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Modeling Traditional Literacy, Internet Skills and Internet Usage: An Empirical Study

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This paper focuses on the relationships among traditional literacy (reading, writing and understanding text), medium-related Internet skills (consisting of operational and formal skills), content-related Internet skills (consisting of information and strategic skills) and Internet usage types (information- and career-directed Internet use and entertainment use). We conducted a large-scale survey that resulted in a dataset of 1008 respondents. The results reveal the following: (i) traditional literacy has a direct effect on formal and information Internet skills and an indirect effect on strategic Internet skills and (ii) differences in types of Internet usage are indirectly determined by traditional literacy and directly affected by Internet skills, such that higher levels of strategic Internet skills result in more information- and career-directed Internet use. Traditional literacy is a pre-condition for the employment of Internet skills, and Internet skills should not be considered an easy means of disrupting historically grounded inequalities caused by differences in traditional literacy.

RESEARCH HIGHLIGHTS

- We examine the relationship between traditional literacy, four types of Internet skills and Internet usage types.
- Traditional literacy has a direct effect on formal and information Internet skills and an indirect effect on strategic Internet skills.
- Differences in Internet usage types are indirectly determined by traditional literacy and directly affected by Internet skills.
- Traditional literacy is a pre-condition for the employment of Internet skills.
- Internet skills should not be considered an easy means of interrupting historically grounded inequalities caused by differences in traditional literacy.

Keywords: web searching and information discovery; information retrieval; computing education; universal access; computing literacy

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1. INTRODUCTION

Many policies support initiatives to ensure a citizenry capable of living in an information society. A key variable in information access and inequality is Internet skills (DiMaggio *et al*., 2004; Mossberger *et al*., 2003; Solomon *et al*., 2003; Van Dijk, 2005; Van Dijk and Van Deursen, 2014; Warschauer, 2004). A dearth of Internet skills might result in disadvantages or even exclusion from global communities (Sutherland-Smith, 2002). In the contemporary (and future) information society, Internet skills increasingly determine people's positions in the labor market and in social life (Van Deursen and Van Dijk, 2011). Van Dijk and Van Deursen (2014) and Helsper (2012) stress that the main consequence of differences in Internet skills is a varying level of participation in several societal fields. For example, in economics, Internet skills facilitate access to information about job opportunities, and in health, these skills

enable early detection of potential medical problems, or allow for collaborative treatment of illnesses. The focus on Internet skills in research and policy leads some to believe that the challenges of traditional literacy have disappeared. Traditional literacy, or the ability to read, write and understand text, is a primary source of information and communication. There is some evidence that one's capacity to use the Internet remains contingent on his or her level of traditional literacy (e.g. Wilder and Dressman, 2006). However, empirical studies focusing on the relationship between traditional literacy and Internet skills among populations at large are, to our knowledge, non-existent. One reason for this lack of empirical investigations might be the overabundance of Internet skills-related concepts and definitions that often remain abstract and are rarely applied (Bawden, 2008). In this study, we conducted a survey of the Dutch population with two goals:

(i) To empirically investigate how traditional literacy influences Internet skills. We consider Internet skills to be a multidimensional concept, accounting for both medium-related Internet skills, or skills related to the more basic and technical aspects of Internet use, and content-related Internet skills, or skills required to use Internet content. This distinction facilitates an improved understanding of how traditional literacy affects both basic Internet operation and more advanced skills, such as mastering search processes.
(ii) To empirically investigate how an individual's traditional literacy level and Internet skills determine how he or she uses the Internet. Deficiencies or weaknesses in either traditional literacy or Internet skills may limit Internet use to relatively simple entertainment activities. Conversely, people with high levels of traditional literacy and Internet skills may be better able to utilize the informational aspects of the Internet. Different uses of the Internet may eventually lead to the disempowerment and exclusion of certain individuals (Van Dijk, 2005; Witte and Mannon, 2010).

2. THEORETICAL BACKGROUND

2.1. Traditional literacy

Literacy has had a variety of definitions over time, becoming more representative of the skills needed to function successfully in an information or knowledge society. Traditionally, literacy has been defined as the ability to use written language actively and passively or the ability to read, write, spell, listen and speak (Moats, 2000). Bawden (2001, p. 220) states that the simplest form of literacy involves the ability to use language in its written form: 'A literate person is able to read, write and understand his or her native language and express a simple thought in writing'. In 1991, the US National Literacy Act defined literacy as an individual's ability to read, write and speak in English to solve problems at a level of proficiency necessary to function in society, to achieve one's goals and to develop one's knowledge and potential. Street (1984) defined literacy as conceptions of reading, writing and all types of social practices. Many theorists favor such a broad definition in which social contexts of literacy practice are also considered (Warschauer, 2010), asserting that what is considered skillful reading and writing differs with the historical, political and sociocultural contexts (Gee, 1996). When the context is considered, literacy becomes 'having mastery over the process by means of which culturally significant information is coded' (De Castell and Luke, 1988, p. 159). Expert opinion favors the concept of literacy on a continuum that includes the ability to reproduce letter combinations at one extreme and the ability to engage in logical thinking, higher-order cognitive skills and reasoning on the other (Clifford, 1984). Lankshear and Knobel (2004) argued that literacy has many different definitions under varying social conditions and that the nature of the concept changes within the conditions of textual work. Similarly, Leu *et al*. (2004) argued that achieving a precise definition of literacy is not possible because its meaning changes regularly.

