

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.

1

2 **eHealth literacy – the background**

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

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

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

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

25 There is a wide range of consumer-focused eHealth services. Telemedicine, first used in the
26 1920s, is the oldest form of eHealth (7). More recently, the mobile health sector (mHealth or
27 m-Health) has been offering a huge amount of services for diverse user groups and with diverse
28 objectives (8, 9). There are internet-based services such as patient forums, health information
29 pages, electronic patient records or self-tracking systems that can be used along with fitness
30 wristbands or smart watches. In this dynamic environment the eHealth consumer needs to be

1 self-reliant and able to actively participate in his or her health management. When we examine
2 the literature for the so-called digital divide, it is clear that this gap is widening in western
3 civilizations. This is not only due to a lack of access (first level digital divide) but also due to a
4 lack of use (second level digital divide) (10-12). Individuals might therefore be excluded from
5 the potential advantages of eHealth services. There is a gap in the population as to whether
6 people are able to make use of eHealth services or not (13, 14).

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

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

22 eHealth literacy can occur on different levels. The lower level requires operational and
23 navigational skills, while the higher level requires the ability to choose and critically evaluate
24 available information. Each of these levels contributes to the ability to find and assess the
25 quality of health information online. Therefore, a deficiency in any may result in inadequate
26 health literacy and prevent individuals from accessing eHealth resources of high quality (12).
27 A high level of eHealth literacy is argued to be directly connected with the intention to use
28 eHealth services (16). eHealth literacy, as with other literacies, is not a static set of skills but
29 can change over time (15). If the level of eHealth literacy can be identified, services and
30 information can be tailored specifically to the needs of the target group. Therefore, if eHealth
31 services are bespoke to the consumer, they may benefit from the potential advantages (17, 18).
32 In line with the eHealth literacy concept, Norman and Skinner provided the eHealth literacy

1 scale (eHEALS) to measure the individual's literacy level (19). Currently there are papers that
2 mention problems with the existing concept of eHealth literacy or with measurement methods
3 (20-24). In 2011, Cameron Norman provided a guest editorial for the Journal of Medical
4 Internet Research concerning eHealth literacy. In this editorial he mentioned the problem that
5 the original eHealth literacy concept had been developed for the first generation of eHealth
6 services and thus does not include social media. He reasoned that skills and tasks, including,
7 for example, the confidence in expressing oneself clearly in social interactions online, should
8 be part of a measurement instrument of eHealth literacy (23). Since this editorial paper from
9 2011 there, indeed, has been a lot of work on the topic of eHealth literacy but it remains unclear
10 where the research community in this area is standing at the moment and if the problems with
11 the measurement of such a dynamic concept have been solved.

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

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

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

18 The number of the articles using the concept “eHealth literacy” has risen over the years.

19 Having a closer look at the current literature, several findings are revealed, that are presented
20 below.

21 **Finding No. 1: There is a lot of research that deals with eHealth literacy but 22 uses other terms.**

23 Although eHealth literacy is the term most widely used by authors when they are referring to
24 literacies linked to the use of electronic health services, there are numerous articles that used
25 other terms but probably mean the same thing. This, of course, was expected because the
26 concept of eHealth literacy (or e-health literacy) has been launched quite recently and has been
27 mainly used in the fields of research where the concept of health literacy has a strong
28 background, such as in health sciences. In the fields of research where information literacy,
29 health information literacy, and digital or media literacy are the focus, the concepts relating to
30 them are more popular when speaking about the issues related to eHealth literacy.

1 Other terms used include “Internet health literacy” (25), “e literacy” (26), or “digital health
2 literacy” (27). Other researchers do not state the term “eHealth literacy” but describe
3 combinations of different literacies, such as online health literacy, digital literacy, health
4 literacy (28) or talk just about health literacy or health information literacy, even when they
5 indicate competencies relevant for searching for health information on the Internet (29-32).
6 Furthermore, it must be remembered that there is a lot of research done on the research areas of
7 information seeking and information behavior that do not necessarily use the concept of literacy
8 in the context of seeking, understanding and using online health information.

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

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

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

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

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

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

28 In 2015 Monkman and Kushniruk published the Consumer Health Information System
29 Adoption Model (37). They argued that the consumers’ eHealth literacy level and the demands,
30 which a system has for eHealth literacy are moderating the adoption and the successful use of
31 a consumer-oriented eHealth system. eHealth literacy was placed into context with usability

1 and usefulness of eHealth services and described as a moderating variable between the
2 usefulness and usability of a system and the adoption, value and successful use of it.

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

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

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

20 **Finding No. 3: The eHealth Literacy Scale (eHEALS) was mostly used but**
21 **there are also other measurement approaches.**

22 Mostly the eHealth Literacy Scale (eHEALS) by Norman and Skinner was used (19) to measure
23 the eHealth literacy of diverse study groups. The scale has been translated from English into at
24 least six languages:

- 25 - Italian (38, 39)
- 26 - Chinese (40)
- 27 - Japanese (41)
- 28 - Spanish (42)
- 29 - German (43)
- 30 - Dutch (24)

1 Exploring the literature over the years it is clear that there have been numerous critical voices
2 regarding the eHEALS. In general, Hargittai stated that measurements based on self-assessment
3 show problems of validity (44).

