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Proposing a Survey Instrument for Measuring Operational, Formal, Information, and Strategic Internet Skills

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Observational studies prove to be very suitable to provide a realistic view of people's Internet skills. However, their cost and time are a strong limitation for large-scale data gathering. A useful addition to the measurement of Internet skills would be the development of survey questions for measuring Internet skills. In this contribution, potential survey measures for operational, formal, information, and strategic Internet skills were analyzed. Three steps were followed to obtain valid items; coherences between, on one hand, frequency and agreement scales and, on the other hand, the results of two large-scale performance tests (assignment completion and time spent) are measured, the Fornell and Larcker discriminant validity criterion was used to test discriminant validity of these Internet skills items, and the items are analyzed using a first-order confirmatory factor analysis. The items that resulted from the three steps might be used in future survey measures.

1. INTRODUCTION

The idea behind the digital divide concept is that there are significant benefits from computer and Internet usage and that nonusage results in negative consequences. Now the diffusion of the Internet among households has reached high levels in developed countries, the binary classification of access in terms of physical access (having a computer and an Internet connection or not) is considered to have been superseded and replaced by a divide that is supposed to concentrate on a large number of more complex variables and relations. A more refined understanding of the digital divide has developed, and several conceptualizations of how to approach digital divide research exist (DiMaggio & Hargittai, 2001; Mossberger, Tolbert, & Stansbury, 2003; Van Dijk, 2005; Warschauwer, 2003). One of the factors that is considered to be important in these conceptualizations is the differential possession of digital skills. The focus of this article is on Internet skills (and not on other digital skills such as those needed for personal computers, mobile phones, or digital television). The availability of Internet connections does not, in and of itself, guarantee meaningful use of the Internet. Although it is recognized that Internet skills are not equally distributed in society, few measurements and scientific investigations of the actual skill level possessed by populations at-large have been conducted. A main reason can be found in the lack of available survey instruments.

For studying the levels of Internet skills among populations at-large, a variety of methodologies can be employed. Most of the existing research used surveys that might offer in-depth explorations of participants' skills but in most cases gathered data based on people's own perceptions or estimations of their computer or Internet skills (Kuhlemeier & Hemker, 2007). See, for example, studies conducted by Bunz (2004) or Larsson (2002). Ideally, the measurement of Internet skills should provide the possibility to actually use the Internet. Observational studies prove to be very suitable to provide a realistic view of people's Internet skills. However, their cost and time are a strong limitation for large-scale data gathering. A useful addition to the measurement of Internet skills would be the development of survey questions for measuring Internet skills. Hargittai (2005, 2009) proposed composite variables of survey items that served as better predictors of people's actual Internet skills based on performance tests than measures of users' self-perceived abilities, Internet experience, or amount of Internet use. She proposed survey measures that appear as useful additions to current measurements (or lack thereof). In this contribution, the idea of proposing survey items derived from actual Internet skills levels measured in performance test is further investigated. We propose and test items for four types of Internet skills that have a conditional nature. The main research question is, *Which survey questions are valid and reliable measures of operational, formal, information, and strategic Internet skills?*

To answer this question, first existing measures of Internet skills are overviewed, followed by an explanation of the four Internet skills. After describing the methods employed, in the Result section three steps are described that together result in survey measures for all four Internet skills. In the first step the correlations between several skills items (a set of items using a frequency scale and a set of items using an agreement scale)

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and actual performances (number of tasks completed successfully and the time spent) are measured for all four Internet skills. In the second step, the Fornell and Larcker (1981) discriminant validity criterion is used to test discriminant validity of the Internet skills items that showed the highest correlations in Step 1. In this step, the items that have the highest potential for further analyses are selected based on their internal consistency. Finally, in the third step the items are further analyzed using a first-order confirmatory factor analysis based on a new data sample.

2. THEORETICAL BACKGROUND

2.1. Internet Skills Survey Measures

In most Internet skill measurements, people are presented with a list of skills and are asked to evaluate how well they perform those skills. Although self-report questionnaires have advantages—such as the ability to present a large number of questions on a wide range of skills in a short time, simple scoring, fast processing, and cost effectiveness (Kuhlemeier & Hemker, 2007)—this method has significant problems of validity (Hakkarainen et al., 2000; Hargittai, 2005; McCourt Larres, Ballantine, & Whittington, 2003; Merritt, Smith, & Renzo, 2005; Talja, 2005; Van Deursen & Van Dijk, 2010). Interpretations of skills not only are perspective and context dependent but also depend upon with whom they compare themselves (Talja, 2005). Merritt et al. (2005) checked the validity of self-reports concerning computer skills and found that these were rated higher than actual skills. Although, in general, higher self-efficacy leads to a greater likelihood of using the Internet (Eastin & LaRose, 2000) and to a higher completion of online tasks (Torkzadeh & Van Dyke, 2002), this kind of measurement has significant problems of validity and is a poor predictor of performance. Experience shows that men, especially young men, overrate their performance, whereas some women and older people underrate it (Hargittai & Shafer, 2006). Consequently, it is not clear to what extent differences in self-ratings correspond to real differences in skills.

