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Internet skill-related problems in accessing online health information

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ABSTRACT

Purpose: Despite the amount of health information available online, there are several barriers that limit the Internet from being adopted as a source of health information. The purpose of this study was to identify individual skill-related problems that users experience when accessing the Internet for health information and services.

Methods: Between November 2009 and February 2010, 88 subjects participated in a performance test in which participants had to complete health-related assignments on the Internet. Subjects were randomly selected from a telephone book. A selective quota sample was used and was divided over equal subsamples of gender, age, and education. Each subject was required to complete nine assignments on the Internet.

Results: The general population experiences many Internet skill-related problems, especially those related to information and strategic Internet skills. Aging and lower levels of education seemed to contribute to the amount of operational and formal skill-related problems experienced. Saving files, bookmarking websites, and using search engines were troublesome for these groups of people. With respect to information skills, the higher the level of educational attainment, the less problems the participants experienced. Although younger subjects experienced far less operational and formal skill-related problems, it was revealed that older subjects were less likely to select and use irrelevant search results and unreliable sources. Concerning the strategic Internet skills it was revealed that older subjects were less likely to make inappropriate decisions based on information gathered.

Conclusions: The amount of online health-related information and services is consistently growing; however, it appears that the general population experiences many skill-related problems, particularly those related to information and strategic Internet skills, and they become very important when it comes to health. These skills are also problematic for younger generations who are often seen as skilled Internet users. The results of the study call for policies that account for low levels of Internet skills.

1. Introduction

Online health information has several potential benefits for health-care consumers; it saves time and effort, affords easier access, provides help when feeling embarrassed or stigmatized, and enables one to obtain additional information. Obtaining health information online may also lead to healthier lifestyles, early detection of potential medical problems, collaborative treatment of illnesses, and access to treatments to which a local provider may not have access [1,2]. Many online health information providers seem to assume that when

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people have access to the Internet, the above-mentioned benefits automatically apply. However, it is increasingly acknowledged that in addition to the question of physical Internet access, Internet-related skills should become a focus of attention [3–5]. This is, for example, illustrated in three drawbacks to online health information: available information is often incomplete [6]; the scientific quality of online health information is difficult to evaluate [7,8]; and it is not easy for users to understand the retrieved information and then put it into practice [9]. Although several tools are being developed to address the need for more reliable health information online, they have not been proven universally acceptable in evaluating different health websites' quality of information [10]. In a literature overview of such tools, it was concluded that more work is needed to develop and establish reliable indicators of quality health websites [10]. Even if this were achieved, the appropriate Internet skills are still required to benefit most from health information that is provided online.

In general and also in the domain of healthcare, measurements of Internet skills have proven inconsistent and mainly rely on an individual's perception of his/her skills or knowledge. This method of measurement is typically used for the obvious reason that actual performance tests are time-consuming and expensive. Unfortunately, self-reporting results in questionable validity [11–15].

This study relies on actual performance tests in which subjects had to complete health-related assignments on the Internet. The performance tests were conducted in the Netherlands, a particularly interesting context because Internet access rates have reached very high levels: 94% in 2010, of which almost 100% is broadband (CBS Statistics Netherlands, 2011). From an international perspective, this is one of the highest penetration rates of broadband Internet access. In discussions regarding who is able to keep up with digital advancements and who is not, it is important to focus on aspects that transcend physical Internet access. Previous research indicates that high levels of physical access to the Internet does not automatically mean that the population also has the skills to benefit most from it [5].

To guide the performance tests, a comprehensive definition of four Internet skills was applied; this definition accounted for both technical aspects related to using the Internet and substantial aspects related to Internet content [14,15]. The four Internet skills are listed in Table 1 and can be divided in medium- and content-related Internet skills. The first type of medium-related Internet skills is the operational Internet skills. This indicates a set of basic skills in using Internet technology, such as using an Internet browser. The second type of medium-related Internet skills is the formal Internet skills which relate to the hypermedia structure on which the Internet is built; here, this refers to the hypermedia structure, which requires navigation and orientation skills. The first type of content-related Internet skills are the information Internet skills, derived from studies that adopt a staged approach in explaining the actions via which users try to fulfill their information needs [16]. Finally, strategic Internet skills are the second type of content-related Internet skills. These skills refer to the capacity to use the Internet as a means to reach a particular goal and more generally, to improve one's social status. The definition is based on the classical approach to decision making [17]. Consider, for example, choosing a particular treatment or hospital for a specific condition. The four Internet skills are based on individual abilities that integrate relevant skills necessary for the general population to function well in an increasingly digital environment [14]. Accounting for both medium-related Internet skills and content-related Internet skills avoids a technologically deterministic viewpoint. Furthermore, the definition contains gradients of difficulty, with the four skills having a sequential and conditional nature [18].

Table 1 – Medium- and content-related Internet skills.

