MEASURING DIGITAL SKILLS

Performance tests of operational, formal, information and strategic Internet skills among the Dutch population

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ABSTRACT

This paper focuses on one of the factors that appears to be important in several conceptualizations of how to approach the digital divide; the differential possession of so-called digital skills. Since a lot of digital skill related interpretations are given to an extended range of terms only few frameworks are available that mostly lack operational definitions. To encourage more research to focus on in-depth skill measurements, we propose operational definitions for operational, formal, information and strategic skills. We use this framework to measure the Internet skills of the Dutch population at large, by giving 109 subjects nine assignments to be accomplished on the Internet. Subjects were recruited following a two step approach; randomly select a sample from the book/list of fixed telephony subscribers, followed by drawing a selective quota sample for the strata of gender, age and educational level. The results indicate that on average 80% of the operational skill Internet tasks, 72% of formal Internet skills tasks, 62% of the information Internet skills tasks and 22% of strategic Internet skills tasks assigned have been successfully completed. Performances are significantly different for people with high, medium and low level of education attained and for people with different age, but not for people with different gender, not for weekly time spent on the Internet, and on most occasions not even for years of Internet experience. Seniors above 55 perform worst in all skills. Young people between 18 and 30 are superior in operational and formal skills but not in information and strategic skills.

1. INTRODUCTION

A central issue on the scholarly and political agenda of new media development is the gap between those who have and do not have access to computers and the Internet (Van Dijk 2006). This split between the ‘haves’ and ‘have-nots’ of new media use has most often been framed in the term ‘digital divide’ (Hargittai, 2004). Although the prevailing research approach mainly focused on this binary classification of access, now a more refined understanding of the digital divide has appeared and several conceptualizations of how to approach digital divide research exist (e.g., DiMaggio & Hargittai, 2001; Mossberger et al. 2003; Van Dijk, 2006; Van Dijk & Hacker, 2003).

Instead of choosing a specific conceptualization, we will focus on one of the factors that appears to be important in all of them: the differential possession of so-called digital skills. Even when people have equal access to computers and the Internet, they may not have the skills to engage in a wide variety of uses. In the explanation of different usage of the Internet, the level of digital skills appears to be one of the most important factors. It has a strong independent weight according to contemporary digital divide research (Mossberger, Tolbert & Stansbury 2003; Van Dijk, 2005). Furthermore, this factor is most appropriate for intervention by educational policies and new media design or by the supply of websites and help functions. Finally and most importantly, very little scientific research has been done for the actual level of digital skills possessed by populations at large (most measurements are done in small educational settings or as a part of computer classes). Almost every measurement of the actual level of digital skills of populations has been done by survey questions asking respondents for an estimation of their own digital skills. This kind of measurement obviously has significant problems of validity (Hargittai, 2003; Talja, 2005; Merritt, Smith & Renzo 2005). The only way to obtain a direct measure of a skill is by means of a test which measures that skill. There are only few serious scientific experimental tests of Internet users' skills (e.g., Hargittai, 2002a; Eshet-Alkalai & Amichai-Hamburger, 2004).

This article is organized as follows: after the research background we will frame two research questions. These questions will be answered by using an operational framework for measuring digital skills that is introduced in section 3. In section 4 the method is explained and section 5 provides the research results. Finally, section 6 contains the conclusions and section 7 the discussion.

2. RESEARCH BACKGROUND AND RESEARCH QUESTIONS

The literature regarding digital skills is not consistent in the terms used and in the underlying concepts, as Bawden already stated in 2001. Because a lot of interpretations are given to an extended range of terms, one should not expect agreement on what constitutes digital skills or why they are required (Martin, 2006). This stipulates the need for more academic research. The few studies conducted (e.g., De Haan, 2003; Hargittai, 2002) show large variation of digital skills among different social segments, but do not explain what these skills exactly comprehend. A deeper understanding is needed to escape the simplification of early digital divide research where only binary classifications were considered. A new simplification might appear: the simple duality of can's and can-nots.

There are some frameworks available for measuring digital skills, but mostly lack operational definitions. They stay at the level of conceptual definitions and indicators or indexes. Steyeart (2000, 2002) and Van Dijk (2005; Van Dijk & Hacker, 2003) introduced the concept of digital skills as a succession of three general types of skill. Steyaert distinguishes between instrumental skills (the operational manipulation of technology), structural skills (the structure in which information is contained) and strategic skills (the basic readiness to pro-actively look for information, information-based decision-making and scanning of the environment for relevant information). Van Dijk (2002; Van Dijk & Hacker, 2003) elaborated and changed this conceptual definition to distinguish between operational skills (operate computer and network hardware and software), formal information skills (the ability to understand and to handle the formal characteristics of a computer and a computer network, substantial information skills (the ability to find, select, process and evaluate information in specific sources of computers and networks according to specific questions and needs) and strategic skills (the capacities to use these sources as the means for specific goals and for the general goal of improving one's position in society). Both Steyeart and Van Dijk define these skills as

cumulative and suggest that they are applicable on multiple facets of both computer and Internet use. Despite the cumulative nature, they claim these skills can and should be measured separately (starting with instrumental or operational skills). This could provide opportunities to investigate how these skill levels are distributed among social segments in the population.

