Perceived eHealth Literacy vis-a-vis Information Search Outcome: A Quasi-Experimental Study

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ABSTRACT

Based on self-efficacy theory, our study investigated the relationship between perceived eHealth literacy and information search outcome. Information search outcome was measured by knowledge gained and the change in confidence level. We developed two hypotheses suggesting that high perceived eHealth literacy participants will gain more knowledge and become more confident in their post-search answers. A quasi-experimental study was conducted. 17 participants each from high and low perceived eHealth literacy groups used Google search engine to search for three topics, each with three factual questions. The results showed that both perceived eHealth literacy groups were able to find the correct answers, but only high perceived eHealth literacy participants were more confident in their search outcome. The finding corroborates the positive relationship between efficacy and outcome expectations in self-efficacy theory.

CCS CONCEPTS

• **Human-centered computing**; • **Human computer interaction (HCI)**; • **HCI design and evaluation methods**; • **User studies**;

KEYWORDS

eHealth literacy, self-efficacy theory, outcome expectation, information search outcome, online health information

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1 INTRODUCTION

Health consumers are relying on Internet search engines to access online health information, make medical decisions, diagnose themselves, and consult with healthcare professionals about the information they found [1, 2]. With the autonomy to search health information freely, consumers are more in control of their health conditions, which can positively improve their health and increase involvement in medical decisions [3]. Nevertheless, the quality of online health information is still concerning and can vary depending on the source [4]. Trusting and using low quality online information may lead to detrimental health outcome.

Using health misinformation can cause negative consequences on multiple levels [5]. Without the appropriate knowledge and skills to evaluate health information, misinformation may arouse consumers' emotional state and increase their anxiety and fear (internal level), also known as cyberchondria [6]. The relationship between patient-clinician can deteriorate (interpersonal level) and patients may even postpone a clinical encounter (service-related level) [5]. Another troubling aspect of using false health information is that it can be easily underreported in studies. Relying on self-report, health consumers may not realize they are harmed by the found information [7]. To protect health consumers from being victimized by online information search, it is essential that consumers learn how to find, evaluate, and use online health information.

Electronic health literacy (eHealth literacy) originated from self-efficacy theory [8] and is defined 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" [9]. Based on this definition, consumers with different levels of eHealth literacy should behave differently when performing online information search. Nevertheless, there has not been much research investigating the effect of eHealth literacy on information search behaviors and related search outcome. To bridge this gap, this study applies self-efficacy theory [8] and focuses on reporting the relationship between perceived eHealth literacy and information search outcome.

2 RELATED WORK

2.1 Self-Efficacy Theory

Self-efficacy is an individual's belief in their ability to perform certain behaviors. Behaviors that can potentially lead to positive outcome are more likely to happen if individuals are confident in their behavioral skills. Higher efficacy expectation might lead to greater outcome expectations, that is an individual's confidence about certain outcome is expected to result from successful behaviors and task completion. Self-efficacy theory [8] thus emphasizes that cognitive process plays a prominent role in acquisition and retention of behaviors.

The essence of eHealth literacy is one's perceived ability to perform a series of information search actions to improve health outcome. Human behavior is seen as an influential factor that bridges one's cognitive thoughts and health outcome. Given that the original concept of eHealth literacy is derived from self-efficacy theory

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[10], self-efficacy theory serves as the backbone in our investigation of the effect of perceived eHealth literacy on information search outcome. The relationships of information behaviors with perceived eHealth literacy and information search outcome are also studied [11] but not reported in this paper.

2.2 eHealth Literacy

With online resources and technologies becoming the major sources of health information, consumers need to expand and learn new skills to interact with online health information. Norman and Skinner thus propose an updated concept of health literacy [9] – eHealth literacy. Their Lily model explains six fundamental skills in eHealth literacy [9]. Traditional literacy refers to the ability to read, speak, write, and understand language. Media literacy is the ability to process the meaning of media content and recognizing that media shapes messages according to social and political agendas. Information literacy refers to the ability to organize, find, and use information. Computer literacy refers to the knowledge required to use digital technologies to solve problems. Scientific literacy is the knowledge of understanding the nature of scientific knowledge, methods, reasoning, terminology, and applying knowledge in daily life. Lastly, health literacy is the ability to understand health information and make related decisions.

