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Information and strategic Internet skills of secondary students: A performance test

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ABSTRACT

In this study, the information and strategic Internet skills of Dutch secondary students were measured in a performance test. Participating students were asked to complete assignments on the Internet. The findings reveal that the levels of both information and strategic Internet skills have much room for improvement. Of the variables that influenced these skills, the level of education was most important, whereas the years of Internet experience and the number of hours spent online weekly did not have any effect. Among the most important specific information and skills related to problems the secondary students experienced were defining proper search queries, evaluating the information found, maintaining focus, or taking the appropriate steps to reach the final goal. Overall, the secondary students' performance calls into question whether they possess a sufficient level of information and strategic skills for using the Internet for homework or school projects.

1. Introduction

Scholars and students use the Internet for several facets of schoolwork, such as for working on their homework, finding information for projects or talks, and communicating with classmates. Internet skill is generally believed to contribute to better learning outcomes and successful school careers (Kuhlemeier & Hemker, 2007). Unfortunately, not every student is equally proficient in the Internet skills they need for school (Lauman, 2000). Because Internet skills are not a standard component of the current curriculum, few attempts are made in schools to improve them. It is generally believed that technology, such as the Internet, empowers learning and provides additional education (Buckingham, 2007). This concept, however, is dubious, and research on the matter is often misrepresented (Buckingham, 2007). In addition, it is often assumed that younger people are skilled in using the Internet. Van Deursen, Van Dijk and Peters (2011), however, revealed that this is mainly true for so-called button knowledge. Van Deursen and Van Dijk (2010) elaborated on the following range of Internet skills:

- Operational Internet skills. These are derived from concepts that indicate a set of basic skills in using Internet technology.
- Formal Internet skills. These relate to the hypermedia structure of the Internet, which requires the skills of navigation and orientation.
- Information Internet skills. These are derived from studies that adopt a staged approach in explaining the actions through which users try to fulfill their informational needs.
- Strategic Internet skills. These refer to the capacity to use the Internet as a means of reaching particular goals and for the general goal of improving one's position in society. The emphasis lies on the procedure through which decision makers can reach an optimal solution as efficiently as possible.

An important aspect of the above distinctions is the avoidance of a technologically deterministic viewpoint. Skills related to the use of the Internet as a medium (operational and formal) and those related to the content provided by the Internet (information and strategic) are both accounted for. By applying this definition to performance tests, Van Deursen and Van Dijk (2011) revealed that the level of operational and formal Internet skills generally appeared to be quite high. The level of information and strategic Internet skills, however, left much room for

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improvement. Van Deursen and Van Dijk (2011) found that with increasing age, the level of the medium-related operational and formal Internet skills decreased. However, although young people performed well on the medium-related Internet skills, they still showed a strikingly low level of information and strategic Internet skills. In fact, it was shown that age has a direct positive effect on content-related skills, meaning that older people perform better on these skills than do young people (Van Deursen et al., 2011). It is important to understand here that the content-related skills somehow depend on the medium-related skills because the absence of medium-related skills indicates that one will not have the opportunity to perform the content-related skills. Unfortunately, it was shown that seniors have considerable problems with the operational and formal Internet skills that strongly influence their performance on the information and strategic Internet skills.

The performance tests conducted by Van Deursen and Van Dijk (2011) only considered people over 18 years old. For them, the level of information and strategic Internet skills appeared, in general, to be quite low. We sought to evaluate the level of information and strategic Internet skills among secondary students under 18 years of age. At secondary schools, many teachers seem to assume that students know how to use the computer, surf the web, and communicate via e-mail (Kuhlemeier & Hemker, 2007). As a result, little attention to these skills is given in classes. If secondary education teachers are to tailor their instruction to the needs of all students, they need to familiarize themselves with the Internet skills students require (Lauman, 2000; Leu, 2002).

