Primary school children's internet skills: a report on performance tests of operational, formal, information, and strategic internet skills

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Primary School Children's Internet Skills: A Report on Performance Tests of Operational, Formal, Information, and Strategic Internet Skills

ALEXANDER J.A.M. VAN DEURSEN
University of Twente, Netherlands

ANKE GÖRZIG
London School of Economics and Political Science, UK
University of West London, UK

MARIANNE VAN DELZEN
HANNEKE T.M. PERIK
ANNE GRACE STEGEMAN
University of Twente, Netherlands

The performance levels of fundamental (i.e., operational and formal) and advanced (i.e., information and strategic) Internet skills and their potential predictors were assessed among a sample of Dutch primary school children. The findings suggest that primary school children possess sufficient levels of fundamental but not advanced Internet skills and, hence, might not be able to make best use of important opportunities the Internet has to offer. Children employed very ineffective and inefficient search strategies and did not combine information to make beneficial decisions. Contrary to previous survey research findings, no performance differences among boys and girls were revealed when using actual performance tests. Training programs to support advanced Internet skills among primary school children should be considered.

Keywords: Internet, skills, literacy, children

Alexander J. A. M. van Deursen: a.j.a.m.vandeursen@utwente.nl
Anke Görzig: a.s.Goerzig@lse.ac.uk
Marianne van Delzen: m.vandelzen@student.utwente.nl
Hanneke T. M. Perik: h.t.m.perik@student.utwente.nl
Anne Grace Stegeman: a.g.m.stegeman@student.utwente.nl
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Introduction

As in most developed countries, in the Netherlands there are very few children who do not use the Internet. Occasionally, children are regarded as online experts, although this has been challenged as a prevailing myth (Facer & Furlong, 2001; Livingstone, Bober, & Helsper, 2005). Young people's relationship with the Internet is complex and masked by poorly evidenced remarks of natural affinity (Bennett, Maton, & Kervin, 2008). Children use the Internet for several facets of schoolwork, such as for homework and for finding information for projects or presentations. Successful use of the Internet for such activities requires specific skills that are believed to contribute to better learning outcomes and successful school careers (Kuhlemeier & Hemker, 2007). Further, Livingstone et al. (2005) showed that children's Internet skills mediate the benefits of their Internet use. Moreover, it has been shown that Internet skills are not only important because they increase opportunities for learning, participation, creativity, and communication, but also because they have been associated with lower harm following the experience of online risks (Livingstone, Haddon, Görzig, & Ólafsson, 2011). In addition, the concept of the "ladder of opportunities" has been proposed, suggesting that progress through different stages of enhanced and more advanced Internet use is related to increasing Internet skills and complex usage (Livingstone & Helsper, 2007).

In the current study, actual (not self-reported) Internet skill levels of children in their final stages of primary school are assessed. For this group, Internet skills are needed to ensure a smooth and successful transition to secondary school (Kuhlemeier, 2003). Our investigation is guided by an elaborated framework of Internet skills that discriminates between fundamental skills, such as operational Internet skills (basic skills in using Internet technology) and formal Internet skills (skills related to the hypermedia structure of the Internet, which require navigation and orientation), as well as more advanced skills, such as information Internet skills (the actions through which users try to fulfill informational needs) and strategic Internet skills (the capacity to use the Internet as a means of reaching particular goals) (Van Deursen & Van Dijk, 2009, 2010). These skills have a sequential and conditional nature (Van Deursen, Van Dijk, & Peters, 2011) and therefore to a large extent correspond with the idea of the "ladder of opportunities." Likewise, children who lack information and strategic Internet skills have far fewer opportunities than children who possess these skills.

Not much is known about the actual Internet skill levels of Dutch primary school children, or the relationship between skill level and frequency of Internet use and the number of years already online, as well as the potential problems encountered by children when implementing those skills. Hence, an observational study was conducted in which participants were asked to complete assignments online to assess primary school pupils' actual Internet skill levels. In addition, the study investigated differences between boys and girls, the role of hours spent online and the number of years online, and problems encountered during the assignments with respect to the four types of Internet skills. The following research questions were addressed:

RQ 1: What are the levels of operational, formal, information, and strategic Internet skills among primary school pupils?

RQ 2: Are gender, hours spent online, and the number of years online associated with the levels of operational, formal, information, and strategic Internet skills among primary school pupils?

RQ 3: What specific problems associated with Internet skills do primary school pupils' experience?

Theoretical Background

Identification of Internet Skills

Although there is a plethora of definitions related to Internet skills, very few attempts have been made to propose a definition that can be applied to actually measurement of Internet skills. Based on an extensive literature review, Van Deursen and Van Dijk (2009, 2010) proposed a theoretical framework that outlines the general skills an Internet user needs to function well in an information society. This framework is also applicable to primary school children, who increasingly depend on the Internet in their lives. The empirically tested framework considers that for effective use of the Internet, technical skills alone are not sufficient. The framework's validity was tested by a correspondence to the Standards for Educational and Psychological Testing based on the model designed by Messick (1995). See Van Deursen and Van Dijk (2010) for an elaborate evaluation of both reliability and validity of the framework.