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

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

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

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

1 information. They describe the Health-RRSA as a combination of an electronic survey
2 and an electronic test (52, 53).

- 3 - Ashurst et al criticized eHEALS as a self-assessment tool and used other self-efficiency
4 items. (20).
- 5 - Britt et al used the eHEALS in combination with items from Ajzen’s planned behavior
6 theory (46).
- 7 - Chan et al proposed the combination of the eHealth literacy model and Bloom’s
8 Taxonomy – a classification of intellectual behavior in learning that includes six
9 cognitive process dimensions which differ in regard to their complexity (47, 48).
- 10 - Van der Vaart et al. performed observation studies on how users solved eHealth-related
11 tasks (17, 24). As well as Ashurst et al. they criticized the self-assessment character of
12 eHEALS (20).
- 13 - Chew presented a new eHealth literacy scale based on six components of eHEALS (49).
- 14 - Hanik and Stellefson investigated the perceived and actual eHealth literacy of students
15 using the Research Readiness Self-Assessment (RRSA-h) instrument (51).
- 16 - Stellefson, together with Hanik, Chaney and Tennant, used a Q-technique factor
17 analysis to identify students’ perspectives of personal eHealth search practices and
18 linked it with the participants’ eHealth literacy (57).
- 19 - Jones developed the “Patient eHealth Readiness Scale” (PERQ), which includes
20 competency-related items as well as contextual factors such as Internet use, support by
21 other persons and demographics such as age or gender (54).
- 22 - Most recently Van der Vaart and Drossaert published a new Digital Health Literacy
23 Instrument – the DHLI which takes Health 1.0 as well as interactive Health 2.0 aspects
24 into account (58). This self-assessment tool should be tested in the future among diverse
25 population groups.

26 Overall, it appears that researchers who developed new measurements did not take previous
27 work by other researchers into account. Therefore, currently it appears that the research
28 community in eHealth literacy is providing numerous “stand-alone tools” that are not used or
29 reworked by others.

30 **Finding No. 4: There are several definitions of eHealth literacy.**

31 Norman and Skinner, pioneering in the field of eHealth literacy, provided the definition of
32 eHealth Literacy that is widely used: eHealth literacy is “the ability to seek, find, understand,

1 and appraise health information from electronic sources and apply the knowledge gained to
2 addressing or solving a health problem” (15).

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

5 - Chan and Kaufman: “A set of skills and knowledge that are essential for productive
6 interactions with technology-based health tools” (47).

7 - Koss: “The ability of consumers (directly or with assistance) to use computers and other
8 communication technologies to find, read and understand health information to make
9 personal decisions” (59). It has to be noted that, for us, it was not possible to find the
10 definition Bautista cited in his article on the Internet or elsewhere - the source might
11 have been removed.

12 - Gilstad: “The ability to identify and define a health problem, to communicate, seek,
13 understand, appraise and apply eHealth information and welfare technologies in the
14 cultural, social and situational frame and to use the knowledge critically in order to solve
15 the health problem” (36).

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

19 “eHealth literacy involves the interplay of individual and social factors in the use of
20 digital technologies to search, acquire, comprehend, appraise, communicate and apply
21 health information in all contexts of healthcare with the goal of maintaining or
22 improving the quality of life throughout the lifespan” (59).

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

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

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

- 4 - Knowledge about one's own health
- 5 - Ability to interact with information
- 6 - Ability to engage with technology
- 7 - Access to technologies that work
- 8 - Access to technologies that suit individual needs
- 9 - Feel that using technologies is beneficial
- 10 - Feel in control and secure when using technologies

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

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

24 "eHealth literacy *includes a dynamic and context-specific set of individual and social*
25 *factors as well as technology constraints (such as the fit of a system to a user)* in the
26 use of digital technologies to search, acquire, comprehend, appraise, communicate,
27 *apply and create* health information in all contexts of healthcare with the goal of
28 maintaining or improving the quality of life throughout the lifespan."

1 **Finding No. 5: Most articles on eHealth literacy are patient-/citizen-/user-**
2 **oriented and do not put eHealth literacy in a broader context.**

3 A large part of articles on eHealth literacy describes the measurement of eHealth literacy and
4 most of the articles are strongly consumer-/citizen-/patient-oriented. This means that they
5 measure the literacy of certain groups, to draw conclusions such as working on appropriate
6 education programs for individuals to enhance their eHealth literacy (61), or to better
7 understand factors that lead to the misunderstanding of electronic health information (62).
8 Mostly, the eHealth literacy of students (e.g. (31, 46, 51-53, 61, 63-67)), and patients (e.g. (16,
9 17, 25, 29, 30, 68-75)) have been measured in studies focusing on eHealth literacy. The eHealth
10 literacy of elderly persons has also been investigated (e.g. (69, 76-80)) just like the literacy of
11 adult population groups in general (e.g. (78, 81-85)). The eHealth literacy of parents of ill
12 children was measured in some articles (e.g. (62, 86-88)), and the eHealth literacy level of
13 children has been examined as well (e.g. (28)). Some articles focus on the eHealth competencies
14 of patients regarding genetic testing (e.g. (71, 89)), or they focus on the eHealth literacy of war
15 veterans (e.g. (90)).

