacy of defined user groups has been measured. Another broad field of research includes articles which deal with the promotion of eHealth literacy in (mostly elderly) individuals. Both topics – the measurement of eHealth literacy and the promotion of those competencies – are often lacking both a well-founded theoretical basis and approaches to put eHealth literacy in a broader context. Furthermore, the researchers often did not draw conclusions, especially when it came to the design of fitting eHealth solutions for the individual’s eHealth literacy level. The eHealth literacy scale eHEALS is based on a cognitive view of learning and knowledge acquisition, and is mostly used to assess the literacy level of individuals. There are critical voices regarding the underlying eHealth literacy concept of Norman and Skinner and the scale itself. Numerous researchers are aware of limitations in relation to both social media platforms and interactivity in eHealth services. Therefore, there are approaches based on social constructivism to extend or rework the understanding of eHealth literacy and to create new measurement tools. However, these approaches often seem to be stand-alone and are not built upon work of other researchers. The concept of eHealth literacy has been defined several times but mostly the definition by Norman and Skinner from 2006 has been used.

A new gold standard of the understanding of what defines eHealth literacy is needed, as the one by Norman and Skinner is no longer up-to-date. The authors of this paper propose a new definition that includes aspects like interactivity, a dynamic evolvement of literacy, changing
information practices of individuals and the integration of technology aspects. The new definition is stated as follows:

“eHealth literacy includes 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.”

A gold standard is also needed for measuring eHealth literacy – there are several approaches besides eHEALS but they have not been used in practice and do not take the work of other researchers into account. Methods are needed that are based on theories that also include further acceptance factors and interactive Health 2.0 aspects.

Methods and measurements, which combine subjective self-assessments and the objective measurement of the individual´s skills and abilities concerning eHealth should be developed. In general, self-reports are more susceptible to retrospective recall of behavior and social desirability than objective measurements. In fact, there is an on-going debate on whether health (information) literacy represents a skill-based construct for health self-management or, in a broader sense, whether it captures the personal activation or motivation to manage health (121). The self-assessed measurements may reflect more on the self-efficacy and motivation of the individual than his/her actual skills and abilities (see e.g., (122)). However, both aspects are important and they also make independent contributions to health.

Another research gap can be found in the deficient integration of health professionals in the research of eHealth literacy – both in measuring and in defining eHealth literacy aspects. eHealth literacy is mostly seen from a laypersons’ perspective. There are only few approaches where the potential aspects of eHealth literacy – beyond the personal factors of a layperson - are taken into account. This includes technical aspects (the systems’ suitability for the user) and the point of view of health professionals.

Last but not least the linkage between the measurement of eHealth literacy and the design of appropriate eHealth solutions is very weak. There is almost no starting point for eHealth designers who might want to take the individual’s eHealth literacy level into account when creating electronic health solutions.
To conclude, the research community in eHealth literacy needs to focus on the following aspects in the future:

1. To agree on an updated definition of eHealth literacy.

2. To set a gold standard for measuring eHealth literacy subjectively (and objectively). To take the work of other researchers into account when creating new scales in order to avoid numerous “stand-alone approaches”.

3. In case of studies that aim at measuring eHealth literacy: To provide clear information on the reasons why the literacy was measured, on the theoretical basis on which the research is taking place and on the handling of the results.

4. To consider the design of eHealth literacy interventions not only for elderly people but for other user groups as well.

5. To consider the viewpoints of health professionals and laypersons AND other aspects such as technological constraints as well as to not consider eHealth literacy as isolated from related areas of research such as research on usability or technology acceptance.

6. To provide a clear guidance for the developers of eHealth services on how to process the different levels of eHealth literacy of their intended users.

Authors’ contributions

LG, HE, HG, ALP and JM work together in an international research group on eHealth literacy. For this article they all provided their expertise and knowledge on eHealth literacy. LG carried out the writing of the manuscript, HE, HG, ALP and JM commented intensely and provided further aspects and text pieces. MS supervised the work and provided the initial idea to write a viewpoint paper on eHealth literacy.

Acknowledgements

The present work was performed in partial fulfillment of the requirements for obtaining the degree “Dr. rer. biol. hum.”. We acknowledge support by Deutsche Forschungsgemeinschaft and Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) within the funding programme Open Access Publishing.
Conflicts of Interest

We have read and understood the policy on the declaration of interests of Informatics for Health and Social Care and declare that we have no competing interests.
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