# Online information problem solving. An overview of the strategies used by 8- to 13-year-old students in French-speaking Belgium

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## ABSTRACT

*In French-speaking Belgium, one of the new missions of the teacher will be to develop learners' information skills, namely their skills in searching, evaluating, and using information on the web. But do teachers know the strategies used by their students to adapt their teaching interventions? The aim of this study is to provide an overview of the different strategies used by 8 to 13 year old students when searching online. To achieve this objective, we use the IPS-I model and a methodology based on the analysis of the actual practices of 260 primary and secondary school students. Our results show that almost all of the students tested are novices in information retrieval. They do little or no research planning, use basic strategies, never check the reliability and relevance of the information they find and do not cite the sources used. These findings, in the light of previous empirical research on online search behaviour, allow for reflection on educational interventions and provide recommendations for educational practice.*

## KEYWORDS

*Online search, Students, information behaviour, navigation, digital literacy*

## RÉSUME

*En Belgique francophone, une des nouvelles missions de l'enseignant sera de*

*développer les compétences informationnelles des apprenants, à savoir leurs compétences de recherche, d'évaluation et d'utilisation de l'information sur le web. Mais les enseignants connaissent-ils les stratégies utilisées par leurs élèves afin d'adapter leurs interventions pédagogiques ? La présente étude vise à faire un état des lieux des différentes stratégies utilisées par les élèves de 8 à 13 ans lorsqu'ils effectuent une recherche en ligne. Pour atteindre cet objectif, nous nous appuyons sur le modèle IPS-I et nous avons recours à une méthodologie fondée sur l'analyse des pratiques effectives de 260 élèves du primaire et du secondaire. Nos résultats montrent que la quasi-totalité des élèves testés font Figure de novices en matière de recherche d'informations. En effet, ils ne planifient peu ou pas leurs recherches, emploient des stratégies basiques, ne vérifient jamais la fiabilité et trop peu la pertinence de l'information détectée et ne citent pas les sources utilisées. Ces constations, à la lumière de recherches empiriques antérieures sur les comportements de recherche en ligne, permettent une réflexion sur les interventions pédagogiques et énonce des recommandations pour la pratique éducative.*

## MOTS-CLÉS

*Recherche en ligne, élèves, comportement d'information, navigation, compétence numérique*

## Introduction

With the Internet, information has become more accessible in a few clicks and seconds. Since 1995, the network has grown exponentially (Cardon, 2019). In Belgium, the 10.86 million internet users (94% of the population) spend an average of 5H01 on the internet every day (Degraux, 2019).

As the web has become a preferred source of information, it is not surprising that students choose this modality first and foremost to meet their school and daily information needs (Smahel et al., 2020). This increased access to information is due to the fact that students from primary to university level (Fraillon et al., 2014) are very easily connected to the internet via their mobile devices (Smahel et al., 2020).

Educating them to be able to search and be critical on the web has therefore become one of the important goals of education and this from the early years of schooling (Hämäläinen et al., 2020). Yet, this skill is little worked on for its own sake at school (Brante & Strømsø, 2018). The learning activities offered by teachers remain very limited in this respect (Kumps et al., 2022). School traditions and teaching practices often continue, for example, to focus on reading single texts, and thus one-sided learning content, instead of dealing with multiple documents and materials with conflicting views. This would better prepare students for the demands of online work (Hämäläinen et al., 2020).

Currently, the educational system of French-speaking Belgium, wanting to fill this gap, suggests in its new reference materials (Fédération Wallonie-Bruxelles, 2022) that pupils should be able to acquire transversal competences in this field. Thus, being able to search effectively for information on the Internet will be one of the skills that pupils will necessarily have to develop from the age of 8. Given the speed of ICT, much of the existing research on children's online information retrieval is somewhat outdated and very little has been published in the last five years (Vanderschantz et al., 2014). Therefore, the aim of our study is to try to give a comprehensive overview of the strategies used by pupils when faced with an online information search situation for the age groups impacted by the new Belgian reference frame (Fédération Wallonie-Bruxelles, 2022).

To better understand the cognitive process of learners in this domain and the indispensable specificity of teaching to master it (Macedo-Rouet et al., 2019), a theoretical review of the literature based on the IPS-I model (Brand-Gruwel et al., 2009) tends to show that young people's competences seem limited. Therefore, we can hypothesise that the behaviours observed in 8- to 13-year-old students will be closer to the behaviours of the novice than to those of the expert.