16 There might be a lack of theoretical frameworks in studies which regard the measurement of
17 eHealth literacy. Most of them use measurement instruments (mostly the eHealth literacy scale)
18 and draw conclusions. Nevertheless, there is only a weak foundation on theoretical aspects such
19 as the fact that eHealth literacy consists of several sub-literacies as found by Norman and
20 Skinner (15). The finding is supported by the work of Mackert et al. which states that more than
21 90% of all published studies on eHealth literacy or health literacy are not based on theories
22 (91).

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

26 Nevertheless, there are a few articles with a more context-oriented focus on eHealth literacy,
27 such as the paper by Chen and Lee that describes the finding that eHealth literacy has a direct
28 effect on eHealth behavior (64). Another example of more context-oriented work is the paper
29 by Diviani et al. – the authors had a closer look at the relationship between health literacy and
30 the evaluation of online health information (81). Furthermore, Suri et al. found that eHealth
31 literacy was associated with the use of the Internet for obtaining information on a healthy
32 lifestyle (31). Another general approach to see eHealth literacy in a broader context is

1 represented by the paper by Xesfingi and Vozikis, who used a large sample of citizens to explore
2 factors that contribute to their eHealth literacy (92). Klecun, Lichtner and Cornford also
3 explored eHealth literacy in a multi-dimensional way and even provided suggestions for third
4 persons (in this case policy makers and managers) on how to factor the eHealth literacy of
5 citizens in their decisions (26). Monkman and Kushniruk also provided suggestions for third
6 parties by enhancing the online guide on health literacy of the U.S. Department of Health and
7 Human Services (93) by mobile health applications (94). Park, Cormier and Glenna have
8 recently published a study that aimed to link the self-assessed eHealth literacy of citizens to
9 implications on healthcare professionals as to best communicate with their patients (85).

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

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

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

25 Similar to articles in which eHealth literacy was measured, a theoretical background is often
26 missing - also in the field of eHealth literacy interventions (98). Furthermore, there still is the
27 question of how to link measured levels of eHealth literacy to the development of eHealth
28 services. How do we as consumers or information providers benefit from the information on
29 the differences of individual eHealth levels?

1 **Question 2: Which are the research gaps on which the scientific**
2 **community should focus more in the future?**

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

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

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

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

29 Ideas like these are linked only weakly to eHealth literacy articles. One example that, indeed,
30 represents practical guidelines for eHealth developers and considers the user's skill set is the
31 work of the research group of Norgaard, Kayser et al. They provided practical guidance for
32 eHealth designers on how to take eHealth literacy into account by proposing an iterative
33 framework to assess the needs of the users. Developers should therefore design personas of the

1 intended users and follow the seven eHealth literacy domains (knowledge about one’s own
2 health; ability to interact with information; ability to engage with technology; access to
3 technologies that work; access to technologies that suit individual needs; feel that using
4 technologies is beneficial; feel in control and secure when using technologies) (21).

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

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

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

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

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

27 The eHealth literacy community needs to evaluate the existing measurement possibilities and
28 agree on how to measure eHealth literacy in the future.

1 **Gap No. 3 There is only a weak inclusion of medical professionals in the**
2 **measurement and definition of eHealth literacy.**

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

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

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

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

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

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

30 Gilstad provided an extended model in which context plays an important role (36) – this should
31 be taken as the starting point to broaden the understanding of eHealth literacy.

1 **Gap No. 5: eHealth literacy is not the only barrier within the use of eHealth.**

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

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

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

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

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

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

1 “eHealth literacy includes a dynamic and context-specific set of individual and social
2 factors, as well as consideration of technological constraints in the use of digital
3 technologies to search, acquire, comprehend, appraise, communicate, apply and create
4 health information in all contexts of healthcare with the goal of maintaining or
5 improving the quality of life throughout the lifespan.”

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

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

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

25 Last but not least the linkage between the measurement of eHealth literacy and the design of
26 appropriate eHealth solutions is very weak. There is almost no starting point for eHealth
27 designers who might want to take the individual’s eHealth literacy level into account when
28 creating electronic health solutions.

29 To conclude, the research community in eHealth literacy needs to focus on the following
30 aspects in the future:

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

- 1 2. To set a gold standard for measuring eHealth literacy subjectively (and objectively). To
2 take the work of other researchers into account when creating new scales in order to
3 avoid numerous “stand-alone approaches”.
- 4 3. In case of studies that aim at measuring eHealth literacy: To provide clear information
5 on the reasons why the literacy was measured, on the theoretical basis on which the
6 research is taking place and on the handling of the results.
- 7 4. To consider the design of eHealth literacy interventions not only for elderly people but
8 for other user groups as well.
- 9 5. To consider the viewpoints of health professionals and laypersons AND other aspects
10 such as technological constraints as well as to not consider eHealth literacy as isolated
11 from related areas of research such as research on usability or technology acceptance.
- 12 6. To provide a clear guidance for the developers of eHealth services on how to process
13 the different levels of eHealth literacy of their intended users.