The four types of skills identified can be divided into medium-related Internet skills (operational and formal) and content-related (information and strategic) Internet skills. The notion of "operational Internet skills" was derived from concepts such as technical competence, referring to the basic skills required to make use of the Internet. "Formal Internet skills" relates to the hypermedia structure upon which the Internet is built, requiring navigation and orientation that are not always easy in an environment with unlimited design features.

The first of the content-related skills, "information Internet skills," was based on Marchionini's (1995) staged approach to explain the actions by which users attempt to fulfill information needs. Key stages are the selection of a search system, defining search queries, selection of information, and evaluation. "Strategic Internet skills" are the second type of content-related Internet skills and include the capacity to use the Internet as a means of attaining particular goals. The framework's strategic skills were based on a classical approach to decision making (Miller, 2006). The procedure entails goal orientation (being aware of the opportunities offered by the Internet and subsequently determining the goal of the Internet session), engaging in the right actions (gathering and combining various online information sources to achieve the best means to reach the desired goal), making decisions about how to reach the original goal by using retrieved information in a selective manner, and, finally, gaining positive outcomes of Internet use by making optimal decisions. Strategic Internet skills assume that information sources are not the only sources that are analyzed. Distinctions should further be made between goals and means, and between what is more and less important in attaining these goals.

By accounting for both technical aspects related to the use of the Internet as well as the substantive aspects related to content, a technologically deterministic viewpoint is avoided. Furthermore,

the framework contains gradients of difficulty and has a sequential and conditional nature (Van Deursen, Van Dijk, & Peters, 2011). For example, before you can evaluate the results of a search query, you need to be able to perform one. Specific skills proposed by Van Deursen and Van Dijk (2009, 2010) are the following:

Operational Internet skills

Operating an Internet browser:

- Opening websites by entering the URL in the address bar;
- Navigating forward and backward between pages using the browser buttons;
- Saving files;
- Opening various common file formats (e.g., PDF);
- Bookmarking websites;
- Changing the browser's preferences.

Operating Internet-based search engines:

- Entering keywords in the proper field;
- Executing the search operation;
- Opening search results in the search result lists.

Operating Internet-based forms:

- Using the different types of fields and buttons;
- Submitting a form.

Formal Internet skills

Navigating the Internet by:

- Using hyperlinks (e.g., menu links, textual links, image links) in different menu and website layouts.

Maintaining a sense of location while navigating 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.

Information Internet skills

Locating required information through the following processes:

- Choosing a website or a search system to seek information;
- Defining search options or queries;
- Selecting information (on websites or in search results);
- Evaluating informational sources.

Strategic Internet skills

Taking advantage of the Internet through the following processes:

- 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.

Children's Internet Skill Levels

Despite the importance of Internet skills for primary school children, there are relatively few valid measures of students' actual skill levels. Studies are often inconsistent in their measurements, and much of the data refers to self-reports, which have significant problems of validity (Hargittai, 2005; Merrit, Smith, & Renzo, 2005; Van Deursen & Van Dijk, 2010). Consequently, it is not clear to what extent differences in self-ratings correspond to real differences in skills. Although, in general, higher self-efficacy leads to a greater likelihood of using the Internet (Eastin & LaRose, 2000), children's reported confidence in using the Internet may well exceed their actual expertise (Buckingham, 2005). In general, overestimation occurs partly because people who are unskilled suffer a dual burden: Not only do they reach erroneous conclusions and make unfortunate choices, but their incompetence might also rob them of the metacognitive ability to realize it (Kruger & Dunning, 1999). Unfortunately, the overestimation of skill levels or the reluctance to admit to lacking knowledge and skill when using the Internet may affect how children approach learning new skills (Banwell & Gannon-Leary, 2000).