Much of the literacy-related literature of the last decade focuses on what it means to be literate in contemporary society, referring to a spectrum of abilities that relate to digital technologies, particularly the Internet. These definitions often attempt to extend the traditional notion of literacy beyond its application to the medium of writing (Buckingham, 2010; Livingstone, 2004; Warschauer, 2004). The term media literacy, for example, originally involved the ability to analyze respected works of literature and to communicate effectively by writing well (Brown, 1998). With the arrival of the computer, the Internet and other digital media, it became questionable whether the concept of media literacy could simply be extended or that these media had different characteristics and usage opportunities requiring other types of literacy. The ability to critically evaluate media content has transformed into a general ability to evaluate the validity and reliability of information sources and has expanded to cover the (inter)active engagement required for interactive digital media. Similarly, the concept of digital literacy is considered a vital complement to reading, writing and understanding texts in the 21st century (Jenkins *et al*., 2006). Scholars generally agree that traditional reading, writing and understanding derived from a long tradition of book and other print media are no longer sufficient (Coiro, 2003). The Internet provides new text formats, purposes for reading and ways to interact with information that can confuse and overwhelm people who are only taught to extract meaning from conventional print texts (Coiro, 2003).

In this study, we provide an empirical investigation of traditional literacy in relation to the skills necessary for Internet use. This undertaking requires a traditional literacy concept that can be clearly measured. We consider the traditional literacy concept to be the ability to read, write and understand text, also framed under the umbrella terms functional literacy

or fundamental literacy (Frisch *et al*., 2012). Functional or traditional literacy can be considered the basic dimension of all literacy concepts (Frisch *et al*., 2012). Our premise is that these basic dimensions of literacy are primary requisites for using the Internet.

2.2. Internet skills

The idea of Internet skills is only one of many similar concepts (e.g. information literacy, web fluency, digital skills, network literacy, web competency, etc.) that resulted from the rapid diffusion of digital technologies throughout society (Bawden, 2008). Unfortunately, the great variety of terminologies leads to little agreement on the exact definition of Internet skills or, therefore, on what skills constitute such skills (Bawden, 2008; Virkus, 2003). Furthermore, operational definitions that are applicable to empirical investigations are scarce because standardized operational definitions often seem to serve commercial purposes, such as use in training programs, or are aimed at specific target groups. The focus of this study is the use of the Internet by the population at large. Terminology should encompass both the basic skills necessary to access and use the Internet and those skills required to comprehend and use the accessed content (Bawden, 2008; Eshet-Alkali, 2004; Gilster, 1997; Gui and Argentin, 2011; Mossberger *et al*., 2003; Selwyn, 2003; Steyaert, 2002; Van Dijk and Van Deursen, 2014; Warschauer, 2004). For example, Gilster (1997) suggested that the Internet requires skills for both navigating networked technologies and interpreting the meaning of digital messages. Similarly, Mossberger *et al*. (2003) focused on both technical competence (a narrow set of skills required to operate the Internet) and information literacy (the skills to recognize when information can solve a problem or fill a need and to effectively employ information resources). Most explanations of the information literacy concept also considered technical and substantive aspects (e.g. Boekhorst, 2003; Shapiro and Huges, 1996). Steyaert (2002) and Van Dijk (2005) introduced a range of sequential skills that they claim should be measured separately. Building upon the more general digital skill definitions proposed by Steyaert and Van Dijk, Van Deursen and Van Dijk (2010) proposed an elaborate definition from an extensive review of literature on individual abilities specifically aimed at helping the general population function well online. Van Deursen and Van Dijk (2010) identified and explained two types each of medium- and content-related Internet skills. By accounting for both technical aspects related to Internet use and substantive aspects related to Internet content, a technologically deterministic viewpoint can be avoided (see Table 1).

Operational Internet skills are the first type of medium-related Internet skills and are derived from concepts such as instrumental skills (Steyaert, 2002), technical competencies (Mossberger *et al*., 2003), technological literacy (Carvin, 2000) and technical proficiency (Søby, 2003). Operational Internet skills are the basic skills for using Internet technology. First, we consider operating toolbars, buttons and menus. Without the skills to use these features, one cannot open a website in an Internet browser. The second group of operational skills includes using different types of user input options. People must be familiar with online forms offering various types of input fields (e.g. text boxes, pull-down menus and list boxes) to fill them. Finally, we consider file management or the opening and saving of various file formats that can be found online. Websites, for example, can be managed in bookmarks. Table 1 provides an overview of the operational skills required to use the Internet.

The second type of medium-related Internet skills is referred to as *formal Internet skills* and relate to the hypermedia structure upon which the Internet is built. This structure requires users to be able to navigate and orient themselves when using the Internet (Kwan, 2001; Park and Kim, 2000). Navigating is necessary to use the vast and diverse number of online websites, platforms and menu layouts offered. These layouts differ in (the placement of) text, content, backgrounds, photos, frames, links, buttons and pop-ups. Furthermore, such layouts differ in (traditional and more recent) features designed to help the user navigate; elements such as color of text and links; multimedia elements such as sound, animation or video; and interactive features such as chats, forms or message boards. Orientation is necessary when navigating non-linear paths online. Disorientation is a frequently cited problem in hypermedia use (Lee, 2005). Most traditional media are linear, giving the user little control over the flow of information. Hypermedia provide a formal structure that enables users to choose non-linear paths rather than the fixed formal structures of print media, such as chapters, paragraphs and references (Kwan, 2001; Coiro and Dobler, 2007).