14 **Authors' contributions**

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

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1 **Conflicts of Interest**

- 2 We have read and understood the policy on the declaration of interests of Informatics for
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References

1. Eysenbach G. What is e-health? *Journal of medical Internet research*. 2001;3(2):e20.
2. Oh H, Rizo C, Enkin M, Jadad A. What is eHealth: a systematic review of published definitions. *Journal of medical Internet research*. 2005;7(1):e1.
3. Eysenbach G. Consumer health informatics. *Bmj*. 2000;320(7251):1713-6.
4. Holmström I, Röing M. The relation between patient-centeredness and patient empowerment: A discussion on concepts. *Patient education and counseling*. 2010;79(2):167-72.
5. Santana S, Lausen B, Bujnowska-Fedak M, Chronaki C, Prokosch H, Wynn R. Informed citizen and empowered citizen in health: results from an European survey. *BMC Family Practice*. 2011;12(20).
6. Hyppönen H, Faxvaag A, Gilstad H, Hardardottir GA, Jerlvall L, Kangas M, et al. Nordic eHealth Indicators: Organisation of research, first results and the plan for the future. *Ministers CNCO, editor*2013. 119 p.
7. Rooij van T, Marsh S. eHealth: Past and future perspectives. *Personalized Medicine*. 2016;13(1):57-70.
8. van Velsen L, Beaujean DJ, van Gemert-Pijnen JE. Why mobile health app overload drives us crazy, and how to restore the sanity. *BMC Med Inform Decis Mak*. 2013;13:23.
9. Mosa AS, Yoo I, Sheets L. A systematic review of healthcare applications for smartphones. *BMC Med Inform Decis Mak*. 2012;12:67.
10. Chatterjee N. Bridging the Digital Divide: Internet Literacy Training for Outreach and Lay Health Educators. *American Journal of Health Education*. 2002;33(6):368-70.
11. van Dijk JAGM. *The Deepening Divide: Inequality in the Information Society*: SAGE Publications; 2005.
12. Chesser A, Burke A, Reyes J, Rohrberg T. Navigating the digital divide: a systematic review of eHealth literacy in underserved populations in the United States. *Informatics for health & social care*. 2015:1-19.
13. Cotten SR, Gupta SS. Characteristics of online and offline health information seekers and factors that discriminate between them. *Social science & medicine (1982)*. 2004;59(9):1795-806.
14. Lustria ML, Smith SA, Hinnant CC. Exploring digital divides: an examination of eHealth technology use in health information seeking, communication and personal health information management in the USA. *Health Informatics J*. 2011;17(3):224-43.
15. Norman CD, Skinner HA. eHealth Literacy: Essential Skills for Consumer Health in a Networked World. *Journal of Medical Internet Research*. 2006;8(2):e9.
16. Noblin A, Wan T, Fottler M. The Impact of Health Literacy on a Patient's Decision to Adopt a Personal Health Record. *Perspectives in Health Information Management*. 2012;Fall(9 (Fall)): 1e).
17. van der Vaart R, Drossaert CH, de Heus M, Taal E, van de Laar MA. Measuring actual eHealth literacy among patients with rheumatic diseases: a qualitative analysis of problems encountered using Health 1.0 and Health 2.0 applications. *J Med Internet Res*. 2013;15(2):e27.
18. U.S. Department of Health and Human Services OoDPaHP. *Health literacy online: A guide to writing and designing easy-to-use health Web sites*. Washington, DC: 2010.
19. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. *J Med Internet Res*. 2006;8(4):e27.
20. Ashurst EJ, Jones RB, Williamson GR, Emmens T, Perry J. Collaborative learning about e-health for mental health professionals and service users in a structured anonymous online short course: pilot study. *Bmc Medical Education*. 2012;12.
21. Kayser L, Kushniruk A, Osborne RH, Norgaard O, Turner P. Enhancing the Effectiveness of Consumer-Focused Health Information Technology Systems Through eHealth Literacy: A Framework for Understanding Users' Needs. *JMIR human factors*. 2015;2(1):e9.
22. Norgaard O, Furstrand D, Klokker L, Karnoe A, Batterham R, Kayser L, et al. The e-health literacy framework: A conceptual framework for characterizing e-health users and their interaction with e-health systems. *Knowledge Management and e-Learning*. 2015;7(4):522-40.

