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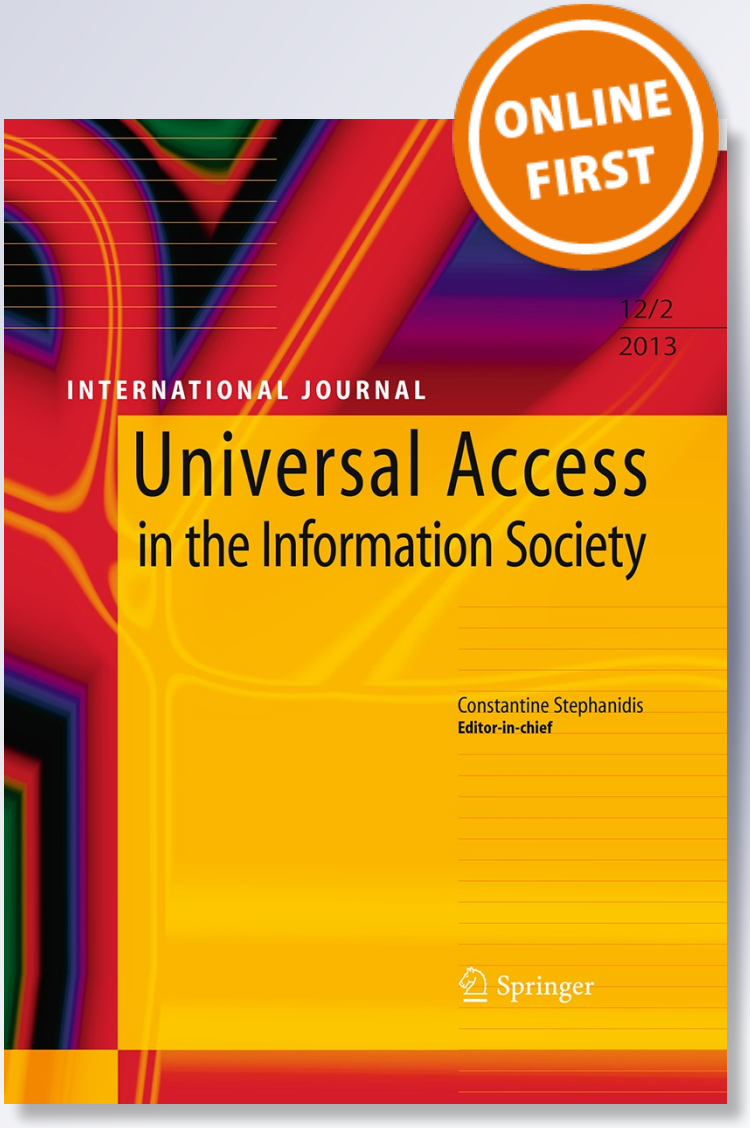
**Universal Access in the Information Society**
International Journal

ISSN 1615-5289

Univ Access Inf Soc
DOI 10.1007/s10209-013-0304-5




Springer

Univ Access Inf Soc
DOI 10.1007/s10209-013-0304-5

LONG PAPER

# Self-assessed and actual Internet skills of people with visual impairments

**Thea van der Geest · Hans van der Meij · Carolina van Puffelen**



**Abstract** The Internet can make available to people with a visual impairment information and services that are otherwise inaccessible. But do visually impaired users actually use common Internet applications and do they have the necessary skills? This article reports a two-part study addressing these questions. The first part was an interview study in which 73 young and 69 older Dutch people with a visual impairment were questioned about usage of applications such as e-mail, chat, and web forms, and their self-perceived competence. The young participants reported more frequent use of Internet applications and mentioned multiple goals (i.e., social and educational), compared to the older. Both groups considered themselves reasonably competent, with the young rating themselves higher. The second part was a case study with 20 young and 20 older participants from the first study, who performed common Internet tasks, using websites or applications that complied with accessibility guidelines. Task performance was analyzed in detail for demonstrated skills. Actual performance proved to be unrelated to self-rated competence. Moreover, the competence of both young and older participants fell far short of what active participation in society requires, especially for the more complex information and strategic skills. The success rate on the performance tasks was low. People with a visual impairment should receive extensive support for the acquisition of higher-level skills that are called upon when using Internet information and services in order to participate in society.

**Keywords** Internet usage · Internet skills · Visual impairment · Accessibility · Self-assessment · Performance measurement

## 1 Introduction

The Internet and in particular the World Wide Web has become the primary source of information and entertainment for many people. The Internet is also developing into an important channel for services and transactions. As the role that the Internet plays in people's lives becomes increasingly prominent and essential, the issue of unintended exclusion becomes more pressing. It is important to know who is likely to be deprived of universal access to communication, information and services that are moved to the Internet. This is especially critical for people with various types of disabilities. Internet applications have the potential to empower them, because they can have content presented to them in the modality or form they prefer or need. They can also access information and services at the place, the pace and the time they prefer or need. However, they must have sufficient mastery of Internet skills in order to benefit from the potential of the Internet.

Traditionally, issues of access, exclusion and the digital divide have been approached from the standpoint of physical access to technology. In many West-European

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Published online: 05 July 2013

countries, household access among the population at large is 70 % or higher; in the Netherlands, where this study was conducted, access at home has reached 90 % [1]. In these countries it is no longer the physical access to computers that is most important; instead, what becomes critical is what the users can do (skills) and actually do (usage) on the computers that are available to them. In response to the finding that many studies on Internet usage and skills were limited in scope, lacked a precise definition of skills and depended mainly on surveys with self-assessment questions, Van Deursen and Van Dijk [2, 3] proposed a new framework for understanding Internet access.

This paper is based upon that framework, but whereas Van Deursen and Van Dijk [2, 3] examined a representative sample of the Dutch population at large, this study concentrates on Internet use by young and older people with a visual impairment. More specifically, it addresses the following questions: (1) What types of Internet applications (e-mail, chat, web forms and information search) are used by people with a visual impairment, and for which purposes? (2) How do people with a visual impairment perceive their skill level in using these applications and do their self-assessed skills match their actual (demonstrated) skills?

Surprisingly enough, little is known about the Internet skill level of people with a severe visual disability. Policies for improving their access to Internet services and information have focused on making the websites and applications meet accessibility guidelines, without taking into account whether or not the users have acquired the skills needed for access.

The first part of this article describes a self-assessment study in which visually impaired young and older people (vision $\leq 0.3$) were interviewed on their use of Internet applications and their perceived Internet skills. The second part is an extensive case study, in which a sample from the target population was asked to perform a set of Internet tasks. Their performance was analyzed in detail for demonstrated skills, and then also compared to their self-rated skills to examine the relationship between self-assessed and actual skills.