Kuhlemeier and Hemker (2007) proposed the multiple-choice "Internet skills for school" assessment (ISFS), an indirect measure of students' Internet skills, with the goal of screening whether students entering secondary school have sufficient Internet skills. The ISFS has several advantages over self-report questionnaires; however, as the authors themselves emphasize, compared to a computer-based performance test, the ISFS is less authentic. Furthermore, the results do not give much insight into the specific skill problems experienced. Overall, research indicates that children might lack several of the skill indices defined in the previous section (e.g., Davis, 2003; Druin, Foss, Hatley, Golub, Guha, Fails, & Hutchinson, 2009; Harrison Comber, Fisher, Haw, Lewin, & Lunzer, 2003; Klein, Yarnall, & Glaubke, 2001; Metzger, Flanagin, & Zwarun, 2003; O'Hanlon, 2002; Volman, Van Eck, Heemskerk, & Kuiper, 2005). Although children are among the most frequent users of the Internet, searching and browsing present many challenges (Druin et al., 2009). Children consider the Internet an overwhelming environment for finding information (Ba, Tally, & Tsikalas, 2002). They experience problems navigating sites with poorly organized links, formulating information problems, evaluating information, specifying search queries, and judging search results (e.g., Walraven, Brand-Gruwel, & Boshuizen, 2008). Some studies highlight what children do when they need information (e.g., Bilal, 2000; Bilal & Kirby, 2002; Cooper, 2005). These studies, for example, suggest that children prefer to browse rather than use a search engine and have difficulty in understanding the information presented to them on results pages (e.g., Druin et al., 2009). Results from performance tests on information and strategic Internet skills among secondary students revealed much room for improvement (Van Deursen & Van Diepen, 2013). Among the most important problems related to information and strategic skills were defining search queries, evaluating information, focusing on the goal of the session, and taking the appropriate steps to reach the final goal.

The current study employs an elaborated Internet skill framework while additionally going beyond surveys or simulated software. Although testing the real-life skills of Internet users in a behavioral study is a highly labor-intensive process, it should provide the best method of obtaining a direct measure of skill as well as an account of the problems encountered.

Differences in Internet Skills Among Primary School Children

Research has provided several variables that account for differences in Internet skills. This study investigates the association between Internet skills and three background variables: gender, hours spent online, and the number of years online.

Most studies that report gender differences in skills used self-assessment, which revealed that females tend to evaluate their Internet skills as lower than those of males (Hargittai & Shafer, 2006; Livingstone et al., 2011; Van Deursen & Van Dijk, 2010). A similar finding was shown for the 11- to 16-year-old children of the EU Kids online project (Livingstone et al., 2011), and for girls in secondary schools who assessed their skills as lower than those of boys (Kuhlemeier & Hemker, 2007). However, girls appear to have a more realistic view of their own digital skills than boys, who tend to overrate their skills (De Haan & Huysmans, 2002; Ehrlinger & Dunning, 2003; Hakkarainen, Ilomäki, Lipponen, Muukkonen, Rahikainen, & Tuominen, 2000). Overall, it is not clear as to what extent the differences in self-ratings correspond to real differences in skills. Large, Behehti, and Rahman (2002) revealed that boys and girls around age 11 do differ in the way they search for information. The boys in their study, for example, used only one keyword more often than the girls, who combined multiple keywords. The boys also tended to click links more often and stayed on a page for shorter periods of time than did the girls. These differences, however, did not result in a large variety of actual search results. Information and strategic Internet skills performance tests among secondary children did not reveal any gender differences (Van Deursen & Van Diepen, 2013). Therefore, we hypothesize:

H1: Primary school boys and girls do not differ in operational, formal, information, and strategic Internet skills.

The number of hours spent online as well as for how many years someone has been using the Internet have been identified as important precursors for Internet skill levels (Hargittai, 2005; Sonck, Kuiper, & De Haan, 2012). However, when accounting for different types of Internet skills, the situation appears more nuanced. In actual performance tests among the general adult Internet user population, the number of years online affected only the operational and formal skills; there was no direct effect on information and strategic Internet skills (Van Deursen et al., 2011). The number of years online or spending a lot of hours online does not guarantee that one is able to process information into useful knowledge (Kuiper, Volman, & Terwel, 2005). The latter requires high levels of information and strategic skills, which in turn depend on a child's cognitive development. We hypothesize the following:

H2a: The number of years online is related to the level of operational and formal Internet skills of primary school pupils.

H2b: The number of years online is not related to the level of information and strategic Internet skills of primary school pupils.

H3a: The hours spent online is related to the level of operational and formal Internet skills of primary school pupils.

H3b: The hours spent online is not related to the level of information and strategic Internet skills of primary school pupils.

Method

Sample

A total of 76 children (35 female) in four classes from three Dutch primary schools participated in the performance tests. All children were in the final stages of primary school and were between 9 and 13 years of age (M = 11.33, SD = 0.76). Children in primary schools are a relatively heterogeneous group in terms of skill level and in the Netherlands are not separated by academic ability before starting secondary school. In all schools, entire classes were asked to participate in our study of Internet skills.

Data Collection and Procedure

Before conducting the performance tests, the children's parents were informed about the nature and purpose of their participation and their consent was obtained. The test in schools 1 and 2 took place in November 2012; School 3 did the tests in May 2012. All tests were conducted at school, ensuring an equal setting for all participating children. The tests were performed on a laptop with several Internet browsers installed to replicate regular Internet use. No default page was set on the browsers, and all of the assignments started with a blank page. To ensure that participants were not influenced by a previous user's actions, the browser was reset after each session. In addition, downloaded files, form content, and passwords were removed, and the laptop was rebooted.