- 1 23. Norman C. eHealth literacy 2.0: problems and opportunities with an evolving concept. *J Med*
2 *Internet Res.* 2011;13(4):e125.
- 3 24. van der Vaart R, van Deursen AJ, Drossaert CH, Taal E, van Dijk JA, van de Laar MA. Does the
4 eHealth Literacy Scale (eHEALS) measure what it intends to measure? Validation of a Dutch version
5 of the eHEALS in two adult populations. *J Med Internet Res.* 2011;13(4):e86.
- 6 25. Robinson C, Graham J. Perceived Internet health literacy of HIV-positive people through the
7 provision of a computer and Internet health education intervention. *Health information and libraries*
8 *journal.* 2010;27(4):295-303.
- 9 26. Klecun E, Lichtner V, Cornford T. e-Literacy in health care. *Stud Health Technol Inform.*
10 2014;205:843-7.
- 11 27. Mein E, Fuentes B, Soto Mas F, Muro A. Incorporating digital health literacy into adult ESL
12 education on the US-Mexico border. *Rhetoric, professional communication, and globalization.*
13 2012;3(1):162-74.
- 14 28. Hernán-García M, Botello-Díaz B, Marcos-Marcos J, Toro-Cárdenas S, Gil-García E.
15 Understanding children: a qualitative study on health assets of the Internet in Spain. *International*
16 *Journal of Public Health.* 2015;60(2):239-47.
- 17 29. Bidmon S, Terlutter R. Gender Differences in Searching for Health Information on the
18 Internet and the Virtual Patient-Physician Relationship in Germany: Exploratory Results on How Men
19 and Women Differ and Why. *Journal of Medical Internet Research.* 2015;17(6).
- 20 30. Bidmon S, Terlutter R, Rottl J. What explains usage of mobile physician-rating apps? Results
21 from a web-based questionnaire. *J Med Internet Res.* 2014;16(6):e148.
- 22 31. Suri VR, Majid S, Chang YK, Foo S. Assessing the influence of health literacy on health
23 information behaviors: A multi-domain skills-based approach. *Patient Education and Counseling.*
24 2016;99(6):1038-45.
- 25 32. Niemelä R, Ek S, Eriksson-Backa K, Huotari M-L. A screening tool for assessing everyday
26 health information literacy. *Libri: International Journal of Libraries and Information Services.*
27 2012;62(2):125-34.
- 28 33. Xie B. Effects of an eHealth literacy intervention for older adults. *J Med Internet Res.*
29 2011;13(4):e90.
- 30 34. Griebel L, Sedlmayr B, Prokosch HU, Criegee-Rieck M, Sedlmayr M. Key factors for a
31 successful implementation of personalized e-health services. *Stud Health Technol Inform.*
32 2013;192:965.
- 33 35. Venkatesh V, Morris MG, Gordon BD, Davis FD. User Acceptance of Information Technology:
34 Toward a Unified View. *MIS Quarterly.* 2003;27(3):425-78.
- 35 36. Gilstad H, editor Toward a comprehensive model of eHealth literacy. *CEUR Workshop*
36 *Proceedings; 2014.*
- 37 37. Monkman H, Kushniruk AW. The Consumer Health Information System Adoption Model. *Stud*
38 *Health Technol Inform.* 2015;218:26-31.
- 39 38. De Caro W, Corvo E, Marucci AR, Mitello L, Lancia L, Sansoni J. eHealth Literacy Scale: An
40 Nursing Analysis and Italian Validation. *Stud Health Technol Inform.* 2016;225:949.
- 41 39. Diviani N, Schulz PJ. Validation of an Italian Version of the eHEALTH Literacy Scale (I-EHEALS).
42 *Medicine 20: World Congress on Social Media, Mobile Apps, Internet/Web 20; Malaga, Spain 2014.*
- 43 40. Koo M, Norman CD, Chang H-M. Psychometric Evaluation of a Chinese Version of the eHealth
44 Literacy Scale (eHEALS) in School Age Children. *International Electronic Journal of Health Education.*
45 2012;15:29-36.
- 46 41. Mitsutake S, Shibata A, Ishii K, Okazaki K, Oka K. [Developing Japanese version of the eHealth
47 Literacy Scale (eHEALS)]. [*Nihon koshu eisei zasshi*] Japanese journal of public health. 2011;58(5):361-
48 71.
- 49 42. Paramio Perez G, Almagro BJ, Hernando Gomez A, Aguaded Gomez JI. [Validation of the
50 eHealth Literacy Scale (eHEALS) in Spanish University Students]. *Revista española de salud pública.*
51 2015;89(3):329-38.

