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Internet skill levels increase, but gaps widen: a longitudinal cross-sectional analysis (2010–2013) among the Dutch population

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In the current contribution, we investigated how (1) the levels of operational, formal, information, and strategic internet skills changed between 2010 and 2013, and how (2) the observed skill patterns differ across gender, age, and education. All internet skills are measured among representative samples of the Dutch population in 2010, 2011, 2012, and 2013. Cross-sectional data are repeated to consider patterns of change at the aggregate level. The levels of operational and formal internet skills increased most. Information internet skill remained more or less consistent, and strategic internet skills only revealed a very small increase. Policies related to internet skills are largely aimed at improving basic skills among specific target groups. Future policies should shift towards improving information and strategic skills, which will be a more difficult challenge. Gender, age, and educational background are all important variables related to skill inequalities. As age increases, internet skill levels decrease. Information internet skills only increased for people aged over 65 years between 2010 and 2013. It seems that the gain in operational and formal internet skills among older people results in a better performance on information internet skills. The higher educated, the higher the levels of all four internet skills. The skills gap between the higher educated, on the one hand, and lower and middle educated, on the other hand, increased, while the gap between low and middle educated decreased. We expect that a particular share of inequality concerning information and strategic internet skills will remain and that these inequalities are long lasting.

Keywords: internet skills; digital divide; longitudinal survey; digital literacy

1. Introduction

Recent theorization of internet adoption recognizes that a binary classification around physical access does not reflect the complexity of what it means to be online. Within theory around digital inclusion, an increasing number of researchers argue that more attention should be paid to skills aspects of engagement with the internet and how these aspects relate to different types of social exclusion (e.g. DiMaggio & Hargittai, 2001; Helsper, 2012; Mossberger, Tolbert, & Stansbury, 2003; van Deursen & van Dijk, 2011; van Dijk & van Deursen, 2014; Warschauer, 2003). As a consequence, in several countries digital inclusion policies have been developed to improve individuals' internet skills. These policies, however, often target a specific group focusing on technical aspects, or the basic skills to go online. Also problematic are the contentious measurements of internet skills. In measurements, internet *skills* are in fact internet *use*, or they

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are assessed by using self-reports which are context dependent and positively biased (van Deursen & van Dijk, 2010). Often an educational perspective is taken with a focus primarily on the assessment of students in particular courses (Litt, 2013), not the assessment of regular and daily use of the internet in general by larger populations. Several researchers have tried to tackle measurement problems by creating more subtle classifications of internet skills of populations at large (see e.g. Buckingham, 2007; Eshet-Alkalai & Amichai-Hamburger, 2004; Helsper & Eynon, 2013; Livingstone, 2008; van Deursen & van Dijk, 2009, 2010; Warschauer, 2003). In the current contribution, we applied an internet skill classification proposed by van Deursen and van Dijk (2009, 2010). Their framework integrates several conceptualizations and considers both technical aspects (medium-related skills) and content aspects (content-related skills). Medium-related internet skills consist of operational skills, which include a basic command of an internet browser, and formal skills, which include the ability to navigate and orient oneself within the internet's hypermedia structure. The first type of content-related internet skills consists of information skills, which include the ability to find, select, and evaluate sources of information on the internet. Secondly, strategic skills refer to one's capacity to use the internet as a means to reach particular personal and professional goals.

Applying the internet skill classification introduced above provides two important advantages. First of all, measures for these four types of internet skills are satisfactory in terms of reliability and construct validity (i.e. convergent and discriminant validity), and were constructed using skill performance field tests as benchmarks (van Deursen, van Dijk, & Peters, 2012). Secondly, the classification goes beyond a technical approach by considering a detailed overview of both medium-related and content-related internet skills. Both advantages help us to achieve the two main goals of the current analysis. The first goal is to investigate how the levels of operational, formal, information, and strategic internet skills changed between 2010 and 2013. The second goal is to investigate how the observed skill patterns differ for individuals across gender, age, and educational level of attainment, the three most consistent variables in digital inclusion studies. There is no empirical evidence about how these relationships have changed over time, although several policies aimed at improving internet skills among specific sections of the populations exist. Most existing investigations provide one-off 'snapshot' analyses, causing a lack of detailed analyses about how internet skills patterns have developed over time. In the current study, we investigate all four types of internet skills among a representative sample of the Dutch population in the years 2010, 2011, 2012, and 2013. Cross-sectional data are repeated to consider patterns of change at the aggregate level. The Netherlands has a robust digital infrastructure and in 2013, 97% of the population had a home broadband connection. Results of the study help in improving theory and practice as in regards to different skill levels and their antecedents.