To encourage more research to focus on in-depth skill measurements, we will propose operational definitions for the four types of digital skills Van Dijk (2005) elaborated. However, instead of considering formal information skills and substantial information skills as subcategories of information skills, they are here introduced as two separate categories. While formal skills strongly relate to the characteristics of digital technology (see section 3.2), information skills together with strategic skills, relate to the content provided by the medium. The leads to the following:

- Operational skills: the skills to operate digital media.
- Formal skills: the skills to handle the structures of digital media.
- Information skills: the skills to locate information in digital media.
- Strategic skills: the skills to employ the information contained in digital media towards personal (and professional) development.

This framework is applied to measure the Internet skills of Dutch citizens. These skills as measured here are a combination of computer skills, mainly appearing in operational skills, and formal, information and strategic Internet skills. In the special case that was used in our empirical study we tried to measure Internet skills that are expected to be mastered by every citizen in online public services. The problems described and the framework proposed lead to the following research question:

- RQ 1: What are the levels of operational, formal, information and strategic digital skills of Dutch citizens?

It is expected that the level of these four skills will vary over different segments. A selective quota sample was drawn for the strata and quota of gender, age and educational attainment (see section 4.1), the three most important factors in digital divide research. The number of respondents also allowed for taking the following factors in consideration: Internet experience, intensity of Internet use, help from peers when using the Internet, the primary location for using the Internet and social position (active/inactive). This leads to the following research questions:

- RQ 2: Are there statistically significant differences among the categories of gender, age, educational level, Internet experience, amount of time weekly spent on the Internet, help from peers, primary location of Internet use and social position?

3. AN OPERATIONAL FRAMEWORK FOR MEASURING INTERNET SKILLS

This section contains the operational definitions for operational, formal, information and strategic skills, and the measurements and sample procedure.

3.1 Operational skills

When focusing on the World Wide Web, most of the measurements of operational skills are conducted by presenting respondents survey questions about their Internet-related knowledge. Both Steyeart and Van Dijk refer to the European computer driving license (the global governing body of the end-user computer skills certification programme), which is narrowly focussed on operational skills. Other useful operational definitions emphasizing operational skills are presented by Bunz (2004) and Larsson (2002). The latter created a Digital Literacy Checklist developed following Gilster's (1997) definition of the concept ‘digital literacy’. Partly based on these definitions, we define operational skills as being able to:

- Operate an Internet browser:
    - Opening websites by entering the URL in the browser’s location bar;
    - Surfing forward and backward between pages using the browser buttons;
    - Saving files on the Hard Disk;

    - Opening various common file formats (e.g., PDF, SWF);
    - Bookmarking websites;
    - Changing the browser's preferences (e.g., start page);
    - Using hyperlinks.
- Operate online search engines:
    - Entering keywords in the proper field;
    - Executing the search operation;
    - Opening search results in the search result lists.
- Complete online forms:
    - Using the different types of fields and buttons (e.g., drop-down menus);
    - Submitting a form.

3.2 Formal skills

When using the Internet, traditional skills need to be complemented by a unique form of digital skills. These skills, defined here as formal skills, allow users to make use of hypermedia (of which the Internet is the classic example). According to Gilster (1997), hypermedia technology presents new challenges of digital literacy. It allows users to choose their own non-linear paths since graphics, audio, video, plain text and hyperlinks intertwine. In contrary, the old media are mostly linear which gives the users little control over the flow of information. On the internet, users cannot only move forward, but also backward and to unknown locations, referred to as cross-referencing. Cross-referencing enables the user to redirect the flow of information, but also characterizes a difficult problem for users of the Internet (Kwan, 2001). Without a sense of location, distance, and necessary direction, it is not surprising that users often have a strong sense of disorientation (Kwan, 2001), the most frequently cited problem in hypermedia (Lee, 2005). Empirical research of hypermedia has suggested that disorientation often restricts the effectiveness (Lee, 2005). Users appear to become lost independent of their content domain expertise which gives reasons to think about disorientation in terms of site structure, connectivity, and design, independent of the specific information topics being navigated (Danielson, 2002).

We consider the following indicators for measuring formal skills among populations at large:

- Navigating on the Internet, by:
    - Recognising and using hyperlinks (e.g., menu links, textual links, image links) in different menu and website lay-outs.
- Maintaining a sense of location while navigating on the internet, meaning:

- Not getting disoriented when surfing *within* a website;
- Not getting disoriented when surfing *between* websites;
- Not getting disoriented when browsing through, and opening search results.