Besides measures of self-efficacy, surveys also employ indirect measures for Internet skills. Large benchmarks (such as Eurostat) use surveys in which respondents are asked which of a number of activities they have ever carried out. There is no measurement or observation of actual Internet skills. Internet skills are thus put on par with Internet usage, although the relation between the two variables is not clear.

2.2. Defining Internet Skills

To encourage research to focus on in-depth skill measurement and to support the achievements of digital divide research, Van Deursen and Van Dijk (2009, 2010) elaborated four types of Internet skills from an extensive literature overview that can be divided in both medium- and content-related Internet skills. The first type of medium-related Internet skills are the operational Internet skills, which they derived from concepts such as instrumental skills (Steyaert, 2002), technical competence (Mossberger et al., 2003), technological literacy (Carvin, 2000), and technical proficiency (Søby, 2003). All these concepts indicate a set of basic skills in using Internet technology. The second type of medium-related Internet skills are the formal Internet skills, which relate to the hypermedia structure on which the Internet is built. This structure requires the skills of navigating, and orientating (Edwards & Hardman, 1989; Kwan, 2001; Park & Kim, 2000). The first type of content-related Internet skills are the information Internet skills, derived from studies that adopt a staged approach in explaining the actions via which users try to fulfill their information needs (Marchionini, 1995). Finally, strategic Internet skills are the second type of content-related Internet skills. These are the capacity to use the Internet as a means of reaching particular goals and for the general goal of improving one's position in society. The definition of strategic skills is based on the classical approach to decision making, with an emphasis that lies on procedures through which decision makers can reach an optimal solution as efficiently as possible (Miller, 2006).

The four Internet skills categories are based on individual abilities, which means they include relevant skills necessary for the general population to function well in an increasingly digital environment. They are listed in Table 1. The four Internet skills have a sequential and conditional nature. Content-related skills somehow depend on the medium-related skills because the absence of medium-related skills means that one will not even come to perform the content-related skills (Van Deursen, Van Dijk, & Peters, 2011). The Internet, for example, makes information seeking more difficult because it assumes a number of new operational and formal skills to begin with.

Van Deursen and Van Dijk (2010, 2011a, 2011b) tested all four Internet skills separately in a range of performance tests. The main benefits of the proposed range of skills are (a) a definition and measurements of several types of Internet skills distinguished by others in the literature, (b) a taxonomy representing a extensive range of Internet skills, and (c) the idea of a conditional nature of medium-related skill types and content-related skill types in this taxonomy. Van Deursen and Van Dijk (2010) showed that the proposed definition and measurements are appropriate, reliable, and valid. The actual results of the performance tests conducted among a large sample of the Dutch population and the actual implications of these results are described elsewhere in depth (see Van Deursen & Van Dijk, 2009, 2010, 2011a, 2011b). Here, we focus on providing survey measures, validated by the results of actual performance tests.

3. METHOD

To propose valid and reliable survey measures for the four types of Internet skills, we use the data collected in two large-scale performance tests, one conducted in 2009 and one in 2010. In these tests, data were gathered on around 100 randomly

TABLE 1
Conceptual Definition for Internet Skills (van Deursen & Van Dijk, 2009, 2010)

Medium-related Internet skills	
Operational Internet skills	*Operating an Internet browser, meaning:* Opening web sites by entering the URL in the browser's location bar; Navigating forward and backward between pages using the browser buttons; Saving files on the hard disk; Opening various common file formats (e.g., PDFs); Bookmarking web sites; Changing the browser's preferences. *Operating Internet-based search engines, meaning:* Entering keywords in the proper field; Executing the 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 on the Internet, meaning:* Using hyperlinks (e.g., menu links, textual links, image links) in different menu and web site layouts. *Maintaining a sense of location while navigating on the Internet, meaning:* Not becoming disoriented when navigating within a web site; Not becoming disoriented when navigating between web sites; Not becoming disoriented when opening and browsing through search results.
Content-related Internet skills	
Information Internet skills	*Locating required information by doing the following:* Choosing a web site or a search system to seek information; Defining search options or queries; Selecting information (on web sites or in search results); Evaluating information sources.
Strategic Internet skills	*Taking advantage of the Internet by doing the following:* Developing an orientation toward a particular goal; Taking the right action to reach this goal; Making the right decision to reach this goal; Gaining the benefits resulting from this goal.