2. Theoretical background

2.1. *Digital divide*

Several scholars suggest that internet access has the potential to reproduce or even reinforce existing forms of social inequality (e.g. Hargittai, 2008; Helsper, 2012; Mason & Hacker, 2003; van Dijk, 2005; Witte & Mannon, 2010). Such suggestions often concern discussions around the so-called digital divide. The main consequence of the digital divide is that people have different access to information, knowledge, and other resources that could contribute to more general social inequalities and power differences (Bonfadelli, 2002). Access should be considered a multidimensional concept, ranging from attitudes, physical access, skills, motivation, autonomy of use, amount of usage, and types of internet usage (e.g. Attewell, 2001; Chen & Wellman, 2004; DiMaggio, Hargittai, Celeste, & Shafer, 2004; Helsper, 2012; Katz & Rice, 2002;

Livingstone & Helsper, 2007; Mossberger et al., 2003; Norris, 2001; Ono & Zavodny, 2007; Pearce & Rice, 2013; Selwyn, 2006; van Dijk, 2005; Warschauer, 2003). The digital divide generally implies differences in access based on socio-economic divisions. In recent years, the digital divide debate has centred on the acquisition of the necessary skills to use the internet efficiently and effectively, also referred to as the second-level digital divide (Hargittai, 2002).

2.2. *Internet skills*

The focus of this study is the level of internet skills among the population at large. Internet skills concepts should account for both basic skills necessary to use the internet, and skills required to comprehend and use online content (Bawden, 2008; Boekhorst, 2003; Eshet-Alkalai, 2004; Gui & Argentin, 2011; Helsper & Eynon, 2013; Mossberger et al., 2003; Selwyn, 2003; Steyaert, 2002; van Deursen & van Dijk, 2009, 2010; Warschauer, 2003). This way, a purely technical viewpoint is avoided. Van Deursen and van Dijk (2009, 2010) explained two types each of medium- and content-related internet skills. Both skill sets proved to be theoretically and empirically distinct. Table 1 provides an overview of operational, formal, information, and strategic internet skills required to use the internet.

Table 1. Conceptual definitions for internet skills (van Deursen & van Dijk, 2009, 2010).

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

The first type of medium-related internet skills is operational internet skills. These skills are derived from concepts such as technological literacy, instrumental skills, technical competencies, or technical proficiency (Mossberger et al., 2003; Søby, 2003; Steyaert, 2002). Operational internet skills can be considered as basic skills required to use the internet. Included are not only operating toolbars, buttons, and menus, but also the skills to use different types of user input fields (e.g. text boxes, pull-down menus, and list boxes). Furthermore, file management or the opening and saving of various file formats that can be found online is part of operational skills. Websites, for example, can be managed using bookmarks.

The second type of medium-related internet skills is referred to as formal internet skills. These skills relate to the hypermedia structure upon which the internet is built, requiring users to be able to navigate and orient themselves (Kwan, 2001). Navigating is necessary to use the enormous and diverse number of websites, platforms, and menu layouts, which all differ in (the placement of) text, content, photos, frames, links, buttons, sound, animation, or video. Orientation is necessary when navigating non-linear paths. On the internet, orientation is a frequently cited problem since users choose non-linear paths rather than the fixed formal structures of print media, such as chapters, paragraphs, or references (Coiro & Dobler, 2007; Kwan, 2001; Lee, 2005).

The first type of content-related skills is information skills. These skills are derived from a staged approach to fulfil information needs (Marchionini, 1995). Information internet skills include searching, selecting, processing, and evaluating online information. Strategic internet skills are the second type of content-related internet skills and include the capacity to use the internet to attain particular benefits. Strategic skills are derived from the classical approach to decision-making that emphasizes procedures through which optimal solutions are reached (Miller, 2006). The procedure begins with goal orientation, followed by engaging in the right actions. Next comes making decisions about how to reach the original goal using selectively retrieved information. The final step is obtaining the benefits of making the optimal decision.

Based on a number of large-scale performance tests in which people were asked to complete assignments on the internet, a sequential and conditional nature between the four internet skills was confirmed (van Deursen, van Dijk, & Peters, 2011). Operational and formal internet skills are necessary but insufficient for performing satisfactorily on information and strategic skills.

2.3. *Determinants of internet skills*

Digital divide studies revealed several socio-demographic variables that explain individual differences in internet skills. Three variables that appear consistent in such explanations are gender, age, and education. In the current longitudinal analysis, we will focus on these three variables. The contribution of gender in relation to internet skills is the least consistent. This can be explained by taking a closer look at how internet skills in most studies are measured, namely by self-assessments. Men have more stereotyped attitudes regarding who is capable of using the internet, and self-assessments consistently show that women exhibit lower levels of internet skills (Cooper, 2006; Goulding & Spacey, 2002; Wasserman & Richmond-Abbott, 2005). In actual performance tests, however, the measures of skills of men and women do not differ much (Hargittai & Shafer, 2006; van Deursen & van Dijk, 2010, 2011). Hargittai and Shafer (2006) concluded that gender may not directly influence the level of internet skills, but that it does come into play in one's perception.