All children were tested separately so they could not see other children's screens or discuss assignments. After arriving, the participant was given a verbal instruction about the procedure. Prior to the test, a five-minute questionnaire was administered to gather personal data. After completing the questionnaire, the participant was given a sequence of five assignments with several subtasks, one at a time. During the tests, a variety of process indicators were recorded (such as specific user actions and successful completion of the assignments) using Morae recorder (TechSmith, v2.2). In total, 76 detailed log files of the screen recordings were created to enable in-depth analysis.

The participant decided when he or she was finished. After a specific maximum amount of time had passed (determined from pilot tests), the instructor gently asked the participant to move on to the next assignment. If the correct answer was not found, the task was rated as not completed. The test leader refrained from influencing the participant's strategies. The instructor measured the levels of completion and the time spent on the tasks.

Measurements

The Number of Years Online and Hours Weekly Spent Online

Children indicated how many years they had been online (M = 5.32, SD = 1.45, range = 1–8, missing values: 2) and how many hours weekly they spent online (M = 11.47, SD = 10.6, range = 1–56, missing values: 3) on a desktop or mobile device such as laptop, tablet, or smartphone.

Levels of Internet skills

The assignments were designed by a group of four researchers. Before the performance tests were conducted, five participants were recruited to participate in a pilot test. In the pilot test, the assignments and the subtasks were tested for comprehensibility and applicability. Although the assignment topics were different for each school, they measured the same range of skills in the same sequence. The created assignments were fact based. All subtasks had a correct action or answer. Open-ended subtasks were avoided because of the potential ambiguity and subjectivity of interpreting answers. Only one answer was considered as correct, and incomplete or partially complete subtasks were rated as unsuccessful.

The first assignment was used to measure operational skills and contained five subtasks: (1) entering the URL of a website in the location bar, (2) saving a file to the hard disk, (3) bookmarking the homepage of a website, (4) using the back button, and (5) operating a search engine (test 1) or completing an online form (tests 2 and 3). The second assignment was used to measure formal Internet skills and contained three subtasks. In each subtask, respondents were asked to find a simple piece of information on a website. All three sites used different layouts. Two assignments, each containing three subtasks, were used for measuring information Internet skills. Finally, the participants were given one strategic skill assignment in which they were asked to complete the subtask of making a decision based on information to be collected. In Appendix A, the relations between the assignments and the Internet skills are listed for one of the three performance tests.

The outcomes for all four types of Internet skills were primarily measured in terms of the number of successfully completed tasks. Average percentage scores of completion for each skill type were computed to retain the scale metric and ease of interpretation.

Internet Skill-Related Problems

The richness of the recorded video data required a systematic approach for coding. Based on the Internet skills reported in Table 1, several Internet skill-related problems that users might experience were coded. In total, 29 problems were identified. Appendix B contains the coding scheme. All codes represent a specific problem whose occurrence was counted during task completion. Both operational and formal skill problems were recorded during specific tasks designed for these corresponding skills. Occurrences of coded information skill problems were counted during the completion of the information

skill-related assignments. Occurrences of the coded strategic skill problems were counted during the completion of the strategic skill assignment. Each video-recording session took approximately two-and-a-half hours to code and analyze.

Results

Levels of Internet Skills

In order to explore the participants' level of Internet skills, we looked at the average rates of successful Internet skill task completion across schools: 71% of the operational Internet skills tasks, 88% of the formal Internet skills tasks, 56% of the information skills tasks, and 14% of the strategic Internet skills tasks were completed successfully. Task completion rates and averages by school can be seen in Table 1. Later statistical analyses (see section on *Differences in Internet Skills*) demonstrated that there are no significant differences in skills between schools.

Table 1. Successful Task Completion by Skill Type and School.

	Task completion	
	M(SD)	*%*
School 1; N = 28		
Operational tasks (5)	3.2(1.2)	64.2
Formal tasks (3)	2.5(0.7)	82.0
Information tasks (6)	3.1(1.8)	52.3
Strategic tasks (1)	0.1(0.3)	8.0
School 2; N = 20		
Operational tasks (5)	3.4(0.9)	68.0
Formal tasks (3)	2.1(0.6)	98.3
Information tasks (6)	3.5(1.1)	58.3
Strategic tasks (1)	0.1(0.0)	10.0
School 3; N = 28		
Operational tasks (5)	4.0(1.1)	80.0
Formal tasks (3)	2.4(0.6)	84.0
Information tasks (6)	3.5(1.3)	57.7
Strategic tasks (1)	0.3(0.4)	25.0

Differences in Internet Skills

The data were considered within the limits of a normal distribution if the dividend of the skewness and kurtosis statistics and their respective standard errors did not exceed ±2.0. Outliers were identified with the boundaries of ±3 standard deviations from the mean and adjusted to the respective boundary. The number of years online was log-transformed because it was positively skewed (*skew* = 1.96, *SE* = .28) and the square root was taken for formal skills because it was negatively skewed (*skew* =

−.79, *SE* = .28). One outlier was adjusted to the upper boundary for Internet use. Correlational analyses revealed that information skills are significantly related to operational skills and that girls have higher formal skills than boys (see Table 2).