The eHealth Literacy Scale (eHEALS) [10], which consists of eight items, has been the most frequently used scale to measure eHealth literacy [12]. The scale contains three factors related to online information search: *awareness* of available resources, *skills* needed to access information, and the ability to *evaluate* information [13, 14]. eHEALS has high level of internal consistency [15, 16]. It also has been translated into many languages with positive psychometric results [17-19].

Studies have investigated the effect of eHealth literacy on information search behaviors. One found that consumers with high and low eHealth literacy evaluated information from various sources differently [20]. Their reading and scanning patterns also varied when evaluating webpages [21]. People with low health literacy were found to have difficulty recalling information after viewing webpages [22]. These studies show that self-efficacy can impact information search behaviors. However, they did not take information search outcome into consideration.

2.3 Information Search Outcome

In Information Science, the term "search outcome" can be ambiguous as, historically, studies treat outcome as the product of an information retrieval system, measured by, for example, precision and recall [23]. Search outcome can also be viewed as a user's search outcome, or in a broader sense, "information use". Information search outcome can either be conceptual or instrumental information use [24]. Conceptual outcome are the changes of users' knowledge. Instrumental outcome are the tangible changes in applying information to action.

Only a few studies have compared perceived eHealth literacy and search outcome by having participants conduct search tests [25, 26]. Search tests are tasks generated by researchers, where each task tests different skills required to accomplishing task goals. However, not all tasks were about online information search. For instance, a few tasks in [26] were about operating an electronic medical record system and generating content online. Most tasks in [25] provided step-by-step guidance for participants to follow and did not test user's search behavior. Furthermore, those studies mostly focused on behavioral outcome instead of user's information use. Search outcome was measured, for example, as task completion rate, completion time, number of assistances given, and observation score rated by researchers. Overall, little research has been conducted to investigate the relationship between perceived eHealth literacy and information search outcome.

3 HYPOTHESES

Informed by self-efficacy theory [8] and existing literature, we conducted a quasi-experimental study to investigate the effects of perceived eHealth literacy on information search outcome. We specifically focused on conceptual information search outcome, which referred to acquiring knowledge to satisfy information need [24]. Therefore, one of the included variables was "knowledge gained". Additionally, as explained by self-efficacy theory, individuals formed expected beliefs of the outcome after performing certain behaviors. As a result, another variable we considered was participants' change in the "confidence level" from before to after a search. Based on the definition of eHealth literacy, eHealth literate consumers should be more skilled at searching online health information and better at producing search outcome. As a result, we proposed two hypotheses:

H1: High perceived eHealth literacy consumers' knowledge gained is greater than low perceived eHealth literacy consumers after online health information search.

H2: High perceived eHealth literacy consumers are more confident in their found answer than low perceived eHealth literacy consumers after online health information search.

4 METHOD

4.1 Participants

34 participants took part in the study (Table 1), 17 each from low and high perceived eHealth literacy group (measured through eHEALS). Extreme groups sampling method was implemented to increase the sample variability [27]. Participants were divided into two perceived eHealth literacy groups. Participants were recruited through the university' mailing system, social networking sites, snowball sampling, and handing out flyers around campus. After respondents filled out the pre-screening survey, 119 respondents met the recruiting criteria. Based on the number of eligible respondents and their eHEALS score, a tertile split was performed to divide them into three perceived eHealth literacy groups: low (N = 39, eHEALS score range: 1.75 to 3.5), medium (N = 46, score range: 3.625 to 4), and high (N= 34, score range: 4.125 to 5). Only 17 respondents in the low and high perceived eHealth literacy groups were contacted.