3.3 Information skills

In information literacy theory there are standards produced by several libraries and information professional bodies. These standards are all derived from the widely accepted definition of the American Library Association (ALA) (Correia & Teixeira, 2003). According to the ALA, an information literate person is "able to recognize when information is needed and has the ability to locate, evaluate and use the needed information effectively." Standards and models based on this definition initially addressed higher education and were then extended to schools (Snavely, 2001). The positive side is that some of these standards also refer to skills for participatory citizenship (Snavely, 2001). They address information-seeking which in academic research is mostly seen as an action in which a user tries to fulfil an information need. There are a number of studies in information-seeking behaviour that follow a staged approach to explain the process. The model described by Marchionini (1995) best suites digital environments. Taking cues from this model we define the first measurable step as choosing a specific system, which depends on the information seeker's previous experience with the task domain, the scope of his/her personal information infrastructure, and the expectations about the answer that may have been formed (Marchionini, 1995). After choosing a search system, a user must formulate search queries. This step is partially dynamic for Internet based search applications and there are a wide range of techniques system designers have used to assist the information seeker (Marchionini, 1995). Selecting the most relevant results is the next step and often a difficult one. When only few search results are returned, they can be scanned quickly, browsed systematically, or inspected comprehensively. However, when people use broad searching strategies in large-scale search engines, a vast number of often unsuitable results will appear (Livingstone, 2005). This problem is reinforced

by the fact that information seekers often don't venture past the first page of the search result pages (e.g., Aula & Nordhausen, 2005; Birru et al., 2004; Hargittai, 2002b). Selecting information is a process that not only occurs after using a search engine. Also within (single) webpages or websites users locate information. Finally, the evaluation of information sources is considered. Information is not always of the same quality, calling upon specific skills that enable users to check the actual correctness of data and the reliability of the sources ('the art of critical thinking' (Gilster, 1997)). We consider the following indicators for measuring information skills among populations at large:

- Locating required information, by:
  - Choosing a search system or appropriate website to seek information;
  - Defining search queries;
  - Selecting information (on websites or in search results);
  - Evaluating information sources.

3.4 Strategic skills

The three types of skill discussed so far relate to an effective use of the internet. Strategic skills are related to the purpose of this use. Van Dijk (2005) defines strategic skills as the capacity to use computer and network sources as the means for particular goals and for the general goal of improving one's position in society. A related concept is the 'usage gap' (Bonfadelli, 2002; Van Dijk, 2005), the gap between those who use technology for professional and educational development and those who mainly use it for entertainment. There is also a strong link with Bourdieu's (1984) discussion of how particular capitals (economic, educational and cultural) influence everyday lives and activities. Accumulating these capitals increases the value of the internet and will be higher for people with better strategic skills (Pruulman-Vengerfeldt, 2006).

Although strategic skills will hardly depend on operational and formal skills alone, together with information skills they serve as the means to reach a particular goal by one's own initiative. In order to acquire strategic skills, users must be critical, analytical and must have a

high degree of information skills. Strategic skills have never been measured separately, or measured at all. In our view, taking advantage of the internet is a process that entails four steps in an analytical distinction. The first step is goal orientation. This means being aware of the opportunities the web offers and selecting one or more of these opportunities for a particular personal goal. Keeping an eye on this goal and acting towards this goal, is difficult and hard to learn, especially in a digital media landscape that offers an enormous amount of distracting stimuli. The second step is taking the right actions on the Internet. This means combining the various possible information sources to achieve the best means for the goal desired. After the right actions are taken it is time to make decisions to reach the original goal by using the (often excessive amount of) information retrieved selectively. Making decisions is the third step and should be done by consulting the right information sources, relevant for work, study or personal life. The final step is gaining benefits on one or more of these areas. When the right decisions are made they can be turned into benefits of a personal, social, professional or educational nature.

Taking these four steps in consideration, we consider the following subsequent indicators for measuring strategic skills among populations at large:

- Taking advantage of the internet, by:
    - 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 belonging to this goal.

4. METHOD

4.1 Subjects

Subjects were recruited in July 2007 by a research agency that randomly dialled telephone numbers in villages and cities in the Twente region. Because literacy levels differ in cities and

rural environments the cities and villages were chosen according to a distribution that equals the national distribution of the Netherlands. A condition of invitation was that the participant acknowledged to use the internet at least once every month for more than only e-mail. Although this condition excluded around 20 percent of the Dutch population, it ensured that also low frequency users who are nonetheless familiar with the Internet are included. The invitation policy also took care that not mainly 'computer lovers' accepted the invitation by reassuring people who feared the test. Subjects were promised 20 euros for their participation in a one and a half hour research session about their internet use and were assigned according to their availability (appointment). The willingness to participate as a subject in this study was 20 percent of those first dialled.