The first type of content-related skills is *information Internet skills*. Van Deursen and Van Dijk (2010) derived the definition of these skills from Marchionini's (1995) well-known staged approach, which explains the actions users take when trying to fulfill information needs. Information Internet skills include searching, selecting, processing and evaluating information from online texts, videos, images, sounds and numbers. *Strategic Internet skills* are the second type of content-related Internet skills. These skills include the capacity to use the Internet to attain particular goals, as well as the ability to attain the general goal of improving one's position in society. The definition of strategic skills is based on the classical approach to decision-making, which emphasizes procedures through which decision makers can efficiently reach an optimal solution (Miller, 2006). The procedure begins with goal orientation, followed by engaging in the right actions. Next comes the time to make 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 large-scale performance tests in which people were asked to complete assignments on the Internet, Van Deursen *et al*. (2011) confirmed a conditional nature between operational and formal Internet skills on the one hand and

Table 1. Conceptual definitions of Internet skills (Van Deursen and Van Dijk, 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 forms, meaning: • 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 information sources.
Strategic Internet skills	Taking advantage of the Internet by: • developing an orientation toward 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.

information and strategic Internet skills on the other. It was revealed that operational and formal Internet skills are necessary but insufficient for performing satisfactorily on information and strategic skills. The findings of the performance tests revealed that operational and formal Internet skill deficiencies primarily occur among seniors and less educated portions of the population (Van Deursen and Van Dijk, 2009, 2011). However, the results also revealed a significant direct positive effect of increasing age on content-related information and strategic skills, implying that older people perform better with regard to these skills (Van Deursen *et al*., 2011). However, an important caveat results from the sequential and conditional nature of Internet skills: although older people display better content-related Internet skills, their efforts are also hindered by their impaired medium-related skills (Van Deursen *et al*., 2011). The positive effect of the content-related skills is neutralized by the many medium-related skill impairments older people experience. In this study, we investigate the four skills separately. From the supposed conditional nature of the four skills, we propose the following hypotheses:

H1a: Operational skills have a positive effect on formal, information and strategic Internet skills.

H1b: Formal Internet skills have a positive effect on information and strategic Internet skills.

H1c: Information skills have a positive effect on strategic Internet skills.

2.3. Internet skills and traditional literacy

As Internet skills are a multidimensional concept, we investigate the relationships among traditional literacy and the four separate types of Internet skills.

Operational Internet skills are also referred to as 'button knowledge.' Buttons or other visual signs cause readers to

focus on cues often unrelated to the alphabetical writing system of language featured in print media (Hammerberg, 2001). Internet browsers contain many audio-visual signs that reduce the constraints encountered by people with lower levels of traditional literacy (e.g. Medhi *et al.*, 2007). Several scholars studied the conventions of interface design and its role in comprehension and usability, accounting for different levels of traditional literacy (e.g. Bohman and Anderson, 2005). From these studies, it can be concluded that the Internet presents several advantages over printed texts. The combination of sounds, visuals, text and animations—or what Kress (2003) calls multimodal texts—helps one to better understand content. Icons and pictures provide opportunities for those with limited reading and comprehension skills to better understand Internet content (Coiro, 2003). Furthermore, one-click operations enable fast and automatic input of various types of content. Operational skills include the ability to save and open files, use online forms, bookmark websites and execute search operations. We expect that these operations require at least some reading skills but not high levels of traditional literacy in most cases. We hypothesize that:

H2a: The level of traditional literacy has a positive effect on operational Internet skills.

Regarding formal skills, we assume that traditional literacy becomes even more important. Formal skills involve navigating and using different website and menu designs that vary in user-friendliness. Website user-friendliness requires a user for whom traditional literacy is automatic and transparent (Wilder and Dressman, 2006). Formal skills also involve orientation. Although most traditional media are read in a linear fashion, giving the user little control over the flow of information, hypertexts on the Internet have embedded links to other texts, which forces users to choose non-linear paths rather than the fixed formal structures of print media (e.g. chapters, paragraphs and references). Without a sense of location, distance or necessary direction, users unsurprisingly often experience significant disorientation (Ahuja and Webster, 2001; Kwan, 2001; Lee, 2005). We expect that both orientation and navigation require the ability to quickly read and understand pieces of text. Without sufficient levels of traditional literacy, the meanings of these texts might remain unclear, complicating Internet navigation and orientation. Although some scholars have argued that websites that provide navigational support (e.g. site maps, overviews and link suggestions) reduce disorientation or navigational problems (Brusilovsky, 2004), we expect that websites still require some level of traditional literacy. We hypothesize that:

H2b: The level of traditional literacy has a positive effect on formal Internet skills.

It is not clear whether people can acquire the necessary information Internet skills when traditional literacy is insufficient. The acts of searching, selecting, processing and evaluating information from online videos, images, sounds, texts and numbers largely correspond to the information skills used with traditional print media. However, comprehension of Internet text requires additional practices, skills and strategies (Coiro and Dobler, 2007; Leu *et al.*, 2007). Owing to the greater storage capacity, accuracy and selectivity of the Internet compared with traditional media (Van Dijk, 2005), additional emphasis is placed on information skills online. For example, conducting an online search often yields a large number of results, including many that do not fit the intended goal. Therefore, the selection aspect of information skills is more difficult online than when accessing traditional media (Marchionini, 1995). Furthermore, online readers select and copy (pieces of) text more easily than they do in print environments (Sutherland-Smith, 2002), accentuating the need to evaluate the validity and reliability of accessed information. Evaluating information online requires high levels of traditional literacy because such assessment is performed within the context of an even more complex task, namely decision-making and arguing (Fitzgerald, 1998). People with low levels of traditional literacy find it hard to scan text; need a great deal of concentration and effort; do not notice any content above, below, or to the sides of their focus of attention; rarely compare facts among multiple sources; and overall are less likely to access information online or use search systems at all (Summers and Summers, 2005). We hypothesize that:

H2c: The level of traditional literacy has a positive effect on information Internet skills.