Participants' age range was between 20-60 years old. Older adults were not considered as they tend to have lower eHealth literacy [28]. Participants were required to be native English speakers with at least high school education, normal or corrected vision (due to the use of eye-tracker – this data is not reported in this paper), and not be diagnosed with any of the three health conditions used in the study search tasks. Students or professionals from fields related to

Table 1: Participants' demographic characteristics

	High eHealth	Low eHealth	All
eHEALS (SD)	4.5 (0.3)	3.1 (0.4) *	3.8 (0.8)
Age (SD)	31.8 (13.2)	23.9 (7.5)	27.8 (11.3)
Gender			
Female	12	8	20 (59%)
Male	5	8	13 (28%)
Non-binary	0	1	1 (3%)
Education level			
High school	4	10	14 (41%)
Bachelor's degree	6	4	10 (29%)
Master's degree	6	3	9 (27%)
Doctoral degree	1	0	1 (3%)
Racial group			
Asian	2	4	6 (17%)
Caucasian/White	10	8	18 (53%)
Hispanic/Latinx	3	3	6 (18%)
Mixed	2	2	4 (12%)

* Average eHEALS score in past studies ranged from 3.72 – 4.0 [31, 32]. Range of scores for high and low groups were 4.125 – 5 and 2.125 – 3.625, respectively.

medicine or healthcare were excluded as they tend to have higher eHealth literacy [29, 30].

4.2 Tasks

Participants were asked to conduct one training task and three simulated tasks in random order; each task contained three questions. The simulated tasks were factual search tasks. Factual task was selected because they have a definite answer and help avoid ambiguity of assessing search outcome (knowledge gained). The four health topics were schizophrenia (training task), Ebola virus, hepatitis, and HIV prevention (Table 2).

The search topics and questions were selected and designed from the most searched diseases and conditions listed on the Centers for Disease Control and Prevention (CDC) website. Originally each task topic had 5 questions. To select questions that were less well-known (higher discernibility), all questions were tested by 150 Amazon Mechanical Turk workers. The three questions that had the lowest accuracy rate for each topic were then chosen to be included in the study.

4.3 Measurement

eHEALS was used to measure eHealth literacy [10] in the pre-screening survey. The scale consists of eight items measured on a 5-point Likert scale, with higher scores indicating higher eHealth literacy levels. The score was averaged across the eight items.

For information search outcome, participants were asked to answer the question in an open-ended format and rate the confidence of their answer on a four-point scale before (pretest) and after (posttest) each search. The accuracy of their responses was scored as 2 for accurate response, 1 for partially accurate response or 0 for inaccurate response. YSC assessed the responses. A four-point scale was selected to measure confidence level, enforcing participants to select a positive or negative but not neutral attitude toward their answers. Knowledge gained and confidence level were calculated as score difference by subtracting pretest from posttest score. The score of those two variables were averaged across all questions per participant for data analysis.

4.4 Procedure

When participants arrived at the lab, they first learned about the purpose and procedure of the study and then signed the consent form. The experiment was conducted by using iMotions software[1]. Participants performed a training task to guide them through the procedure. Then they performed the three search tasks. The order of the tasks and questions was randomized. For each search task, participants first read the task scenario and the first question. Participants then answered the question and rated their confidence level of their answer on Qualtrics survey. Then participants started searching for the factual information by using Google search engine. When participants completed the search and closed the webpage, another Qualtrics survey was shown and asked them to enter the answer they found and rate their confidence level again. Afterward, participant continued searching for the next question. Thus, the three questions were presented one at a time instead of showing them at once. The reason was to avoid having participants accidentally encounter relevant information without explicitly conducting the search. After completing the three questions, participants then moved on to the next search task. Search history was not recorded

[1] www.imotions.com

Table 2: An example of the task scenarios and questions

Topic	Scenario & Questions	Source
Hepatitis	Imagine a friend of yours was recently diagnosed with hepatitis A. You are worried about your friend and want to learn more about hepatitis regarding the following questions: 1. Which form of hepatitis can be passed on through contaminated food or water? 2. Which form of hepatitis can exist for years without symptoms? 3. Vaccines have been developed to protect against which hepatitis viruses? You want to answer these questions, so you decide to find information through Google.	[33, 34]

in the browser, thus did not affect other participants' search experience. Upon completion of the study, which lasted 1 hour, participants received a $25 value e-gift card and an information sheet that contained the correct answers to the questions.