For studying the levels of Internet skills, a variety of methodologies can be employed. Most of the existing research on Internet skills used surveys that might offer in-depth explorations of participants' skills, but in most cases gathered data based on people's own perceptions or estimations of their computer or Internet skills (Kuhlemeier & Hemker, 2007). People are presented with a list of skills and are asked to evaluate how well they perform those skills. Although self-report questionnaires have advantages—such as the ability to present a large number of questions on a wide range of skills in a short time, simple scoring, fast processing, and cost effectiveness (Kuhlemeier & Hemker, 2007)—this method has significant problems of validity (Hakkarainen et al.; Hargittai, 2005; McCourt Larres, Ballantine, & Whittington, 2003; Merritt, Smith, & Renzo, 2005; Talja, 2005; Van Deursen & Van Dijk, 2010). Research among young students revealed that 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; Hakkarainen et al.). Consequently, it is not clear to what extent differences in self-ratings correspond to real differences in skills. Besides using surveys, interactive standardized approaches might be used to measure Internet skill levels. An example of such an approach is the Eductional Testing service iSkills assessment, designed to measure information literacy (Katz, 2007). The iSkills assessment is delivered over the Internet in a secured testing environment. The assessment presents scenario-based performance tasks in which students solve information problems using simulated software such as email, web browser, or presentation software.

Choosing an assessment instrument involves consideration of various factors, including approach, feasibility, implementation, scope, reporting structure, cost, as well as consideration of output needs and social context (Covello, 2010). The most valid measurement of Internet skills, however, goes beyond surveys or simulated software: A measurement of Internet skills should provide the possibility for actual real-life Internet use. Observational studies could be very suitable to provide a realistic view of students' Internet skills. However, their cost is a strong limitation for large-scale data gathering. Although observational studies discourage interruption of participants—which makes it difficult to obtain contextual information (Kellar, Hawkey, Inkpen, & Watters, 2008)—and testing the actual skills of Internet users in a behavioral study is a highly labor-intensive process, they seem to be the most suitable methods of obtaining a direct measure of skill. A variety of process indicators may be automatically recorded, such as user actions and successful completion.

To obtain a realistic view of people's Internet skills, an observational study is conducted in which subjects are asked to complete assignments on the Internet.

RQ 1: What are the levels of information and strategic Internet skills among secondary students?

Because secondary students are heterogeneous, the Internet skill level is likely to differ between segments of students. The differentiating factors accounted for are discussed in the next section. The second research question is the following:

RQ 2: What factors determine the Internet skill levels of secondary students?

In addition to identifying general skill levels and how they differ among secondary students, we are also interested in revealing the individual Internet skills-related problems they experience. The third research question is the following:

RQ 3: What specific skills-related problems do users experience online?

2. Theoretical background

Van Deursen and Van Dijk (2010) proposed a definition for the general user population to function well in an increasingly digital society. For information (based on information processing models) and strategic (based on decision making models) Internet skills, the following specific indices have been proposed:

Information Internet Skills: Locating required information through the following processes:
- ○ Choosing a Web site or a search system to seek information;
- ○ Defining search options or queries;
- ○ Selecting information (on Web sites or in search results);
- ○ Evaluating 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.

Prior related research reveals that scholars and students might lack several of these specific skill indices (Davis, 2003; Harrison et al., 2003; Klein, Yarnall, & Glaubke, 2001; Metzger, Flanagin, & Zwarun, 2003; O'Hanlon, 2002; Volman, van Eck, Heemskerk, & Kuiper, 2005). Walraven, Brand-Gruwel, and Boshuizen (2008), for example, revealed that young people have problems in formulating

information problems, evaluating information found online, specifying search queries, and judging search results. According to Ba, Tally, and Tsikalas (2002), children consider the Internet to be a chaotic and overwhelming environment for finding information. In addition to indicating the level of information and strategic Internet skills among secondary students, we are also interested in the variables that determine the levels of these skills. These factors will now be discussed, and hypotheses will be formulated.