Medium-related Internet skills	
Operational skills	*Operating an Internet browser, meaning:* • Opening websites by entering the URL in the location bar • Navigating forward and backward between pages using the browser buttons • Saving files to the hard drive • Opening various common file formats (e.g. PDFs) • Bookmarking websites • Changing the browser's preferences • Using text or images with hyperlinks *Operating Internet-based search engines, meaning:* • Entering keywords in the proper field • Executing a search • Opening search results in the search result lists *Operating Internet-based form, meaning:* • Using different types of fields and buttons • Submitting a form
Formal skills	*Navigating on the Internet, meaning:* • Using hyperlinks (e.g. menu links, textual links, image links) in different menu and website layouts *Maintaining a sense of location while navigating on the Internet, meaning:* • Not becoming disoriented when navigating within a website • Not becoming disoriented when navigating between websites • Not becoming disoriented when opening and browsing through search results
Content-related Internet skills	
Information skills	*Locating required information by doing the following:* • Choosing a website or a search system to seek information • Defining search options or queries • Selecting information (on websites or in search results) • Evaluating information sources
Strategic skills	*Taking advantage of the Internet by doing the following:* • Developing a plan to achieve a particular goal • Taking the right actions to reach this goal • Making the right decisions to reach this goal • Benefiting from achieving this goal

Based on the health-related performance tests discussed here, Van Deursen and Van Dijk already concluded that, although the level of operational and formal Internet skills appears to be quite high, information and strategic Internet skills leave much room for improvement [19]. However, Van Deursen and Van Dijk discussed only the general completion rates of the assignments charged to the participants [19]. This study focuses in detail on the specific individual skill-related problems that users encounter when completing health-related assignments. The recordings of the participants' screen actions are used to analyze the performance tests in more detail. For example, this study measured whether people were able to save files, bookmark websites, navigate different website designs, define proper search queries, evaluate information, or make decisions based on having complete information. For all analyzed problems Internet users experience, the number of occurrences was counted, revealing differences among users. This study poses two research questions:

1. What individual skill-related problems do users experience when they use the Internet to access health information?
2. Are there differences between different segments of the population when it comes to individual skill-related problems?

2. Methods

To answer the two research questions, performance tests were conducted in which participants had to complete health-related assignments on the Internet. The study tested for several problems that participants may experience during assignment completion. This section describes the participant recruitment process, the method of data collection, the assignments participants were required to complete, and the applied coding scheme that was used to identify individual skill-related problems.

2.1. *Participants*

Participants were recruited by randomly dialing telephone numbers in cities and villages of Twente (eastern region of the Netherlands). In line with procedures applied in prior research, the condition to participate was that the respondent use the Internet at least once per month for more than e-mailing [5,11]. This ensured that low-frequency users familiar with the Internet were also included. The invitation policy put people who feared tests at ease. Only adult Dutch-speaking users were included, and the respondents were promised 25 Euros for their participation in a one-and-a-half-hour research session.

The representativeness of the findings was strengthened by applying a stratified random sampling method. The first step entailed randomly calling people from a telephone book. After introducing the study to those who answered the phone, they were asked for their gender, age, and level of education completed. In the study, a selective quota sample was applied to reach equal subsamples of gender, age (equal number of subjects in the following age ranges: 18–29, 30–39, 40–54, and 55–80), and level of education completed (equal number of subjects in the categories of low, middle, and high). When respondents fit into one of the subsamples and indicated their willingness to participate, their contact and e-mail address were recorded, and a time for the research session was scheduled. Respondents received a follow-up confirmation letter in the mail that contained directions to the research site. Respondents were reminded of the session by phone the day before the study.

2.2. *Study flow*

The performance tests were conducted from November 2009 to March 2010 in an office at the University of Twente. Before the actual tests, a 10-min survey was administered to gather personal data. Subjects were asked about factors that are important in discussions of the digital divide, including birth year, gender, level of education completed, amount of Internet use (in hours per week), Internet experience (in years), location of primary Internet use, social support networks and socio-economic status.

After completing the questionnaire, the participants were given a sequence of nine assignments one at a time. Participants decided when they were finished or wanted to give up. No encouragement was provided because the pressure to succeed is already higher in a laboratory setting than at home. After a specific amount of time (determined for every task based on 12 pilot-tests) had passed (see Appendix A for the maximum time allowed), the test leader asked the participants to move on to the next assignment.

In the performance tests, participants used a keyboard, a mouse and a 17-in. monitor connected to a laptop with a high-speed Internet connection. The laptop was programmed with the three most popular Internet browsers (Internet Explorer, Mozilla Firefox, and Google Chrome), allowing the participants to replicate their normal way of accessing the Internet. No default page was set on the browsers, and all assignments started with a blank page. To ensure that subjects were not influenced by a previous user's actions, the browser was reset after each session by removing temporary files, cookies, and favorites. In addition, downloaded files, history, forms, and passwords were removed, and the laptop was rebooted.

Morae Recorder (TechSmith, Version 2.2) was used to record the screen actions analyzed in this study. Detailed log files of the recordings were created with Morae Manager (TechSmith, Version 2.2) to enable in-depth analysis.

2.3. *Assignments*

The assignments that the participants had to complete were all health-related and accessible to the general user population (see Appendix A for a complete overview of the assignments and corresponding Internet skills). All assignments were fact-based and had a correct action or answer. Open-ended tasks were avoided because of the ambiguity associated with interpreting many potential answers. Two assignments (consisting of eight tasks) were used to measure operational Internet skills, two assignments (consisting of four tasks) were used to measure formal Internet skills, three assignments were used to measure information Internet

skills, and two assignments were used to measure strategic Internet skills. All assignments were pilot-tested with 12 subjects to ensure comprehensibility and applicability.

2.4. Coding Internet skill-related problems

Based on the four Internet skills reported in Table 1, Van Deursen and Van Dijk coded several Internet skill-related problems that users might experience [15]. All codes represent a specific problem whose occurrence was counted during task completion. The coding scheme proved very useful in a performance test that focused on government-related information and services [15]. See Table 2 for the complete coding scheme.