Strategic Internet skills are derived from the decision-making process (Miller, 2006). This process first includes awareness of the opportunities offered by the Internet and determining the goal of the Internet session. Next, it requires engaging in the right actions, such as gathering and combining various online information sources to achieve the best means to reach the desired goal. Decisions are then made about how to reach the original goal by using the often-excessive amount of information retrieved selectively. This skill requires developing a set of options and evaluating them according to developed criteria. The final step is to obtain the benefits of making the optimal decision. To acquire strategic skills and employ them on the Internet, users must be critical and analytical and must have a high level of information skills (Van Deursen and Van Dijk, 2009, 2010). People with low levels of traditional literacy generally make many decisions without the benefit of context, relying on semi-relevant facts (Viswanathan *et al.*, 2005). The greater the difficulties experienced by those with lower levels of literacy when trying to cognitively process information, the greater the sense of risk and, therefore, the higher the level of anxiety experienced when making complex decisions (Wallendorf, 2001). We hypothesize that:

H2d: The level of traditional literacy has a positive effect on strategic Internet skills.

2.4. Types of Internet usage

The second goal of this study is to investigate how traditional literacy and Internet skills influence how the Internet is used in daily life. This investigation requires a classification of types of Internet usage. For such a classification, several scholars have taken the uses-and-gratifications approach (Katz *et al*., 1974) as a starting point. In this approach, a list of motivations is derived from the examination of a medium. Other approaches include the technology acceptance model (Davis, 1989) and the social cognitive theory (LaRose and Eastin, 2004). Several studies account for differences in use by grouping Internet users into typologies (e.g. Ortega Egea *et al*., 2007). Consequently, a variety of classifications can be employed to plot Internet usage. Kalmus *et al*. (2011) evaluated the motives for Internet use by applying an exploratory factor analysis to a list of several online applications. The items were clustered into two groups: first, social media and entertainment and secondly, work and information. We employ this dual distinction to investigate how Internet skill levels contribute to how the Internet is used. Our premise is that those with lower levels of information and strategic Internet skills may be unable to access information and take advantage of career-directed Internet applications. People with low levels of content-related Internet skills might be unable to actively search for information. Furthermore, those with lower content-related Internet skill levels may be more inclined to use the Internet for non-informational activities that involve only simple skills and superficial information processing. Internet use presumes a mastery of Internet skills; the levels of skill required, however, depend on the particular uses, not all of which are socially laudable. We hypothesize that:

H3a: Operational and formal Internet skills have a positive effect on both entertainment and information- and career-directed uses.

H3b: Information and strategic Internet skills have a positive effect on information- and career-directed uses.

2.5. Core model

The research model presented in Fig. 1 displays the hypothesized relationships among traditional literacy, the four Internet skills and the two Internet usage types.

3. METHOD

3.1. Sample

This study draws upon a sample collected in the Netherlands over 2 weeks in September 2012 using an online survey. To obtain a representative sample of the Dutch population, we made use of PanelClix, a Dutch professional market research organization. Their panel consists of more than 108 000 people and is believed to be a largely representative sample of the Dutch population. Members receive a small incentive of a few cents for every survey they complete. Invitations were e-mailed to participants in three groups with quotas for gender, age and education level to ensure that the study's final sample represented the Dutch population fairly. In total, 5000 people were randomly selected from the panel, and we obtained responses from 1008 individuals (20%). Specific respondent background variables were compared with the latest official Dutch statistics. Quotas were used to ensure accurate population representation. Analyses showed that the gender and formal education levels of our respondents matched official statistics. Respondents had a mean age of 51.7 years (SD = 16.5), with ages ranging from 18 to 88. While this mean exceeded the average age in the Netherlands, we did not include people under 18 in the sample. Table 2 summarizes the demographic characteristics of the respondents. Almost all respondents had been born in the Netherlands (95%). Respondents' average amount of Internet experience was 12.0 years (SD = 4.8).

The online survey used specific software that checked for missing responses and then prompted users to respond to such

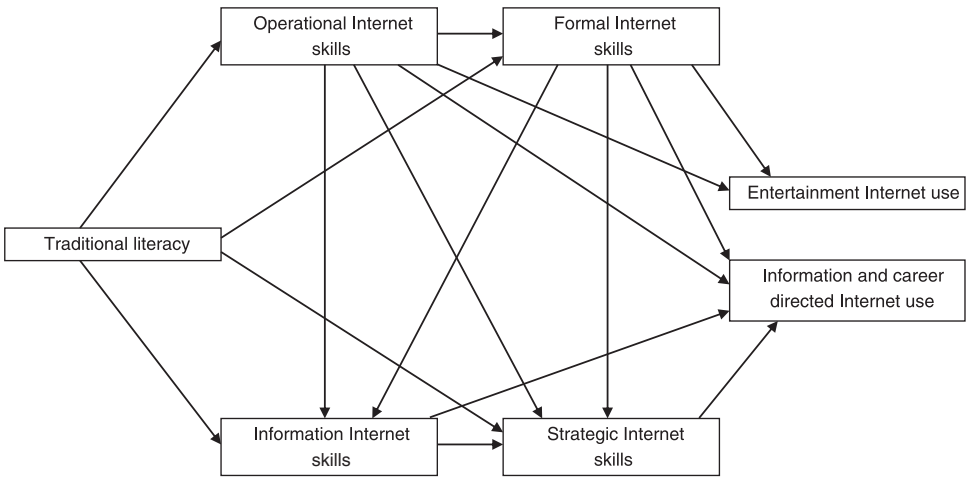

Figure 1. Conceptual model.