Hargittai and Shafer (2006), Van Deursen and Van Dijk (2011), and Kuhlemeier and Hemker (2007) all conducted actual performance tests that revealed no differences between men and women. Most studies that reported differences used self-assessments in which women tended to assess their Internet skills as being worse than those of men (Van Deursen & Van Dijk, 2010) or in which girls in secondary schools assessed their skills as being worse than those of boys (Kuhlemeier & Hemker, 2007). However, Large, Beheshti, and Rahman (2002) revealed that boys and girls around age 11 do differ in the way they search for information. Boys, for example, used only one keyword more often than girls, who combined multiple keywords. Furthermore, boys tended to click links more often and stayed on a page for shorter periods of time than did girls. These differences, however, did not result in large differences in the actual results. This leads to the following hypothesis:

H1. *There are no gender differences in information and strategic Internet skills.*

When considering age, older people are often regarded as "laggards" in the diffusion process for innovation (Rogers, 1995). Young people become familiar with the Internet at an early age and are thus considered to be more skillful than older individuals. As stated previously, this assumption is a cause of concern. However, when considering only secondary school children, a considerable difference might exist between the pupils in the youngest class and the older students who are about to leave secondary school. We hypothesize the following:

H2. *With increasing age, secondary students will possess better information and strategic Internet skills.*

Education is the most consistent global predictor of the use of information communication technologies (ICTs). Hargittai (2002) revealed that among people between the ages of 30 and 70, those with higher education successfully completed more assignments and needed less time. According to Van Deursen and Van Dijk (2011), education was the most important predictor of the level of Internet skills, especially information and strategic Internet skills. For the latter, in fact, education was the only significant contributor. It seems logical to assume that these differences also exist among secondary students.

H3. *With increasing educational levels, secondary students will possess better information and strategic Internet skills.*

People who spend more time online—whether at work or anywhere else—will acquire more knowledge about the Internet and thus develop better online skills (Hargittai, 2002, 2005). Moreover, people who have been Internet users for a longer period of time are expected to be better at finding information online because they have more experience to draw upon (Hargittai, 2002). In general, for both computers and the Internet, the length of previous experience and the amount of current usage have been associated with greater technological expertise (Schumacher & Morahan-Martin, 2001; Weil & Rosen, 1995). Van Deursen and Van Dijk (2011), however, found that Internet experience only affected the medium-related skills, and that there was no direct effect on the information and strategic Internet skills. Indeed, having technical knowledge of the Internet does not guarantee that one is able to process information into useful knowledge (Kuiper, Volman, & Terwel, 2005). Therefore, we hypothesize the following:

H4. *Internet experience has no influence on the level of information and strategic Internet skills of secondary students.*

H5. *The number of hours spent online weekly has no influence on the level of information and strategic Internet skills of secondary students.*

3. Method

To obtain a valid measurement of secondary students' information and strategic Internet skills, an observational study was conducted in which subjects were asked to complete assignments on the Internet.

3.1. Sample

Our aim was to include secondary students who differ in age and in levels of educational attainment. Therefore, we selected nine classes in a Dutch secondary school to participate in the performance tests, which were equally divided over three educational levels and three age categories (11–12–13, 14–15, and 16–17). The school was chosen for its well-equipped computer laboratory. In every class, 5 boys and girls were selected by randomly picking names from the class list of students. The selected boys and girls were asked to participate in the performance test. Of the 60 students, 54 subjects agreed to participate. Table 1 contains the characteristics of the participants. The average number of years of Internet experience was 5.9 (SD = 1.97), and the average amount of Internet use was 1.8 (SD = 1.09) hours a day. The average number of days per week of Internet use was 5.5.