To be able to generalize from the findings, the representativeness of the sample was deemed to be important. Ultimately a number of 109 people performed the tests following a sample procedure described below. It was unattainable to test a random sample of 800 to 1000 persons from the whole Dutch population because the labour intensity of performance tests (two hours of data collection and at least two hours of intensive analysis) is very high and because travel costs to draw subjects to the university lab nationwide would be very high. To rate the overall representativeness of this sampling approach it should be compared more to the standards of an experimental survey than a survey. Compared to the standards of an experiment the number is high. However, we think here bigger than average experimental groups are needed because we had to take in account large social and cultural differences of computer use and experience that had to be expected.

The sample procedure followed a two step approach. First a sample was randomly selected from the book/list of fixed telephony subscribers. Subsequently, a selective quota sample was drawn for the strata and quota of gender (51 male and 58 female), age (18-29: 25, 30-39: 27, 40-54: 27 and 55-80: 30) and educational attainment (low: 32, medium: 37 and high: 40).

4.2 Technical specifications

The studies were conducted in an office of the University of Twente. Although the participants were unfamiliar with the location and the computer configuration, the setting was equally new for all. During the tasks, participants used a keyboard, a mouse and a 17 inch monitor connected to a laptop not visible for the participant. The laptop connected to the Internet on a high-speed university network and provided the three most popular internet browsers (Internet Explorer, Mozilla Firefox and Opera), allowing participants to replicate their usual internet use. No default page was set on the browsers and all the assignments started with a blank page. To ensure that participants were not influenced by previous user's actions, the browser used was totally reset by removing temporary files, cookies and favourites after each session. Also, downloaded files, the history, forms and passwords were removed and the laptop was rebooted.

Using a single laptop allowed the setup of a particular software application that was required for data recording, namely Morae Recorder, used for recording the screen actions, the participants' facial expressions (using a small Webcam) and the verbal comments the participants made (according to the thinking-aloud method). Detailed log files of the recordings were created with Morae Manager (version 2.1; Techsmidt, 2007) to enable later in-depth analysis of user behaviour (not reported in this paper).

4.3 Nine performance test assignments

We prepared nine assignments that were pilot-tested with twelve participants. The assignments contained actions in retrieving online government information as this was charged by the sponsor of this study, the Dutch Ministry of Internal Affairs. The participants' performance was measured by successful completion, the main outcome, and the time (in seconds) they spent on each assignment. Both completion and time required were noted directly during the sessions. In all of the assignments, the participants themselves decided

when they were finished or wanted to give up on it. After some time a deadline of between 8 and 30 minutes appeared when the test leader gently asked the subjects to pass to the next assignment. However, no encouragements were given because the pressure to succeed already is higher in a laboratory setting than at home. All assignments were of a closed format, only one answer or action was correct. If the correct answer was not found, the task was rated as not completed. The Appendix to this paper contains the full list of nine assignments charged to the subjects. This list is the ultimate and most detailed operational definition (measurement) of the four types of digital skills specified as Internet skills discussed above.

4.4 Questionnaires

Prior to the experiment, a 10-minute questionnaire was administered to gather some personal data such as age, gender, and ethnic background and information about the frequency and location of respondents' regular Internet use, the types of activities they perform online and their social support networks. A second questionnaire was presented after the experiment. The goal of this questionnaire was to find out whether the measured level of the different skill types correlates with participants scores on several items about their internet use. Hargittai (2004) also did this to find proxy variables and questions that can be used to assess digital skills in survey questionnaires.

5. RESULTS

In this paper we will focus on the general level of the four types of Internet skills defined. The specific skill indices are analysed later. We will start by presenting a general overview of the tasks completed. Then, for every type of skill linear regression analyses are performed, both for the number of tasks completed and the time spent on the tasks, to identify factors that influence the skill level. Factors that appear significant are analysed Post Hoc (Bonferroni) to present the differences between the categories or values of variables.

5.1 General overview

According to Table 1, the participants altogether completed 7.2 of the 9 operational tasks (80%). They completed an average of 2.9 of the four formal skills tasks (72%) and an average of 1.9 of the three information skill tasks (62%). The time spent on the information tasks varies substantially. Most problematic however are the two strategic tasks of which the subjects only completed 0.5 overall or 25%. Only 11% of the subjects were able to complete both the strategic skill tasks.

Table 1
Average number of tasks completed and average time spend on the tasks (N=109)

	Average nr of tasks completed			**Time spent on tasks (sec.)**		
	M	**SD**	**%**	**M**	**SD**	**Min. / Max.**
Operational tasks (9)	7.2	2.0	80	553	254	167 / 1200*
Formal tasks (4)	2.9	1.0	72	616	255	242 / 1200*
Information tasks (3)	1.9	0.8	62	939	449	257 / 2157
Strategic tasks (2)	0.5	0.7	25	1466	575	437 / 2719

* 1200 seconds was the maximum time allowed for the nine operational tasks together.

5.2 Operational skills

According to Table 2 education, age and experience are the main predictors of the level of operational skill. They are significant both for number of tasks completed and time spent on the tasks.