Performance tests of operational, formal, information, and strategic internet skills revealed another interesting finding concerning age. Not surprisingly, operational and formal internet skill deficiencies primarily occur among seniors (van Deursen, 2012; van Deursen & van Dijk, 2009). Due to the conditional nature of internet skills, also the levels of content-related internet skills decreased with higher age. However, older people with sufficient medium-related internet skills outperformed their younger counterparts on content-related internet skills (van Deursen et al., 2011). Studies that account for both technical and substantial internet skills generally find that age has a negative relation with technical skills, while the relationship with substantial skills is not significant, or even positive (Eshet-Alkalai & Amichai-Hamburger, 2004; Gui & Argentin, 2011; van Deursen & van Dijk, 2011).

A final strong indicator of internet skills is the level of educational attainment (Bonfadelli, 2002; Gui & Argentin, 2011; Hargittai, 2010; van Deursen & van Dijk, 2011). Education is probably the most consistent global predictor of the use of ICTs, especially concerning internet skills. The higher the level of education, the higher the level of all four theoretical skill dimensions (van Deursen & van Dijk, 2011).

As illustrated, prior investigations suggest that differences across gender, age, and education can be expected when investigating their relationships with the different types of internet skills. The most important contribution of the current investigation, however, is an examination of how these relationships between internet skills and socio-economic variables have changed over the past few years. For example, for operational and formal internet skills, one might expect decreasing socio-demographic differences over time, since these skills are easiest to account for, and most policies are aimed at these skills (van Dijk & van Deursen, 2014). However, this expectation may not be met for information and strategic skills. These skills require higher cognitive abilities, and thus training and education.

3. Method

3.1. *Samples*

The study draws upon four samples collected through online surveys in the Netherlands in September 2010, 2011, 2012, and 2013. All surveys were administered with software that checked for missing responses (users were prompted to respond). The time required to complete a survey was approximately 12 minutes. To obtain representative samples, we made use of a Dutch professional market research organization that has a panel that consists of over 108,000 members. The panel is largely representative of the Dutch population. When participating in a survey, members of the panel receive a small monetary incentive. Each year invitations were sent out in three quotas (accounting for gender, age, and education) to ensure that the final sample represented the Dutch population. In total, we obtained responses from 1418 individuals in 2010 (response rate 29%), 1114 individuals in 2011 (response rate 26%), 1224 individuals in 2012 (response rate 24%), and 1125 individuals in 2013 (response rate 21%). Table 2 summarizes the demographic characteristics of the respondents.

A new random sample was collected in each successive survey and all four samples can be assumed to be independent. We made certain to have done everything possible to make our variables and data comparable. There were no differences in sampling strategy, survey methodology, or variable coding (except for two items related to formal internet skills). The final samples largely matched census data. However, as can be seen in Table 2, not all quotas for gender, age, and education are similar, which is required to compare internet skills in subsequent years. For each of the four data sets, we used the same external aggregate data (national population census) to estimate weights. We derived calibration weights by defining groups based on age, gender, and education. Post-stratification adjustment was applied in the main analysis (weights are scaled to have a mean of 1 in each year) with each individual being weighted equally (at 1). This procedure ensured that no artefactual jumps between the surveys were created. Since the data are cross-sectional, the intention of the post-stratification adjustment was to produce best estimates of the population given the information available at the time.

Table 2. Demographic profiles for 2010 (N = 1418), 2011 (N = 1114), 2012 (N = 1224), and 2013 (N = 1125).

	2010		2011		2012		2013	
	N	%	*N*	%	*N*	%	*N*	%
Gender								
Male	729	51	556	50	623	51	575	51
Female	689	49	558	50	601	49	550	49
Age								
16–35	290	21	245	22	273	22	287	26
36–50	358	25	313	28	346	28	312	28
51–65	528	37	360	32	390	32	318	28
66+	242	17	195	18	215	18	208	19
Education								
Low	402	28	329	30	361	30	337	30
Middle	508	36	443	40	523	43	510	45
High	508	36	342	31	340	28	278	25