## Conceptual framework

### *A competency-based model: Information Problem Solving while using Internet [IPS-I] (Brand-Gruwel et al., 2009)*

In this model, information retrieval is considered as a problem-solving activity because it is based on reaching an end goal within material and often temporal constraints while passing through intermediate sub-goals by mobilising a number of skills, cognitive and metacognitive processes.

The IPS-I model defines 5 components called "constitutive competences" broken down into sub-competences: (1) The definition of problem solving starts with the recognition of an information need. It includes the tasks of reading the problem, formulating questions, activating prior knowledge in memory, clarifying requirements, and determining the information needed. (2) Information search, where the user has to select a search engine, a search strategy, specify the terms of the query and evaluate the results. (3) Information scanning: scanning the information, evaluating it and retaining the relevant information. (4) Information processing where information is read in detail, evaluated and retained to develop content. (5) Organising information: formulating the problem, structuring the relevant information and describing the product, realising it and developing content.

Reading is seen as iterative and metacognitive. This is why the IPS-I model also foresees 4 regulating activities during the research process: orientation, monitoring,

steering and evaluation. More precisely, regulation would intervene in order to: manage the task achievements according to the material and temporal conditions; manage and adjust one's information search and analysis behaviours; evaluate the credibility, recency, relevance of the retrieved information; and evaluate the product resulting from one's search after having processed the information.

### *Students' online strategies*

Using the IPS-I model's decomposition into constitutive and regulatory competencies as an analytical framework, each competency is briefly discussed in relation to the literature.

*Defining the problem*

This task does not seem to be a problem for students aged 6 to 18. However, they have difficulties in formulating research questions and activating their prior knowledge (Walraven et al., 2008). In most cases, they start the task immediately without exploring the topic or planning the research (Fleury, 2016).

*Searching for information*

Students turn to a limited number of search engines to find information on the web. They mainly use Google (Sullivan, 2015). When entering their query in the search bar, empirical observations show that younger children (6-12 years old) use one or more keywords, complete sentences (Rouet et al., 2011) or even write down the question they are asking (Vanderschantz et al., 2014). They rarely use synonyms in their attempt (Jochmann-Mannak et al., 2010) and thus define keywords present in their initial question (Vanderschantz et al., 2014). They usually search too broadly and get an overload of results. The presence of spelling errors in their query does not facilitate their search either (Druin, 2009). They do not use advanced search functions or Boolean operators to refine their search (Head, 2013). Thus, they report recurrent difficulties in formulating queries and manipulating interfaces (Macedo-Rouet et al., 2019).

When selecting web pages, students show great uncertainty. They click on links without even reading them (Gwidzka & Bilal, 2017). Some base their choice on titles (Kafai & Bates, 1997) others rely on summaries (Koot & Hoveijn, 2005) or on a URL they know (Vanderschantz et al., 2014). They usually rely on heuristic cues such as the position of the link in the search engine ranking, links with high semantic relevance to the information need, or words with a typographic marker (Rouet et al., 2011). Other practices common to most students can also be observed: the use of the Wikipedia encyclopaedia (Fleury, 2016), forums (Salmerón et al., 2016), but also commercial pages (Issa et al., 2011) to meet their information needs. Thus, learners

erroneously distinguish between relevant and irrelevant elements contained in links (Macedo-Rouet et al., 2019).

*Scanning the information*

At this stage, learners judge the relevance of information on the basis of expected information and not on validity, authority or currency. They may scan only the first few lines of a document or the entire page and either reject a page even though the content is relevant or accept a source as relevant just because it contained the words they were looking for. Most young researchers do not store relevant information if a source seems useful, unlike adults who browse several sites and then only process the information (Boubée & Tricot, 2010).

*Information processing*

When processing, young Internet users read either the first paragraph or the whole page (Vanderschantz et al., 2014). But, they spend little time on the content of the link (Fives & Dinsmore, 2017). It is also noted that students quite frequently switch from one medium to another (Salmerón et al., 2018). It would seem that non-textual content can facilitate comprehension and overcome reading difficulties (Boubée & Tricot, 2010).

*Organising information*

Young readers are able to synthesise information found on the web, but only a minority cite the sources used (Salmerón et al., 2016). Plagiarism of information gathered from the Internet is therefore a common practice among primary and secondary school students (Rinck & Mansour, 2013).