To test the reliability of the empirical work, the coding of the data were replicated by a second observer who coded the recordings of eight subjects, and the results were compared to the primary observer's coding. The comparison revealed no differences in the coded operational and formal skill-related problems. Here, coding was relatively easy because all possible problems that users could experience were tested for in a corresponding task. Occurrences of coded information skill problems were counted during the completion of the three information skill-related assignments. Although these were not measured in specific tasks, they only revealed three points of discussion, all related to the search query being too broad. After some discussion, both coders agreed on how to code this occurrence. Occurrences of the coded strategic skill problems were counted during the completion of the two strategic skill-related assignments. Here, three coded problems resulted in issues related to working in a structured manner, but they were resolved after discussion. Each video-recording session took approximately two-and-a-half hours to code and analyze.

3. Results

Both operational and formal skill problems were recorded during specific tasks designed for these corresponding skills (see Appendix A). To measure the information and strategic skill problems encountered, their total number of occurrences was counted in all 88 screen recordings in order to make statistical analysis possible. Regression analyses were conducted to provide details about the different users who experienced the

Table 2 – Coding scheme.

Individual operational Internet Skill problems	
Address_Bar	Using the address bar incorrectly (e.g. entering keywords)
Save_File	Not being able to save a file to the hard drive
Save_Picture	Not being able to save a picture from a website
Bookmarking	Not being able to bookmark a website
Form	Using a web form incorrectly (e.g. buttons or drop-down menus)
Search_Engine	Not recognizing the search engine or input field
Search_Queries	Using search queries incorrectly (not spelling)
Individual formal Internet skill problems	
Design_Website	Experiencing problems with different website designs
Design_Menu	Using website menus incorrectly (e.g. not being able to scroll over menus)
Orientation_Within	Not knowing one's location within a website
Orientation_Between	Entering a browser window that opens automatically without realizing
Orientation_Search	Not being able to open more than one search result
Individual information Internet skill problems	
System_Proper	Not choosing a proper search system or way of searching
Queries_Wrong	Using too broad search queries not based on the search task
Queries_Booleans	Not using Booleans to limit search results (e.g. parentheses)
Search_Advanced	Not using advanced search methods (e.g. date or excluding keywords)
Search_Limit	Not searching within search results
Select_Sponsor	Choosing sponsored or commercial results
Select_First three	Not checking more than the first three search results
Select_First page	Not checking more than the first page of search results
Select_Irrelevant	Choosing irrelevant search results
Information_Form	Filling out a form that does not lead to the necessary information
Information_Wrong	Using information that is not applicable to the situation
Information_Source	Using information from a less reliable website
Information_Date	Using information that is outdated
Information_Check	Not checking information on another website
Individual strategic Internet skill problems	
Orientation_Stimuli	Being distracted by irrelevant stimuli (e.g. banners)
Orientation_Start	Not knowing how or where to start with the assignment
Action_Misled	Being misled (e.g. working towards a goal that does not deliver personal benefits)
Action_Source_Single	Using information from only one website (source)
Action_No_structure	Working towards the final answer in an unstructured way (randomly)
Action _Support_Wrong	Using incorrectly websites that support the decision-making process
Decision_Wrong	Making an incorrect decision based on the information acquired
Decision_Incomplete	Making a decision based on incomplete information

Table 3 – Subjects over the quota variables of gender, education, and age, and the control variables of location of Internet use, assistance needed, socio-economic status, and participation in an Internet course.

	n (%)
Gender	
Male	45 (51%)
Female	43 (49%)
Age	
18–29	24 (27%)
30–39	18 (21%)
40–54	23 (26%)
55–80	23 (26%)
Education	
Low (e.g. primary school)	25 (28%)
Middle (e.g. high school)	32 (36%)
High (e.g. college and university)	31 (35%)
Primary location of Internet use	
At home	75 (85%)
At work	1 (1%)
At school	8 (9%)
At friends or family	3 (3%)
At a library	1 (1%)
Assistance when using the Internet	
No	49 (56%)
Yes, from family	18 (21%)
Yes, from friends	17 (20%)
Yes, from colleagues	4 (5%)
Yes, from a helpdesk	0 (0%)
Socio-economic status	
Employee	30 (34%)
Retired	14 (16%)
Student	21 (24%)
Househusband/housewife	4 (4%)
Employer	6 (7%)
Disabled	4 (5%)
Unemployed	9 (10%)
Participation in an Internet course	
No	63 (72%)
Yes	25 (28%)

observed problems. The independent variables in the regression model were gender, level of education completed (from 1 – low to 3 – high), age (years since birth), Internet experience (years online), amount of time spent on the Internet (hours per week), use of social support (yes/no), the primary location of Internet use (at home/elsewhere), and socio-economic status (active/inactive).

3.1. *Sample*

The characteristics of the participants are included in Table 3. The average number of years of Internet experience was 9.3 (SD 4.3), and average amount of Internet use was 12.2 h per week (SD 13.7). Overall, the study's participants represented a diverse group of Internet users.

3.2. *Operational Internet skill-related problems*

The participants experienced several operational skill-related problems on websites offering health information and services. The *use of the address bar* appeared to be problematic for 6% of the subjects (5 out of 88), all of whom were senior citizens. These participants did not recognize the Internet browser and had no idea how to start the session. This was primarily caused by the fact that, for them, seeing Google means using the Internet. If Google did not appear immediately after starting the Internet browser, they did not know how to proceed.