## 2 Background

### 2.1 From digital divide to digital literacy

This section focusses on the issues of Internet access and usage. The word *access* is often used to mean easy availability of the devices and the network, that is, the physical prerequisites for using the Internet. Usage, on the other hand, refers to knowing about, wanting to work with and actually working with Internet applications.

For most people, having physical access simply means having a computer with an Internet connection available. For visually impaired people it is somewhat more complex. Many of them also need assistive technologies to get access to the Internet. They may depend upon a screen reader for reading out the text, a screen magnifier for enlarging a portion of the screen, or a Braille reader for a tactile representation of the content of the site. This dependency on assistive technology has two important drawbacks. First, people must have access to and be capable of using these additional devices. The second drawback concerns technological delay. Invariably, assistive technology lags behind hardware and software developments. This means that people with a visual impairment must overcome more physical obstacles for gaining access to the Internet than other people [see 4–11].

Until recently, the barrier of physical access to the Internet has been referred to as the digital divide, e.g., by [12, 13]. But as more and more people have acquired computers and connected them to the Internet, this meaning of the term has eroded. Indeed, in 2006 a Ministerial Conference on e-Inclusion came to the conclusion that the physical digital divide now tends to be superseded by a digital divide that relates to frequency and quality of use [14]. In other words, as the physical problem of Internet access, the 'old' digital divide, has largely been solved in Western countries, another type of digital divide has emerged, namely that of Internet skills and usage [12].

The various facets that fall under Internet skills and usage are sometimes subsumed under the term digital literacy, which has been defined as the ability to understand and use information from a wide range of Information and Communication Technologies [15]. It has been surprisingly difficult to measure digital literacy in a satisfactory way, however. Researchers have found it hard to capture the broad range of activities that are encompassed and frequently fail to offer a precise definition of the component skills [16].

There is a framework that is rapidly gaining recognition as a comprehensive means for examining Internet skills and usage [13, see also 2, 3, 17]. According to this framework, one should look at the main areas of participation in society that Internet usage affords and the various skill types that are involved in such uses. [13] distinguishes seven areas of participation: economic, spatial, cultural, political, social, educational and institutional. This study focuses on the last three areas. Participation in these three areas depends, according to [13], on people's awareness of the affordances of the Internet for realizing a goal in that specific area. For instance, to engage in social participation through the Internet one should know, among other things, that the Internet can be used to connect to people. To engage in institutional participation through the Internet

one should know, among other things, that many governmental departments provide their information and services through websites, and one must be able to fill out web forms for getting access to web services. In addition to being aware of the possibilities for participation, people also need to be motivated to pursue these goals within this medium.

This article begins by detailing the social, educational, and institutional areas of participation (Sect. 2.2). In part 1 of the study, people with visual impairments were interviewed about their use of Internet applications, eliciting their goals or reasons for using the applications, seen as expressions of the goals they pursue in particular areas of participation. Respondents were asked to rate their own skill level for each of the Internet applications that they reported using.

### 2.2 Areas of participation in society

The use of the Internet for *social participation* is now widely accepted as an alternative to, and extension of, 'face-to-face' and telephone communication with friends, relatives, groups or communities. The possibilities of the Internet, e-mail, chat and newer social media such as Facebook and Twitter have added a new dimension to social contact and civic engagement. Like more traditional communication channels, they can help create a sense of community and belonging. Social networks that are formed and maintained online are acquiring an ever more important role in people's social lives. Lack of skills in this area excludes people from building such social networks, and from benefiting from the accompanying' social capital'.

Internet usage has become indispensable for *educational participation,* especially in higher education at present; this will also be the case for other levels of education in the near future. In many schools, the use of the Internet and electronic learning environments is a built-in feature. Teachers use these environments to distribute course content, stimulate educational activities, store student products and administer tests, among other functions. Students apply the technology for sharing and exchanging ideas, actively exploring simulations and explanatory materials, searching for new information, and many more activities. Students with a visual impairment can benefit from these opportunities even more than regular students. The Internet offers them access to regular and special needs education in the school as well as at home, and it enables them to use the same learning materials that are available to other students. If the students lack the skills to engage in the related tasks, their school career is at risk. The young respondents in the conducted study all were of school age, so they were asked in particular about their use of Internet applications for educational purposes.

Internet usage for *institutional participation* has also gained widespread popularity. An increasing number of commercial and public institutions such as banks, insurance companies or health care organizations have made their information and services available on the Internet for potential customers, clients and citizens. Some organizations have already made their website(s) the primary venue for informing or helping people, or are about to do so. For instance, the Dutch government is currently planning to deploy personalized websites for citizens to handle transactions for tax filing, rent, healthcare subsidies and childcare compensation. It is easy to imagine that this could lead to exclusion from services for people who lack the skills to use these applications. The same applies for getting access to health information or customer support. As the Internet quickly becomes a major portal for informing patients about the treatment of diseases, and for consumers seeking to communicate with customer support, those who lack the necessary Internet skills will be left behind. The answers of older participants in the conducted study focuses in particular on their use of Internet applications for institutional participation.

The study reported in this paper focuses on Internet usage by people with visual impairments within the areas of social, educational (young) and institutional (older) participation, which are considered as essential and exemplary forms of participation in society.

## 3 Part 1: study of Internet usage and self-assessed Internet skills

### 3.1 Research questions

The first part of the study focuses on the usage of Internet applications and self-assessments of the skills needed to use them. It examines the views of young and older people with a visual impairment about their own uses of the Internet. The study was conducted by means of a structured interview over the telephone. The research questions for this part of the study were:

1. How often and for how many hours in the past week did the participants use a specific Internet application, e.g., e-mail?
2. For which purposes did they use the specific Internet application?
3. How did the participants rate their skills at using the specific application?

The focus is on a set of applications that encompass the key activities of synchronous or asynchronous communication (e-mail, chat), information retrieval and exchange (information search and interpretation) and transactions and services (web forms).

### 3.2 Participants

In the Netherlands, three organizations (Bartimeus, Sensis and Visio) provide state-funded support for visually impaired people. They offer care, rehabilitation, training and assistance for all people with a vision of 0.3 or less. Computer training is one of the services that these organizations provide. The authors were requested to conduct an exploratory study on the effectiveness of computer training in terms of empowering people to participate in society. Two inclusion criteria were used to select the participants in the study.

First, a participant needed to have taken part in computer training provided by one of these organizations in the 3 years preceding the study. For the majority of the selected young people, their most recent training was part of their special needs education, e.g., a Laptop Boot Camp week. Most of the selected older participants had taken part in a care and rehabilitation program that included computer and Internet training, and took 2 h per week over a period of 36 weeks.

Secondly, the participant needed to be at least 10 years old and in the primary or secondary school system (young), or over 55 years old (older). The exclusion of participants from the intermediate age group was based on the pragmatic consideration that relatively few people in that age group qualify for state-provided support and care. They constitute only a small portion of the target audience for the training provided by the three support organizations.