Table 2. Demographic profile (n = 1008).

	n	%
Gender		
Male	510	50.6
Female	498	49.4
Age		
18–40	254	25.2
41–60	436	43.3
60+	318	31.5
Education		
Low	329	28.9
Middle	443	38.9
High	342	30.1

unanswered questions. A pre-test of the survey was conducted with 10 Internet users in two rounds, and adjustments were made at the end of each round based on participant feedback. After the respondents in the second round offered no substantial comments, the survey was deemed ready to post. The time required to answer the survey questions was ∼12 min

3.2. Measures

The questionnaire gathered information related to the respondents' demographics, traditional literacy, Internet skills and Internet usage. To measure *traditional literacy*, we used a validated 11-item scale proposed by De Greef *et al*. (2013). Appendix Table A1 lists the descriptive statistics for each item. Sample items included the following: 'I have difficulties with reading and understanding information from my municipality' and 'I find it difficult to read and understand my telephone bill'. The following response scale was used: 1 (strongly agree), 2 (agree), 3 (disagree) and 4 (strongly disagree). Scores on the scale exhibited high internal consistency, as demonstrated by a Cronbach's α of 0.94. In the analyses, all items were recoded so that higher scores corresponded with higher levels of traditional literacy.

Internet skills were measured using an instrument proposed by Van Deursen *et al*. (2012). This instrument proposed a 21-item inventory for operational, formal, information and strategic Internet skills. Rather than drawing upon self-assessments, these items asked for actual behaviors that serve as indices for skills. The questionnaire's psychometric properties have repeatedly been proved to be satisfactorily reliable and valid. Specifically, the questionnaire was constructed using extensive ecologically valid skill performance field tests as benchmarks. Accordingly, the instrument employed here is more favorable than the self-assessments of skills because the latter have been found to have significant problems with validity (e.g. McCourt Larres *et al*., 2003; Merritt *et al*., 2005). Appendix Table A2 lists the descriptive statistics for each item. Scores on the four scales exhibited high internal consistency. Cronbach's α was 0.72 for operational skills, 0.80 for formal skills, 0.82 for information skills and 0.81 for strategic skills.

Internet usage types were measured drawing upon several items used in the survey. Respondents were asked to indicate to what extent they use the Internet for various usage types or activities. Respondents were asked how frequently they engage in these activities using a five-point scale that ranged from 'never' to 'daily' as an ordinal-level measure in the analysis. Sample items constructed to measure entertainment use include 'How often do you listen to music on the Internet?' and 'How often do you watch videos online?' Sample items constructed to measure information- and career-directed Internet use include 'How often do you participate in federal policy online?' and 'How often do you search for information about training or education online?' Principal component analysis with varimax rotation was used to determine two underlying usage clusters, one related to entertainment and one to information- and career-directed Internet use. Factor loadings were employed at 0.4 and above for each item (Field, 2000). In total, 12 items were retained in a two-factor structure, which together accounted for 56.0% of the total variance. The resulting two-factor solution, the factor's labels, and the descriptive statistics are displayed in Appendix Table A3. Internal consistency for the Internet usage cluster, measured using Cronbach's α coefficients, was 0.70 for entertainment Internet use and 0.81 for information- and career-directed Internet use.

3.3. Data analysis

We applied structural equation modeling using Amos 20.0 (Arbuckle) to test the conceptual model presented in Fig. 1. This statistical methodology takes a confirmatory (i.e. hypothesis-testing) approach to the analysis of a structural theory bearing on certain phenomena (Byrne, 2001). Typically, this theory represents causal processes that generate observations of multiple variables (Bentler, 1985). The term structural equation modeling conveys the following aspects: (i) the causal processes under study are represented by a series of structural equations and (ii) the structural relations can be modeled pictorially to enable a clear conceptualization of the theory (Byrne, 2001). Then, the hypothesized model can be tested statistically in a simultaneous analysis of the entire system of variables to determine the extent to which it is consistent with the data. If the goodness of fit is adequate, the model argues for the plausibility of postulated relations among variables; if it is inadequate, the tenability of such relations is rejected (Byrne, 2001). As suggested by Hair *et al*. (2006), to obtain a comprehensive model fit we included the indices of χ^2 statistic, ratio of χ^2 to its degree of freedom computed (χ^2/df), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA) and the standardized root mean residual (SRMR). These fit indices are typically used to represent all categories of model fit: absolute, parsimonious and incremental.

4. RESULTS

4.1. Structural model

The fit results obtained from testing the validity of a causal structure of the conceptual model in Fig. 1 are as follows: $\chi^2(4) = 10.42$; $\chi^2/\text{df} = 2.60$; SRMR = 0.02; TLI = 0.99; RMSEA = 0.04(90% confidence interval [CI] = 0.01, 0.07). A significant χ^2 value indicates a lack of satisfactory model fit. For improvement, we deleted a non-significant path from traditional literacy to operational Internet skills (see Table 3 for the low correlation), resulting in a model with good fit and a non-significant χ^2 value: $\chi^2(4) = 10.56$; $\chi^2/\text{df} = 2.11$; SRMR = 0.02; TLI = 0.99; RMSEA = 0.03 (90% CI = 0.00, 0.06). The correlation matrix of the variables is displayed in Table 3.