- 1 43. Soellner R, Huber S, Reder M. The concept of eHealth literacy and its measurement: German
2 translation of the eHEALS. *Journal of Media Psychology*. 2014;26(1):29-38.
- 3 44. Hargittai E. Survey Measures of Web-Oriented Digital Literacy. *Social Science Computer*
4 *Review*. 2005;23(3):371-9.
- 5 45. Paige SR, Krieger JL, Stelfefon ML. The Influence of eHealth Literacy on Perceived Trust in
6 Online Health Communication Channels and Sources. *Journal of health communication*. 2016:1-13.
- 7 46. Britt RK, Collins WB, Wilson KM, Linnemeier G, Englebert AM. The Role of eHealth Literacy
8 and HPV Vaccination Among Young Adults: Implications from a Planned Behavior Approach.
9 *Communication Research Reports*. 2015;32(3):208-15.
- 10 47. Chan CV, Kaufman DR. A framework for characterizing eHealth literacy demands and barriers.
11 *J Med Internet Res*. 2011;13(4):e94.
- 12 48. Chan CV, Matthews LA, Kaufman DR. A taxonomy characterizing complexity of consumer
13 eHealth Literacy. *AMIA Annual Symposium proceedings / AMIA Symposium AMIA Symposium*.
14 2009;2009:86-90.
- 15 49. Chew F. Developing a New Scale to Measure E-Health Literacy. *Medicine 20 World Congress*
16 *on Social Media, Mobile Apps, Internet / Web 202014*.
- 17 50. Furstrand D, Kayser L. Development of the eHealth Literacy Assessment Toolkit, eHLA. *Stud*
18 *Health Technol Inform*. 2015;216:971.
- 19 51. Hanik B, Stelfefon M. E-Health Literacy Competencies among Undergraduate Health
20 Education Students: A Preliminary Study. *International Electronic Journal of Health Education*.
21 2011;14:46-58.
- 22 52. Ivanitskaya L, Brookins-Fisher J, I OB, Vibbert D, Erofeev D, Fulton L. Dirt cheap and without
23 prescription: how susceptible are young US consumers to purchasing drugs from rogue internet
24 pharmacies? *J Med Internet Res*. 2010;12(2):e11.
- 25 53. Ivanitskaya L, O'Boyle I, Casey AM. Health Information Literacy and Competencies of
26 Information Age Students: Results From the Interactive Online Research Readiness Self-Assessment
27 (RRSA). *J Med Internet Res*. 2006;8(2):e6.
- 28 54. Jones R. Development of a Questionnaire and Cross-Sectional Survey of Patient eHealth
29 Readiness and eHealth Inequalities. *Medicine 20*. 2013;2(2):e9.
- 30 55. Koopman RJ, Petroski GF, Canfield SM, Stuppy JA, Mehr DR. Development of the PRE-HIT
31 instrument: patient readiness to engage in health information technology. *BMC family practice*.
32 2014;15:18.
- 33 56. Seckin G, Yeatts D. Being an Informed Consumer of Health Information and Assessment of
34 Electronic Health Literacy in a National Sample of Internet Users: Validity and Reliability of the e-HLS
35 Instrument. 2016;18(7):e161.
- 36 57. Stelfefon M, Hanik B, Chaney JD, Tennant B. Analysis of ehealth search perspectives among
37 female college students in the health professions using Q methodology. *J Med Internet Res*.
38 2012;14(2):e60.
- 39 58. van der Vaart R, Drossaert C. Development of the Digital Health Literacy Instrument:
40 Measuring a Broad Spectrum of Health 1.0 and Health 2.0 Skills. *J Med Internet Res*. 2017;19(1):e27.
- 41 59. Bautista JR. From solving a health problem to achieving quality of life: redefining eHealth
42 literacy. *Journal of Literacy and Technology*. 2015;16(2).
- 43 60. Framework for Information Literacy for Higher Education 2016 [Available from:
44 <http://www.ala.org/acrl/standards/ilframework>.
- 45 61. Park H, Lee E. Self-reported eHealth literacy among undergraduate nursing students in South
46 Korea: A pilot study. *Nurse education today*. 2015;35(2):408-13.
- 47 62. Knapp C, Madden V, Wang H, Sloyer P, Shenkman E. Internet use and eHealth literacy of low-
48 income parents whose children have special health care needs. *J Med Internet Res*. 2011;13(3):e75.
- 49 63. Brown CA, Dickson R. Healthcare students' e-literacy skills. *Journal of allied health*.
50 2010;39(3):179-84.
- 51 64. Chen W, Lee KH. More than search? Informational and participatory eHealth behaviors.
52 *Computers in Human Behavior*. 2014;30:103-9.

- 1 65. Notari M, Sobko T, Churchill D, editors. Personal biometric information from wearable
2 technology tracked and followed using an ePortfolio: A case study of eHealth literacy development
3 with emerging technology in Hong Kong higher education. Proceedings of the 12th International
4 Conference on Mobile Learning 2016; 2016.
- 5 66. Park H, Park H. eHealth Literacy Skills Among Undergraduate Nursing Students in the U.S. and
6 South Korea. *Stud Health Technol Inform*. 2016;225:899-900.
- 7 67. Robb M, Shellenbarger T. Influential factors and perceptions of eHealth literacy among
8 undergraduate college students. *Online Journal of Nursing Informatics*. 2014;18(3):1-.
- 9 68. Duplaga M. A cross-sectional study assessing determinants of the attitude to the introduction
10 of eHealth services among patients suffering from chronic conditions. *Bmc Medical Informatics and
11 Decision Making*. 2015;15.
- 12 69. Emmerton LM, Aponte J, Nokes KM. Electronic health literacy of older Hispanics with
13 diabetes. *J Med Internet Res*. 2015.
- 14 70. Hu Y, Haake J. Search your way to an accurate diagnosis: Predictors of Internet-based
15 diagnosis accuracy. *Atlantic Journal of Communication*. 2010;18(2):79-88.
- 16 71. Mills R, Powell J, Barry W, Haga SB. Information-Seeking and Sharing Behavior Following
17 Genomic Testing for Diabetes Risk. *Journal of Genetic Counseling*. 2015;24(1):58-66.
- 18 72. Ossebaard HC, Seydel ER, van Gemert-Pijnen L. Online usability and patients with long-term
19 conditions: a mixed-methods approach. *International journal of medical informatics*. 2012;81(6):374-
20 87.
- 21 73. Milne RA, Puts MT, Papadakos J, Le LW, Milne VC, Hope AJ, et al. Predictors of High eHealth
22 Literacy in Primary Lung Cancer Survivors. *Journal of cancer education : the official journal of the
23 American Association for Cancer Education*. 2015;30(4):685-92.
- 24 74. Bakken S, Fiscella K, Boyd M, Brown J, Carroll J, Cassells A, et al. Activation of persons living
25 with HIV for treatment, the great study. *J Med Internet Res*. 2015;15:1056.
- 26 75. Hennemann S, Beutel ME, Zwerenz R. Drivers and Barriers to Acceptance of Web-Based
27 Aftercare of Patients in Inpatient Routine Care: A Cross-Sectional Survey. *J Med Internet Res*.
28 2016;18(12):e337.
- 29 76. Choi NG, Dinitto DM. The digital divide among low-income homebound older adults: Internet
30 use patterns, eHealth literacy, and attitudes toward computer/Internet use. *J Med Internet Res*.
31 2013;15(5):e93.
- 32 77. Manafò E, Wong S. Assessing the eHealth Literacy Skills of Older Adults: A Preliminary Study.
33 *Journal of Consumer Health on the Internet*. 2012;16(4):369-81.
- 34 78. Tennant B, Stellefson M. eHealth Literacy and Web 2.0 Health Information Seeking Behaviors
35 Among Baby Boomers and Older Adults. *Journal of Medical Internet Research* 2015;17(3):e70.
- 36 79. Watkins I, Xie B. The effects of jigsaw-and constructive controversy-based collaborative
37 learning strategies on older adults' eHealth literacy. *Gerontechnology*. 2013;12(1):44-54.
- 38 80. Zibrik L, Khan S, Bangar N, Stacy E, Novak Lauscher H, Ho K. Patient and community centered
39 eHealth: Exploring eHealth barriers and facilitators for chronic disease self-management within
40 British Columbia's immigrant Chinese and Punjabi seniors. *Health Policy and Technology*.
41 2015;4(4):348-56.
- 42 81. Diviani N, van den Putte B, Meppelink CS, van Weert JC. Exploring the role of health literacy
43 in the evaluation of online health information: Insights from a mixed-methods study. *Patient
44 education and counseling*. 2016;99(6):1017-25.
- 45 82. Kim SH, Son YJ. Relationships Between eHealth Literacy and Health Behaviors in Korean
46 Adults. *CIN - Computers Informatics Nursing*. 2016.
- 47 83. Mitsutake S, Shibata A. Associations of eHealth Literacy With Health Behavior Among Adult
48 Internet Users. *Journal of Medical Internet Research*. 2016;18(7):e192.
- 49 84. Mitsutake S, Shibata A, Ishii K, Oka K. Association of eHealth Literacy With Colorectal Cancer
50 Knowledge and Screening Practice Among Internet Users in Japan. *J Med Internet Res*.
51 2012;14(6):e153.