Saving a file to the hard drive was measured through two tasks. In the first task, participants had to save a brochure (in PDF) about head lice, and in the second, they had to save a picture on the top of a webpage. Saving the brochure was problematic for 35% of the subjects (31 out of 88). Here, 20% of the subjects (18 out of 88) had absolutely no idea how to save the file and skipped the task. Another 11% (10 out of 88) did not save the file but instead saved the whole webpage because they could not differentiate between the two different actions. Finally, three subjects bookmarked the webpage, believing the file was now saved. Twenty-seven percent of the participants (24 out of 88) were unable to save a website's picture. The participants who failed this task had absolutely no idea how to proceed and seemed to be unaware of how to make use of the right mouse button on a website.

Filling out an online form and *bookmarking a webpage* did not yield many problems. The latter task was successfully completed by 82% of all subjects (72 out of 88), while only 7% (6 out of 88) experienced problems with the former. The main problem encountered was simply overlooking input areas, which resulted in a warning message that was not always understood.

Operational problems with the use of *search engines* were experienced by 16% of the participants (14 out of 88). Ten percent of the participants (9 out of 88) typed *search queries without using spaces*, and 6% (5 out of 88) entered *search queries into the address bar*.

Failing to save a file to the hard drive, save a picture, bookmark a website, and operational problems with using search engines are presented in Table 4. Because the problems experienced are measured in a specific task with a binary outcome (successful/not successful), logistic regression analyses were performed to identify what factors appear significant in the regression model. In the models for saving the brochure file (*Nagelkerke* $R^2 = 41$; Chi square = 35.49, $P = 01$), age is a negative contributor (older participants completed less tasks successfully), while the level of education and years of Internet experience are positive contributors. The results are the same for saving a picture from a website (*Nagelkerke* $R^2 = 44$; Chi square = 32.25, $P < 001$). Regarding problems experienced in bookmarking (*Nagelkerke* $R^2 = 40$; Chi square = 28.88, $P < .01$), age is a negative contributor to the amount of successfully completed tasks. For the use of search engines (*Nagelkerke* $R^2 = 44$; Chi square = 32.66, $P < 001$), age is also a negative contributor, while education is positive. Other factors, including Internet experience and the amount of Internet use, did not appear significant.

3.3. *Formal Internet skill-related problems*

Formal Internet skills problems refer to both navigation and orientation. To identify navigation problems, which constitute *lay-out and website design*-related problems, participants were asked to find the addresses (simple information that

Table 4 – Logistic regression analysis of operational skill-related problems.

	Saving file		Saving picture		Bookmarking		Search engines	
	Exp(B)	P	Exp(B)	P	Exp(B)	P	Exp(B)	P
Gender (m/f)	0.60	.26	0.50	.09	0.44	.16	1.05	.95
Age (years)	0.96	<.001	0.91	<.001	0.93	<.01	0.93	.02
Education (low–high)	2.23	.03	2.52	.03	0.65	.29	2.67	.01
Internet experience (years)	2.24	.03	2.12	.04	1.10	.20	1.48	.52
Time online (hours per week)	1.02	.42	0.98	.36	1.02	.51	1.09	.42
Took an Internet course (n/y)	1.25	.72	1.25	.76	0.76	.70	1.93	.18
Using peers for help (n/y)	2.17	.20	1.53	.55	0.72	.61	0.68	.59
Primary location of use (home/elsewhere)	2.38	.36	0.47	.39	0.66	.63	0.78	.62
Socio-economic status (inactive/active)	1.31	.68	0.29	.11	0.57	.46	1.16	.31

requires only minimal information Internet skills) of three health-related agencies in a Dutch city. All three agencies employed a very different design and menu. Thirty-two percent of the participants (28 out of 88) were not successful in retrieving all three addresses. Sixteen percent of the participants (14 out of 88) did not notice the 'contact' button, which was displayed on the front-page main menu of all three sites. Thirteen percent (11 out of 88) experienced problems using the roll-over menu included on one of the websites. These participants – all senior citizens – did not seem to understand that they could move the mouse indicator over the menu items. Finally, three subjects did not recognize one website's menu at all and continued to move around on the homepage.

To identify if the participants experienced problems of *orientation within a specific website*, they were asked to follow some of the website's hyperlinks. Although it took some of the participants quite a long time, they all eventually made it to the final page. However, when instructed to click an external link to measure *orientation between websites*, 27% of the subjects (24 out of 88) experienced problems. They lost their orientation after the new browser window was opened. They did not understand why the back button of the new browser was deactivated and overlooked the website in the original window, even when it was still visible.

Maintaining *orientation when navigating search results* was measured by asking subjects to open the first and fourth search results after conducting a search operation on the website of a large healthcare organization. Twenty-four percent of the subjects (21 out of 88) experienced problems. Most of them did not know how to return to the original search result list after opening the first result and had to conduct the search again. Five subjects did not seem to understand the difference between the fourth search result and the fourth page of search results. According to Table 5, in the logistic regression models for using different website designs (*Nagelkerke* $R^2 = 41$; Chi square = 31.05, $P < 001$), age, education, and Internet experience are the three significant contributors. Similar results are found for orientation between websites (*Nagelkerke* $R^2 = 63$; Chi square = 56.17, $P < 001$). Younger, more educated, and more experienced participants are less likely to have such problems. Gender is also significant, with men being less likely to experience problems related to orientation between websites. Finally, gender, age, and education are significant for orientation-related problems related to browsing search results (*Nagelkerke* $R^2 = 62$; Chi square = 47.97, $P < 001$).