It was planned to include a random selection of 75 young and 75 older participants with a visual impairment in the study. This would have constituted 13.6 % of the total population matching the selection criterion of having received training in the past 3 years. For reasons of privacy, recruitment was done by a representative of the organization that provided the training. The response rate was relatively high, with 77 % of the young and 98 % of the older accepting the invitation to participate in the interview study. Attrition was low. Those who initially agreed to the interview but later withdrew did so due to health-related problems (4 cases), involvement in other studies at the same time (2 cases) and because they could not be reached after repeated attempts (2 cases).

The mean age of the 73 young participants is 14.3 (range 10–19), with slightly more boys than girls (56.2 vs 43.8 %). All young participants attend primary or secondary school. The large majority attend special needs schools where digital skills training, including Internet usage, is part of the curriculum. Students in mainstream schools receive extra support from a specialized teacher. Nearly all of them have had their impairment from birth. About one in four (24.7 %) use a Braille reader, nearly half use a screen reader or magnifier (47.9 %).

The mean age of the older participants is 68.6 (range 56–88), with slightly more male than female respondents (58.0 vs 42.0 %). For a small group of older participants (7.4 %) the highest completed formal education was primary school. About sixty percent (60.3 %) had completed secondary education. Just under a third (32.3 %) finished tertiary education. Nearly all the older participants developed their visual impairment later in life. A small number (6.7 %) of them use a Braille reader, whereas over eighty percent (82.6 %) work with a screen reader or magnifier.

### 3.3 Instrument

The study employs a structured interview consisting of a mix of closed and open-answer questions. The first section of the interview contains questions about personal characteristics such as age, education level, and type of visual impairment. The second section revolves around questions on the use of Internet applications and self-appraisal of skills needed for using those applications. These questions address specific features or applications such as e-mail, chat, information search and web forms. The full set of interview questions (in Dutch) is available from the authors upon request.

### 3.4 Procedure

The interview was conducted by telephone. After a brief introduction by the researcher, each interview started by requesting the participants' informed consent and recording it. For the young participants this meant obtaining consent from one of their parents. To ensure that participants fully understood the questions about features or applications, the interview followed a three-part sequence.

First, an application was described to the participant. For example, web forms were introduced as follows: "The following questions all deal with web forms. These forms are fields on a web page that you can fill in. For example, people often need to fill in a web form to request a brochure or to buy a product."

Second, a series of questions followed about usage in relation to goals. For example, after indicating that they used the Internet for searching information, respondents would be asked a follow-up question about the different goals they seek to satisfy by doing this: "In searching for information, what information are you typically looking for?" These follow-up questions probed respondents to be specific. Responses were later classified as corresponding to a social, educational or institutional area of participation.

Third, for applications such as e-mail and chat there was a question about frequency (i.e., "How many hours did you spend last week on x?"). Finally, for all the Internet applications that the respondents reported using, they were

asked to self-assess their skills (i.e., "How good do you think you are at using x?") on a five-point Likert scale, ranging from 'not good at all' to 'very good'.

The complete set of interview questions was represented in flow-chart format on the interviewer's computer, using the program Softcall to guide the researcher through the telephone interviews. For closed questions the researcher could check off the appropriate boxes in the program. Answers to open questions were summarized on the spot and the summary typed in, and later checked against the recorded session. A typical interview took about 45 min to complete.

### 3.5 Data analysis

In comparisons between young and older participants on their usage of Internet applications a Chi square statistic, in every case with 1 degree of freedom (*df*), was used to test for statistical significance. To avoid the risk of inflation from repeated testing, alpha was uniformly and conservatively set at 0.001 for these tests. For within-group comparisons (e.g., to test whether the young respondents used an application significantly more often for social than for educational participation), the baseline assumption was a binomial distribution for presence or absence. In these cases, a score above or below 3.29 standard deviations from the mean, meaning an alpha of 0.001, signaled statistical significance. For statistically significant findings Cohen's *d* statistic was use to report effect sizes. A *d*-score between 0.20 and 0.50 signals a small effect, between 0.50 and 0.80 the effect is of medium size, over 0.80 the effect is considered large.

### 3.6 Results and discussion

#### *3.6.1 Usage of Internet applications*

What types of Internet applications (e-mail, chat, web forms and information search) are used by people with a visual impairment? A large majority of the young participants indicated using e-mail, chat, web forms and information search (see Table 1). Their usage rate was lowest for web forms, but still more than seventy percent of the young participants said they employed this type of Internet application. Most of the older participants used e-mail and information search. Fewer than half used web forms (40.5 %), and only a few older respondents said they chatted (10.1 %). The higher reported usage for young participants represented a statistically significant difference from the reported usage of older participants for all applications except e-mail.

Participants were also asked to indicate how much time they had spent using an Internet application during the week before the interview. There were large differences between and within participant groups in this respect. Young participants spent the most time chatting, for an average of 7.5 h a week (range 0–48 h; s.d. = 10.48). Usage of e-mail by the young participants took up much less time, with an average of 1.5 h a week (range 0–12 h; s.d. = 2.53). Only a few older participants used chat, and these participants also chatted for a relatively short amount of time. Their average chat time was 1.85 h per week (s.d. = 1.75), an average that was raised considerably by one exceptional older person who reported spending 20 h per week chatting. For this group, e-mail was a more prominent communication channel. They spent on average 2.5 h a week on e-mail (range 0–10 h; s.d. = 2.27).

**Table 1** Usage of Internet applications

| | E-mail | Chat | Web forms | Information search |
|---|---|---|---|---|
| Young ($n = 73$) | 84.9 % | 79.5 %*** | 72.6 %*** | 97.3 %*** |
| Older ($n = 69$) | 82.6 % | 10.1 % | 40.5 % | 71.0 % |

Chat: $\chi^2 = 68.65$, $p < 0.001$; Web forms: $\chi^2 = 14.85$, $p < 0.001$; Information search: $\chi^2 = 18.16$, $p < 0.001$

*** $p < 0.001$

These frequency data indicate that in general the older use Internet applications less often than the young, and also that they spend less time using each application. E-mail is an exception. The two groups do not differ in their e-mail usage, and the average number of hours per week spent using e-mail is higher for the older than for the young.

#### *3.6.2 Areas of participation for Internet use*

Participants were prompted to state the concrete goals for which they used an Internet application. Their answers on this open-answer question were then analyzed to determine the area(s) of participation to which they were referring. For example, when a young participant indicated using e-mail for contacting friends and family, the answer was coded as e-mail usage for social participation, and when this same participant told of also using e-mail for handing in school reports, it was coded as e-mail usage for educational participation.