Table 3. Correlation matrix.

	1	2	3	4	5	6	7
1. Traditional literacy		*0.01*	0.20	0.18	0.09	*0.02*	*−0.06*
2. Operational Internet skills			0.59	0.59	0.63	0.75	0.50
3. Formal Internet skills				0.75	0.65	0.50	0.34
4. Information Internet skills					0.73	0.49	0.36
5. Strategic Internet skills						0.51	0.47
6. Entertainment usage							0.47
7. Information- and career-directed usage							

Note: Significant at $P < 0.05$; non-significant correlations are in italic.

The path model with standardized path coefficients is featured in Fig. 2. The standardized path coefficients indicate a significant direct positive effect of the level of operational Internet skills on formal ($\beta = 0.59$), information ($\beta = 0.23$) and strategic ($\beta = 0.26$) Internet skills. The level of formal skills has a direct positive effect on information ($\beta = 0.61$) and strategic skills ($\beta = 0.13$). The level of information skills has a direct positive effect on strategic skills ($\beta = 0.48$).

The level of traditional literacy has a significant direct positive effect on formal ($\beta = 0.20$) and information skills ($\beta = 0.06$). The direct effect on strategic Internet skills is not significant. Furthermore, the results reveal a significant indirect effect of traditional literacy on strategic skills; the path from traditional literacy to formal Internet skills ($\beta = 0.20$) multiplied by the path from formal Internet skills to strategic Internet skills ($\beta = 0.13$), summed with the path from traditional literacy to information Internet skills ($\beta = 0.06$) and multiplied by the path from information Internet skills to strategic Internet skills ($\beta = 0.48$), the result is 0.06.

Operational and formal Internet skills have a direct positive effect on entertainment use of the Internet ($\beta = 0.70$ and $\beta = 0.09$, respectively). Operational Internet skills also have a direct positive effect on information- and career-directed Internet use ($\beta = 0.37$). The direct effect of formal Internet skills on information- and career-directed Internet use is not significant. However, an indirect effect exists because strategic Internet skills have a direct positive effect on information- and career-directed Internet use ($\beta = 0.26$).

Squared multiple correlations provided information regarding the variance accounted for by the complete set

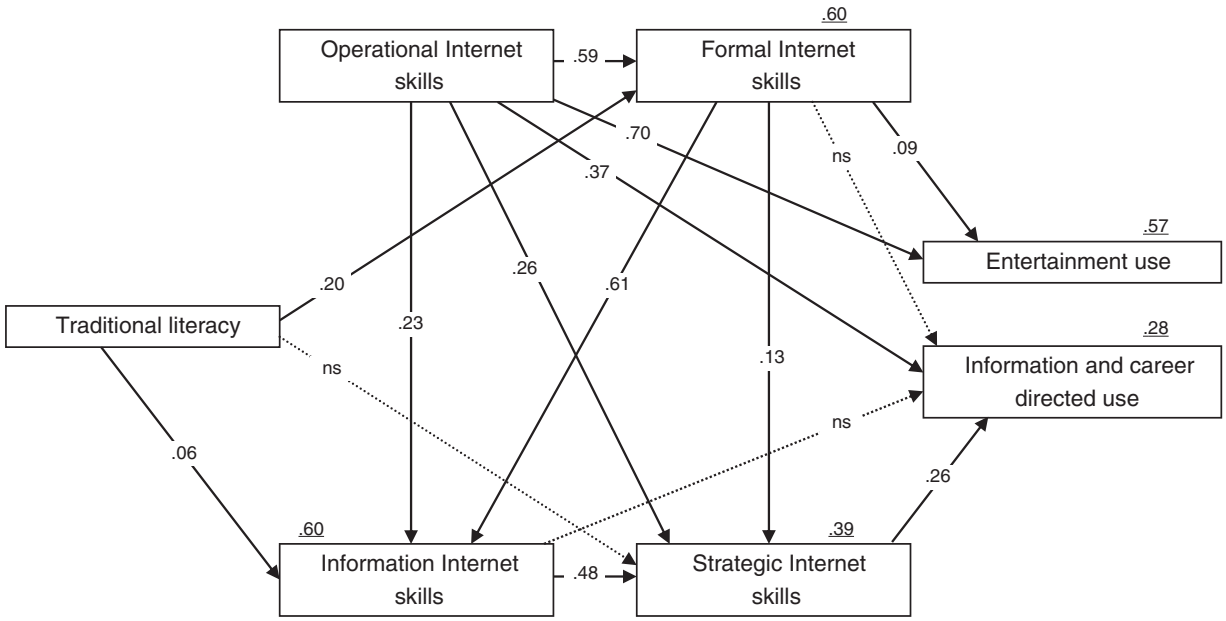

Figure 2. Standardized path coefficients of the model.
Note: Lines are paths significant at 5% level. Dotted lines are non-significant paths. Squared multiple correlations are underlined.

of variables and revealed that entertainment usage and information- and career-directed usage were accounted for at 57 and 28%, respectively.

4.2. Model comparison

To test an alternative model that also includes a path from both information and strategic Internet skills to entertainment use, the validity of a causal structure of the alternative model was tested; $\chi^2(2) = 8.53$; $\chi^2/df = 2.84$; SRMR = 0.02; TLI = 0.99; RMSEA = .05 [CI = 0.01, 0.08]). The results obtained from testing the validity of the alternative models indicate a significant χ^2 value. Furthermore, the standardized paths from both the information and the strategic Internet skills on entertainment Internet use are not significant. In conclusion, when the paths from both information and strategic Internet skills to entertainment use are removed from the research model, the resultant model had a significantly better fit. Thus, the original model is preferred over the alternative model.