3.4. *Information Internet skill-related problems*

To identify problems related to information Internet skills, participants were asked to complete three search assignments. The first assignment used a specific healthcare website, while in the second and third assignments, participants could *choose their own starting point*. Ninety-five percent of the participants (83 out of 88) chose Google, while the remaining five subjects used another popular Dutch website (startpagina.nl).

The second stage in the search process was defining search queries. This step led to considerable problems that strongly

Table 5 – Logistic regression analysis of formal skill-related problems.

	Different layouts		Orientation between websites		Browsing search results	
	Exp(B)	P	Exp(B)	P	Exp(B)	P
Gender (m/f)	1.73	.33	0.25	.04	0.22	.04
Age (years)	0.93	.00	0.92	.00	0.91	.00
Education (low–high)	3.84	.00	2.61	.04	4.61	.00
Internet experience (years)	2.43	.04	2.25	.04	1.17	.15
Time online (hours per week)	0.96	.09	1.01	.86	0.98	.62
Took an Internet course (n/y)	0.45	.23	1.47	.64	0.41	.34
Using peers for help (n/y)	0.59	.36	0.38	.15	0.93	.93
Primary location of use (home/elsewhere)	0.64	.57	9.22	.09	3.09	.46
Socio-economic status (inactive/active)	0.21	.05	1.00	.99	0.71	.69

impacted the entire search process (after all, it becomes harder to select suitable search results when no specific queries are used). As much as 64% of the participants (56 out of 88) performed search operations using *search queries that were too general* for the given assignment. For example, the keyword 'tick' was used to search for a remedy against Lyme's disease, and the keyword 'back' was used to search for a back problem that was described in detail in the task description. Strikingly, 31% of the subjects (27 out of 88) did not seem to be aware of the fact that multiple keywords could be entered into the address bar.

Only four subjects limited the number of search results with quotation marks. None of the participants used advanced search methods (e.g. exact word combinations or entering dates).

Forty-one percent of the participants (36 out of 88) did not go *beyond the first three search results* (with 14% checking only the first result). Only seven participants went *further than the first page of search results* in one of the conducted search operations. Sixty-three percent of the participants (55 out of 88) selected one or more *irrelevant search results*, and 22% (19 out of 88) selected *irrelevant information pages within a website*.

Thirty percent of the participants (26 out of 88) used information from an unreliable website. In all cases, commercial websites were consulted with a clear tendency towards selling products instead of providing helpful information. None of the participants *evaluated* the date of the retrieved information, while only four subjects verified information retrieved on another website.

The total number of times problems occurred was counted while participants completed the information skill assignments. Reported in Table 6 are the linear regression analyses over this number that revealed significant *F*-values. In the model for using search queries that are too broad ($R^2 = .38$, $F_{9,87} = 5.20$, $P < 001$), education is predictive. Education is also predictive for not going beyond the first three search results ($R^2 = .31$, $F_{9,87} = 5.76$, $P < 001$), selecting irrelevant information ($R^2 = .38$, $F_{9,87} = 5.20$, $P < 001$), and using unreliable sources ($R^2 = .38$, $F_{9,87} = 5.20$, $P < 001$), while those who were more educated experienced these problems less than those who were less educated. Surprisingly, the older the subjects were, the less likely they were to select irrelevant search results and use unreliable sources. No other factors included in the regression models appeared predictive.

3.5. *Strategic Internet skill-related problems*

The first strategic Internet skill-related problem that users may experience falls in the category of staying oriented towards the goal of the session. *Being distracted by irrelevant stimuli* (e.g. banners) was the first indicator and was experienced by 5% (4 out of 88) of the participants. *Not having any idea how to start* one of the two strategic skill assignments was experienced by 36% of the participants (32 out of 88).

A few strategic skill-related problems emerged in the second step in the definitions of moving towards the final goal. Sixty-six percent of the participants (56 out of 88) used *websites that aid users* in making informed decisions. These websites were used particularly in the second strategic assignment that included several possible options for comparing home-care organizations, their specializations, and services offered. However, navigating these websites did not appear to be straightforward. Participants often used them for the wrong purposes (or did not address all the necessary information), and the generated outcomes were not questioned. Of the participants that used these websites, 61% (54 out of 88) were not able to obtain useful information. Twenty-six percent of the participants (23 out of 88) did not *combine multiple information sources* and used information from only one website. This was not sufficient because in almost all cases, these websites did not offer all of the information necessary to complete the assignment successfully. In one of the assignments, for example, subjects had to decide whether it was a good idea to give their three-year-old son vitamin A and D supplements. Most search engines generated results with articles about one of the two vitamins. Therefore, despite the fact that these websites may have been reliable, additional sources were needed to locate all the necessary information.

During the completion of the strategic assignments, 74% of the participants (65 out of 88) worked in an *unstructured* way (determined by verifying if information was gathered piece by piece or by randomly surfing).

The final stage of the strategic process was making decisions. Because the previous steps had already revealed many problems, the number of subjects who ultimately made a *wrong decision* after gathering information is high, accounting for 63% (55 out of 88). Finally, 75% of the participants (66 out of 88) based their decisions on having *incomplete information*.

Table 6 – Linear regression analysis for information skill-related problems.