- 1 85. Park H, Cormier E, Glenna G. Health Consumers eHealth Literacy to Decrease Disparities in
2 Accessing eHealth Information. *Stud Health Technol Inform.* 2016;225:895-6.
- 3 86. Knapp C, Madden V, Marcu M, Wang H, Curtis C, Sloyer P, et al. Information seeking
4 behaviors of parents whose children have life-threatening illnesses. *Pediatric blood & cancer.*
5 2011;56(5):805-11.
- 6 87. Manganello JA, Falisi AL, Roberts KJ, Smith KC, McKenzie LB. Pediatric injury information
7 seeking for mothers with young children: The role of health literacy and ehealth literacy. *Journal of*
8 *Communication in Healthcare.* 2016:1-9.
- 9 88. Kasparian NA, Lieu N, Winlaw DS, Cole A, Kirk E, Sholler GF. eHealth literacy and preferences
10 for eHealth resources in parents of children with complex CHD. *Cardiology in the young.* 2016:1-9.
- 11 89. Yee LM, Wolf M, Mullen R, Bergeron AR, Cooper Bailey S, Levine R, et al. A randomized trial
12 of a prenatal genetic testing interactive computerized information aid. *Prenatal Diagnosis.*
13 2014;34(6):552-7.
- 14 90. Whealin JM, Jenchura EC, Wong AC, Zulman DM. How Veterans With Post-Traumatic Stress
15 Disorder and Comorbid Health Conditions Utilize eHealth to Manage Their Health Care Needs: A
16 Mixed-Methods Analysis. *J Med Internet Res.* 2016;18(10):e280.
- 17 91. Mackert M, Champlin SE, Holton A, Muñoz II, Damásio MJ. eHealth and Health Literacy: A
18 Research Methodology Review. *Journal of Computer-Mediated Communication.* 2014;19(3):516-28.
- 19 92. Xesfingi S, Vozikis A. eHealth Literacy: In the Quest of the Contributing Factors. *Interactive*
20 *journal of medical research.* 2016;5(2):e16.
- 21 93. Health literacy online: A guide to writing and designing easy-to-use health Web sites2010.
22 Available from: http://www.health.gov/healthliteracyonline/Web_Guide_Health_Lit_Online.pdf.
- 23 94. Monkman H, Kushniruk A. A health literacy and usability heuristic evaluation of a mobile
24 consumer health application. *Stud Health Technol Inform.* 2013;192:724-8.
- 25 95. Watkins I, Xie B. Designing a web-based interactive eHealth literacy tutorial for an older
26 adult-oriented intervention. *Gerontechnology.* 2014;13(2):303.
- 27 96. Xie B. Experimenting on the Impact of Learning Methods and Information Presentation
28 Channels on Older Adults' e-Health Literacy. *J Am Soc Inf Sci Technol.* 2011;62(9):1797-807.
- 29 97. Xie B, Yeh T, Walsh G, Watkins I, Huang M, editors. Co-designing an e-health tutorial for older
30 adults. *ACM International Conference Proceeding Series;* 2012.
- 31 98. Watkins I, Xie B. eHealth literacy interventions for older adults: a systematic review of the
32 literature. *J Med Internet Res.* 2014;16(11):e225.
- 33 99. Manafò E, Wong S. eSEARCH©: A Tool to Promote the eHealth Literacy Skills of Older Adults.
34 *Journal of Consumer Health on the Internet.* 2013;17(3):255-71.
- 35 100. Manafò E, Wong S. Promoting eHealth literacy in older adults: Key informant perspectives.
36 *Canadian Journal of Dietetic Practice and Research.* 2013;74(1):37-41.
- 37 101. Hibbard JH, Mahoney ER, Stock R, Tusler M. Do increases in patient activation result in
38 improved self-management behaviors? *Health services research.* 2007;42(4):1443-63.
- 39 102. Holman H, Lorig K. Patients as partners in managing chronic disease2000 2000-02-26
40 08:00:00. 526-7 p.
- 41 103. Mosen DM, Schmittiel J, Hibbard J, Sobel D, Remmers C, Bellows J. Is patient activation
42 associated with outcomes of care for adults with chronic conditions? *The Journal of ambulatory care*
43 *management.* 2007;30(1):21-9.
- 44 104. Ricciardi L, Mostashari F, Murphy J, Daniel JG, Siminerio EP. A national action plan to support
45 consumer engagement via e-health. *Health affairs (Project Hope).* 2013;32(2):376-84.
- 46 105. Roett MA, Wessel L. Help your patient "get" what you just said: a health literacy guide. *The*
47 *Journal of family practice.* 2012;61(4):190-6.
- 48 106. Enwald H. Tailoring health communication: the perspective of information users' health
49 information behaviour in relation to their physical health status. [doctoral dissertation]. Oulu: Acta
50 *Universitatis Ouluensis;* 2013.
- 51 107. GASEL project: Final Report. Oulu, Finland: University of Oulu, 2016.