3.2. *Measures*

The questionnaires gathered information related to the respondents' demographics, internet usage, and skills. For measuring internet skills, we used a 19-item inventory for operational, formal, information, and strategic internet skills (van Deursen et al., 2012). Two items for formal internet skills were removed from the analysis since they were altered in 2011 (to increase internal reliability). Instead of drawing upon self-assessments, the 17 remaining items ask for actual behaviours that serve as indices for skills. The questionnaire's psychometric properties have been proven to be satisfactory in terms of reliability and construct validity (i.e. convergent and discriminant validity). The questionnaire used actual skill performance field tests as benchmarks, which makes it more favourable than self-assessments of skills that have significant problems of validity (e.g. Bunz, 2004; Hargittai, 2005; Merritt, Smith, & Renzo, 2005; Talja, 2005; van Deursen & van Dijk, 2010). In the questionnaire, respondents were asked to indicate to what extent they perform certain internet skill-related actions. For example, one of the items for operational internet skills asked how often one downloads programs from the internet, and one of the items for information internet skills asked how often one checks retrieved information on another website. Respondents were asked how frequently they perform several activities using a five-point scale that ranged from 'never' to 'daily' as an ordinal level measure in the analysis. Table 3 lists the descriptive statistics for each item. We conducted a confirmatory factor analyses to check whether the four different internet skills would appear. Principal Component analysis with varimax rotation confirmed a four-cluster structure explaining 60% of the variance. Scores on the scales exhibited moderate to high internal consistency (measured by Cronbach's alpha).

In all surveys, gender was included as a dichotomous variable. To measure age, respondents were asked for their year of birth, which was then transposed to a continuous age variable. Data on education were collected by degree. These data were subsequently divided into three overall groups of low, medium, and high educational levels attained.

3.3. *Data analysis*

Firstly, the means and standard deviations for all four internet skills from 2010 to 2013 were counted to conduct Bonferroni post hoc ANOVA tests and to determine whether and how internet

Table 3. Descriptives and reliabilities of usage clusters, 2010–2013 (scale ranging from 1 – never to 5 – daily).

	2010		2011		2012		2013	
	M	SD	*M*	SD	*M*	SD	*M*	SD
Operational skills (α = .78)	*2.63*	*0.97*	*2.65*	*0.97*	*2.73*	*0.94*	*2.78*	*0.98*
Save files	3.36	1.29	3.38	1.29	3.34	1.23	3.32	1.28
Use the refresh button	2.72	1.61	2.72	1.61	3.01	1.54	3.04	1.52
Upload files to another computer	1.95	1.21	2.00	1.23	2.18	1.29	2.24	1.32
Download program	2.10	1.18	2.13	1.20	2.14	1.20	2.17	1.22
Watch video files	3.00	1.27	3.02	1.27	3.00	1.27	3.12	1.34
Formal skills (α = .69)	*2.19*	*0.97*	*2.20*	*0.97*	*2.35*	*0.97*	*2.44*	*1.01*
Find websites to be confusing (*recoded*)	2.48	1.19	2.49	1.18	2.57	1.12	2.63	1.13
Experience difficulties with a website's layout (*recoded*)	1.91	1.04	1.91	1.04	2.13	1.11	2.24	1.15
Information skills (α = .80)	*3.36*	*0.93*	*3.37*	*0.92*	*3.42*	*0.87*	*3.43*	*0.90*
Find the information you were looking for	4.10	0.93	4.12	0.92	4.00	0.99	3.98	0.99
Use special search Booleans	2.27	1.43	2.27	1.43	2.21	1.38	2.28	1.43
Use more than one search keyword	3.74	1.19	3.75	1.20	3.82	1.19	3.81	1.17
Examine only the top three results (*recoded*)	3.62	1.23	3.64	1.23	3.72	1.21	3.71	1.22
Check information retrieved on another website	3.08	1.26	3.09	1.26	3.37	1.27	3.39	1.22
Strategic skills (α = .79)	*2.84*	*0.89*	*2.85*	*0.88*	*2.92*	*0.88*	*2.94*	*0.90*
Use reference websites	2.54	1.07	2.53	1.07	2.77	1.14	2.78	1.10
Gain financial benefits	2.46	1.19	2.46	1.20	2.57	1.13	2.62	1.18
Benefit from using the internet	3.41	1.30	3.45	1.29	3.42	1.19	3.37	1.18
Use information about a specific subject from multiple sites	2.89	1.19	2.89	1.19	2.85	1.14	2.91	1.13
Make a decision based on retrieved information	2.84	1.20	2.88	1.20	2.97	1.14	2.99	1.16

skills have changed. To identify predictors, multiple linear regression analyses were performed for each skill with gender, age, and education as independent variables. To examine changes over time, we added the survey year to the models. Interaction terms were added to each model to examine whether changes in internet skills were different between gender, age, and education. To avoid multi-collinearity between the predictors and the interaction terms, the predictor variables were centred (i.e. put in deviation form by subtracting means from observed scores), and the centred predictors of interest were multiplied to form interaction terms.

4. Results

4.1. *Changing skill levels*

In Table 4, the means and standard deviations for all four internet skills are displayed for the years 2010, 2011, 2012, and 2013. Post hoc tests revealed significant changes for operational internet skills ($F(3,5516) = 7.39$, $p < .001$), formal internet skills ($F(3,5516) = 20.50$, $p < .001$), and strategic internet skills ($F(3,5480) = 3.90$, $p < .01$). For these three skill clusters, the level of skills increased between 2010 and 2013. Post hoc tests for information skills were not significant ($F(3,5480) = 2.14$, $p = .09$).