Table 2. Correlations Among Predictors and Internet Skills.

	1.	2.	3.	4.	5.	6.	7.	8.
1. Gender (male = 0)	1							
2. Age	−.02	1						
3. Internet use	.12	.1	1					
4. # of years online	.04	.12	.07	1				
5. Operational skills	.09	.13	.13	.07	1			
6. Formal skills	−.25*	.13	−.14	.08	−.02	1		
7. Information skills	−.10	−.16	.09	−.12	.39**	−.10	1	
8. Strategic skills	−.01	.05	−.13	.01	.02	.05	−.09	1

*Correlation is significant at the 0.05 level (2-tailed);
**Correlation is significant at the 0.01 level (2-tailed).

To test our hypotheses, we performed a 4(skills) x 2(gender) ANCOVA (analysis of covariance) with skills as repeated measures. The number of years online, hours weekly spent online, age, and school (dummy coded) were added as covariates. Standardized values were used for the four skill measures to make their scales comparable.

In line with our hypothesis, there was not a main effect for gender ($F(1, 62) = 2.22$, $p = .14$) or a gender by skills interaction ($F(3, 186) = .90$, $p = .44$). Contrary to our predictions, there were no differences in the effects of hours weekly spent online or number of years online on different Internet skill types, and no interaction effects of hours weekly spent online by skill ($F(3, 186) = 1.43$, $p = .34$) and the number of years online by skill ($F(3, 186) = .37$, $p = .78$). Confirming the assumption that there were no differences in skill levels among schools, the main effects of the two school dummy variables ($F(1, 62) = 3.31$, $p = .07$; $F(1, 62) = 1.71$, $p = .20$) as well as their interactions with skill ($F(3, 186) = .61$, $p = .61$; $F(3, 186) = 2.37$, $p = .07$) showed no significant effects. All other effects were also not statistically significant ($ps > .05$).

Individual Skill-Related Problems

To identify problems the pupils' experienced associated with each skill, we counted the number of occurrences of the 29 identified problems in the coding scheme in all 76 screen recordings.

Operational Skills-Related Problems

The first operational task was using the address bar. Overall, 12% of the children did not succeed in using the address bar. Most of the children who did not succeed failed the task due to misspelling the address without noticing. They resolved their failure to open the website by going to Google and searching

for the specific site there. Three children used spaces in the typed address, which was resolved after notification of the error.

Saving a file to the hard disk was the most difficult operational skill task for the children. On average, 30% failed to save a file to the hard disk. Ten of the pupils who failed this task seemed to have no knowledge of how to save files. Another 10 pupils clicked *open* instead of *save* in the save dialog box. This, of course, did not result in the file actually saving, as the pupils believed it would. Other mistakes included assuming that the file was immediately saved after opening the save dialog box only. In one school, children were asked to save the file in a specific location on the hard drive. Here, the 82% success rate would drop to 10% if this were also taken into account.

Remarkably, performing the relatively simple back-button operation appeared to be a difficult task for 25% of the pupils. When asked to move one page back by using the back button of the browser, they clicked the *home* button of the website and started to follow links to the requested page from the start, or typed the whole URL again in the address bar, followed by clicking through the same route again to get to the right page. This not only took more time, it also resulted in confusion since many of the pupils who did this had forgotten what page they were actually looking for.

The operational use of a search engine did not reveal any problems. All pupils knew how to enter queries and conduct a search.

On average, 66% succeeded in bookmarking a website. Children who failed the test did not seem to be aware of this feature. It is worth noting that a substantial number of the pupils who succeeded at this test were also not aware of bookmarks, but learned independently how bookmarks worked during the test.

The use of an online form did not appear to be very difficult. However, 10% did not succeed due to filling out their first and last name in the same field, even though two separate fields were provided. This resulted in an error message that was not understood.

Formal Skills-Related Problems

The children were most successful completing the formal Internet skill tasks. The primary school children seem to be comfortable in navigating different website and menu layouts. The pupils were asked to find the physical address of three companies (in this case, museums, which varied depending on the attended school) on the company's website. The three websites were selected based on their layout and menu designs in order to provide a range of styles from static to flashy.

Although few problems occurred and 88% of the children succeeded in finding the website addresses, some interesting findings can be reported. When children are not sure where to look or go next, they often turn to randomly clicking links. This resulted in consulting the same pages multiple times. Furthermore, the pupils navigated the websites quickly, sometimes overlooking information. Occasionally,

this resulted in initially missing hyperlinks that would have brought them to the page where the address could be found.