*Guidance, Monitoring, Piloting*

Adolescents do not feel the need to plan their research unlike a strategic researcher who monitors and directs his or her process quite often (Brand-Gruwel et al., 2009). The international ePIRLS 2016 assessment (9–10-year-olds) confirms this finding by mentioning that most students (83%) do not go back and forth when searching online. Novice searchers are nevertheless defined as impatient, clicking and changing sites regularly (Dinet et al., 2012). They are also seen as easily distracted (Issa et al., 2011). The students therefore show weaknesses in managing their activities, planning their strategies or changing them if they are ineffective (Vanderschantz et al., 2014).

*Evaluating information*

Students know the appropriate criteria (source, prior knowledge, social validation, relevance, date of publication, etc.) for checking reliability (Salmerón et al., 2018). Yet

when they are in a real research context, they fail to apply them (Macedo-Rouet et al., 2019). They therefore tend not to assess the reliability of information at any stage of the information search (Gwidzka & Bilal, 2017).

In view of this description of actual practices, we can consider that learners show difficulties in the process of information search, despite being confident in their online search strategies and in their ability to evaluate information (Fraillon et al., 2014).

## Methodology

In the following, we describe the methodology used to test our initial hypothesis and to assess students' behaviour when searching for information online. To do so, we specify the sample considered, the proposed online research tasks and the data collection tools created.

### *Research questions*

To assess the students' online search behaviour, we considered the process variables against a coding grid (Table 1). We therefore considered each behaviour as an independent variable.

We also took into account two dependent variables: the age of the learners and the nature of the information to be searched. Age was taken into account in view of the evolving nature of online problem solving skills (Vanderschanchtz et al., 2014) and the doubling of time spent on the Internet by adolescents aged 12-16 years compared to 9-10 years (Smahel et al., 2020). To observe possible differences in the strategies used, the subjects in our sample were divided into three age groups (group 1: 8-9 years; group 2: 10-11 years; group 3: 12-13 years). The nature of the information also attracted our attention. Indeed, Simonnot (2007) and Lecomte (2019) distinguish several types of online information according to the author's intention. They speak of 'misleading content' for falsifications that may be intentional (e.g. propaganda, fake news, etc.) or unintentional (e.g. based on prejudices). They contrast this with "safe information" whose source inspires a certain confidence in the population (people or organisations promoted as referents, libraries, museums, etc.).

Based on the set of variables we have just described, we will provide some answers to a main research question: *What are the online information search strategies of 8 to 13 year old students during three successive online information search tasks?* and to a sub-research question: *Do online search strategies differ according to the age of learners?*

### *Sample*

Three groups of students (N = 260) whose mother tongue is French participated in

our study: (1) 8-9 years old; 96 students; 43 girls, (2) 10-11 years old; 88 students; 42 girls, (3) 12-13 years old; 76 students; 30 girls.

These three groups were made up of non-repeating pupils, without any particular learning disability, from schools located in French-speaking Belgium and were based on the voluntary participation of teachers in the research. None of the teachers reported organising specific online information-seeking activities with their students in the classroom. These were observed in the middle of the school year (February 2020).

Of the 260 students who participated in the online search activities, only 234 were retained for the analysis of their online information-seeking behaviour. Indeed, in order to be able to compare students' behaviour, we only kept the subjects who had completed the entire proposed protocol. Students who stopped participating before completing the three proposed search tasks were not considered in our analyses. As a result, the first task was completed by all 260 participants. In the second task, 12 students did not wish to continue (8 students aged 8-9 and 4 aged 10-11). A further 16 pupils (8 pupils aged 8-9, 7 aged 10-11 and 1 aged 12-13) did not complete the third research activity. The justification for their abandonment was the difficulty of the activity: "it's really too difficult" "I don't want to continue, I can't find the answer". In the end, our sample consisted of 234 students (Figure 2): 80 (35 girls) from group 1; 77 (37 girls) from group 2; 75 (29 girls) from group 3.