3.2. Data collection and procedure

The study was conducted in June 2011 in the school's office. This approach controlled for quality in Internet connectivity and hardware/software, and it also ensured that the setting was equally different and new for all participants. During their assignments, the subjects used a keyboard, a mouse, and a 17-inch monitor, which were connected to a laptop from which the test leader could watch the subjects' actions.

Table 1
Gender, education, and age of subjects.

	N	%
Gender		
Male	28	51.9
Female	26	48.2
Age		
11, 12, 13	19	35.2
14, 15	18	33.3
16, 17	17	31.5
Education		
Low	18	33.3
Medium	18	33.3
High	18	33.3

The laptop was programmed with the same two Internet browsers that they could use at school (Microsoft Internet Explorer and Mozilla Firefox), which allowed the subjects to replicate their regular Internet use. No default page was set on the browsers, and all of the assignments started with a blank page. To ensure that the subjects were not influenced by a previous user's actions, the browser was reset after each session by removing temporary files, cookies, and favorites. In addition, downloaded files, history, form contents, and passwords were removed, and the laptop was rebooted. CamStudio-Recorder was used to record the screen actions of the subjects who completed the assignments.

After arriving at the office, the subjects were given verbal instructions about the procedure of the study. Prior to the test, a 5-min questionnaire was administered to gather personal data. After the subjects completed the questionnaire, they were given a sequence of four assignments, one at a time. The subjects themselves decided when they were finished or wanted to give up on an assignment. No encouragement was given because the pressure to succeed was already higher in a laboratory setting than at home. After a specific maximum amount of time had passed (determined from the pilot-tests), the test leader gently asked the subjects 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 subjects' strategies.

The test leader directly measured the levels of completion and the time spent on the tasks. The task completion rate was considered to be the most important outcome. However, because one user could be very slow but eventually find the correct answer, while another could find the answer almost immediately, the time spent on the assignments was also considered as a measurement of success.

3.3. Assignments

Two assignments were used for measuring information Internet skills, and two were used for measuring strategic Internet skills. To complete the strategic skill assignments also information skills are required (there is a conditional nature between these skills). Therefore, the strategic skill assignments can be considered as more difficult than the two information skill assignments. The outcomes for both types of Internet skills were primarily measured in terms of the number of tasks solved successfully. However, we also measured the time spent on each assignments. We avoided open-ended assignments because of the ambiguity and subjectivity to interpretation of many potential answers. Therefore, only one answer was considered as correct and not accomplished or partially accomplished tasks were rated as unsuccessful. Before the performance tests were conducted among participating students, five subjects were recruited to participate in a pilot test in which the assignments were tested for comprehensibility and applicability. The assignments are listed in Appendix A.

3.4. Analyses

An easy way to estimate scores for each individual factor (the two Internet skills) involves summing scores corresponding to all items (Comrey & Lee, 1992). In the next section we will provide percentages of the total number of assignments completed, and percentages of completion for each skill. Furthermore, we computed average percentage scores for both information and strategic Internet skills assignments completion to retain the scale metric and easy interpretation. Since both assignments for each skill have the same weight, summing scores is appropriate.

The explanatory variables that are discussed in Section 2 are accounted for in the Internet skills measurements. In the next Section, linear regression analyses will be presented, which will identify which of these variables appear to be significant to the number of assignments completed and the time spent. The general prerequisites of linear regression analysis are fulfilled (Bland, 1995). The independent variables are discrete or continuous, the dependent variable is continuous; the observations are independent of each other; the relationship between the variables is linear; the prediction errors are approximately normally distributed; the variance of the dependent variable is approximately constant with different values of the independent variables. In the regression analyses, gender is included as a dichotomous variable and age as a continuous variable. Data on education were collected by degree and were subsequently divided into three overall groups of low, medium, and higher educational attainment. Internet experience was measured according the number of years the secondary students have been using the Internet. The amount of Internet use was measured according to the number of hours respondents spent browsing the Internet weekly (with the week before the survey being used as a reference).