Information Skills-Related Problems

In each school, children were given two information-searching assignments. For example, they were asked to find the name of a male rabbit, the name of the first emperor of the Roman Empire, or the name of the National park in which the Deltawerken are situated.

The first task concerning information skills involved choosing a source for finding information. On average, 82% of all children used Google as point of departure. Notably, most of the remaining pupils used the method of typing search queries into the address bar. By doing so, the pupils were either directed to a website that happened to have the typed words as their URL, or they were directed to the standard search engine embedded in the Web browser, which in the case of Microsoft, for example, is Bing. Some pupils turned directly to Wikipedia.

The second task involved the search queries defined by the pupils. Here, a remarkable finding appears: Instead of using keywords, the most common way of finding the answer was by typing the whole question in the search bar (including the question mark). On average, 90% of the pupils employed this method at least once. Furthermore, in most cases, the full questions were entered by typing rather quickly and therefore they contained many spelling mistakes. In only a few cases were these mistakes corrected; most often, the students made no corrections and simply chose one of the top results from their search. Besides entering the whole question, on average 45% of the pupils used search queries at least once, most often a single keyword. None of the pupils used Booleans in their searches to limit search results or used advanced search methods.

Entering entire questions resulted in a lot of irrelevant search results. Most often, pupils conducted a single search operation for a given question, even when it did not lead to the correct answer. On average, only 25% used a second search operation in one or more cases. Given the low percentage of correct answers, this should be considered strikingly low—even more so because the main reason for a second search operation was a spelling mistake, not the appearance of irrelevant results. None of pupils searched within the listed search results to limit the number of results. On average, 82% of the pupils only inspected the first three search results (or fewer). An important caveat is that on average, 56% of the pupils did not inspect the source, but just took the information straight from the short lines Google provides in the result lists. If the child did not find a satisfying answer from this short text, a second search attempt was conducted. None of the children went beyond the first page of search results. Furthermore, half of the pupils in one or more cases used sponsored links; they did not seem to be aware that these were advertisements.

None of the pupils cross-checked the information they found with another website. Furthermore, information was in several cases taken from online forums. It seems that the children were unaware of the huge amount of unreliable information present on the Web.

Strategic Skills-Related Problems

According to the strategic skill definition, individuals need to maintain focus on a goal, take appropriate actions to reach the goal, and make the right decisions. Then, they can actually benefit from Internet use. For example, in one of the strategic Internet skill assignments, the pupils were asked to select a zoo with king penguins in the Netherlands to visit, accounting for entrance fees and the cost of a train ticket to where the zoo is located.

The first task accounted for in the analysis considers taking proper steps to reach the final goal. In this example, none of the children accounted for all the required information. Although 70% compared different zoos, they did not take into account the cost of the train ride. Only 50% visited the National Railways website to look up ticket prices. Only 10% actually succeeded in finding prices. The second task concerning strategic skills involved decision making based on all of the required information. Although 90% of the pupils did not have all the information, everybody provided an answer. The 10% of pupils who collected all the right information still made the wrong decisions because of incorrect calculations.

Another class was given an assignment to select a zoo and the best day to visit this zoo based on the presence of penguins and the days the animals are fed. To answer this question, for example, only 64% used more than one website. The children had difficulty concentrating and in some cases even just looked at pictures of penguins in Google's image search and then guessed the answer. Only 18% found the zoo where the king penguins are situated, and a remarkably low 8% suggested the right day to visit the zoo.

In the third school, pupils had to decide between visiting two leisure parks based on entrance fees and train fares. Again, 64% did not collect all relevant information. Again, accounting for the train fares appeared a difficult task. In two cases, children turned to Google and typed, "What is cheaper, Efteling or Walibi?" A few others used Google and searched for "train tickets." Of all pupils, 89% eventually gave an answer, of which 25% was correct.

Discussion

Main Findings

In the current investigation, we conducted time-consuming performance tests of Internet skills among Dutch primary school pupils to assess their actual levels of Internet skills and associated problems. The first research question concerned determining the level of Internet skills. At first glance, it seems that primary school pupils perform well on operational and formal Internet skills; however, as the results revealed, there is also room for improvement of these skills, which is discussed below. The most problematic are the performances on information and strategic Internet skills. It seems that pupils have little understanding of how information on the Internet should be found or dealt with. Although they are familiar with the basic operations of a search engine, it seems their knowledge for the most part ends there. The conditional nature of the skills definition used for identifying Internet skills explains that

performance of strategic skills that are reliant on information skills becomes even more problematic. Combining multiple pieces of information to come up with the best answer proved to be difficult, even when the questions involved decisions the children might actually face in their daily lives. Although we do not know what exactly children learn at school concerning information and strategic skills, both skills are important assets to their future careers; in secondary school, it is expected that students use the Internet for homework assignments. The searches the pupils were asked to complete could very well be encountered in real life situations—for example, if they were preparing a presentation for school. So although it is unclear what causes the low levels of information and strategic skills, the findings are potentially worrying. Just providing Internet access to pupils is not enough; they do need substantial training.