selected Internet users who performed online tasks in a research setting. All of their online actions were recorded and later analyzed. See Van Deursen and Van Dijk (2009, 2010, 2011a, 2011b) for more detail and the study instruments. The in-person observations of people's online behavior resulted in two measures of Internet skills: the percentage of tasks completed successfully and the amount of time spent on the eight tasks. In both tests, eight assignments were used to measure operational Internet skills, four for measuring formal Internet skills, three for measuring information Internet skills, and two for measuring strategic Internet skills. In the first study, general leisure-related assignments were used that geared toward the consciousness of all Internet users. The assignments in the second study were all health related and accessible to the general user population.

After the assignment completion, participants were presented with survey questions that included scaled items, which together represent the four types of Internet skills. The most common response formats used in measurement scales are frequency (how often), evaluation (how much do you like it), and agreement (how much do you agree) (Redding, Maddock, & Rossi, 2006). In the first study, the items used a frequency scale. Respondents were asked to complete items with response options that were anchored on a 5-point Likert scale, ranging from 1 (*never*) to 5 (*daily*). The items measured the frequency of various Internet skill-related activities that are related to the Internet skills definition. Items for all four Internet skills were constructed and pretested among 10 respondents for clearness, conciseness, understanding, and reading level. In the second study, the questionnaire used a 7-point Likert

scale on which respondents were asked to rate their agreement with several Internet skills-related behaviors, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). In addition, here, the items for all four Internet skills were constructed and pilot tested among 10 respondents for clearness, conciseness, understanding, and reading level. In analyzing the responses from the questionnaire, all negatively keyed items are recoded. For missing values (13 in the first study and 10 in the second), mean substitution is applied; missing values are replaced by the average of the observed values for that item.

4. RESULTS

4.1. Correlations Between Internet Skills Survey Items and Observed Internet Skills

Table 2 shows the Pearson's correlation coefficients among the frequency scale items and the two outcomes of actual performance (i.e., percentage of tasks successfully completed and amount of time spent on the eight tasks). The signs of the coefficients are in the expected direction. For percentage of tasks successfully completed, the correlation coefficients are positive, suggesting that commanding or experiencing the several related

TABLE 2
Pearson's correlations between frequency scale items and the number of operational (o), formal (f), information (i), and strategic (s) internet skills assignments completed successfully and the time spent

On the Internet, How Often Do You . . .	Task Completion	Time Spent
save files	**.48****	**−.48****
complete forms (e.g., application forms)	**.44****	**−.45****
use the refresh button	**.44****	**−.45****
upload files to another computer	**.42****	**−.44****
use back and forward buttons	**.42****	**−.38****
download programs from the Internet	**.41****	**−.34****
watch video files	**.46****	**−.51****
download music files	**.41****	**−.43****
add a Web site to the "Favorites"	**.27****	**−.20***
save photos on your PC	**.26****	**−.19***
use multiple browser windows	**.56****	**−.66****
find Web sites to be confusing	**−.37****	**.40****
navigate without getting lost	**.32****	**.41****
feel disoriented	**−.29****	**.33****
experience difficulties with a Web site's layout	**−.29****	**.41****
know exactly where a link will take you	**.28****	**.37****
check information retrieved on another Web site	**.44****	−.18
examine only the top results	**.33****	**−.39****
Search for information	**.30****	**−.40****
find the information you were looking for	**.30****	**−.26****
use advanced search options (e.g., Boolean operators)	**.30****	**−.23***
examine the results on subsequent result pages	**.30****	−.14
use more than one search keyword	**.24***	**−.23***
evaluate the source of the information found	**.20***	−.18
make a decision based on retrieved information	**.48****	.15
use information about a specific subject from multiple sites	**.42****	.12
buy a product based on retrieved information	**.38****	.10
benefit from using the Internet	**.31****	.11
reach your intended goal	**.29****	.06
use reference Web sites	**.28****	.04
gain financial benefits	**.27****	.13
compare products	**.24***	**.21***
work towards a specific goal	**.22***	**.26****

Note. Significant correlations are in bold.
*$p < .05$. **$p < .01$.

actions as presented in the items is positively correlated with the subject's actual Internet skills. The negative coefficients for time spent on tasks show that those who perform actions more often take less time to complete the tasks. In the majority of cases, the coefficients are statistically significant for both outcome skills measures. This suggests that the created items may be used as a proxy for actual skill measures.