The dataset contained no missing values. The test leader checked all data carefully for missing answers during the performance tests. If information was omitted, the subjects were asked to provide the answer.

During the completion of the information and strategic skills assignments, the occurrences of several specific information and strategic indices were counted. For the information Internet skills, these indices included the search system used, the number of search queries, the use of Booleans to limit search results (e.g., parentheses), the amount of searches conducted, and the evaluation of the information found. For the strategic Internet skills, indices included accounting for all the tasks requirements, the use of decision support websites, and making decisions based on all required information. All these indices were carefully checked during the analyses of the video recordings.

4. Results

4.1. Levels of Internet skills

Overall, an average of 2.6 (64%) of the four Internet skills assignments were completed successfully. According to Table 2, 24% of the subjects were able to complete all four assignments successfully, while 6% were unable to complete any of the four assignments.

Table 3 reveals that 69% of the subjects were able to complete the first assignment successfully, while 76% completed the second assignment. The performance on the two strategic assignments was worse: 59% of the subjects completed assignment 3 successfully, and 52% completed assignment 4. While attempting to complete the strategic skill assignments, 11 subjects gave up in assignment 3, while eight gave up in assignment 4. Overall, for the two information skills assignments, 72% were completed successfully, while 56% of the two strategic skill assignments were completed successfully. Table 3 further reveals that the time spent on each assignment varied substantially.

4.2. Determinants of Internet skills

To identify factors that influence the level of both information and strategic Internet skills, linear regressions were conducted: one with the number of assignments completed successfully and one with the time spent as dependent variable. Table 4 summarizes the results for the information Internet skills.

According to Table 4, education is the main contributor to the number of successfully completed information skill assignments. The higher the level of education that a subject had attained, the better was the successful completion rate average. Age was significant to the time spent on the information assignments. The older that the subjects were, the less time they spent on the assignments. Other explanatory variables did not appear to be significant for the successful completion of assignments or the time spent.

Table 5 summarizes the results for strategic Internet skills. For the two strategic Internet skills, education, again, is the main contributor to the number of assignments successfully completed. The higher the level of education that a subject had attained, the higher was the average completion rate. Of all other explanatory variables, none appeared to be significant.

Tables 4 and 5 provide answers to the posed hypotheses. The first hypothesis, that no gender differences exist between information and strategic Internet skills, is supported. Boys and girls do not seem to differ in their information and strategic Internet skills. The second hypothesis, that with increasing age, secondary students will possess better information and strategic Internet skills, is only marginally supported. Age is only significant for the time spent on the information skills. Hypothesis H3, which states that with increasing educational level, secondary students will possess better information and strategic Internet skills, is supported. Education was significant for both the number of successfully completed information and strategic assignments. Finally, hypotheses H4 and H5 are not supported. Both Internet experience and amount of Internet use do not affect the levels of information and strategic Internet skills of secondary students.

4.3. Individual skill-related problems

4.3.1. Information skills-related problems

Assignments 3 and 4 were prepared to identify information Internet skill-related problems. A first possible problem related to information skills considers the search queries defined by the subjects. The number of keywords used in all conducted search operations are reviewed in Table 6. This table reveals that the maximum amount of keywords used in both assignments was seven. In the first assignment, most subjects (55%) used two keywords. In the second, most used three (46%). On average, 10% of the subjects only used one keyword, thereby limiting the chances for a positive outcome.

More important than the number of keywords used, however, is the quality of the search queries. In the first assignment, the single keyword *Duinrell* was used in seven cases to search for the number of slides in the Tikibad (a large pool in one of Duinrell's many holiday parks). Furthermore, in two cases, the full assignment was entered into the search bar, resulting in unusable search results. In four other cases, similar but shorter questions (including question marks) were formulated to function as search queries. To find the number of slides in the Tikibad, 21 subjects used the combination of *Duinrell* and *Tikibad*. A total of 27 subjects also used the keyword *slides* in their search.