4.2. *Determinants of internet skills*

Table 5 displays the results of the regression analyses for each of the four internet skills. Gender, age, and education are significant predictors for all skills. Men score higher on all four internet

Table 4. Post hoc tests (Bonferroni with 5% significant level) for internet skills; *M*(SD) for 2010–2013.

	2010	2011	2012	2013
Operational skills	2.63 (0.97)[a]	2.65 (0.97)[a,b]	2.73 (0.94)[b,c]	2.78 (0.97)[c]
Formal skills	2.19 (0.97)[a]	2.20 (0.97)[a]	2.35 (0.97)[b]	2.44 (1.01)[b]
Information skills	3.36 (0.93)[a]	3.37 (0.92)[a]	3.42 (0.87)[a]	3.43 (0.90)[a]
Strategic skills	2.84 (0.89)[a]	2.85 (0.88)[a,b]	2.92 (0.88)[a,b]	2.94 (0.90)[b]

Note: For 2010–2013, within each row, means with non-common superscripts are significantly different.

skills than women. Age negatively affects all skills levels, meaning that younger respondents have higher skills than older respondents. Education shows a positive effect on all four internet skills. Table 5 furthermore reveals that some of the changes in skill scores over time differ for subgroups of age and education. Concerning age, we see that the difference in information skills between the oldest age group and the three younger groups is narrowing. See Figure 1. Figures 2–4 reveal that differences for operational, formal, and information internet skills between low, middle, and high educated people have changed between 2010 and 2013. For all three skill types, the difference between low and middle educated decreased, while the gap between high and middle educated increased.

5. Discussion

5.1. *Main findings*

The importance of internet skills is part of a perspective that refers to the second-level digital divide (Hargittai, 2002). The first level of the digital divide focuses on physical access to digital technology. The second-level divide focuses on gaps in skills and differences in engagement. The effects of these gaps in terms of social inequality are more profound and lasting than the relatively simple and temporary problems posed by physical access gaps (van Dijk & van Deursen, 2014). The effects of gaps in skills might cause structural inequality between classes or categories of people. These effects might produce an information elite who commands high levels of internet skills and as a result a more diverse use of the internet. In the current contribution, we combined four large-scale studies conducted among the Dutch population. We used an elaborate conceptual framework of internet skills that has been applied in empirical research

Table 5. Multiple linear regression analyses for internet skills, standardized betas (β).

	Operational skills	Formal skills	Information skills	Strategic skills
Gender (M/F)	−.24***	−.10***	−.15***	−.17***
Age	−.50***	−.15***	−.35***	−.34***
Education	.05***	.12***	.12***	.07***
Year	.07***	.13***	.06***	.06**
Gender*year	.01	−.01	.03	.02
Age*year	−.00	−.03	.05***	.02
Education*year	−.03*	−.05**	−.06***	−.02
F	163.71***	58.35***	168.18***	148.53***
Adj. R^2	.29	.06	.18	.16

*$p < .05$.
**$p < .01$.
***$p < .001$.

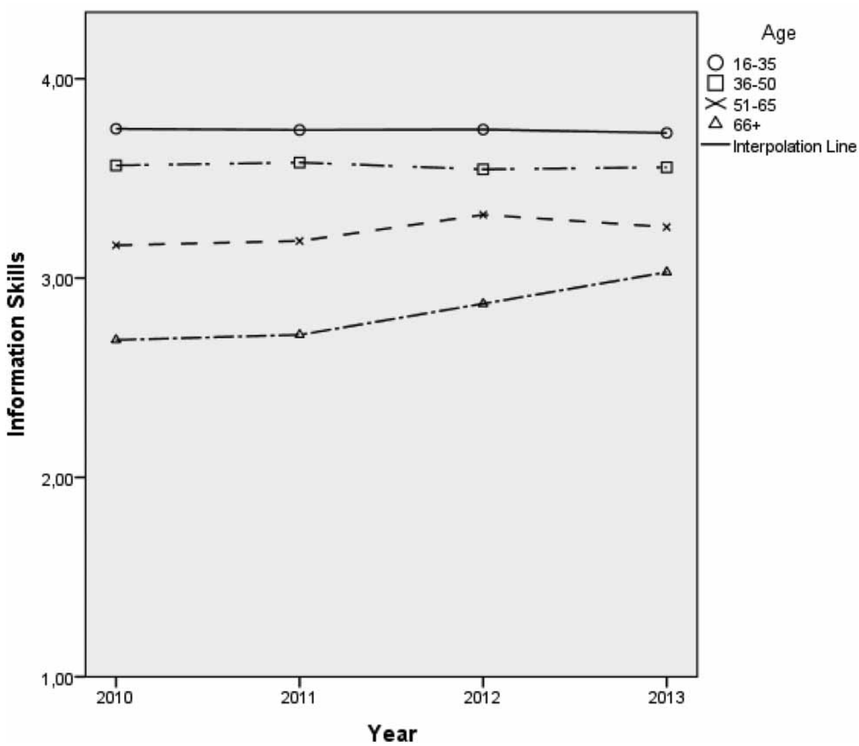

Figure 1. Age patterns related to information internet skills, 2010–2013.