	Broad search queries		Limited use of search results		Irrelevant selection		Unreliable sources	
	β	P	β	P	β	P	β	P
Gender (m/f)	.07	.13	.12	.08	−.03	.12	.06	.12
Age (years)	.05	.70	−.18	.02	−.12	.08	−.22	.03
Education (low–high)	−.27	.01	−.31	.01	−.27	.02	−.23	.03
Internet experience (years)	−.14	.08	−.15	.09	−.10	.31	−.19	.06
Time online (hours per week)	−.08	.43	−.09	.34	−.07	.29	.03	.65
Took an Internet course (n/y)	.06	.57	.03	.65	.04	.50	−.18	.06
Using peers for help (n/y)	−.11	.09	.05	.10	−.10	.09	.05	.57
Primary location of use (home/elsewhere)	−.09	.14	.03	.12	.07	.15	.04	.68
Socio-economic status (inactive/active)	.04	.73	−.05	.65	.09	.34	−.05	.52

Table 7 – Linear regression analysis for strategic skill-related problems.

	No idea how to start		One single website		Lack of structure		Incorrect decisions	
	β	P	β	P	β	P	β	P
Gender (m/f)	.10	.11	.10	.07	.06	.32	.05	.15
Age (years)	.06	.68	−.08	.12	.10	.07	−.18	.04
Education (low–high)	−.25	.01	−.33	.01	−.25	.02	−.22	.03
Internet experience (years)	−.03	.41	−.13	.10	−.14	.11	.06	.11
Time online (hours per week)	−.19	.04	−.09	.33	.09	.19	.03	.58
Took an Internet course (n/y)	.01	.57	.05	.12	.03	.52	−.11	.09
Using peers for help (n/y)	.04	.09	.05	.11	−.09	.10	.02	.67
Primary location of use (home/elsewhere)	−.04	.43	.03	.33	.05	.25	.04	.61
Socio-economic status (inactive/active)	−.07	.63	.09	.45	.06	.32	−.04	.51

Linear regression analyses over the total occurrences of specific problems that revealed significant *F*-values are reported in Table 7. Education is predictive in the models for not knowing how or where to start ($R^2 = .29$, $F_{9,87} = 4.22$, $P < 001$), using only one website to make decisions ($R^2 = .20$, $F_{9,87} = 3.19$, $P < 001$), working in an unstructured manner ($R^2 = .22$, $F_{9,87} = 3.44$, $P < 001$) and making incorrect decisions based on the information found ($R^2 = .17$, $F_{9,87} = 2.11$, $P = 01$). Furthermore, older subjects make less wrong decisions, and people who spend a lot of time online weekly are more likely to know how to approach beginning a strategic skill assignment.

4. Discussion

4.1. *Relevance of findings*

This study was the third in a series of three performance tests conducted in 2008, 2009, and 2010 [5,14,15]. All three studies used a different context for the assignments that the participants had to complete on the Internet. The first study used government-related assignments to measure Internet skills, while the second and third used general leisure- and health-related assignments, respectively. The general results of the three studies were similar, and a large number of assignments were not completed successfully. Although the level of operational and formal Internet skills appears to be quite high (with the exception of primarily senior citizens and the less educated), the level of information and strategic Internet skills leave much room for improvement. The present study is a more comprehensive analysis of the data reported in the third study. The actual screen actions recorded during task completion were subjected to a detailed analysis with the goal being to identify the exact individual skill-related problems experienced by Internet users. The main benefits of this analysis are that it is not limited by the use of a survey method (in which skills are measured indirectly or by self-evaluations) and that a comprehensive definition of Internet skills, which identifies a broad range of possible problems that users might experience online, is applied.

The amount and type of problems that users experienced in the present study are comparable to the amount of problems users experienced when using the Internet for government-related information and services [15]. This suggests that the lack of Internet skills that causes these problems cannot simply be attributed to the fact that Internet users are non-government or non-healthcare professionals. The general Internet user, for example, seems to have problems with working in a structured manner or with taking decisions based on the gathered information. When overviewing the amount of problems people experience online, one might seriously question whether the general Internet user possess the necessary skills to use the increasing amount of online information and services.

One of the study's findings is that age is primarily related to the number of operational and formal problems experienced by users. In fact, it was revealed that older subjects were less likely to select irrelevant search results and to use unreliable sources. Similar results were found in the Internet skills performance test that used government-related assignments [15]. An explanation to this finding may be that additional intellectual skills required to master these skills are likely to appear. The low frequency of operational and formal Internet skills problems that young people experience does not guarantee the development of these additional skills. While this result accounts for today's society and generational differences, it is not known if the same differences will persist in the future. Although operational and formal skills are easiest to account for, they may persist because technology is constantly changing and with these changes will emerge new specific operational and formal skill-related problems. Other factors that accompany aging, like cognitive decline, motor skills or arthritis, may also cause senior citizens to encounter digital skill problems.

Another important finding is that the level of educational attainment seems to be very important for all Internet skills. The more educated the subject is, the fewer Internet skill problems he or she encounters. Katz and Rice argued that less educated people have difficulties in applying Internet content to their functional needs [20]. A fairly common argument is that people learn Internet skills better by trial and error than in formal educational settings [3]. Based on this and other studies' findings, however, it seems that this argument mainly accounts for operational and formal Internet skills but not for information and strategic skills [5].

4.2. *Study limitations*

Few empirical investigations are available regarding Internet skills and studies that attempt to measure these skills are

often limited in the definitions used, the small sample sizes and the survey method for data collection in which skills are measured indirectly or by self-evaluations. In the study reported here, actual performance tests are administered, directly measuring Internet skills. Although this is the most valid method for measuring these skills, the amount of time that participants work on the assignments – up to 2 h – is high. Since the average completion time was about 70 min, issues of potential fatigue and lack of motivation might have had some influence on the results. The subjects were not explicitly spurred and themselves decided when they were finished or wanted to give up on an assignment. However, one might also argue that in a test situation people are more motivated to complete the assignments. In real-life quests for information, people might grab the phone if they do not succeed immediately on the Internet.