5 RESULTS

Nearly all participants did not know the answer to the questions before the search. There were only 5 instances where participants answered the question correctly or partially correctly before the search (2 from low and 3 from high eHealth literacy group).

5.1 Knowledge Gained

Unpaired two-samples Wilcoxon test was performed to analyze the effect of perceived eHealth literacy on knowledge gained as the data was not normally distributed (Shapiro-Wilk normality test p-value = 0.01). The result showed that perceived eHealth literacy did not have a significant effect on knowledge gained ($p = 0.35$), indicating that high (median = 1.78) and low (median = 1.67) perceived eHealth literacy participants did not differ in their ability to find answers to the questions. H1 was not supported.

5.2 Confidence Changes

Unpaired two-sample t-test was performed to analyze the effect of perceived eHealth literacy on confidence level (Shapiro-Wilk normality test p-value = 0.12). The result showed that perceived eHealth literacy had a significant effect on confidence level ($t = 2.18$, $df = 32$, $p < 0.05$): high perceived eHealth literacy participants ($M = 3.62$, $SD = 0.28$) were more confident in their submitted answer after the search compared to low perceived eHealth literacy participants ($M = 3.37$, $SD = 0.38$). The effect size was 0.75 (Cohen's d). As a result, H2 was supported.

6 DISCUSSION

We adapted self-efficacy theory [8] and investigated how perceived eHealth literacy (efficacy expectation) affected information search outcome (outcome expectation). Our study contributes to the literature by focusing on the relationship between these two variables in the context of online information search. The findings show that although high and low perceived eHealth literacy participants were both able to find the correct answers to factual questions, only high perceived eHealth literacy participants were more confident in their search outcome.

The insignificant results shown on knowledge gained can be explained by the design of the tasks. In Neter and Brainin's study [25], the tasks were designed based on different levels of skill complexity: accessing, understanding, appraising, applying, and generating information. They found that low perceived eHealth literacy participants had lower task completion rate. Furthermore, tasks that required more complex skills had lower completion rate. Other studies also found that easier search tasks required more low-level cognitive skills and less effort to complete [35, 36]. In our study, the selection of factual tasks was influenced by the measurement of information search outcome. Exploratory tasks tend to have opinion-based or multiple answers, which makes it difficult and less objective to assess the outcome. With factual tasks, the search outcome is more objective as there are specific correct answers. Since our factual tasks mostly required low-level search skills, such as accessing, understanding, and appraising skills, they were likely not challenging enough for low perceived eHealth literacy participants to complete. The past studies that used exploratory tasks either did not measure information search outcome [25] or the search topic was not related to health information [35, 36].

Even though both participant groups were able to find the correct answers, participants who thought they were better at searching online health information (efficacy expectation) were more confident in their answers (outcome expectations). This finding corresponds to the positive relationship described in the self-efficacy theory [8] between efficacy expectations and outcome expectations: individuals have more confidence in their outcome if they have higher belief in their behaviors. Empirical studies on diabetes patients' self-care behaviors also supported this positive relationship [37, 38]. Overall, our study findings contribute to the literature in the field of online information search.

As self-efficacy theory suggested, behavior is also a factor that can affect outcome expectation. As past studies have shown, high and low eHealth literate consumers tend to perform information search behaviors differently [20, 21]. Hence, in the future we plan to analyze how eHealth literacy affects information search behaviors (query formulation, information evaluation, and information extraction) [11] and whether these behaviors mediate the relationship between perceived eHealth literacy and information search outcome. This future investigation may explain the results found in this study.

There are limitations to our study. First, our study only asked participants to search for factual tasks. Future studies can use exploratory tasks or tasks that require higher cognitive skills. Second, we only focused on users' conceptual search outcome. Future research can explore eHealth literacy's effect on instrumental search outcome. Lastly, we only recruited young and middle-aged adults without considering other age groups.

7 CONCLUSION

This study examined the relationship between perceived eHealth literacy and information search outcome. We found that participants in high and low perceived eHealth literacy groups were both able to find correct answers to factual questions. However, high perceived eHealth literacy participants were more confident in their answers. Our study contributed to the literature by corroborating the positive relationship between efficacy expectation and outcome expectation from self-efficacy theory.

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