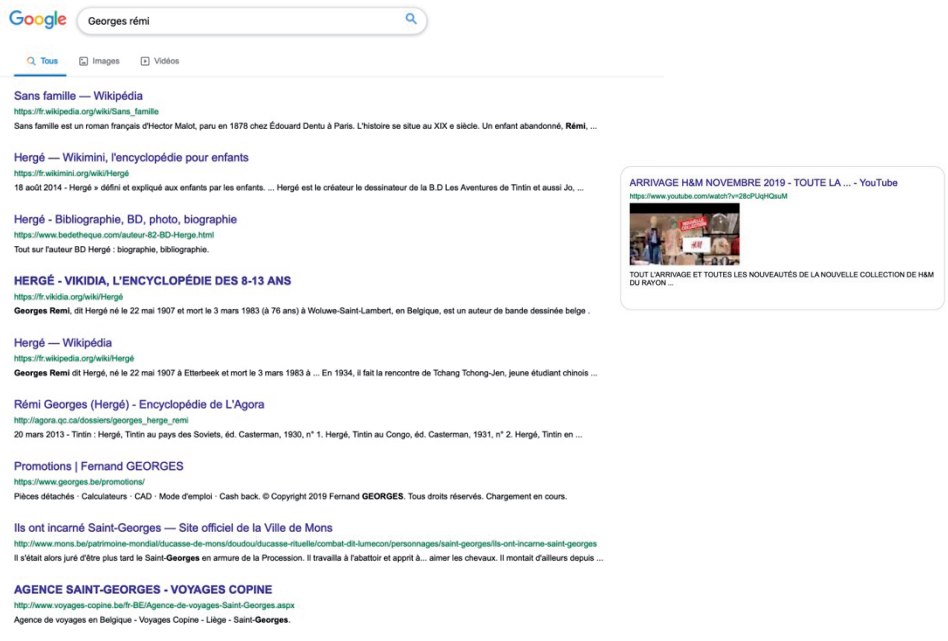
### *Instrumentalization*

In order to answer our research questions, we created the digital environment "Schoolgle", three information retrieval tasks and a coding grid, allowing us to code the observed behaviours.

#### *Schoolgle*

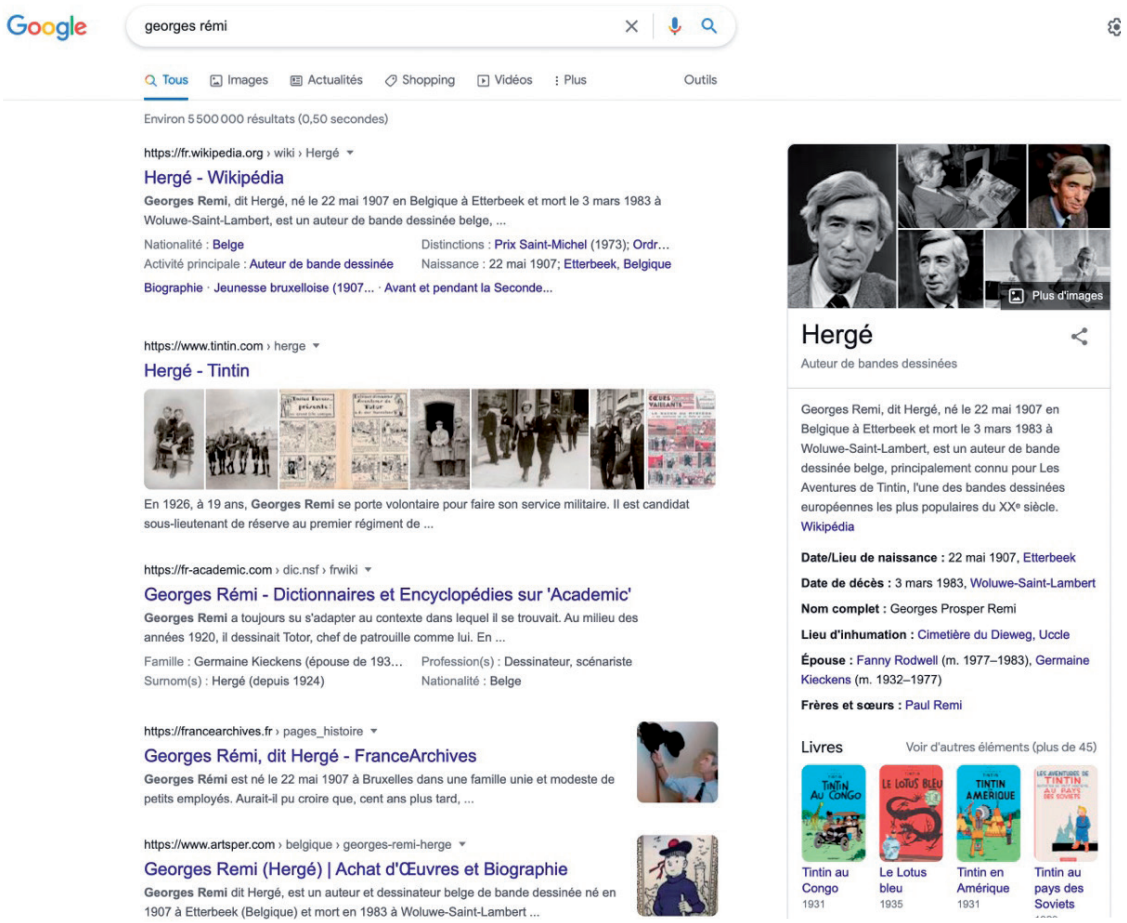
In order to describe students' online behaviours/strategies and to observe differences between the types of content to be read and the ages targeted, we created a mobile application that we called "Schoolgle". This controlled digital environment allowed us to expose each learner to the same search modalities but also to introduce the variables we wanted to test (e.g. bolding links, inserting irrelevant links, providing a Wikipedia link…). In addition, we made sure that this application resembled the Google search engine to the maximum of our technical possibilities (Figure 1 vs Figure 2) given its frequent use (Sullivan, 2015). To do this, we copied the visual aspect of its home page and its results pages, keeping only the types of search that interested us: text, image, and video.