- 1 108. Clarke MA, Belden JL, Koopman RJ, Steege LM, Moore JL, Canfield SM, et al. Information
2 needs and information-seeking behaviour analysis of primary care physicians and nurses: a literature
3 review. *Health information and libraries journal*. 2013;30(3):178-90.
- 4 109. Younger P. Internet-based information-seeking behaviour amongst doctors and nurses: a
5 short review of the literature. *Health information and libraries journal*. 2010;27(1):2-10.
- 6 110. Griebel L, Kolominsky-Rabas P, Schaller S, Siudyka J, Sierpinski R, Papapavlou D, et al.
7 Acceptance by laypersons and medical professionals of the personalized eHealth platform,
8 eHealthMonitor. *Informatics for health & social care*. 2016:1-18.
- 9 111. MacLure K, Stewart D. Self-Reported Digital Literacy of the Pharmacy Workforce in North
10 East Scotland. *Pharmacy*. 2015;3:182-96.
- 11 112. MacLure K, Stewart D. Digital literacy knowledge and needs of pharmacy staff: a systematic
12 review. *Journal of innovation in health informatics*. 2016;23(3):560-71.
- 13 113. Ahmed S. mHealth Literacy: Characterizing people's ability to use smartphone-based health-
14 related applications [doctoral dissertation]. Champaign, Illinois: University of Illinois at Urbana-
15 Champaign; 2015.
- 16 114. Davis FD, Bagozzi RP, Warshaw PR. User Acceptance Of Computer Technology: A Comparison
17 Of Two Theoretical Models. *Management Science*. 1989;35(8):982-1003.
- 18 115. Venkatesh V, Bala H. Technology Acceptance Model 3 and a Research Agenda on
19 Interventions. *Decision Sciences* 2008;39(2):273-315.
- 20 116. Venkatesh V, Davis FD. A theoretical extension of the Technology Acceptance Model: Four
21 longitudinal field studies. *Manage Sci* 2000;46(2):186-204.
- 22 117. Fishbein M, Ajzen I. *Belief, Attitude, Intention and Behavior: An Introduction to Theory and
23 Research*. Reading, MA1975.
- 24 118. Compeau D, Higgins C. Application of social cognitive theory to training for computer skills.
25 *Inform Syst Res*. 1995;6(2):118-43.
- 26 119. Mohamed AHM, Tawfik H, Norton L, Al-Jumeily D, editors. e-HTAM: A Technology
27 Acceptance Model for electronic health. *Innovations in Information Technology (IIT)*, 2011
28 International Conference on; 2011 25-27 April 2011.
- 29 120. Ahadzadeh AS, Pahlevan Sharif S, Ong FS, Khong KW. Integrating Health Belief Model and
30 Technology Acceptance Model: An Investigation of Health-Related Internet Use. *Journal of medical
31 Internet research*. 2015;17(2):e45.
- 32 121. Smith S, Curtis L, Wardle J, von Wagner C, Wolf M. Skill Set or Mind Set? Associations
33 between Health Literacy, Patient Activation and Health. *PLoS ONE*. 2013;8(9):e74373.
- 34 122. Enwald H, Hirvonen N, Huotari M, Korpelainen R, Pyky R, Savolainen M, et al. Everyday health
35 information literacy among young men compared with adults with high risk for metabolic syndrome
36 – a cross-sectional population-based study. *Journal of Information Science*. 2016;42(3):344-55.

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