In the second assignment, subjects had to find the best restaurant in Amsterdam (based on the number of Michelin stars). Here, the most frequently used search query (12 subjects) was *restaurant in Amsterdam*, which is not specific enough for the assignment.

An important observation is that none of the conducted searches included the usage of Booleans (quotation marks, for example). During the completion of the strategic skill assignments, Booleans were used only once. In this instance, however, the quotation marks were used improperly, with the entire question being placed between them.

The next problem considered the amount of searches conducted, which are summarized in Table 7. This table reveals that most subjects only conducted one search operation.

Finally, in the first assignment, 11 subjects took the answer directly from the small amount of information provided by Google results without clicking any actual links. In 17 cases, the subjects who could not find the answer in the text to the question about the number of slides in Tikibad, started counting the slides on an online map. Also, one respondent simply made up his own answer.

Table 2
Successfully completed assignments ($N = 54$).

# Assignments completed successfully	# Subjects	%
0	3	5.6
1	8	14.8
2	12	22.2
3	18	33.3
4	13	24.1

Table 3
Successful completion rate of assignments and time spent.

	Successful completion		Time spent (minutes)		
	n	%	*M*(SD)	Min	Max
Assignment 1	37	68.5	1:15 (1:08)	0:10	5:49
Assignment 2	41	75.9	2:02 (1:43)	0:21	9:65
Assignment 3	32	59.3	3:50 (2:47)	0:45	11:19
Assignment 4	28	51.9	7:03 (3:29)	1:49	14:58

4.3.2. Strategic skills-related problems

We have already shown the low number of strategic skill assignments completed successfully. Here, we will identify the main problems that are encountered when solving strategic Internet skills assignments. According to the strategic skill definition, individuals need to maintain focus on the goal, take appropriate actions to reach the goal, and make the right decisions. Then, they can actually benefit from Internet use. In the first strategic Internet skill assignment, subjects were asked to select the best campground in France at which they would like to spent their holiday. Aside from the presence of a disco, the campground had to be in France and include a pool, according to the demands of parents. In the second assignment, the subject had to select the best place to play laser tag game (a popular game similar to paintball), in which restrictions also applied concerning location, price, and time.

The first problem accounted for in the analysis considers taking proper steps to reach the final goal. In the third assignment, for example, a helpful step would have been to use a website that is specifically aimed at locating specific campgrounds. However, only 27 (50%) of the subjects used such a decision support website. The other subjects used Google. Here, 10 of the 27 subjects did not verify the suggested campground nor did they check whether it existed. An example from assignment 4 considers the necessity for checking the distance between the location of laser tag and Tienhoven. A striking 42 subjects (78%) did not take this into account.

The second problem concerning strategic skills involved decision making based on all of the required information. Prior research revealed that young people often adjust their original search according to what they were able to find (Walraven et al., 2008). For the third assignment, 21 subjects (39%) selected a campground that did not meet all of the demands. In the fourth assignment, 28 subjects did not select a laser tag site that met all requirements.

5. Discussion

5.1. Main findings

Regarding research question 1, we conclude that the level of information and strategic Internet skills among Dutch secondary students have much room for improvement. This is especially so when considering the feasible context used for the assignments and the fact that in actual Internet use outside of the artificial test situation, performances will likely be worse. In a test situation, subjects are stimulated to perform, even though we did not explicitly encourage the subjects in this study. On average, only 64% of all assignments were completed successfully. This result supports related research conducted on students. Kuiper (2007), for example, found that students use the Internet at a relatively young age but lack the skill of reflection regarding search results and critical website reading skills.

Regarding research question 2, we are able to conclude that educational attainment is the most important contributing factor to the level of information and strategic Internet skills. The higher the levels of a student's education, the better were their performances. Information and strategic skills strongly relate to education and intellectual capacities. It is often argued that people learn Internet skills more in practice, by trial and error, than in formal educational settings (e.g., De Haan & Huysmans, 2002; Van Dijk, 2005). From the results here it is possible to conclude that this not goes for information and strategic skills.