While other ways of defining Internet skills often focus on specific aspects of Internet use (e.g. navigating, defining search queries, evaluation), the definition of 'skills' applied in the present analysis is derived from multiple research fields [14], with the different skills being arranged in a particular order. There are three important characteristics of this definition. Firstly, the definition of Internet skills has a sequential and conditional nature. Secondly, the definition focuses on task- and goal-oriented Internet use. This goes beyond the more traditional definitions of media literacy by suggesting more (inter)active use, or use that consists of interactions between programs or people, transactions of goods and services, and decision making. Thirdly, the proposed skills should be mastered by every Internet user to effectively use the medium. However, the applied Internet skills definition is not complete. The definition of Internet skills used in the actual measurements limits the content-related aspect of Internet skills to information. However, the Internet's communication capacities have gained considerable attention over the last few years. In the domain of healthcare, for example, online discussion groups have drawn considerable attention. Additional communication-related problems that users may experience when using the Internet for health-related searches would be a valuable addition to the coding scheme.

Another limitation of the applied framework is that it does not account for content creation and content sharing. These activities refer to so-called Web 2.0 applications. Although these skills have been ignored, it can be expected that both information and strategic Internet skills are crucial for these activities, even more than they are for information retrieval. Active participation and user-generated content require a high level of Internet skills, particularly for serious topics like health. In the study reported here, communication skills and skills for content creation were not measured because their addition would have made the performance tests, which already required up to one-and-a-half hours of the subjects' time, unrealistic.

4.3. *Future work*

The four definitions of Internet skills focus primarily on the Internet as an information and service provider. As just outlined, communication skills required for computer-mediated communication (e.g. emailing, chatting, social networking, online discussions) and content creation are not included in these definitions. Adding these skills would require the adoption of particular theories of communication, and it would pose problems for creating an operational definition. However, measuring these skills is certainly one of the next steps required for research into digital skills.

Future work should investigate how differences in Internet skills can be reduced. Improving Internet skills means reducing individual skill-related problems. While new media developers can implement websites that consider the problems of senior citizens and those who are less educated, there is also a strong need for educational intervention.

Some of the (mainly formal) problems users experienced may have been caused or strengthened by usability issues related to the design of the health websites visited. Although it is hard to point to the exact causes of the problem, it can be expected that websites that score low on usability aspects exacerbate problems caused by a lack of skills. This should be accounted for in future research.

5. Conclusions

Both higher age and lower levels of education contribute to the number of operational and formal skill related problems users experience online. The major operational problem is saving a (PDF) file. Many health agencies offer information in brochures using the PDF format. Especially seniors and lower educated people seem to need more support on how to open and save files. The operational use of search engines is also not a self-evident task for everyone (e.g. entering keywords in the address bar or typing keywords attached to each other). Using web-based forms caused only some problems for lower-educated and seniors.

Regarding formal Internet skill, the most frequently experienced problem was the lack of orientation when navigating between health websites, but also within health websites and between search results (e.g. not knowing how to return to the result list). Also, health websites' menus – especially roll-over – were sources of confusion. Mostly seniors and low-educated participants experienced these problems. It seems that the design and implementation of health websites should offer better support for these groups.

A major information skill related problem seems to be the formulation of overly general search queries. Educational attainment is a strong contributor to this problem. A problem that almost all participants experienced is the limited use of search results; typically, the first three results attracted attention. Surprisingly, older participants were less likely to select irrelevant search results. This illustrates that information skills are not necessarily more easily mastered by the digital generation. This was also illustrated by the fact that older participants were less likely to use unreliable sources.

Regarding strategic skill related problems it was revealed that the use of websites that support users in making informed decisions was problematic. Lower levels of educational attainment contributed to not knowing where to start, working in an unstructured manner, using only one single health website to make a decision, and to making wrong decisions.

Summary points
Known

- The general level of Internet skills among populations at large leave much room for improvement (even in countries with high levels of physical access to the Internet).
- Although the general level of operational and formal Internet skills in general seems acceptable, especially information and strategic Internet skills are problematic when using the Internet for accessing health information and services.

Added to our knowledge

- Specific operational Internet skill problems people experience when using the Internet for accessing health information and services are difficulties in saving files, bookmarking Web sites, and using search engines (e.g. typing keywords in the address bar or without spaces).
- Specific formal Internet skill problems people experience when using the Internet for accessing health information and services are difficulties in navigating different designs, or keeping orientation when using different designs and browsing search results.
- Seniors and people with lower levels of education mainly experience operational and formal Internet skill problems.
- Specific information Internet skill related problems people experience when using the Internet for accessing health information and services are difficulties in defining search queries, selecting relevant information, and evaluating information.
- Specific strategic Internet skill related problems people experience when using the Internet for accessing health information and services are difficulties in combining information sources, working in a structured manner, and making decisions based on full information tenure.
- People with lower levels of education have most information and strategic Internet skill-related problems. With age increasing the amount of these problems decreases.