Table 2
Linear regression results of the nr. of operational tasks completed and time spent (N = 109)

	Nr of tasks completed		**Time spent on tasks**	
	t	**Beta**	**t**	**Beta**
Gender (male / female)	-0.82	-.06	-1.30	-.08
Age (young – old)	-3.13	-.30***	5.11	.43***
Education (low – high)	3.86	.32***	-2.75	-.27***
Internet experience (years)	1.90	.15*	-2.56	-.18**
Weekly time online (hours)	0.55	.04	-1.44	-.10
Followed a Internet course (no / yes)	0.45	.03	-0.14	-.01
Using peers for help (no / yes)	-1.47	-.12	1.83	.13
Primary location of use (at home / elsewhere)	1.15	.08	-1.15	-.07
Working situation (inactive / active)	1.62	-.15	-1.97	-.16*
R^2	.52		.64	
F	14.02***		22.34***	

*p<.05, **p<.01, ***p<.001.

In Table 3 the ANOVA results of age and the number of tasks completed are presented. People with higher age score lower than young people on number of tasks completed ($F(1,107)=11.47$, $p<.001$) and need more time ($F(1,107)=30.95$, $p<.001$). However, according to Table 3 this effect is caused by the oldest age group that significantly differs from the other three groups for number of tasks completed and total time spent.

Table 3
ANOVA results for number of operational skill tasks completed and total time spent by age.

	Number of tasks completed			**Total time spent on tasks**	
	M	**SD**	**% of all tasks**	**M**	**SD**
18-29	8.24_a	1.51	91.6	367_a	136
30-39	8.04_a	1.22	89.3	427_b	113
40-54	7.07_a	1.88	78,6	560_b	235
55-80	5.87_b	1.96	64.1	811_c	255

Within each column, means with non-common subscripts are significantly different.

ANOVA tests for education are presented in Table 4. The high educated complete more tasks than the low educated ($F(1,105)=17.91$, $p<.001$) and also need less time ($F(1,105)=9.99$, $p<.001$). The analysis also shows that this effect is mainly caused by the level of the higher educated that significantly differs from both the lower educated ($p<.001$) and the medium educated ($p<.001$). There is no significant difference in between the lower and the medium educated for number of tasks completed ($p=.08$) and total time spent ($p=.25$).

Table 4
ANOVA results for nr. of operational skill tasks completed and total time spent by education.

	Number of tasks completed			**Total time spent on tasks**	
	M	**SD**	**% of all tasks**	**M**	**SD**
Low	6.03_a	1.86	66.7	680_a	277
Medium	7.00_a	2.17	77.2	579_a	253
High	8.40_b	1.06	93.3	432_b	178

Within each column, means with non-common subscripts are significantly different.

5.3 Formal skills

As presented is Table 5, education and age again are the main predictors for the number of formal tasks completed and for the amount of time spent on the tasks. Additionally, receiving help from others when using the Internet has a negative effect on the number of formal tasks completed ($F(1,108)=14.07$, $p<.001$). This is also the case for the location of Internet use;

people that use the Internet primarily at home score higher on formal skills than people that most often use it elsewhere ($F(1,108)=8,21$, $p<.01$). ANOVA results for age and education are presented in Table 5 and 6.

Table 5
Linear regression results of the nr. of formal tasks completed and time spent (N = 109)

	Nr of tasks completed		**Time spent on tasks**	
	t	**Beta**	**t**	**Beta**
Gender (male / female)	1.06	.08	-2.17	-.15
Age (young – old)	-2.58	.25**	5.01	.46***
Education (low – high)	2.94	-.26*	-1.98	-.16*
Internet experience (years)	1.56	.13	-1.68	-.13
Weekly time online (hours)	-0.30	-.02	-1.66	-.13
Followed a Internet course (no / yes)	1.00	.07	-0.24	-.02
Using peers for help (no / yes)	3.08	-.26**	1.65	.13
Primary location of use (at home / elsewhere)	2.40	-.18*	-0.76	-.05
Working situation (inactive / active)	1.26	.12	-1.07	-.09
R^2	.49		.57	
F	12.39***		16.46***	

*p<.05, **p<.01, ***p<.001.

Seniors complete less tasks than younger people ($F(1,108) = 9.93$, $p<.001$). Again, this effect is mainly caused by the oldest age group that significantly differs from the other three groups that do not differ among each other. Also, seniors need more time ($F(1,108)=29.20$, $p<.001$). See Table 6.

Table 6
ANOVA results for number of formal skill tasks completed and total time spent by age.

	Number of tasks completed			**Total time spent on tasks**	
	M	**SD**	**% of all tasks**	**M**	**SD**
18-29	3.44_a	0.58	86.0	449_a	157
30-39	3.08_a	0.94	77.0	457_a	145
40-54	2.93_a	0.96	73.3	657_b	197
55-80	2.13_b	1.11	53.3	859_c	238

Within each column, means with non-common subscripts are significantly different.