In answering the second research question, we did not find differences between boys and girls in terms of their performance with Internet skills. This is inconsistent with findings using self-report measures to assess Internet skills, but supports the assumption that gender differences in self-report measures of performance might arise due to boys' tendency to overrate their actual performances. The number of years online and the hours spent online do not reveal any skill differences overall or for different kind of skills. This might seem contradictory to the findings associated with the "ladder of opportunities," which sets use in relation to skills. However, a closer look at the ladder of opportunities shows that it is *complex* use (as opposed to *more* use) that is thought to be related to advanced skills. Hence our findings are particularly applicable to information and strategic Internet skills, which do not become better based on prior experiences or more intensive use of the Internet as the results of this study suggest. These skills require training.

The third research question concerns the specific skill-related tasks children had to perform. Concerning operational Internet skills, it seems that these pupils need to learn how to save files and how to bookmark websites. Both skills seem to be very helpful, and perhaps essential, in preparing school projects. Investigations of formal skills revealed room for improvement in the students' inefficient, quick, and random way of navigating and orientating online. Before using the Internet in school programs, assessments should provide an indication whether students have an adequate level of operational and formal skills. If not, they should be taught first.

More worrisome, however, is the way pupils search for information. Defining keywords appeared to be a difficult task, and pupils seemed too opportunistic in the selection of the search results; moreover, they directly took information from the Google results line without considering any additional context in which the results are presented. Overall, pupils were not very concerned about the quality of the information found. The findings emphasize that pupils are in desperate need of training to find information. They need to become more critical in their attitude toward online content. The information skills problems are reflected in their performance with strategic Internet skills. Combining information to actually make the most out of using the Internet seems to be a few steps too far for this age group. Of course, these skills reflect one's analytical abilities, but the low scores found in this study suggest that pupils who will continue on to high levels of education need additional training.

The results stress that in primary school, Internet skill instruction deserves more attention. When information and strategic skills are implemented in courses such as language, history, biology, and geography, they might be effectively picked up, and teachers will be more motivated to spend additional time and effort in teaching these skills. However, opportunities for Internet skill improvements can also be sought outside the context of schools. For example, Madden, Ford, Miller, and Levy (2006) revealed that guidance both from adults and peers affects a child's ability to search successfully.

Limitations and Future Research

Performance tests are a time-consuming and costly way of measuring Internet skills; however, such tests have several advantages over studies that attempt to measure Internet skills through self-evaluations. Often, studies are limited in the skills definitions used or in the methods used for data collection. Despite the valid method, there are several limitations that should be noted. In our study, 76 pupils from three schools participated. Because of the small sample size and the nonrandomized selection process, it is not possible to generalize these results to the population of Dutch primary school students as a whole. However, at a minimum, several indicative conclusions can be drawn from the primary school pupils' performances.

A second limitation might involve the topics of the assignments. Although we have tried to develop realistic informational needs, we do not know whether the topics might have, for example, affected the participants' motivation to complete the assignments. On the other hand, we used different assignments in all three schools, and performance in each school did not differ significantly. The findings showed that children employ ineffective and inefficient search strategies and do not successfully combine information to make a good decision. Mancall, Aaron, and Walker (1986) stressed that programs aimed at improving information skills should consider levels of cognitive development. Although we attempted to reflect children's cognitive behavior, our findings might also suggest that some of the information and strategic Internet skills were too difficult for children between 9 and 13 years of age. The age difference did not lead to significant differences in performances.

Prior research suggests that the most important skills predictor is one's level of educational attainment (e.g., Van Deursen & Van Dijk, 2009, 2010). Unfortunately, when using primary school pupils as participants, the result is that no educational levels are officially assigned yet; pupils of all skill levels are together in every class. Future studies might, however, include some background information—for example, interim tests results from different courses such as language or math.

This article did not address the various platforms by which a child might access the Internet. Since the time of writing, particularly the rise of tablets has been spectacular. For many users, PCs and even laptops have been exchanged for tablets. Both young and old are attracted by the easy and intuitive interface of tablets. Tablets and other mobile devices might help children to speedily learn basic operational and formal skills. However, in terms of content-related digital skills, the deceptive ease of use of tablets might also hold an important hidden danger. The freedom of performing content-related skills on such devices might be much more controlled and limited by the application itself than on desktops and

laptops with complete functionality. In future studies, the proposed skills framework should also be tested while using mobile devices with often limited or preprogrammed functions.