Based on the results of this study, one might seriously question whether the general Internet user population is capable of using online health information and service sources. It appears that the general population experiences many skill-related problems, especially those related to information and strategic Internet skills. These skills are also problematic for younger generations who are often considered skilled Internet users. What is particularly distressing is the fact that the information and assistance provided by the Internet is, in practical terms, unavailable to those citizens with the most frequent health problems and the highest mortality rates, that is, those with low levels of education and the elderly. For them, skills (or lack thereof) can become vital in the most literal sense. For example, this may occur when the unskilled cannot find the hospital with the shortest waiting list for surgery or with the best qualifications. This also occurs when these individuals lack additional crucial information that may help them in prevention and treatment of acute diseases or when they are unable to request a second opinion about a proposed treatment.

Author contributions

AvD contributed to the study concept, design and implementation, analysis and interpretation of the findings, and preparation of the manuscript.

Conflict of interest

No conflict of interest exists.

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Appendix A.

Operational Internet skills Opening Web sites by entering the URL in the browser's location bar. Using text or images with hyperlinks. Opening various common file formats. Saving files on the Hard Disk.	**Assignment 1** (max time allowed: 12 min) 1. Go to the Web site of the RIVM (www.rivm.nl). 2. Click on the link 'Infectieziekten' in the menu on the left. Click on the subject 'Thema's'. Click on the subject 'Hoofdluis'. Click on the subject 'Voorlichtingsmateriaal downloaden of bestellen'. 3. Open the brochure 'Brochure veelgestelde vragen'. Save the brochure in "My Documents".
Navigating forward and backward between pages using the browser buttons. Bookmarking Web sites.	4. Use the back button to go back to homepage of the RIVM Web site. 5. Add the homepage to the Favourites (or bookmarks
Operational Internet skills Operating Internet-based forms: Using the different types of fields and buttons; Submitting a form; Saving files from the Internet on the Hard Disk.	**Assignment 2** (max time allowed: 8 min) 6. Go to the Web site of MinVMS (www.minvws.nl). Click on the link 'Uitgebreid zoeken.' Complete the fields using the information given. 7. Execute the search function and open the third search result. 8. Save the logo of the MinVWS on the desktop of the computer.
Formal Internet skills Not becoming disoriented when navigating within a Web site. Not becoming disoriented when navigating between Web sites. Not becoming disoriented when opening and browsing through search results.	**Assignment 3** (max time allowed: 10 min) 1. Go to the website of ZonMW (www.zonmw.nl). Follow the options: Onderwerpen/Jeugd/Zorg voor Choose the option: 'RIVM/Jeugdgezondheid'. 2. In both windows, go to the homepage of the Web site opened: Go to the homepage of the RIVM Web site in the new opened window. Go to the homepage of the RIVM website in the original window. 3. Perform a search on the ZonMW Web site with keyword 'infectie'. Open the first search result. Open the fourth search result.
Formal Internet skills Navigating on the Internet by using hyperlinks (e.g. menu links, textual links, image links) in different menu and Web site layouts.	**Assignment 4** (max time allowed: 10 min) 4. Find the addresses of the following three health organizations. Use the Web sites of the organization: ISALA Clinic in Zwolle (www.isala.nl). BOSK Organization for the disabled (www.bosk.nl/). GGZ Enschede (www.ggznederland.nl).
Information Internet skills Locating required information, by: Defining search options or queries; Selecting information (on a Web site); Evaluate information found.	**Assignment 5** (max time allowed: 12 min) 1. Imagine. . .You would like to know more about the H1N1 influenza. This was originally called the Swine Flu. Answer the following question, using the Web site of Dokterdokter (www.dokterdokter.nl): Why is the name Swine flu not correct?
Information Internet skills Locating required information, by: Choosing a Web site or a search system to seek information; Defining search options or queries; Selecting information (in search results); Evaluating information sources.	**Assignment 6** (max time allowed: 12 min) 2. Imagine. . .During a hike you are bitten by a tick. A red spot appears that increases. This is a sign you have been infected with Lyme borreliosis. A friend recommends to start with an antiviral (remedy against viral infections) immediately, since Lyme's disease can have very unpleasant consequences, especially when treatment starts too late! Answer the following question using a search engine (e.g. Google or the Web site you use at home): Is it a good idea to start an antiviral remedy?

Information Internet skills
Locating required information, by:
Choosing a Web site or a search system to seek information;
Defining search options or queries;
Selecting information (in search results);
Evaluating information sources.

Strategic Internet skills
Taking advantage of the Internet, by:
Developing an orientation towards a particular goal;
Taking the right action to reach this goal;
Making the right decision to reach this goal;
Gaining the benefits resulting from this goal.

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Assignment 7 (max time allowed: 12 min)
3. Imagine. . .The last few months, your son has been suffering problems with his back. His back shows a deviation to the left. It looks like one leg is shorter than the other, although this does not appear to be the case. Answer the following question using a search engine (e.g. Google or the Web site you use at home): What is the name of the condition your son suffers from?

Assignment 8 (max time allowed: 12 min)
1. Imagine. . .You have a three-year-old son. Your mother gives you the advise to give him extra vitamins A and D. Your mother believes these are necessary for a healthy growth. Answer the following question using a search engine (e.g. Google or the Web site you use at home): Would you give your son both extra vitamins A and D?

Assignment 9 (max time allowed: 30 min)
2. Imagine. . .Your mother is 82 years old. Lately, she has been suffering from dementia and impaired hearing. You decided to find a homecare organization in Enschede that has a special caring program for these complaints. You also would like the organization to organize daily activities for seniors. Use the Internet to find a homecare organization in Enschede that meets your demands?

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