Table 2 show the area(s) of participation for which a specific Internet application was used by the respondents. The percentages in the tables are computed by dividing the number of people who mentioned a usage goal by the total number of people who reported using a particular Internet application. For example, in Table 4 the score of 79 % for social usage of e-mail by the young is computed by dividing 49 by 62. It indicates that 49 out of the 62 young

**Table 2** Use and areas of participation for usage

| | Use | Social | Educational/institutional |
|---|---|---|---|
| E-mail | | | |
| Young | 84.9 % ($n = 62$) | 79.0 % ($n = 49$)[a] | 59.6 % ($n = 37$) |
| Older | 82.6 % ($n = 57$) | 100 % ($n = 57$)[a] | 38.6 % ($n = 22$) |
| Chat | | | |
| Young | 79.5 %*** ($n = 58$) | 100 % ($n = 58$)[a] | 86.2 % ($n = 50$)[a] |
| Older | 10.1 % ($n = 7$) | 100 % ($n = 7$) | 0 % ($n = 0$) |
| Web forms | | | |
| Young | 72.6 %*** ($n = 53$) | 71.7 % ($n = 38$) | 32.0 % ($n = 17$) |
| Older | 40.5 % ($n = 28$) | 14.3 % ($n = 4$)[b] | 50.0 % ($n = 14$) |
| Information search | | | |
| Young | 97.3 %*** ($n = 71$) | 76.1 % ($n = 54$)[a] | 97.2 % ($n = 69$)[a] |
| Older | 71 % ($n = 49$) | 22.4 % ($n = 11$)[b] | 77.6 % ($n = 38$)[a] |

Comparisons between groups: *** $p < 0.001$

[a] Score is significantly higher than chance expectations

[b] Score is significantly lower than chance expectations

participants using e-mail mentioned one or more purposes that fell within the area of social participation.

Many young participants indicated that they used all four Internet applications for social purposes, with chat especially dedicated to this purpose. That is, all chatting young respondents indicated using it for social participation. Usage for educational purposes varied more across applications for the young. For this area of participation, the use of chat and of information search was significantly above chance expectations. Use of e-mail and of web forms was neither extremely low nor high in this respect. Within-group comparisons did not reveal any statistically significant difference between participation areas (i.e., social or educational). In other words, when a young participant used a particular application, it was for social as well as educational reasons.

For the older, the outcomes were more varied; there was a stronger connection between an application and a specific area of participation. All the older respondents who used e-mail (83 %) and chat (10 %) said they used these for social reasons. Within-group comparisons revealed that e-mail use for social purposes significantly outnumbered its usage for institutional purposes, $\chi^2 = 15.51$, $p < 0.001$. Web form usage and information search by the older yielded the opposite outcome, namely that usage for institutional purposes was prevalent. Within-group comparisons for information search revealed a statistically significant difference favoring institutional participation, $\chi^2 = 14.88$, $p < 0.001$. Social use for web forms and information search was significantly below chance-level expectations.

In summary, a significantly greater proportion of young respondents said they were using chat, web forms and Internet search, compared to the older respondents. For the young, usage type is also more evenly spread over social and educational areas of participation. Older respondents reported a less diversified use of Internet applications for areas of participation. That is, this group said they were using e-mail mainly for social purposes, and web forms and information search for institutional participation.

### 3.6.3 *Self-appraisals of skills*

The participants' self-appraisals of their skills at using e-mail, chat, web forms and information search are shown in Table 3. With mean scores around four on a five point scale for all applications, the young respondents express a relatively strong belief in their own competencies. Older respondents consistently rate themselves lower in competence compared to the young on all Internet applications. With effect sizes ($d$) of 0.80 and higher, the difference in self-assessment scores between the young and older is large.

### 3.6.4 *Discussion of usage and self-assessed skills*

This part of the conducted study examined the usage of Internet applications and looked at the self-assessed usage skills of young and older people with a visual impairment. The research was driven by questions such as to what degree and for what purposes people with visual disabilities use Internet applications and how skilled they consider themselves to be at Internet use.

The young respondents reported frequent usage of all four applications included in the study: e-mail, chat, web forms (for access to web services) and information search. The older said they used Internet mainly for e-mail and information search. The young claimed to use all applications primarily for social purposes and less for education. In contrast, the older mentioned that they used e-mail for social purposes, and web forms and information search for institutional participation. The few older respondents using chat said they did so for social reasons.

The young expressed great confidence in their Internet skills. This was even true for web forms, which they indicated using the least. The older gave significantly

**Table 3** Mean self-appraisals+ of skills for Internet applications (standard deviations in parentheses)

| | E-mail | Chat | Web forms | Information search |
|---|---|---|---|---|
| Young ($n = 73$) | 4.18 (0.53) | 4.21 (0.55) | 3.96 (0.55) | 4.03 (0.48) |
| Older ($n = 69$) | 3.65*** (0.67) | 3.86 (0.90) | 3.36*** (0.91) | 3.22*** (0.87) |

+Scores vary between 1–5: 1 = very poor; 2 = poor; 3 = neutral; 4 = good; 5 = very good

Comparisons between groups *** $p < 0.001$: $F_{\text{e-mail}}(1,117) = 23.07$, $p < 0.001$, $d = 0.88$; $F_{\text{chat}}(1,63) = 2.15$, n.s.; $F_{\text{web forms}}(1,79) = 13.82$, $p < 0.001$, $d = 0.80$; $F_{\text{information search}}(1,118) = 42.11$, $p < 0.001$, $d = 1.15$

lower, but still positive self-assessments of their skills in handling e-mail, web forms and information search.

The results of part 1 of the study give a relatively positive view of the use of Internet applications by young and older people with visual impairments. Of the young respondents, all of whom had received training in computer or Internet use in the past 3 years, 72–97 % used standard applications such as e–mail and search. The older reported high numbers for e-mail usage (82.6 %) and information search (71 %), with slightly over 40 % using web forms that are typical for various web services. Overall, both groups are relatively self-confident about their skills in using those applications. The next research step was to check whether they indeed have the types and levels of skills that could support them in using Internet applications to truly participate in society.

## 4 Part 2: case studies of actual Internet skills

### 4.1 Research questions

As everyone who has ever struggled with an Internet application can attest, knowing what to use the Internet for and wanting to use the Internet for a particular goal is not the same thing as actually being able to achieve one's goal. The research literature on Internet skills has shown that self-assessments of Internet skills are not necessarily a good indicator of the actual, demonstrated skills seen when people perform Internet tasks [16, 17]. Taking this into account, a follow-up study was conducted with the same group of respondents. It was decided to examine the actual Internet skills of a number of respondents and compare them against their self-assessed skills. The research questions for part 2 of the study were:

1. To what extent are people with a visual impairment able to perform common tasks with Internet applications?
2. Which specific Internet skills do they demonstrate when performing common Internet tasks?
3. Are self-assessments of skills good predictors of the actual, demonstrated Internet skills of people with visual impairments?