Children's Internet use primarily happens at home. The most natural way to acquire these skills is through learning by doing and getting help from people in the social environment who can provide instruction. This includes parental guidance of children, from the first moment children start using digital media. However, formal education remains necessary for learning appropriate Internet skills. It has been shown that teachers' support in relation to children's Internet use has been beneficial to their skill development (Kalmus, Von Feilitzen, & Siibak, 2012). The younger generations most need formal education to learn more and better content-related information and strategic skills. This does not rule out that informal learning could help in all types of Internet skills. Future research should account for contextual factors in relation to Internet skills.

Finally, future studies should incorporate additional Internet skills relevant for primary school children, who are increasingly engaged in online communication and content creation activities. Van Dijk and Van Deursen (2014) recently completed their framework with communication and content creation skills. Particularly interesting is the way that children might employ one skill to make up for the lack of another (for example, participants may use communication skills to answer questions when their information skills are lacking) (Van Deursen, Courtois, & Van Dijk, 2014).

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Appendix A: Example Assignments and Corresponding Internet Skills.

Operational Internet Skills	**Assignment 1**
Opening websites through address bar; Saving files; Bookmarking websites; Navigating forward and backward using the browser buttons; Operating Internet-based search engines: Entering keywords; Executing the search operation; Opening search results. Operating Internet-based forms: Using the different types of fields and buttons; Submitting a form.	1. Go to the website of the zoo Artis (www.artis.nl). 2. Click on the link "plattegrond, horeca en voorzieningen." Save the map of the zoo on the computer's desktop. 3. Bookmark the homepage of the website. 4. Use the "back button" to go back to homepage of the Artis website. 5. Use the search engine to search for "leeuw." Open the second search result. *Not measured here.*
Formal Internet Skills	**Assignment 2**
Navigating the Internet by: Using hyperlinks in different layouts; Not becoming disoriented when navigating within a website; Not becoming disoriented when navigating between websites.	Find the addresses of the following three museums in Twente. Use the following websites: 1. The Twents techniek museum in Enschede (www.twentstechniekmuseum.nl) 2. The Historisch museum Hengelo (www.historischmuseumhengelo.nl) 3. The Zoutmuseum in Delden (www.zoutmuseum.nl)
Information Internet Skills	**Assignment 3**
Locating required information by: Defining search options or queries; Selecting information; Evaluating information found.	Imagine . . . Your parents are going to take you on a holiday to the province of Zeeland. You would like to know a little more about this area. Answer the following questions by using a search engine (e.g., Google or the website you use at home): - What are the adjacent Dutch provinces? - The Deltawerken in Zeeland are built to prevent flooding. In what year did the big North Sea flood hit Zeeland? - What is the name of the park where you can see the Deltawerken? -

Information Internet Skills	**Assignment 4**
Locating required information by: Choosing a website or a search system to seek information; Defining search options or queries; Selecting information (in search results); Evaluating information sources.	Imagine . . . You have to do a class talk about swimming pools. You would like to include some interesting facts. Answer the following question using a search engine (e.g., Google or the website you use at home): • How many public swimming pools are there in the Netherlands? • What is the largest public swimming pool in the Netherlands? • What public swimming pool has the longest slide?
Strategic Internet Skills	**Assignment 5**
Taking advantage of the Internet by: 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.	Imagine . . . You and your parents are going to a theme park! You have two options: Walibi Flevo or the Efteling. You would like to find out the cheapest option when going by train. Please consider entrance fees and train tickets (regular second-class tickets for you and your parents), departing from Hengelo.

Appendix B: Coding Scheme for Internet Skill-Related Problems

Operational skill problem
Incorrect use of address bar (e.g., entering keywords)
Not being able to save a file
Not being able to use the back button
Not being able to bookmark a website
Not being able to use a Web form correctly
Not recognizing the search input field
Not being able to use search queries correctly (not spelling)
Formal skill problems
Experiencing problems with different layout and website designs
Overlooking required hyperlinks
Consulting visited pages again
Information skill problems
Using Google as point of departure
Query_Using only a single keyword
Query_Typing the whole question in the search bar
Query_Using symbols to limit search results (e.g., parenthesis)
Query_Using advanced search methods (e.g., date or excluding keywords)
Results_Not conducting a second search when necessary
Results_Not searching within search results to limit results
Results_Not checking more than the first three search results
Results_Not checking more than the first page of search results
Results_Not opening the result but only scanning the short piece of search text
Results_Selecting sponsored search results
Evaluation_Not cross-checking information found
Evaluation_Using forum information without checking
Evaluation_Not reading information found properly
Strategic skill problems
Decision_Not accounting for all required information
Decision_Not using more than one website
Decision_Not making a correct decision based on the information acquired
Decision_Guessing an answer after not finding information
Benefits_Giving a wrong answer