**FIGURE 1**




*Schoolgle interface*

**FIGURE 2**




*Google interface*

Technical construction

In order to keep the environment under control, our application only works offline. Depending on the terms typed by the user, predetermined search results are returned, divided into two parts. Firstly, a list of sites matching the search, and for each one a title and an extract from the site, possibly an image. We obtain these lists by automatically copying the results obtained on the real Google site, whose presentation we also imitate. Secondly, each site included in our results is copied so that the user can visit a replica of it, offline. The copy is made with HTTrack software. We sometimes had to correct the copies of the sites, which do not always behave like the original, and we also

reduced the possible navigation depth on each site. Finally, we created an offline version of the YouTube video viewing page, which displays our videos offline.

Pedagogical construction

According to the requests formulated by the student, a page of results "All", "Images", "Videos" are proposed. The student can then click on these tabs to modify the media to be viewed. The "All" tab allows the student to find information containing all media (text, videos, images), while the other two tabs (as their name indicates) present a specific media.

The list of results of the query, follows the presentation format of the most commonly used search engines. Thus, each reference includes, from top to bottom, the following information: a title, displayed and underlined in blue, corresponding to the title of the web page; an address, displayed in green, corresponding to the URL of the web page; a summary, displayed in black, corresponding to extracts of text from the web page.

Each result list contains a minimum of 8 web page references. The title of each reference includes one of the key words of the question. In these proposals, there is an alternation between thematically relevant web pages to answer the question asked and non-relevant pages. On one of the references (relevant or not), the keyword is typographically marked by a display in bold characters. In each list of queries, there is at least one wikipedia link, one forum link and one social network link. An advertisement, at the top right of the results page, has also been added.

*Coding grid*

Our observation grid is structured around the 5 constituent competences of the IPS-I model. For each stage, cognitive and metacognitive behaviours are defined in the light of the empirical research presented above. In the steps where the use of the tablet was required, technical behaviours were added.

For each of the constituent skills, indicators were defined based on empirical research (top-down approach). For scoring, we used descriptive codes, i.e. it does not imply any interpretation and can be directly linked to live observed behaviours or to recording segments of the tablet. Thus, our scoring system is linked to the frequency of occurrence of sub-skills (Table 1).

*Information search tasks*

The mobile application and the coding grid were therefore used to describe the students' behaviour when conducting an online search. For this purpose, we also designed three information search tasks.