From the respondents in part 1 of the study who volunteered for the follow-up skills test, 40 cases (20 young and 20 older) were randomly selected and asked to perform a set of tasks. Their screen actions and task performance were analyzed in detail, using a four-tier skills hierarchy as the framework for analysis.

### 4.2 A typology of Internet skills

Obviously, Internet use not only depends on intentions and goals, but also requires mastery of a complex set of skills, such as those involved in activating programs, opening websites, making appropriate choices from menus, conducting searches, interpreting and applying the findings, etc. Van Dijk en Van Deursen [2, 3, 13] have classified Internet skills into four main types: operational, formal, information, and strategic skills. In addition, they suggest that there is a hierarchical relationship between these skills. Each skill type is described below. "Appendix 1" presents the operational definitions.

*Operational skills* enable people to handle the computer hardware and software, the equipment for the Internet connection and, for the visually impaired, the assistive technology. Operational skills are nicknamed 'button knowledge' in reference to the fact that these skills are mainly about knowing what key(s) to press. Operational competency enables people to perform actions such as those needed to activate a program, save a file, print a text, and navigate a menu or website.

*Formal skills* concern the particular formal characteristics of the Internet and the skills needed to master them. The nodes and links structure is typical of the Internet. With formal skills, people can recognize and access nodes that are linked to other websites on the Internet. In addition, these skills encompass browsing and navigating, and include maintaining a sense of location while navigating.

*Information skills* enable people to seek, search, select and process information to meet their goals. Sometimes these skills are referred to as information literacy skills. With information skills people can perform actions such as formulating a search question, defining appropriate search terms, formulating effective queries in a search engine, selecting the relevant information from a website, and assessing the credibility of web information.

*Strategic skills* are related to the various purposes for which people use the Internet. They help people achieve their personal goals by applying the resources they find on the Internet. With these skills people can exploit what has been called the Internet's digital capital. Strategic skills help people to make decisions and achieve what they set out to do, in a way that best serves their needs and interests. In the end, strategic skills result in improving people's quality of life and/or their position in society. Compared to the others, these skills are more abstract and difficult to observe.

The four skill types presumably build upon each other hierarchically [2, 3]. Operational skills form the foundation for gaining access to the Internet. On the Internet itself, formal skills help people to know their whereabouts when surfing different web pages and websites. On top of these, information skills are needed to search for information. And finally, strategic skills are needed to be able to use the Internet for one's personal goals or benefit.

As part 2 of the study, all screen actions of 20 young and 20 older respondents who were performing six common Internet tasks were recorded, and each of their actions was labeled with the skills demonstrated.

### 4.3 Participants

All participants from the interview study (part 1) were asked whether they would also agree to take part in the performance study (part 2). Of those who consented, 20 young and 20 oldery participants were randomly selected. It was checked whether these 40 participants were representative for the whole group of participants for study 1, which proved to be case. The answers of both groups on the personal, computer usage and skills self-appraisal questions in the interview were compared; the comparison showed that there were no statistically significant differences between the selected cases and the other respondents from part 1 of the study.

### 4.4 Instruments

Participants were asked to complete three Internet tasks from the social area of participation and three tasks from the educational (for the young) or institutional (for the older) area of participation (see Table 4, "Appendix 2" presents more detailed descriptions). There was no chat task, because part 1 of the study had revealed that only a few older ever chatted.

An effort was made to match the complexity and skill-dependency of the educational assignments for the young with those of the institutional assignments for the older. When a task involved the use of a specific website, that site met the first priority level (A) for accessibility (WCAG 1.0) and carried the Dutch 'Drempelvrij' [Barrier-Free] quality seal for accessible websites.

Information and task analyses were conducted to determine all the specific action steps that participants would need to take in order to complete the task. These steps were then categorized as requiring operational, formal, information or strategic skill, following the classification of [13]. Typically, most tasks consist of a set of action steps that call upon the mastery of two or more skill types and that may also call upon the same skill type repeatedly. Table 5 illustrates the breakdown into action steps and the kind of skill types entailed for the most complex task. Table 5 also shows the level of skills mastery demonstrated by the participants in part 2 of the study in performing that task. For all six tasks together, the

**Table 4** Overview of the six tasks in performance study

| Internet application | Task | Area of participation |
|---|---|---|
| E-mail | #1 Compose and send an e-mail with an attached file to someone you know | Social |
| | #2 Download a specific file (brochure), save it on your desktop, and send it as an e-mail attachment to the researcher at the university | Educational/Institutional |
| Web forms | #3a Fill in the web form of a public transportation trip planner (young) | Educational |
| | #3b Fill in a web form to calculate health care subsidy (older) | Institutional |
| Information search | #4 Look up the telephone number of a support organization | Social |
| | #5a Search for information on Roman highways for a school history project (young) | Educational |
| | #5b Search for information on the required document when passport is stolen (older) | Institutional |
| | #6 Select an appropriate trip destination/hotel on the basis of various contradictory criteria | Social |

**Table 5** Action steps within a task and classification into a skill type

| Action steps for task #6: Select an appropriate trip destination/ hotel on the basis of various contradictory criteria | Skill type | Skill mastery | |
|---|---|---|---|
| | | Young ($n = 20$) | Older ($n = 20$) |
| Locate a search engine | Information | 100 | 100 |
| Define the search terms | Information | 85 | 71 |
| Type the keywords in a search field | Operational | 95 | 76 |
| Open the search results | Operational | 100 | 100 |
| Examine more than one result | Information | 75 | 29 |
| Navigate between websites | Formal | 95 | 47 |
| Use hyperlinks | Formal | 80 | 65 |
| Compare the findings with the criteria | Strategic | 35 | 29 |
| Make the best decision based on the outcomes | Strategic | 25 | 6 |

Skill mastery in %

number of action steps per skill type was as follows: operational skills (24); formal skills (9); information skills (8); strategic skills (3).

### 4.5 Procedure

The performance study was conducted 2–3 months after completion of the interviews in part 1 of the study. All participants completed the Internet tasks either in their school or their own home. Besides saving them a cumbersome journey, conducting the study in situ was also expected to be more comfortable, more relaxing and, consequently, more realistic. In addition, and perhaps just as importantly, it afforded the opportunity to assess the participants' skill under more or less optimal conditions, namely when they could use their own assistive technology and personal settings on the computer.

The participants' behavior was recorded by a video camera to capture their actions on keyboard and screen. We decided not to use a logging program because of the risk of interference with the assistive technology or accessibility settings of the respondents' computers.