4.3. Overview of hypotheses

Hypothesis H1a—The level of operational skills has a positive effect on formal, information and strategic skills—is accepted. Estimation coefficients of all three relations are significant. Hypothesis H1b—The level of formal skills has a positive effect on information and strategic skills—is accepted. Both relations are significant. Accordingly, our findings confirm the sequential nature between the medium-related operational and formal Internet skills and the content-related information and strategic Internet skills. This sequential nature is, furthermore, confirmed by the acceptance of hypothesis H1c—The level of information skills has a positive effect on strategic skills.

Hypothesis H2a—The level of traditional literacy has a positive effect on operational Internet skills—is rejected. Hypothesis H2b—the level of traditional literacy has a positive effect on formal, Internet skills—and H2c—The level of traditional literacy has a positive effect on information Internet skills—are accepted. Hypothesis H2d—The level of traditional literacy has a positive effect on strategic Internet skills—is partially accepted. Owing to the confirmed conditional nature, strategic skills are affected indirectly, following both formal and information Internet skills. Furthermore, besides directly, information skills are also affected indirectly, following formal Internet skills.

Hypothesis H3a—Operational and formal Internet skills have a positive effect on entertainment and information and career-directed Internet use—is partially accepted. The effect of formal Internet skills on information- and career-directed Internet use is not significant. Hypothesis H3b—Information and strategic Internet skills have a direct positive effect on information- and career-directed use—is also partially accepted, as there is a direct positive effect of strategic Internet skills on information- and career-directed Internet use. The effect of information Internet skills is indirect because these skills do affect the levels of strategic Internet skills.

5. DISCUSSION

5.1. Main findings

Several scholars have stressed that digital literacy is a multidimensional concept that must be expanded from media literacy to include the skills necessary to use digital media (e.g. Buckingham, 2005; Warschauwer, 2010). Van Deursen and Van Dijk (2010) proposed a range of skills necessary for the general population to function in an increasingly digital environment, specifically the Internet. These scholars' distinction, which was applied in the current study, reveals that operational skills (the basic skills for using Internet technology) are required before one can engage in the formal skills of navigating and orienting oneself to the Internet and before one can execute information skills (searching, selecting, processing and evaluating information) and strategic skills (using the Internet to attain particular goals and improving one's position in society). Formal skills are required before information and strategic Internet skills can be deployed, and information skills precede strategic Internet skills. This sequential relationship among the four Internet skills improves our understanding of the influence of traditional literacy. The results showed significant effects of traditional literacy on formal, information and strategic Internet skills. Navigation and orientation involve quick scanning of short pieces of text that require reading and text interpretation skills. The latter are especially relevant to information Internet skills and therefore also to strategic Internet skills. People with low levels of traditional literacy are less likely to access information online or use search systems at all (Summers and Summers, 2005). We did not find basic operational Internet skills to be influenced by traditional literacy. The reason for this finding might be that the Internet contains many audio-visual signs that to some extent minimize the constraints experienced by people with lower levels of traditional literacy (e.g. Medhi *et al*., 2007).

By influencing the levels of formal, information and strategic Internet skills, traditional literacy also affects how the Internet is employed. Those with higher levels of strategic skills use the Internet for more information- and career-directed purposes. This finding was expected because strategic skills allow people to benefit from the Internet. Entertainment uses of the Internet are determined primarily by operational Internet skills, whereas higher levels of information and strategic Internet skills do not generally contribute to increased use of the Internet solely for entertainment purposes. Earlier work revealed that Internet skills affect how people use the Internet and consequently the number of risks and opportunities the Internet presents (Livingstone and Helsper, 2007). From the current study, we can add that scholars who integrate a range of different literacy concepts to account for the use of digital media should not

overlook the traditional concept of literacy related to reading, writing and understanding text in print media. As Wilder and Dressman (2006) concluded in their investigation of six adolescents' Internet use, use of the Internet still requires a high degree of proficiency in the conventions of traditional literacy. With the advent of Internet-based reading and writing, the challenges of traditional literacy do not magically disappear. Owing to the growing amount of information on the Internet and people's increasing dependence on information, both traditional literacy and Internet skills can be considered key variables in contemporary society. People with high levels of Internet skills—which depend on levels of traditional literacy—are better able to utilize informational aspects of the Internet. In notions concerning the digital divide, one should add traditional literacy to proposed frameworks of social inclusion regarding technology. Internet skills should not be considered an easy means of correcting historically grounded inequalities caused by differences in traditional literacy. Both traditional literacy and Internet skills are unequally divided among the population (e.g. Helsper and Eynon, 2013; Stanovich, 2008; Van Deursen and Van Dijk, 2009, 2011). Our results show that this causes differences in how the Internet is employed (see also Helsper and Eynon, 2013; Van Dijk and Van Deursen, 2014), resulting in the existence of disadvantaged individuals. Some even suggest that existing societal inequalities are exacerbated online (Van Dijk, 2005; Witte and Mannon, 2010).

The results of the current study have implications for educational curricula. Schools often struggle with the challenges of traditional versus digital literacies. In most cases there is no clear consensus about the role of multiple literacies in classrooms (Cervetti *et al*., 2006). We suggest that schools should continue teaching reading and writing as they have done with print media. Once students have learned how to read, write, and understand texts, they might continue with wider reading environments such as the Internet. However, as noted in Section 2, literacy should also be understood as a set of social practices, rather than merely a cognitive skill. A variety of resources are necessary for its acquisition, such as physical materials (e.g. books, magazines, newspapers, journals and computers), relevant content transmitted via those materials, knowledge, attitude and the right types of community and social support (Warschauer, 2002).