using laboratory performance tests and survey self-assessments (van Deursen & van Dijk, 2010, 2011; van Deursen et al., 2012). The framework proposes a distinction between the four internet skills with a sequential and conditional nature. Operational and formal skills are mainly technical, whereas information and strategic skills are primarily substantive; they require knowledge and particular goals or norms needed for decisions.

What are the main conclusions from the panel data longitudinal analysis? Although we need actual performance tests to determine one's exact skill levels, the results of the current study provide us with valuable information on how the levels of internet skills change over time. After all we used measures that correlate highly with actual performances. The first conclusion is that the levels of operational and formal internet skills increased most between 2010 and 2013. Information internet skill remained more or less consistent, and strategic internet skills only revealed a very small increase. That strategic skills will slowly improve can be explained by the fact that people accustom to their goals and means in internet applications after learning to use them. However, information skills require a base of knowledge and understanding accumulated through lifelong learning. Acquiring these skills in four years is only possible in the condensed activities of formal education. Policy initiatives related to internet skills of the last years were not directed to information skills. Instead they were largely aimed at improving basic operational and formal skills among specific target groups, for example, the elderly. Operational and formal skills are the first requirement to actually make use of the internet. Furthermore, operational and formal internet skills are relatively easy to address in, for example, training programmes or training guides. They are also referred to as 'button-knowledge' and are easier to acquire as compared to information and strategic internet skills, since they put

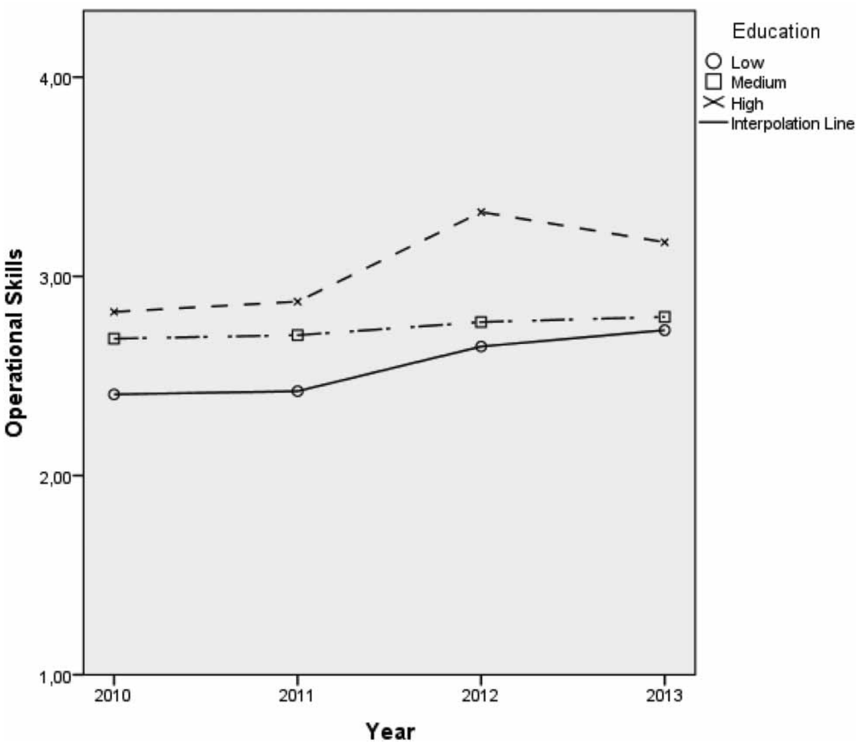

Figure 2. Educational patterns related to operational internet skills, 2010–2013.

less stress on one's cognitive abilities. The overall results do suggest that future skill policies should shift towards improving information and strategic internet skills, which will be a more difficult challenge. All kinds of education (e.g. elementary and adult) will be necessary. In educational contexts, standardized programmes might be helpful in order to achieve nationwide attention. Although several programmes are developed, they tend to be separate initiatives. Internet skills are not a standard component of current curricula and often it is believed that the internet empowers learners by just using it (Buckingham, 2007).