After a brief personal introduction, the participants were asked to be seated at their computer and to complete six tasks. They could work at their own pace and take as long as they wanted. Each task was read aloud and the researcher repeated the instructions as often as the participant requested. Participants were asked to signal to the experimenter when they thought they had completed a task and/or wanted to stop working on it. They were asked to comment on the task or the applications whenever it occurred to them, during or after the task.

### 4.6 Coding and data analysis

For each task, two performance measures were computed: (a) successful task completion, and (b) mastery of skill types. Successful task completion is simply a measure of having performed all the right actions to accomplish a task. Mastery of skill types is a more fine-grained measure. It is the mean success for completing an action step within a task. An example of the outcome of such an analysis is given in Table 5. The left column describes the individual action steps that constitute task performance. In the skill type column, each step is classified as fitting into one of the four skills categories. Finally, in the skill mastery columns, the percentage of all participants who successfully completed an action step is given.

[2, 3, 13] indicate that the four skill types build upon each other, that there is a hierarchical relation among them (i.e., Operational → Formal → Information → Strategic). This relation is examined through correlational analyses. That is, if a hierarchy among skill types exists, the correlational analysis should show a gradual decline in strength of the relation with each higher skill level.

To examine whether the participants' self-appraisals of skills accurately reflected their actual performance, the actual performances of the participants in study 2 were compared against their self-ratings in study 1.

### 4.7 Results and discussion

#### *4.7.1 Task completion scores*

The mean scores for successful completion of the six tasks are presented in Table 6. As it can be seen, the percentage of tasks that were completed correctly is 40 % or lower, for both the young and the older. This is a reason for concern about the respondents' ability to apply what they have learned in their training successfully to real-life tasks.

Comparisons between the two groups of respondents showed that overall the young tended to outperform the older in completing tasks correctly, $F\ (1,39) = 3.52$, $p = 0.069$. However, a significant difference between young and older was found only for information search, $F\ (1,39) = 8.83$, $p = 0.005$, $d = 0.93$. The effect size indicates that this difference was large.

#### *4.7.2 Mastery levels per skill type*

The results for the skill types analyses are presented in Table 7. Considering a criterion of seventy percent or higher to be a signal of satisfactory skill mastery, the data indicate that the young respondents achieved this level for all skill types except strategic skills, where their competency is fairly low. In Van Dijk's classification [13],

**Table 6** Task completion scores for Internet applications in percentages (standard deviation between parentheses)

| | E-mail | Web forms | Information search | Overall |
|---|---|---|---|---|
| Young ($n = 20$) | 40.0 (44.7) | 20.0 (41.0) | 31.7** (22.9) | 32.5 (24.4) |
| Older ($n = 20$) | 20.0 (29.9) | 40.0 (50.3) | 11.7 (19.6) | 19.3 (19.7) |

Comparisons between groups: ** $p < 0.01$

strategic skills are the most complex. These skills call on the capacity of people to engage in higher-order thinking such as relevancy evaluation and decision-making.

The scores of the older are all considerably below the seventy percent criterion, with the exception of operational skills. The effect of their limited competence is also in line with the low task completion scores of this group (see Table 6). Their operational skills, which are basic for the other Internet skills, barely reach the criterion level of 70 %.

Between-group comparisons indicated that the young respondents were significantly more proficient than the older on all of the four skill types, except for strategic skills. With effect sizes of approximately 0.80 and higher these differences are large. The scores for strategic skills contrast sharply with these findings. Here, the older respondents did significantly better than the young. This difference is a medium-size effect.

One may wonder how the participants can score considerably higher on the skill types measure than on the task completion measure. The task completion measure is a stricter measure of success. It depends on having successfully completed all of the separate actions for a task. The skill types measure, in contrast, 'allows' participants to fail in one action step and to succeed in others.

#### *4.7.3 Relationships between mastery levels for skill types*

The question arises of how the various types of skills were interrelated. [13] states that the skills are ordered hierarchically, with mastery of the lower-level skills, such as operational skills, being conditional for higher level skills. Table 8 shows the correlations between the four skill types. The result for the young are displayed in the bottom left half of the table (in italics), and for the older in the top right half (in roman). In both groups there are high and significant correlations between the operational, formal and information skills. For the young, the pattern of correlations follows the predicted order or hierarchy reasonably, but for the older this is not the case. The lowest skill level, operational skills, is as strongly related to formal skills as to information skills. For both groups the strategic skills are unrelated to the other skills. It appears that strategic skills are essentially different from the other three types of skill.

**Table 8** Correlations between mastery of skill types

| | Operational | Formal | Information | Strategic[a] |
|---|---|---|---|---|
| Operational | – | 0.71*** | 0.74*** | −0.18 |
| Formal | *0.85**** | – | 0.74*** | 0.05 |
| Information | *0.53** | *0.53** | – | −0.11 |
| Strategic | *0.44* | *0.36* | *0.29* | – |

Scores for the young in the bottom left half of the Table (in italics), for the older in the top right half (in roman)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

[a] For strategic skills there were 17 older respondents; in all other cases there were 20 respondents

**Table 9** Correlations between task completion scores and self-appraisals of skills

| | E-mail | Web forms | Information search |
|---|---|---|---|
| Young ($n = 20$) | 0.43 | 0.22 | 0.24 |
| Older ($n = 20$) | 0.29 | 0.07 | −0.44 |

### 4.8 Accuracy of self-appraisals

An important question in study 2 was about the extent to which respondents were able to assess their own skills accurately. Table 9 shows the relationship between the respondents' self-appraisals and their task completion scores. No statistically significant correlations were found. For both groups, no relationship could be established between the self-ratings that participants gave of their skills and their actual success in completing the tasks involving e-mail, web forms and information search. In other words, these data signal that neither the young nor the older had a very accurate self-perception of their Internet skills.

**Table 7** Skill mastery scores in percentages (standard deviation between parenthesis)

| | Operational skills | Formal skills | Information skills | Strategic skills |
|---|---|---|---|---|
| Young ($n = 20$) | 80.0* (18.7) | 82.8*** (24.3) | 71.9*** (16.2) | 27.5 (37.1) |
| Older ($n = 20$) | 69.7 (17.6) | 41.1 (29.5) | 41.3 (27.2) | 50.0* (32.4) |

Comparisons between groups: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$: $F_{\text{operational skills}}$ (1,39) = 6.13, $p = 0.018$, $d = 0.79$; $F_{\text{formal skills}}$ (1,39) = 23.7, $p = 0.000$, $d = 1.54$; $F_{\text{information skills}}$ F (1,39) = 18.7, $p = 0.000$, $d = 1.37$; $F_{\text{strategic skills}}$ (1,39) = 4.17, $p = 0.048$, $d = -0.65$

## 5 Conclusion

The results of this two-part study sketch a portrait of young and older Internet users with visual impairments who use common Internet applications such as e-mail, information search and web forms regularly (older) or often (young), with the exception of chat, which is rarely used by the older. The young to a larger extent but also the older to some degree are confident about their own skills in using the applications.