5.2. Limitations

The relationships among traditional literacy, Internet skills and Internet use are rarely empirically investigated. In this study, we attempted to examine these relationships. Although the nature of this research was exploratory and only includes one country, our study does reveal important findings. These findings suggest that one's level of traditional literacy affects one's level of Internet skills, and one's Internet skills determine whether one uses the Internet for information- and career-directed purposes or only for entertainment purposes. Due to the general nature of the conceptual apparatus used in this study, our results most likely apply both within and outside the Netherlands.

Several problems arise regarding validity when using surveys to assess Internet skills. However, to measure operational, formal, information and strategic Internet skills, we employed measures that have repeatedly been proved satisfactory in terms of both reliability and validity. Specifically, our measures of Internet skills were tested using extensive ecologically valid skill performance field tests as benchmarks (Van Deursen *et al*., 2010). Although we used reliable and valid measures, future studies might test for the hypothesized relationships in actual performance tests in which both traditional literacy and Internet skills are measured in a laboratory setting.

In this study, we used measures of traditional literacy that have been pre-tested thoroughly with less educated people (see De Greef *et al*., 2013). Therefore, we do not think that comprehension of the survey was a problem for the participants. However, traditional literacy was considered to comprise the ability to read, write and understand text—requisite skills for responding to self-administered surveys. In general, online surveys must acknowledge and account for both traditional literacy and computer usage. Presumably, all the respondents had to be literate (and at a fairly high level) to participate. This presumption is strengthened by the fact that participants were recruited by e-mail. Accordingly, people with low levels of traditional literacy are excluded, which may have affected the identified relationships. For example, for people with serious reading challenges, the performance of operational skills may also be more difficult. This study did not find that operational Internet skills are affected by traditional literacy. Furthermore, people with low levels of traditional literacy might struggle even more when performing information and strategic Internet skills. Future research should focus on how and to what extent illiteracy influences one's level of Internet skills.

Finally, future studies should investigate whether the relationship between traditional literacy and Internet skills are consistent for different generations. This might shed more light on the implications for teachers and the role of traditional literacy skills in an individual's ability to take advantage of the Internet.

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APPENDIX

Table A1. Descriptives and Cronbach alphas for Traditional literacy ($n = 1008$) (four-point scale ranging from 1 (strongly disagree) to 4 (strongly agree)).

	M	SD
Traditional literacy ($\alpha = 0.94$)		
I have difficulties with reading and understanding information from my municipality	1.96	0.74
I find it hard to read and understand my telephone bill	1.61	0.64
I find it hard to read departure times of trains or busses	1.70	0.67
I have troubles filling in hospital forms	1.70	0.63
I find it difficult to read something out loud	1.64	0.66
I find it difficult to write a happy birthday card	1.59	0.65
I find it hard to fill out forms about work, retirement or payment	1.79	0.73
I have difficulties with reading and understanding subtitles in movies	1.52	0.59
I find it hard to read and understand medicine leaflets	1.66	0.67
I find it difficult to write notes to my roommates, colleagues or friends	1.56	0.63
I find it hard to read on my bank account what is being credited or debited	1.48	0.58

Table A2. Descriptives and Cronbach alphas for the observed Internet skills ($n = 1008$) (five-point scale ranging from 1 (never) to 5 (daily)).

	M	SD
Operational Internet skills ($\alpha = 0.72$)		
Save files	3.38	1.25
Use the refresh button	2.88	1.54
Upload files to another computer	2.02	1.23
Download programs	2.01	1.18
Watch video files	2.80	1.31
Formal Internet skills ($\alpha = 0.80$)		
Know exactly on what webpage you are	4.07	1.11
Navigate without getting lost	3.33	1.44
Know exactly how a website works	3.43	1.35
Keep orientation when browsing a website	3.56	1.33
Know exactly where a link will take you	3.29	1.29
Information Internet skills ($\alpha = 0.82$)		
Check information retrieved on another website	3.30	1.26
Examine more than the top three results	3.68	1.19
Evaluate information found	3.04	1.17
Find the information you were looking for	3.99	0.96
Use more than one search keyword	3.81	1.17
Strategic Internet skills ($\alpha = 0.81$)		
Make a decision based on retrieved information	2.75	1.08
Take advantage from Internet use	4.01	1.12
Use information about a specific subject from multiple sites	2.94	1.15
Benefit from using the Internet	3.39	1.15
Use reference Websites	2.75	1.10
Gain financial benefits	2.46	1.13

Table A3. Descriptives and Cronbach alphas for the usage clusters ($n = 1008$) (five-point scale ranging from 'On the Internet, how often do you …' 1 (never) to 5 (daily)).

	M	SD
Information- and career-directed Internet use ($\alpha = 0.81$)		
Search for information about training or education	1.76	0.96
Participate in online training	1.36	0.86
Search for public information	2.07	0.84
Perform transaction with the government	1.88	0.68
Look for a job vacancy	1.67	1.03
Learn on your own	1.71	1.15
Entertainment Internet use ($\alpha = 0.70$)		
Listen to music	2.77	1.50
Download music or video	2.12	1.31
Free surfing or browsing	3.41	1.53
Share photos	2.42	1.14
Play online games	2.28	1.56
Chat	2.26	1.50