Table 3 shows the Pearson's correlation coefficients among the agreement scale items and the two items measuring actual performance. Here also, the signs of the coefficients are in the expected direction. However, the correlations, especially those concerning information and strategic Internet skills, are lower than the correlations between the frequency scale items and performance outcomes. In the majority of cases considering information Internet skills, the coefficients are not statistically significant for both outcome skills measures. This suggests that the created frequency items might be better suited for use as a proxy for actual skills measures. Therefore, the frequency scale items are further analyzed in Steps 2 and 3. More specifically, the following items are considered (and labeled to ease further analyses):

Operational Internet skills:

- O1 - save files
- O2 - complete forms
- O3 - use the refresh button

TABLE 3
Pearson's Correlations Between Agreement Scale Items and the Number of Operational, Formal, Information, and Strategic Internet Skills Assignments Completed Successfully and the Time Spent

Agreement Measures	Task Completion	Time Spent
I sometimes save files from the Internet	**.54****	**−.54****
Using the Internet browser is self-evident	**.53****	**−.56****
I often download music files	**.49****	**−.60****
I often use the back and forward buttons	**.45****	**−.51****
I often do not now the purpose of the Internet browser buttons	**.44****	**−.47****
I sometimes adjust the Internet browser settings to my personal preferences	**.38****	**−.48****
I sometimes add a Web site to the "Favorites"	**.26***	**−.40****
I often use multiple browser windows at the same time	**.55****	**−.58****
I sometimes find the Web sites' design to be complex	**−.34****	**.36****
On the Internet, I often feel disoriented	**−.33****	**.23***
To me, the design of a Web site is often incomprehensible	**−.32****	**.27***
Web sites are sometimes confusing	**−.23***	**.24***
On the Internet, I often navigate without getting lost	**−.23***	**.22***
On the Internet, I know exactly where a link will take me	.15	−.19
All those different layouts make working with the Internet difficult	.11	−.06
It is often difficult to retrieve a Web site on the Internet	.10	−.18
I should follow a course for searching the Internet	**−.29****	**.35****
I normally use more than one keyword when searching	**.26***	**−.28***
On the Internet, I often do not find what I am looking for	**−.24***	**.25***
I normally examine more than just the top results	.17	**−.34****
I sometimes do not know what search terms to use when searching the Internet	−.17	**.34****
I sometimes check information on another Web site	.03	**−.26***
I normally can easily choose from search results	.07	**−.24***
I do not really care where information on the Internet comes from	.10	−.10
I normally check the source of information on the Internet	.08	−.12
I often gain benefits from using the Internet	**.31****	−.10
Using the Internet brings me little benefit	**−.31****	.09
The Internet sometimes saves me money	**.29****	−.12
Except pleasure, using the Internet brings me little benefit	**.29****	.09
On the Internet, I often achieve my goals	**.24***	−.05
When I have to make a choice, I sometimes consult the Internet	.20	−.02
I sometimes make important decisions with the help of the Internet	.09	−.12

Note. Significant correlations are in bold.
*$p < .05$. **$p < .01$.

- O4 - upload files to another computer
- O5 - use back and forward buttons
- O6 - download programs from the Internet
- O7 - watch video files
- O8 - download music files

Formal Internet skills:

- F1 - use multiple browser windows
- F2 - find Web sites to be confusing
- F3 - nagative without getting lost
- F4 - feel disoriented
- F5 - experience difficulties with a Web site's layout
- F6 - know exactly where a link will take you

Information Internet skills:

- I1 - check information retrieved on another Web site
- I2 - examine only the top results
- I3 - search for information
- I4 - find the information you were looking for
- I5 - use advanced search options (e.g., Boolean operators)
- I6 - examine the results on subsequent result pages
- I7 - use more than one search keyword
- I8 - evaluate the source of the information found

Strategic Internet skills:

- S1 - make a decision based on retrieved information
- S2 - use information about a specific subject from multiple sites
- S3 - buy a product based on retrieved information
- S4 - benefit from using the Internet
- S5 - reach your intended goal
- S6 - use reference Web sites
- S7 - gain financial benefits

4.2. Discriminant Validity and Internal Consistency

Discriminant validity is the degree to which items differentiate between constructs or measure distinct concepts. The Fornell and Larcker discriminant validity criterion is satisfied when a construct is more closely related to its own indicators than to other constructs. Table 4 shows the correlation matrix of the items that resulted from Step 1. A careful examination of the correlations reveals that most of the four Internet skills items converge by exhibiting uniformly high correlations among themselves. However, the rules for discrimination do not hold to indicate the existence of the operational, information, and strategic Internet skills constructs. These theoretically derived constructs are thus not directly represented in the empirical findings. The results do reveal a delineation between the four Internet skills; however, this delineation is not exclusive, with the exception of formal Internet skills. For example, some of the information Internet skills items have strong correlations with strategic Internet skills items.