The task performance of the 2 × 20 respondents in part 2 of the study did not match the relatively self-confident appraisal of their own Internet skills. The success rate measured in terms of correctly completed tasks was below 40 % for all of the tested applications. The young respondents performed below expectations with an overall mean score of 32 % of the tasks correctly completed; the older had a significantly lower success rate, with only 19 % of the tasks correctly completed. In short, these data reveal that the actual Internet skills of the respondents, from an objective point of view, are considerably below what would be required for effective use of the Internet for social, educational and institutional participation. These findings also indicate that one should be cautious in using self-assessments of skill as key input for deciding about the usability of web content for people with visual impairments, or for the contents of a training course.

When the respondents' performances were evaluated for skill type mastery, a more positive picture emerged, especially for the young. The young respondents with visual impairments reached fair to good levels of mastery for the various action steps that constitute three of the four skill types. They demonstrated the required operational, formal and informational skills for over seventy percent of the various action steps. They were, in short, competent at these skill levels. These outcomes are fairly similar to the results presented in [17], which reports skill mastery levels for the Dutch population at large of 80 % for operational skills, 72 % for formal skills and 62 % for informational skills.

For strategic skills however, the performance of the young was considerably below expectations with a score of 27.5 % correct action steps. This is an important observation. It indicates that the young participants lack experience in filling forms, making decisions and comparing various outcomes against implicit or explicit criteria, all of which are important in the kind of Internet tasks that are required for educational and institutional participation. The outcome for strategic skills for the young are more or less equal to the 25 % mastery of strategic skills reported by Van Deursen [17] for the Dutch population at large.

The older did fairly well on the basic operational skills, and below expectations on all other skill types. Assuming that the first three skills levels form a hierarchy, the findings indicate that the older cannot successfully perform tasks that call on more than "button knowledge". Their relatively low mastery of formal and information skills forms a serious threat to their social and institutional participation through the Internet. This finding is even more alarming when seen against the backdrop of having examined a sample of older people with a visual impairment who had received relevant training in the three most recent years before taking the test.

One of the possible explanations for the finding for the older is that this particular group faces a double challenge. For people with visual disabilities, achieving mastery of operational and formal skills depends always on a mixture of knowing how to work the Internet and knowing how to work effectively with assistive technologies such as screen readers and magnifiers (see Abner and Lahm [18]). Obviously, this considerably raises the bar for this group. That bar is probably already very high for the older, because many of them might have started using the computer and Internet later in life. Given their mean age of about 68 years, they might suffer from age-related problems such as reduced attention span and a decline in short-term and long-term memory.

Van Deursen and Van Dijk [2, 3] found that age was a significant factor in performance. Specifically, they indicated that younger respondents experienced far fewer operational and formal skill related problems, but no difference was found for information and strategic skills. Their findings for the older are not entirely consistent with the ones presented in this paper, as the information skills of the young participants were found to be better than those of the older, and the strategic skills of the older participants were found to be higher than those of the young. The pattern found in [2, 3] was not observed in the current studies, but no clues emerged about the reason for this difference.

From a methodological point of view, two outcomes from this study merit further investigation. First, the findings in this study suggest that strategic skills do not fit comfortably within the four-tier hierarchy of skill types that is proposed in [2, 3, 13]. Strategic skills do not simply build upon the basis of the three other skill levels, but appear to be of a different nature. Whether or not this outcome is related to the ages of the participants or to their visual impairment is hard to tell. It is certainly an issue that deserves further investigation.

Second, the study raises a question about the difference between task performance success and skill mastery. The answer is that even one small error made during task performance can lead to an incomplete or incorrect task result. When one of the action steps is not completed correctly, it might affect the outcomes of the action steps that follow, and hence yield an incorrect task result. In short, in measuring Internet usage and skills it may be desirable to

employ two different measures. The skills measure can be used as a good indicator of the average level of mastery or competence for the actions that comprise a skill type. The task performance measure can be used to assess the absolute level of performance success, because it is sensitive to failure in any one of the varied set of actions and skill types that are required for a successful task completion. The presented study has shown that using self-assessments of Internet skills is not a valid and reliable measure of actual Internet skills, at least not for young and older people with visual impairments.

**Acknowledgments** This study was subsidized by the research program "InZicht" (InSight) of ZonMW (Netherlands Organization for Health Research and Development) under Grant Number 94305002. It was carried out in cooperation with the three Dutch support organizations for blind and visually impaired people: Bartimeus, Sensis, and Visio.

## Appendix 1 Operational definitions for Van Dijk's four skills types [3]

**Operational skills involve:**

*Operating an Internet browser (e.g., Internet Explorer, Firefox):*

- opening websites by entering the Uniform Resource Locator (URL), commonly known as the web page address, in the address bar of the Internet browser.
- going backward and forward between websites and web pages using the browser buttons.
- saving files on the Hard Disk.
- opening commonly used file formats.
- bookmarking websites.
- changing the preferences of the Internet browser.

*Operating Internet-based search engines (e.g., Google, Live search):*

- entering keywords in the proper search field.
- executing the search operation.
- opening search results in the search results list.

*Operating an interactive Internet-based form:*

- using the different types of input text fields and buttons.
- submitting a form.

**Formal skills involve:**

*Navigating the Internet:*

- recognizing and using links embedded in different formats (text, images, menus and site maps).
- maintaining a sense of location while navigating the Internet.
- within a website, between websites.
- browsing through and opening results.

**Information skills involve:**

*Being able to locate the required information:*

- locating a website or web search engine for information search.
- defining search options or queries.
- selecting information from search results.
- evaluating the information sources.

**Strategic skills involve:**

*Taking advantage of the Internet:*

- orienting toward a particular goal.
- taking the right action to reach this goal.
- making the right decision to reach this goal.
- gaining the personal benefits pertaining to this goal.

## Appendix 2 Description of the tasks and subtasks on the performance test

Task 1 (Young & Older). Compose and send an e-mail attachment

You are going to type a short message in Word or Notepad and send this file as an e-mail attachment to the researcher.

*Task 1.1*

- Open your text program.
- Type the following message: "I participate in this research".
- Save the file as: message researcher.

*Task 1.2*

- Open your e-mail program.
- Send an e-mail to researcher@universiteit.nl with the text: As promised. With kind regards, your name. Subject of this message is 'test'.

*Task 1.3*

- Attach the file 'message researcher'.
- Send the message.

Task 2 (Young & Older). Download a brochure from the web and send it as an e-mail attachment to the researcher.