Table 7
ANOVA results for nr. of formal skill tasks completed and total time spent by education.

	Number of tasks completed			**Total time spent on tasks**	
	M	**SD**	**% of all tasks**	**M**	**SD**
Low	2.19_a	.98	54.8	710_a	259
Medium	2.86_b	1.06	71.8	649_a	227
High	3.38_c	.74	84.5	515_b	245

Within each column, means with non-common subscripts are significantly different.

Table 7 shows that people with high education complete more tasks than people with lower education ($F(1,108)=14.14$, $p<.001$). There is a difference between the low and the medium ($p<.01$) and the medium and the high level of education attained ($p<.05$). Also, there is a time difference between the three educational levels ($F(1,108)=6.14$, $p<.01$). This effect is caused by the score of the high educated that differs from the medium ($p<.05$) and low educated ($p<.01$).

5.3 Information skills

Regression results in Table 9 indicate that education is the only significant predictor for the number of information tasks completed. Age appears only significant for the amount of time spent on the tasks.

Table 9
Linear regression results of the nr. of information tasks completed and time spent (N = 109)

	Nr of tasks completed		**Time spent on tasks**	
	t	**Beta**	**t**	**Beta**
Gender (male / female)	-1.35	-.13	-0.15	-.01
Age (young – old)	-0.89	-.12	1.84	.23
Education (low – high)	3.12	.36***	-2.06	-.22*
Internet experience (years)	0.60	.07	0.38	-.04
Weekly time online (hours)	-1.02	-.11	0.15	.02
Followed a Internet course (no / yes)	0.27	.02	-0.85	.00
Using peers for help (no / yes)	-0.00	.00	1.82	.19
Primary location of use (at home / elsewhere)	1.12	.11	-0.75	-.07
Working situation (inactive / active)	-0.31	-.04	-1.36	-.16
R^2	.13		.23	
F	2.82***		4.67***	

*p<.05, **p<.01, ***p<.001.

According to Table 9, age does not seem to effect the number of information tasks completed ($F(1,105)=2.75$, $p=.05$). This is also presented in Table 10.

Table 10 JAN, DEZE TABEL <MAG ER VAN MIJ UIT: F IS IMMERS NIET SIGNIFICANT
ANOVA results for number of information skill tasks completed and total time spent by age.

	Number of tasks completed			**Total time spent on tasks**	
	M	**SD**	**% of all tasks**	**M**	**SD**
18-29	1.76_a	.97	59	829_a	317
30-39	2.15_a	.82	72	708_a	286
40-54	2.00_a	.56	67	884_a	388
55-80	1.57_a	.90	52	1288_b	520

Within each column, means with non-common subscripts are significantly different.

Table 11
ANOVA results for nr. of formal skill tasks completed and total time spent by education.

	Number of tasks completed			Total time spent on tasks	
	M	**SD**	**% of all tasks**	**M**	**SD**
Low	1.44_a	0.76	48.0	1119_a	489
Medium	1.78_a	0.85	59.3	972_a	372
High	2.28_b	0.72	76.0	765_b	428

Within each column, means with non-common subscripts are significantly different.

Table 11 shows that the high educated complete more tasks than the low educated ($F(1,108)=10.59$, $p<.001$) and need less time ($F(1,108)=6.21$, $p<.01$). These effects are caused by people with the highest level of education that both for number of tasks completed and time spent score better than people at the other two levels, that show no significant difference.

5.4 Strategic skills

According to Table 12 education is the main predictors for the number of strategic tasks completed. No significant time differences are reported.

Table 12
Linear regression results of the nr. of strategic tasks completed and time spent (N = 109)

	Nr of tasks completed		Time spent on tasks	
	t	**Beta**	**t**	**Beta**
Gender (male / female)	-0.72	-.06	-1.11	-.11
Age (young – old)	-1.42	-.17	-0.19	-.03
Education (low – high)	4.24	.42***	1.06	.13
Internet experience (years)	0.21	.02	0.54	.06
Weekly time online (hours)	-1.60	-.15	-1.23	-.14
Followed a Internet course (no / yes)	0.31	.03	0.47	.05
Using peers for help (no / yes)	-1.61	-.16	1.20	.14
Primary location of use (at home / elsewhere)	-0.61	-.05	-0.26	-.03
Working situation (inactive / active)	1.29	.14	-0.62	-.08
R^2	.30		.01	
F	6.09***		.84	

*p<.05, **p<.01, ***p<.001.

Again, age does not seem to effect the number of strategic tasks completed ($F(1,108)=2.51$, $p=.06$). This is also presented in Table 13. ANOVA results of education are presented in Table 14. This table clearly shows that the effect of education ($F(1,105)=24.28$, $p<.001$) mainly comes from the high educated that significantly differ from the low educated ($p<.001$) and the medium educated ($p<.001$). There is no difference between the lower and the medium educated ($p=1.00$).