Age only had some minor influence, and gender did not reveal any differences at all. Older students needed less time to complete the information Internet skill assignments. An important conclusion is that the level of information and strategic Internet skills among secondary students has a weak relation with Internet experience and the amount of hours spent online weekly. Van Deursen and Van Dijk (2011) revealed that these factors only influence the level of operational and formal skills but not the content-related information and strategic Internet skills. This might also be the case with secondary students. Survey research that uses Internet self-efficacy as a dependent variable often finds prior Internet experience to be a very strong predictor.

In answer to research question 3, we highlighted the most important specific information and skills-related problems that the secondary students experienced. Defining search queries revealed large differences between the subjects. Almost half of the subjects conducted searches using queries that were too general for the assignment. None of the subjects used Booleans. Most striking, however, was the fact that none of the subjects seemed to pay attention to the source of the information found. Finding the answer seemed to be the primary objective, regardless of where the information came from. Information was taken directly from the small portion of text in Google results or even made up.

Table 4
Linear regression on the number of information assignments completed successfully and time spent.

	Assignment completion β	Time spent β
Gender (m/v)	.15	−.01
Age	−.10	−.32*
Education	.37*	−.17
Hours online	.04	−.23
Internet experience	.11	.04
R^2	.17	.17
F	1.84	1.96

*<.05, **<.01, ***<.001; $N = 54$.

Table 5
Linear regression on the number of strategic assignments completed successfully and time spent.

	Assignment completion β	Time spent β
Gender (m/v)	−.03	.10
Age	.05	−.19
Education	.36*	−.19
Hours online	.10	−.02
Internet experience	−.05	−.09
R^2	.13	.11
F	1.40	1.14

*<.05, **<.01, ***<.001; $N = 54$.

Regarding strategic Internet skills, maintaining a strong focus on the final goal was difficult for some subjects. Of greater concern, however, was the inability to take the necessary steps to reach the final goal. Reference websites were neglected by half of the subjects. In addition, in only a few cases was all of the necessary information accounted for, which often resulted in erroneous decision making.

Overall, the performance of the secondary students calls into question whether they have a sufficient level of information and strategic skills required to use the Internet for homework or school projects. Based on the performance tests results, it seems that information and strategic Internet skills should be included as standard components of the educational curriculum. Unfortunately, Internet skills in general and the acquisition of information and strategic skills in particular play a minor role in Dutch classes and, as far as we know, in many other countries in the world. Teachers should attain special training in didactic and information skills suitable for the Internet. In addition, new educational materials should be developed that are designed for Internet use and implemented in existing courses of the school curriculum. When the development of information and strategic skills is implemented in existing courses such as language, history, biology and geography, it is likely that they will improve. Also, teachers will be more motivated to spend additional time and effort.

5.2. Limitations and future research

As outlined in the first section, few actual observations of Internet skills are available. Studies that attempt to measure these skills are often limited in the definitions used, the small sample sizes, and the survey method for data collection in which skills are measured either indirectly or through self-evaluation. The performance tests conducted to test the information and strategic Internet skills in this study, however, also have their limitations.

First of all, 54 subjects participated in our study. It is therefore not possible to generalize these results for all Dutch secondary students. However, in rating the overall representativeness of this sampling approach, it should be compared to the standards of an experiment rather than a survey. For an experiment, this number of subjects is sufficient.

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 subjects' motivation to complete the assignments. On the other hand, the pressure to succeed is higher in a laboratory setting.