Selection of the items that have the highest potential for further analyses is based on the internal consistency, measured with Cronbach's alpha coefficients. As recommended by Nunnally (1978), internal consistency estimates of a magnitude of .70 or greater were sought. For operational Internet skills, item O5 (use back and forward buttons) was deleted to increase internal consistency. The remaining items are as follows:

- O1 - save files
- O2 - complete forms
- O3 - use the refresh button
- O4 - upload files to another computer
- O6 - download programs
- O7 - watch video files
- O8 - download music files

The internal consistency of these items is .76. This creates a new variable that yields correlation coefficients of .55 ($p < .01$) and –.59 ($p < .01$) for successful completion of the operational Internet skills tasks and for the time spent on these tasks, respectively.

All six items regarding formal Internet skills show both convergent and discriminant validity. Item F1 (use multiple browser windows) was deleted to increase internal consistency. The remaining items are as follows:

- F2 - find Web sites to be confusing
- F3 - nagative without getting lost
- F4 - feel disoriented
- F5 - experience difficulties with a Web site's layout
- F6 - know exactly where a link will take you

These items together have a Cronbach's alpha coefficient of .77. This creates a new variable that yields correlation coefficients of .31 ($p < .01$) and –.25 ($p < .01$) for successful completion of the formal Internet skills tasks and for the time spent on these tasks, respectively.

Six of the eight items regarding information Internet skills show a high internal consistency. Items I5 (use advanced search options) and I8 (evaluate the source of the information found) are deleted. The remaining items include the following:

- I1 - check information retrieved on another Web site
- I2 - examine more than one search result
- I3 - search for information
- I4 - find the information I was looking for
- I6 - examine more than one page of search results
- I7 - use more than one search keyword

These items together have a Cronbach's alpha coefficient of .82. This creates a new variable that yields correlation coefficients of .39 ($p < .01$) and –.27 ($p < .01$) for successful completion of the information Internet skills tasks and for the time spent on these tasks, respectively.

Regarding strategic Internet skills, five of the seven items show high internal consistency. Items S3 (buy a product based

TABLE 4
Correlation Matrix of the Operational (O), Formal (F), Information (I), And Strategic (S) Internet Skills Items