You have to find out (Young: for a school project) how the Revenue Office handles personal data.

*Task 2.1*

- Go to the homepage of the Dutch Internal Revenue Office www.belastingdienst.nl.

*Task 2.2*

- Click the link '*Downloaden en bestellen*' in the menu on the right-hand side.
- Click under the tab 'Particulier' the link 'Klachten'.
- Click the link for the brochure *Wet bescherming persoonsgegevens.*

*Task 2.3*

- Download the brochure *Wet bescherming persoonsgegevens.*
- Save the brochure (PDF format) on the desktop of the computer.

*Task 2.4*

- Send the brochure as an e-mail attachment to researcher@universiteit.nl with the text "kind regards". Subject of this message is 'test'.

Task 3 (Young). Fill in a web form

John lives in Ommen and wants to visit his friend George in Boxmeer. You must find out how John can get there by public transport and how long the trip will take.

*Task 3.1*

- Go to the website: www.9292OV.nl.

*Task 3.2*

- Fill in the fields with the following information:
  - John starts from Bouwstraat 12 in Ommen going to Steenstraat 30 in Boxmeer.
  - The date is (the next day) and he wants to arrive at 11.00.
  - He doesn't travel by taxi, metro or ferry.
- Submit the form.
- Answer the following questions:
  - How long will it take John to get there?
  - What time does he need to leave home?
  - What time will he arrive?

Task 3 (Older). Fill in a web form

You would like to apply for Zorgtoeslag, a refund from National Health Care for expenditure for health-related matters. You can find out how much you will be awarded by filling in a specific form on the web.

*Task 3.1*

- Go to the website: www.toeslagen.nl.

*Task 3.2*

- Go to the program '*Proefberekening Zorgtoeslag*'.
- Complete the web form with the given information.
  - You want Zorgtoeslag for 2007.
  - You are over 18 years old.
  - You live in the Netherlands.
  - You have no Zorgtoeslag partner.
  - Your Zorgtoeslag income is 10.000 euro.

*Task 3.3*

- Submit the form.
- Answer the following question:
  - How much Zorgtoeslag will you receive?

Task 4 (Young & Older). Look up telephone numbers

You want information about computer courses with assistive software.

*Task 4.1*

- Go successively to the websites of Visio:www.visio.org, Sensis: www.sensis.nl and Bartimeus: www.bartimeus.nl.

*Task 4.2*

- Look up the telephone number of the offices of Visio and Bartimeus in Rotterdam and the office of Sensis in The Hague.

Task 5 (Young). Information for a history project

You are working on a history project for school about the Roman era in The Netherlands.

*Task 5.1*

Search with the help of a search engine, portal or otherwise to find the name of the village or town in the Netherlands where you can visit an original strategic Roman highway.

Task 5 (Older). Information about a required document

Your passport has been stolen and a certain document is required if you apply for a new passport.

*Task 5.1*

Find out with the help of a search engine which document is needed when you apply for a new passport after your old one has been stolen.

Task 6 (Young). Visiting a zoo

You are on holiday in the province of Gelderland and want to visit a Zoo.

*Task 6.1*

Find out with the help of a search engine, portal or otherwise where in Gelderland you can visit a Zoo with:

- Meerkats and panda bears.
- An entrance price of €15 or less.

Task 6 (Older). Choosing a hotel

You want to visit your family in Zwolle and stay overnight in a hotel.

*Task 6.1*

Find with the help of a search engine, portal or otherwise:

- A hotel in the centre of Zwolle.
- Double room with breakfast included.
- Price of €100 or less.

## References


1. Eurostats.: Levels of internet access—households. Retrieved from: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsiir040_esms.htm (2010). Table code TSIIR040
2. Van Deursen, A.J.A.M., van Dijk, J.A.G.M.: Improving digital skills for the use of online public information and services. Gov. Inf. Q. **26**, 333–340 (2009)
3. Van Deursen, A.J.A.M., van Dijk, J.A.G.M.: Using the Internet: skill related problems in users' online behavior. Interact. Comput. **21**, 393–402 (2009)
4. Asakawa, Ch., Takashi, I.: User interface of a home page reader. Paper presented at the ACM SIGACCESS conference on computers and accessibility, Marina del Rey CA (1998)
5. Dobransky, K., Hargittai, E.: The disability divide in internet access and use. Inf. Commun. Soc. **9**(3), 313–334 (2006)
6. Hollier, S. E.: The disability divide: a study into the impact of computing and internet-related technologies on people who are blind or vision impaired. Dissertation, Curtin University of Technology, Australia (2007)
7. Lazar, J., Allen, A., Kleinman, J., Malarkey, C.: What frustrates screen reader users on the web: a study of 100 blind users. Int. J. Hum. Comput. Interact. **23**(3), 247–269 (2007)
8. Leporini, B., Paternò, F.: Applying web usability criteria for vision-impaired users: does it really improve task performance? Int. J. Hum. Comput. Interact. **24**(1), 17–47 (2008)
9. Miyashita, H., Sato, D., Asakawa, Ch., Takagi, H.: A browser for multimedia: introducing multimedia content accessibility for visually impaired users. In: Proceedings of the 9th international ACM SIGACCESS conference on computers and accessibility. Tempe Arizona (2007)
10. Murphy, E., Kuber, R., McAllister, G., Strain, S., Yu, W.: An empirical investigation into the difficulties experienced by visually impaired Internet users. Univers. Access Inf. Soc. **7**(1–2), 79–91 (2008)
11. Takagi, H., Saito, S., Fukuda, K., Asakawa, C.: Analysis of navigability of Web applications for improving blind usability. ACM Trans. Comput. Hum. Interact. **14**(3): Article No. 13, 1–37 (2007)
12. DiMaggio, P., Hargittai, E., Celeste, C., Shafer, S.: From unequal access to differentiated use: a literature review and agenda for research on digital inequality. In: Neckerman, K. (ed.) Social Inequality, pp. 355–400. Russell Sage Foundation, New York (2004)
13. Van Dijk, J.: The deepening divide: inequality in the information society. Sage, Thousand Oaks (2005)
14. European Commission E-Inclusion: ICT for an Inclusive Society. http://ec.europa.eu/information_society/activities/einclusion (2006). Accessed 10 Oct 2011
15. Gilster, P.: Digital Literacy. Wiley, USA (1997)
16. Hargittai, E.: Classifying and coding online actions. Soc. Sci. Comput. Rev. **22**(2), 210–227 (2004)
17. Van Deursen, A. J. A. M.: Internet skills. Vital assets in an information society. Dissertation University of Twente, Enschede NL (2010)
18. Abner, G.H., Lahm, E.A.: Implementation of assistive technology with students who are visually impaired: teachers' readiness. J. Vis. Impair. Blind. **30**(2), 98–105 (2002)