Improving information skills requires both continuous educational and software design improvement. In formal education, teachers will have to understand that they are needed to help and guide students in commanding information activities on the internet. Teachers should not simply assume that students are more skilled in using the internet than they are. In adult education they can benefit from the lifelong experience of information processing by older students. Information skills can also be supported by better software design. Search engines and other instruments to find and process information online can be improved substantially (van Dijk & van Deursen, 2014). Then, people will learn better information skills when using these instruments.

Gender, age, and educational background are all important variables related to skill inequalities. Men score higher on all skills than women. Note, however, that actual performances in most cases reveal no gender differences (Hargittai & Shafer, 2006; van Deursen & van Dijk, 2010). Furthermore, the results indicate that differences between men and women remained consistent between 2010 and 2013. Concerning age, we found that as age increases, internet skill levels decrease. Worrisome is the finding that the level of information internet skills remained consistent

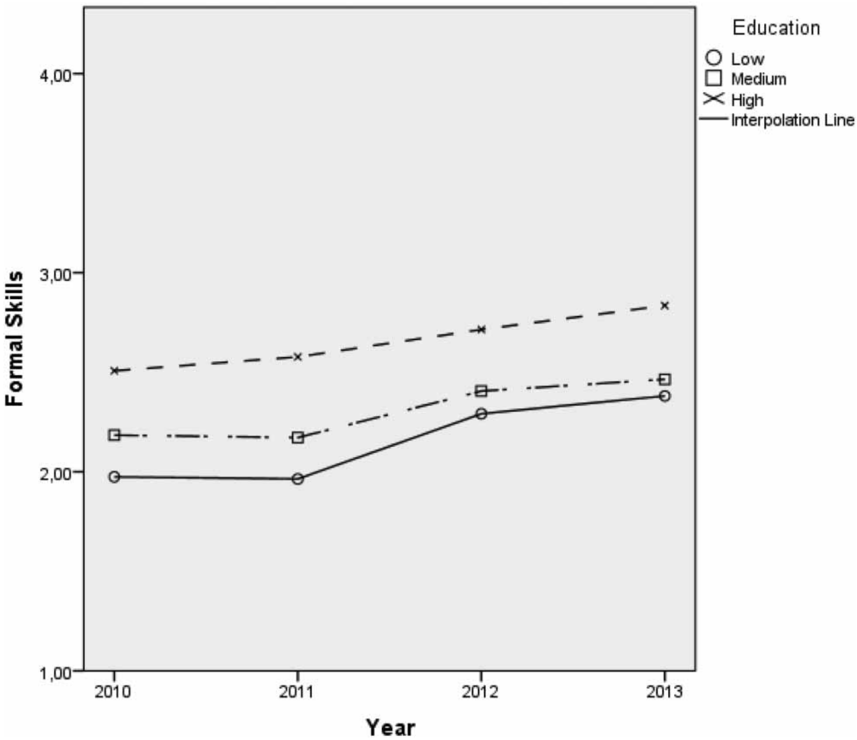

Figure 3. Educational patterns related to formal internet skills, 2010–2013.

for people aged between 18 and 65 years. Information internet skills only increased for people aged over 65 years. This can be explained by the fact that operational and formal internet skills increased over all age groups. Operational and formal skills are required for performances on information and strategic internet skills. Prior studies revealed that if the elderly have sufficient levels of operational and formal internet skills, they might even outperform younger people on information and strategic internet skills (van Deursen et al., 2011). It seems that the gain in operational and formal internet skills among older people results in a better performance on information internet skills. This, of course, can be applauded. However, policies should certainly not overlook people of all other ages. While performance tests revealed that information and strategic internet skills generally appear quite low among most people, the current results furthermore add that the levels of these skills did not improve between 2010 and 2013. We strongly recommend that future policies start focusing on these skills specifically. So far, it seems that this has not yet gone to the heart of the debate. Concerning education, we found that the higher people are educated, the higher their levels of all four internet skills. We furthermore found indications that the skills gap between the higher educated, on the one hand, and the lower and middle educated, on the other hand, increased, while the gap between low and middle educated decreased, at least for operational, formal, and information internet skills. Since content-related internet skills strongly relate to one's cognitive abilities, we expect that a particular share of inequality concerning information and strategic internet skills will remain and that these inequalities are long lasting. This, however, in no way means that internet skill policies should overlook lower and middle educated parts of the population. The results now show that the internet provides more opportunities for those of higher educational backgrounds, which according to