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1. O1	–	**.49**	**.47**	**.42**	**.45**	**.49**	**.61**	**.46**	*.08*	**.25**	*.04.*	*.05*	*.07*	*.07*	**.31**	**.43**	**.40**	**.41**	**.38**	**.37**	**.46**	**.20**	*.18*	*.11*	**.48**	**.22**	*.10*	*.18*	**.33**
2. O2		–	**.42**	**.40**	**.25**	**.31**	**.37**	**.34**	*.02*	*.04*	*.12*	*.00*	*.00*	*.11*	**.24**	**.49**	**.43**	**.38**	**.32**	**.30**	**.34**	**.32**	**.39**	**.17**	**.48**	**.28**	**.21**	**.23**	**.39**
3. O3			–	**.48**	**.35**	**.36**	**.37**	**.39**	**.21**	*.19*	*.09*	*.08*	*.03*	*.07*	**.30**	**.51**	**.39**	**.43**	**.38**	**.37**	**.40**	**.22**	**.22**	*.06*	**.46**	*.15*	*.06*	*.17*	*.08*
4. O4				–	**.17**	**.50**	**.46**	**.40**	*.02*	*.19*	*.08*	*.06*	*.07*	*.05*	*.17*	**.38**	**.27**	*.17*	**.44**	**.19**	**.24**	**.12**	**.19**	*.01*	.42	*.10*	*.09*	*.07*	*.07*
5. O5					–	**.19**	**.32**	**.29**	**.23**	**.28**	*.08*	*.06*	*.01*	**.28**	*.18*	**.49**	**.50**	**.44**	**.20**	**.48**	**.46**	**.35**	**.28**	*.19*	.36	.31	*.03*	.19	**.25**
6. O6						–	**.44**	**.48**	*.08*	**.20**	**.24**	*.08*	*.07*	*.15*	*.17*	**.36**	**.29**	**.31**	**.45**	**.21**	**.21**	*.16*	.21	*.07*	.47	*.14*	*.12*	*.11*	*.17*
7. O7							–	**.66**	*.11*	**.20**	*.04*	*.04*	*.03*	*.14*	*.15*	**.35**	**.46**	**.29**	**.37**	**.24**	**.45**	*.13*	*.13*	*.04*	.36	.25	*.10*	*.17*	**.21**
8. O8								–	*.04*	*.08*	*.14*	*.06*	*.05*	*.12*	*.03*	**.34**	**.29**	**.20**	**.32**	*.17*	**.43**	**.23**	**.20**	.03	.37	*.06*	*.14*	*.12*	*.17*
9. F1									–	**.36**	**.32**	**.32**	**.30**	**.28**	*.07*	*.16*	*.01*	**.25**	*.06*	*.18*	*.11*	*.03*	*.16*	*.10*	*.17*	*.11*	*.03*	*.05*	*.04*
10. F2										–	**.33**	**.38**	**.42**	**.45**	*.06*	**.22**	*.17*	**.29**	*.03*	*.16*	*.11*	*.16*	*.01*	*.06*	*.15*	*.01*	*.15*	*.06*	*.12*
11. F3											–	**.44**	**.44**	**.56**	*.17*	*.18*	*.17*	***.30***	*.03*	*.08*	*.03*	.22	*.06*	*.04*	*.15*	*.15*	*.07*	*.10*	*.07*
12. F4												–	**.39**	**.42**	*.06*	*.02*	*.07*	*.11*	*.13*	*.04*	*.14*	*.04*	*.05*	*.05*	*.00*	*.08*	*.01*	*.01*	*.06*
13. F5													–	**.60***	*.02*	*.10*	*.01*	*.12*	.21	*.05*	*.14*	*.03*	*.09*	*.07*	*.10*	*.09*	*.08*	*.01*	*.03*
14. F6														–	*.03*	*.05*	**.25**	**.28**	*.10*	*.14*	*.13*	*.13*	*.06*	*.00*	*.08*	*.03*	*.04*	*.03*	*.07*
15. I1															–	**.35**	**.26**	**.40**	**.39**	**.37**	**.24**	***.04***	**.23**	*.19*	*.14*	**.32**	*.05*	**.26**	**.28***
16. I2																–	**.57**	**.49**	**.31**	**.65**	**.52**	**.35**	**.54**	**.27**	**.62**	**.31**	*.07*	**.28**	**.36**
17. I3																	–	**.62**	**.24**	**.45**	**.53**	**.40**	**.39**	*.14*	**.49**	**.42**	*.00*	**.33**	**.30**
18. I4																		–	***.18***	**.41**	**.44**	**.34**	**.37**	**.27**	**.49**	**.38**	*.01*	**.29**	**.26**
19. I5																			–	**.31**	**.25**	**.22**	**.20**	*.05*	**.36**	**.23**	*.13*	**.22**	*.08*
20. I6																				–	**.50**	**.38**	**.36**	*.17*	**.33**	**.24**	*.11*	**.26**	**.20**
21. I7																					–	**.40**	**.25**	*.16*	**.43**	**.29**	*.03*	*.17*	*.18*
22. I8																						–	**.22**	**.21**	**.40**	**.27**	*.14*	*.17*	*.18*
23. S1																							–	**.32**	**.51**	**.50**	***.15***	**.55**	**.38**
24. S2																								–	**.29**	**.21**	**.32**	**.24**	**.33**
25. S3																									–	**.35**	***.06***	**.25**	**.32**
26. S4																										–	*.12*	**.36**	**.29**
27. S5																											–	**.23**	*.12*
28. S6																												–	**.55**
29. S7																													–

Note. Significant at $p < .05$. Nonsignificant correlations are in italic; significant correlations are in bold.

on retrieved information) and S5 (reach your intended goal) are deleted. The remaining items are as follows:

- S1 - make a decision based on retrieved information
- S2 - use information about a specific subject from multiple sites
- S4 - benefit from using the Internet
- S6 - use reference Web sites
- S7 - gain financial benefits

These items together have a Cronbach's alpha coefficient of .76. This creates a new variable that yields correlation coefficients of .46 ($p < .01$) and .14 (*ns*) for successful completion of the strategic Internet skills tasks and for the time spent on these tasks, respectively.

4.3. First-Order Confirmatory Factor Analysis

In the third step of the analyses, the 23 remaining items from Step 2 are further validated in a first-order confirmatory factor analysis. To perform this analysis, a third study was conducted in which the 23 items were included in the pilot test of a large-scale survey concerning Internet access and use. Subscribers of a national online panel (administrated by a profit research and consultancy company) were invited via e-mail to voluntary participate in this online survey in August 2010. In total, 300 subscribers were invited, and a total of 238 completed surveys were returned. Because of self-selection, the sample was not representative for all Internet users. However, representativeness was not required as we followed a deductive research strategy. The model is considered universally valid for all Internet users and should therefore also describe a gender-imbalanced sample. A brief overview of the respondents is provided in Table 5.