Table 14
ANOVA results for nr. of strategic skill tasks completed and total time spent by education.

	Number of tasks completed			Total time spent on tasks	
	M	SD	% of all tasks	M	SD
Low	0.19_a	0.40	9.5	1376_a	581
Medium	0.22_a	0.42	11.0	1519_a	557
High	1.00_b	0.78	50.0	1491_a	593

Within each column, means with non-common subscripts are significantly different.

6. CONCLUSION

Answering research question 1 we are tempted to conclude that the Dutch population on average has a fairly high level of operational and formal Internet skills, but that the levels of information skills and especially strategic Internet skills attained are much lower. On average 80% of operational skill Internet tasks and 72% of formal Internet skills assigned have been successfully completed. Information Internet skills are completed in 62% of cases. However, strategic Internet skills are accomplished by only 25% of those subjected to performance tests. The temptation to draw conclusions about absolute levels of performance should be dimmed because we have no standards of comparison. Comparable performance tests in other countries are not available.

Putting the results in perspective we can only make three general claims. First, the Netherlands is a country with very high household Internet penetration (above 80% in 2007) and a high educated population. Results in almost all other countries in the world can be expected to be lower. Second, evidently results depend on the difficulty of tasks charged. We selected relatively simple tasks of using Internet government services, including political communication, that the Dutch government expects every citizen with an Internet connection is able to accomplish. Clearly, this expectation is not justified, at least not regarding information and strategic Internet tasks. Our third claim is that in actual Internet use, outside the artificial test situation created here, performance will be lower. In actual Internet use those tested will quit a particular Internet task earlier. In a test situation subjects are stimulated to perform, though in this case we did not explicitly spur them.

Answering research question 2 we have to conclude that educational level attained is the most important correlating factor. All performances, with all four types of digital or Internet skills, are significantly different for people with high, medium and low education. Especially the high educated perform better than the others.

Age is the second most important correlating factor. Age is significant for operational and formal skills, where seniors of the highest age group (55-80) perform much worse than the three younger age groups. An interesting conclusion is that the so-called 'digital generation' (18-29), that in this investigation also scores relatively high in operational and formal tasks, does not perform significantly better in information and strategic skills than the older age groups.

A remarkable conclusion of this investigation is that the level of digital (Internet) skills has such a weak relation with years of Internet experience and amount of hours spent online weekly. Internet experience only correlates with *operational* skills. It appears that *formal, information and strategic* skills do not grow with years of Internet experience and amount of time spent online weekly. This, and the fact that the older age groups are not inferior to the younger age groups on information and strategic skills, together temper the assumption that with the extinction of the oldest age groups, the skill problem will solve itself. This assumption is primarily based on the level of operational and formal skills.

The most important general conclusion of this investigation is that operational and formal Internet skills are a necessary but not sufficient condition for the performance of information skills and strategic skills in a digital environment (the Internet). For purposes of learning or training, operational and formal skills appear to be obligatory. Research otherwise shows that they are learned more in practice than in formal schooling or training. Only seniors learn relatively more from computer classes, books and people from their social network (de Haan & Huysmans, 2002). However, when the Internet is to be used for particular substantial

purposes (information, external goals) a special training of information and strategic skills should be added in the contexts engaged (such as particular subjects at school and training for organizational, hobby, social and citizen activities). A systematic training of information skills on the Internet is an urgent task for all levels of education, from primary to higher education.

7. DISCUSSION

This paper has shown that operational and formal Internet skills are not the most problematic and unequally divided digital skills. These are the information and strategic Internet skills. This means that surveys that usually only try to measure operational and formal skills, give a flattering picture of the actual digital skills of populations. To this problem of inadequate operational definition of digital skills the problem of validity of surveys measuring these skills should be added: particularly males rate their own skills higher than females. Our performance tests have shown that no significant gender differences exist, at least not in the Netherlands. However, on the question “How good are you in using the Internet?”, men (M=3.80) scored significantly higher than women (M=3.38) on a 5 point scale ($F(1,107)=4,55$, $p<.01$). Also in other observations of actual skills performance tests should be more valid than survey questionnaires.

The biggest problem we approached in preparing operational definitions for digital skills is the difficulty of making a distinction between digital skills in a more narrow sense, that are clearly related to the use of a particular technology, and *intellectual skills*. – In the special case of this investigation, testing the use of online government information, bureaucratic competency or knowledge of how the government works, also is an important type of skill. - This problem did not appear with operational and formal skills that are strongly related to the characteristics of digital technology (in this case computers and the Internet). The problem immediately emerges with information and strategic Internet skills. In fact they themselves

are a combination of digital skills in a narrow sense and intellectual skills. See operational definitions in sections 3.3 and 3.4. Additionally, they require the more narrow operational and formal digital skills as a necessary condition. The four skills defined are cumulative.