A third limitation might be the distinction between information Internet skills and strategic Internet skills. Van Deursen and Van Dijk (2010) attempted to theoretically derive both concepts separately. Information Internet skills resulted from concepts related to information seeking, while strategic Internet skills resulted from decision making processes. However, strategic Internet skills require a high level of information skills; Information Internet skills are a prerequisite for performing well in strategic Internet skills. This makes it challenging to measure both aspects independently. In the strategic skills assignments, it might occur that subjects with lower levels of information skills did not even come to make a decision based on the information collected, simply because they did not find any information. In future studies, additional assignments might be used in which the information is already provided to students, and only the decision making part is requested.

A fourth limitation is that we do not know whether the lack of information and strategic skills that we have observed also appears, to the same extent, in information retrieval using more traditional media and channels. Further research should answer this question by adding comparable information and strategic skills performance tests concerning media other than the Internet. A comparison of the results of all of these tests could show whether the use of the Internet channel makes a difference. This comparison might also show whether Internet use aids in the retrieval of better information and better test results or serves as an additional barrier for secondary students who seem to lack the skills required for the appropriate use of the Internet.

Table 6
Total number of keywords used in Assignment 1 and Assignment 2.

# keywords	Assignment 1		Assignment 2	
	n	%	*n*	%
1	7	13.2	4	7.4
2	29	54.7	6	11.1
3	8	15.1	25	46.3
4	3	5.7	12	22.2
5	4	7.5	5	9.3
6	0	0	1	1.9
7	2	3.8	1	1.9

Table 7
Total number of searches conducted in Assignment 1 and Assignment 2.

# search operations	Assignment 1		Assignment 2	
	n	%	*n*	%
0[a]	1	1.9	0	0
1	47	87.0	34	63.0
2	4	7.4	14	25.9
3	2	3.7	2	3.7
4	0	0	2	3.7
5	0	0	2	3.7

[a] 0 No keywords used, but directly visited a website.

In this study, we only measured information and strategic Internet skills. Other skills, such as the skills to communicate over the Internet or to create content, have been neglected. We claim that information and strategic skills are crucial for these activities. Active participation and user-generated content require high levels of Internet skills, particularly for "serious", as opposed to entertainment, applications. These skills are worthy subjects for future researchers.

Finally, future work should focus on how differences in Internet skills among secondary students can be reduced.

Appendix. A

Information Internet skills	**Assignment 1**
Locating required information, by:	Find out the number of slides at the Tikibad in Duinrell.
Choosing a Web site or a search system to seek information;	
Defining search options or queries;	
Selecting information (on a Web site);	
Evaluate information found.	
Information Internet skills	**Assignment 2**
Locating required information, by:	Imagine that you have won one million euros and have decided to take your parents out for a very fancy
Choosing a Web site or a search system to seek information;	dinner in Amsterdam. Because you now have plenty of money, only the best will do. You decide to go to the restaurant with the most Michelin stars.
Defining search options or queries;	To which restaurant would you go?
Selecting information (in search results);	
Evaluating information sources.	
Strategic Internet skills	**Assignment 3** (max time allowed: 12 min)
Taking advantage of the Internet, by:	Imagine that your parents want to go for a one-week holiday in France. They have already selected
Developing an orientation toward a particular goal;	a campground, but this one has no disco, which is something you would really like! Your parents
Taking the right action to reach this goal;	decide that you can choose a new campground. They ask you to select one in France that has a pool.
Making the right decision to reach this goal;	Keeping in mind the fact that you really want a disco to be present, find a campground that suits
Gaining the benefits resulting from this goal.	all of your needs.
Strategic Internet skills	**Assignment 3** (max time allowed: 30 min)
Taking advantage of the Internet, by:	Imagine that you have an aunt and uncle in Tienhoven who invite you to stay there for a week. During
Developing an orientation toward a particular goal;	your visit, you are allowed to pick an activity to do with their kids. You decide to go and play laser tag.
Taking the right action to reach this goal;	Find the place where you can do this within a half hour driving distance, taking into account how long
Making the right decision to reach this goal;	the game of laser tag lasts, and the price.
Gaining the benefits resulting from this goal.	

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