Prior to the analyses, data were checked for normality. Because of skewness to the lower end of the distribution of the formal Internet skills measures, an inverse (reciprocal) transformation was performed to correct skew (Garson, 2006).

TABLE 5
Subjects Over Gender, Age, and Education

	N	%
Gender		
Male	157	66
Female	81	34
Age		
18–29	5	2
30–39	19	8
40–54	75	32
55–80	138	58
Education		
Low (e.g., primary school)	42	18
Middle (e.g., high school)	77	32
High (e.g., college and university)	119	50

Using a first-order confirmatory factor analysis, the measurement model estimated the extent to which the 23 observed items loaded onto their respective latent variables. All latent constructs but no observed error variances were allowed to covary with one another. The initial measurement model generated poor fit (for required fit measures, see Section 4.6), $\chi^2(224) = 557.81$, $\chi^2/df = 2.49$, standardized root mean square residual (SRMR) = .087, Tucker–Lewis Index (TLI) = .831, root mean square error of approximation (RMSEA) = .079, 90% confidence interval (CI) [.071, .088]. Subsequently, items with highly correlated error variances identified by post hoc modification indices and items that loaded poorly onto its unique factor were removed. This procedure resulted in the reduction of the number of observed indicators of the latent constructs to better fit the measurement model. Two operational Internet skills items (O2 - complete forms, and O8 - download music files) and one information Internet skills item (I3 - search for information) were removed. The internal consistency of the measures was above aspiration level ($\alpha > .70$). The modified measurement model generated a good fit, $\chi^2(164) = 284.01$, $\chi^2/df = 1.73$, SRMR = .061, TLI = .923, RMSEA = .056, 90% CI [.045, .066]. The correlation matrix of the observed variables is shown in Table 6.

Table 7 summarizes the original (uncorrected) means and standard deviations, Cronbach's alphas, the factor loadings (β), and the squared multiple correlations (R^2) of the observed indicators.

5. DISCUSSION

Three points of discussion should be carefully accounted for in future research. First, no clear pattern emerges when the proposed items are analyzed. The desired outcome from discriminant validity criteria is that four different Internet skills constructs would have appeared, as proposed in the Internet skills definition. The analyses revealed that although several specific Internet skills items reveal strong convergence, they also show significant high correlations with items from other Internet skills. This can partly be explained by the nature of the four Internet skills, which is proved to be sequential and conditional (Van Deursen et al., 2011). Although this specific nature suggests significant correlation between the four Internet skills items, still stronger correlations between the items of one specific skill rather than between different Internet skills items would have been the expected result.

Second, Table 6 reveals that most of the items reveal only moderate squared multiple correlations (aspiration level is > .05), which indicates that they are for a large part explaining themselves, instead of the latent construct they belong to. A stronger operationalization of the skill items is needed. Therefore extended item batteries should be developed to obtain more discriminant validity.

Third, despite the significant correlations, it appears that the mean scores of the four Internet skills constructs do not reflect the scores of the actual performance tests very well. Further

TABLE 6
Correlation Matrix

	O1	O3	O4	O6	O7	F2	F3	F4	F5	F6	I1	I2	I4	I6	I7	S1	S2	S4	S6	S7
O1	–	**.343**	**.444**	**.262**	**.331**	*.109*	*.091*	*.069*	*.073*	*.050*	**.343**	**.366**	**.331**	**.439**	**.286**	**.205**	**.184**	**.256**	**.278**	**.280**
O3		–	**.385**	**.325**	**.354**	**.205**	**.130**	**.223**	*−.046*	*.053*	**.254**	**.311**	**.301**	**.328**	**.176**	**.154**	**.224**	**.229**	**.296**	**.298**
O4			–	**.376**	**.347**	*.007*	*.027*	*.009*	*−.115*	*.001*	**.373**	**.385**	**.321**	**.363**	**.308**	**.213**	**.192**	**.303**	**.305**	**.382**
O6				–	**.394**	**.136**	*.078*	*.102*	*.016*	*.050*	**.366**	**.433**	**.383**	**.332**	**.359**	**.392**	**.317**	**.370**	**.369**	**.333**
O7					–	*.043*	*.078*	*.116*	*.069*	**.218**	**.183**	**.216**	**.243**	**.252**	**.155**	**.112**	**.143**	**.204**	**.186**	**.240**
F2						–	**.520**	**.507**	**.206**	**.356**	*.039*	**.135**	*.105*	**.152**	*.070*	*.044*	*.101*	*−.062*	*.117*	**.137**
F3							–	**.539**	**.383**	**.568**	*.018*	**.131**	*.049*	**.158**	*.085*	*−.002*	*.061*	*−.045*	*.076*	*.084*
F4								–	**.348**	**.449**	*.006*	*.095*	*.049*	*.108*	*.030*	*.093*	*.004*	*−.020*	*.077*	*.064*
F5									–	**.488**	*−.030*	*.010*	*−.099*	*−.001*	*.026*	*−.098*	*−.110*	*−.014*	*−.071*	*−.107*
F6										–	*.033*	*.065*	*−.034*	*.057*	*−.017*	*−.065*	*−.050*	*−.138*	*−.023*	*.011*
I1											–	**.595**	**.633**	**.740**	**.576**	**.246**	**.285**	**.304**	**.443**	**.446**
I2												–	**.590**	**.642**	**.452**	**.253**	**.277**	**.337**	**.443**	**.379**
I4													–	**.620**	**.483**	**.271**	**.284**	**.263**	**.467**	**.409**
I6														–	**.564**	**.335**	**.304**	**.306**	**.468**	**.443**
I7															–	**.405**	**.299**	**.405**	**.471**	**.444**
S1																–	**.465**	**.486**	**.531**	**.438**
S2																	–	**.325**	**.490**	**.430**
S4																		–	**.454**	**.359**
S6																			–	**.633**
S7																				–