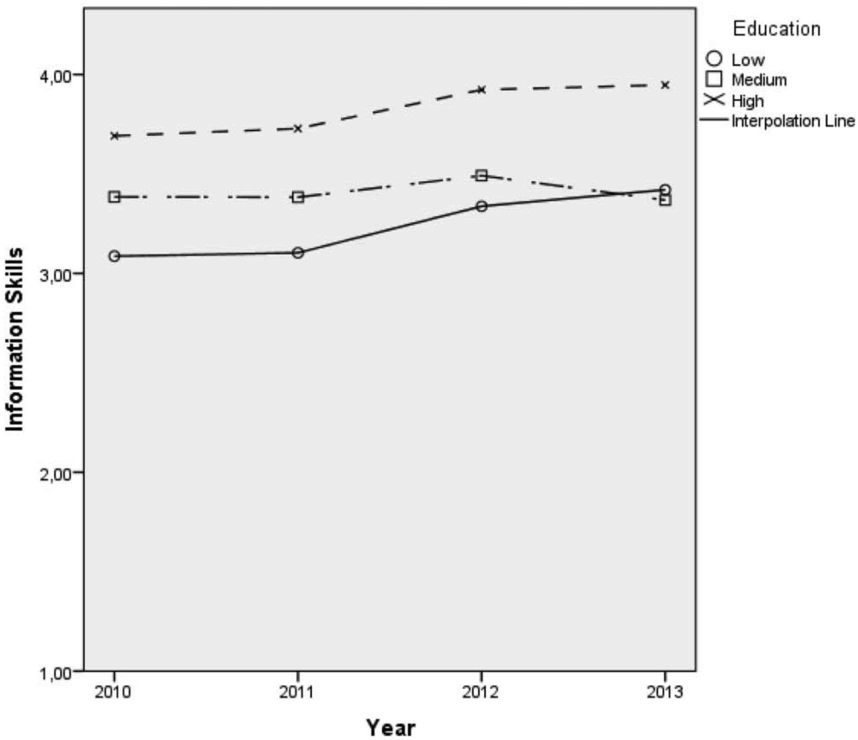

Figure 4. Educational patterns related to information internet skills, 2010–2013.

some scholars might even reinforce their stronger positions in society (Hargittai, 2008; Helsper, 2012; Mason & Hacker, 2003; van Deursen & van Dijk, 2014; van Deursen, van Dijk & ten Klooster, 2015; Wei & Hindman, 2011; Witte & Mannon, 2010).

It is important to keep in mind that in the end it is not internet skills that matter, but the narrowing of inequality in relation to everyday social challenges such as employability and general well-being. The main impact of inequalities of internet skills is more or less participation or exclusion. Therefore, there is a strong need for policies that attempt to compensate for low levels of these skills, especially policies aimed at those with the greatest need. Because the levels of internet skills differ among segments of the population, it is necessary to utilize a variety of treatments. This makes internet skills a complex policy problem that calls for both technological and educational solutions (Livingstone, 2003; van Dijk & van Deursen, 2014). Policies should target specific parts of the populations most in need of internet skill improvements.

5.2. *Limitations*

Concerning internet skill measurements among populations at large, empirical evidence is scarce. Studies often apply doubtful methods in terms of validity and reliability. Overall, three basic empirical methods are employed to investigate the level of internet skills: (1) Surveys with questions that ask for the use of digital media or internet applications, which are assumed to deliver indirect evidence for the command of skills. When an individual uses an application that is conceived to be difficult to use, this is held to be an indication of a high level of skills, (2) the most commonly used method is surveys with self-assessments of skills, and (3) performance tests in a laboratory or other controlled environments that provide subjects with particular assignments to observe their command of skills. The last method is the most valid. Self-assessments lead to the overrating and underrating of the skills possessed. In the current study we applied so-called proxy questions for surveys that best reflect the four skills used in the investigation: operational, formal, information, and strategic. The questions used were all derived from actual performance tests conducted in the Netherlands between 2008 and 2011 (van Deursen et al., 2012). This, however, does not mean that the measures used are perfect. For example, they provide little evidence of actual skill levels, but are more suited to see whether skills levels changed and who performs best. Furthermore, longitudinal cross-sectional panel data with such refined skill measures are, to our knowledge, unheard of. The authors of this investigation are part of a project in which more detailed and elaborate skill measures are defined in order to be used across countries and in European policies. Recently, a report was released with measures for operational, information navigation, social, creative, and mobile skills (van Deursen, Helsper, & Eynon, 2014).

The current study used longitudinal cross-sectional panel data to demonstrate aggregate-level change for populations and subgroups between 2010 and 2013. This timeframe was partly taken out of convenience (data of other years are not yet available). A span of four years is relatively short to determine the long-term trends as those assumed to be happening now. Future studies should continue focusing on changing patterns. And in addition, future studies should attempt to empirically investigate how differences in internet skills actually reflect inequalities in society.

Although repeated cross-sectional data enable demonstration of aggregate-level change for populations or subgroups, it is not possible to discern patterns of individual change. This would require measurements for the same respondents at several points in time. Many repeated cross-sectional surveys do contain some retrospective questions that can be used to consider individual change. However, true longitudinal panel data, where measurements are taken for the same individuals at multiple survey waves, can provide a more flexible alternative.

Disclosure statement

No potential conflict of interest was reported by the authors.

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