**TABLE 1**

*Coding matrix*

| Search steps | Strategies | Behaviours | Examples of authors |
|---|---|---|---|
| Defining the problem | *Cognitive strategies* | Reading the problem | Walraven et al., 2008 |
| | Metacognitive strategies | Write on the paper | Fleury, 2016 |
| | | Asks questions of the experimenter | Vanderschantz et al., 2014 |
| Search for information | Cognitive strategies | Defines 1 keyword | |
| | | Defines 2 keywords | |
| | | Defines 3 keywords | |
| | | Defines 4 or more keywords | |
| | | Writes a question | |
| | | Copy a sentence from the statement | |
| | | Writes a new sentence | Beaufils, 2003 |
| | | Uses a synonym as a keyword | Jochmann-Mannak et al., 2010 |
| | | Performs a search on another topic | Fleury, 2016 |
| | | Makes one or more spelling mistakes | Druin, 2009 |
| | | Chooses the 1st link in the list | Rouet et al., 2011 |
| | | Selects the 2nd or 3rd link in the list | |
| | | Selects the bold link | Rouet et al., 2011 |
| | | Selects a "social network" link | Salmeron, et al., 2018 |
| | | Choose the Wikipedia link | Fleury, 2016 |
| | | Chooses a relevant link | Boubée, 2008 |
| | | Chooses an irrelevant link | |
| | | Chooses an advertising link | Issa et al., 2011 |
| | | Clicks on all links on the page | epirls, 2016 |
| | | Selects a forum link | Salmeron, et al., 2018 |
| | | Returns to a previously viewed link | Walraven et al., 2008 |
| | | Click on the 'Image' tab | Salmeron, et al., 2018 |
| | | Click on the 'All' tab | |
| | | Click on the 'Videos' tab | |
| | Metacognitive strategies | Modifies search terms | Dumouchel, 2016 |
| | | Ask questions of the experimenter | Vanderschantz et al., 2014 |
| | | Changes the challenge | |
| | | Consults the advertisement | Fleury, 2016 |
| | Technical strategy | Uses Boolean operators | Fournier, 2007 |
| | | Uses proximity operators | |
| | | Uses contractures | |

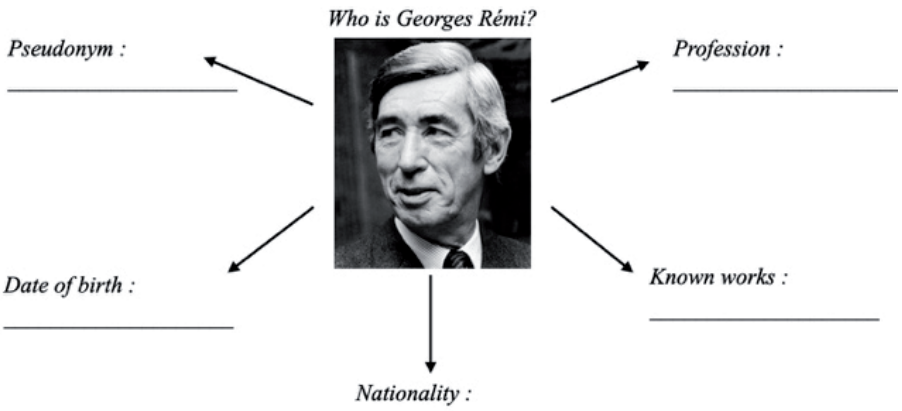
**TABLE 1**

| Search steps | Strategies | Behaviours | Examples of authors |
|---|---|---|---|
| Scan the information | *Cognitive strategies* | Only scans the beginning of the page | Fleury, 2016 |
| | | Scans the whole page | |
| | | Checks reliability: looks at author, date of publication | Gwidzka & Bilal, 2017 |
| | Metacognitive strategies | Goes back to links | Beaufils, 2003 |
| | | Asks questions of the experimenter | Vanderschantz et al., 2014 |
| | | Takes notes | Walraven et al., 2008 |
| | | Consults advertisements | Fleury, 2016 |
| | | Modifies search terms | Vanderschantz et al., 2014 |
| | Technical strategy | Uses search function | |
| | | Bookmarks or favorites | Boubée &Tricot, 2010 |
| Processing information | *Cognitive strategies* | Reads the document | Walraven et al., 2008 |
| | | Checks reliability: looks at author, date of publication | Gwidzka &Bilal, 2017 |
| | | Click on a clickable link in the text | Dinet et al., 2012 |
| | | Clicks on link/picture/video not related to the challenge | Issa et al. 2011 |
| | Metacognitive strategies | Returns to links | Boubée & Tricot, 2010 |
| | | Modifies the terms of the research | |
| | | Asks questions of the experimenter | Vanderschantz et al., 14 |
| | | Takes notes | Walraven et al., 2008 |
| | | Consults advertising | Issa et al. 2011 |
| | Technical strategy | Uses search function | Vanderschantz et al., 14 |
| | | Bookmarks or favorites | Boubée & Tricot, 2010 |
| Organising information | *Cognitive strategies* | Copies information word by word | Peraya & Peltier, 2011 |
| | | Reformulates information | Salmeron, 2016 |
| | | Cites sources | Kiili et al., 2020 |
| | Metacognitive strategies | Returns to links | Boubée & Tricot, 2010 |
| | | Asks questions | Vanderschantz et al., 14 |