Note. Significant at $p < .05$. Nonsignificant correlations are in italic; significant correlations are in bold.

TABLE 7
Descriptive Statistics, Factor Loadings, Squared Multiple Correlations, and Cronbach's Alpha for the Observed Internet Skills Indicators

	M	*SD*	β	R^2
Operational Internet skills (α = .73)				
O1 - save files	2.53	1.30	.60	.36
O3 - use the refresh button	3.38	1.57	.57	.33
O4 - upload files to another computer	3.96	1.22	.66	.43
O5 - download programs	3.99	1.10	.61	.38
O7 - watch video files	3.00	1.19	.53	.29
Formal Internet skills (α = .79)				
F2 - find web sites to be confusing	1.74	0.91		
F3 - navigate without getting lost	1.34	0.68	.80	.64
F4 - feel disoriented	1.49	0.76	.69	.48
F5 - experience difficulties with a web site's layout	1.86	0.88	.51	.26
F6 - know exactly where a link will take you	1.47	0.88	.62	.38
Information Internet skills (α = .87)				
I1 - check information retrieved on another web site	2.86	1.01	.84	.70
I2 - examine only the top results	2.05	1.01	.74	.55
I4 - find the information you were looking for	1.97	1.06	.75	.56
I6 - examine the results on subsequent result pages	1.96	0.95	.86	.74
I7 - use more than one search keyword	1.97	1.06	.67	.45
Strategic Internet skills (α = .81)				
S1 - make a decision based on retrieved information	3.49	1.14	.65	.43
S2 - use information about a specific subject from multiple sites	3.17	1.08	.60	.36
S4 - Benefit from using the Internet	2.97	1.14	.58	.33
S6 - use reference web sites	3.42	0.99	.83	.54
S7 - gain financial benefits	2.51	1.23	.74	.69

research should carefully test, if at all possible, to obtain valid data by using surveys concerning information and strategic Internet skills. However, the current items are very well suitable for identifying Internet skills differences between segments of the population.

A final remark is that the proposed skills instrument is not yet complete in the sense that it does not account for communication and content creation Internet skills. So far these skills are neglected because because adding these skills would have made the performance tests, which already required 1½ hr of the subjects' time, an unrealistic effort. The authors are currently in the process of adding these skills to the framework and subsequently testing them in performance tests. Van Deursen and Van Dijk (2012) already proposed items for communication skills that will be tested in these performance tests.

6. CONCLUSIONS

In this contribution, we analyzed potential survey measures for operational, formal, information, and strategic Internet skills. Three steps were followed to obtain valid items. In the first step, correlations between, on one hand, frequency and agreement scales and, on the other hand, the results of actual performance tests (assignments completion and time spent) are measured. This step revealed that some of the frequency items proposed would serve as the best proxies for measuring Internet skills in surveys. In the second step, the Fornell and Larcker (1981) discriminant validity criterion was used to test discriminant validity of the Internet skills of the remaining items. The items that have the highest potential for further analyses are selected based on their internal consistency. In the third step the items were further analyzed using a first-order confirmatory factor analysis based on a new data sample. The items that resulted from the three steps might be used in future survey measures. These are the items summarized in Table 6. A final remark is that Table 7 reveals that is it possible to observe the four Internet skills separately. This confirms upon the theory discussed in Section 2.

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