This means that we do not know whether the lack of information and strategic skills we have observed does (not) also appear to the same extent in the use of more traditional media and channels. This problem could be solved by adding comparable information and strategic skills tasks in performance tests of the use of other media, first of all print media. A comparison of the results of all these tests could show whether 1. the use of the Internet channel makes a difference and 2. whether Internet use is an aid to achieve better information and other results or introduces another barrier because many people do not master the digital skills (in a narrow sense) required. This extension is a potential job for further research.

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Appendix 1 Assignments

Operational skill assignments

Assignment 1 (max. 12 minutes)

Task 1.1 Go to the website of the Dutch Tax and Custom Administration (www.belastingdienst.nl).

Task 1.2 Click on the link 'Download and order' in the menu on the right.
Click on the subject 'Marriage', placed in the column 'private'.
Click on the link to the brochure 'When you are getting married'.

Task 1.3 Open the brochure 'When you are getting married'.
Save the brochure in the folder 'Marriage' on the desktop of the computer.

Task 1.4 Use the back-button to go back to the 'Download and order' page.

Task 1.5 Click on the link 'Declaration 2006' placed in column 'private'.
Click on 'Declaration software 2006 (Windows)'

Task 1.6 Save the file 'Electronic declaration IB 2006 for Windows' on the desktop.

Task 1.7 Go back to the homepage of the Dutch Tax Administration.
Add the homepage to the favourites (or bookmarker).

Task 1.8 Use the search engine on top of the website using the keyword 'save-as-you-earn deduction'
Open the third search result of the search assignment.

Assignment 2 (max. 8 minutes)

Task 2 Go to the Child care allowance website of the Dutch Tax and Custom administration: www.toeslagen.nl/kinderopvangtoeslag/
Complete the fields using the information given.

The first assignment tests whether a participant is able to perform some basic operations, including clicking a link, saving a DPF, downloading files, adding a website to the Favourites and performing a search operation. In Task 2 participants show that they are able to complete a web based form.

Formal skill assignments

Assignment 3. (max. 10 minutes)

Task 3.1 Go to the website of Postbus51, www.postbus51.nl.
Follow the options *Accommodation / Rent / Rental price/ Rent Subsidy*.
Choose the option: 'What is rent subsidy and how do I apply for it?'

Task 3.2 Click on the link *'Applying for rent subsidy'*.
Go to the homepage of the Allowance website in the new window.
Go back to the homepage of Postbus51 in the old window.

Task 3.3 Perform a search on the Postbus51 website with keyword 'rental price'.
Open the first search result.
Open the second search result.

Assignment 4 (max. 10 minutes)

Task 4 Imagine you just moved to Nijmegen. You would like to look up the physical office addresses of the following organisations: IB-Groep, UWV and CWI.

The first assignment tests whether a participant is able to follow multiple links in a menu and doesn't get disorientated when a new window is opened. In Task 3.3 participants show that they can browse and open (more than one) search results. The second assignment tests

whether participants are able to locate similar contact information in different website layouts and designs. Information skills are not really necessary here since the information is kept very simple.

Information skill assignments

Assignment 5 Parking (max. 12 minutes)

Task 5 Imagine, you just moved to Rotterdam. Because it is hard to find a parking spot, you decide to buy a subscription to a car park. Find out how much a subscription to the car park named 'Spaanse Kade' costs. Use the homepage of the municipality of Rotterdam (www.rotterdam.nl).

Assignment 6 Theft (max. 12 minutes)

Task 6 Imagine, during a day at the shopping mall your passport is stolen. Use a search engine (e.g. www.google.nl, or the one you use at home) to find out what type of document you need to apply for a new passport after the old one is stolen?

Assignment 7 Salary (max. 12 minutes)

Task 7 Imagine you're 25 years old. In between September the 1st and December the 30th you had a full time job in a factory (40 hours / week). Your wage was 1275 euro gross every month. This wasn't much. Use a search engine (e.g. www.google.nl, or the one you use at home) to find out whether you were entitled for more salary during this period? (Yes, because the salary was lower than _ euro. / No, because the salary was higher than _ euro)

In assignment 5 subjects have to find information in a closed environment, one specific website. Assignment 6 and 7 are open web tasks (no specific homepage or search engine).

Strategic skill assignments

Assignment 8 Salary (max. 12 minutes)

Task 8 When your employer paid you too little, what financial benefit can you then personally obtain? Sort this out using the internet.

Assignment 9 Elections (max. 30 minutes)

Task 9 Image that there are national elections soon. You are in doubt whether to vote for the PvdA, the CDA or the VVD. You have the following opinions:

You are in favour of using nuclear energy;
You are in favour of a high child care allowance;
You are against having two nationalities.

Using the Internet, find out which of these three political parties have your first, second and third preference.

In assignment 8 participants need to define specific search queries and select proper resources. The answer is quite easy; reclaiming missed salary. Assignment 9 demands that subjects visit the websites of the political parties or combine the parties' names with a specific position in a search engine.