According to Dumouchel (2016) and Fournier (2007), there are different levels of difficulty in information retrieval tasks. Therefore, we have chosen to propose 3 search tasks related to 3 different themes: namely "Georges Rémi", "Nosebleed" and "Dahu". Our three themes therefore consider a different type of content, progressive complexity

and processes of understanding. Task 1 "Georges Rémi" (Figure 3) is considered to be of low complexity as it does not require any transformation of the information to answer the proposed question. The pupils directly find the information requested on the link consulted (find and retrieve information).

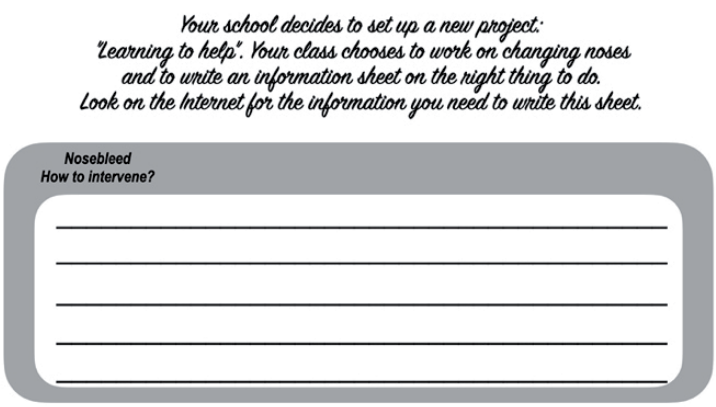
**Figure 3**




*Task 1*

Task 2 "Nosebleed" (Figure 4) is said to be of "moderate complexity" as it requires a summary of the information. Not everything that is read is important to meet the information need. Nevertheless, the confrontation of several sources enriches the answer (finding, taking information, confronting it with other sources and summarising it).

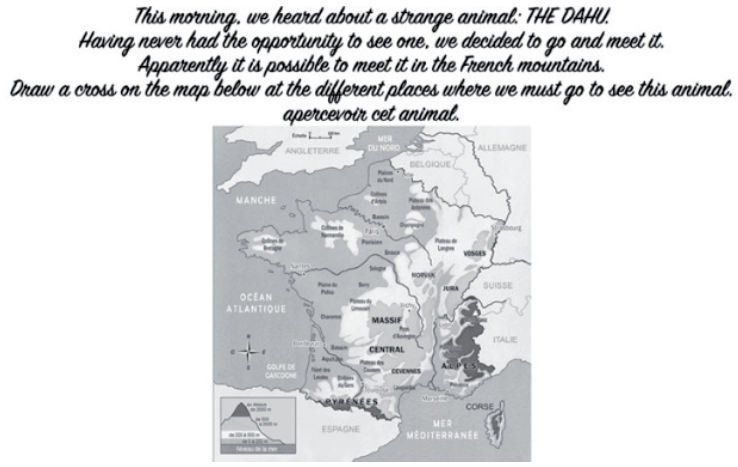
**Figure 4**




*Task 2*

The last task proposed (task 3: Dahu) is the most complex task (Figure 5). It requires the information found to be evaluated, transformed and confronted in order to answer the question correctly (retrieve, collect information, interpret, integrate and examine and evaluate the content).

**FIGURE 5**




*Task 3*

Thus, after having produced a query to answer a question posed, the student was led to select one or more references from a list of references predefined by the experimenter and to process the information to answer each of the three questions. Their entire search procedure was recorded via the tablet. When the experimental device was being carried out, the experimenter took care not to stay next to the pupil so as to allow them to go to the links they wished even if they were not related to the proposed research tasks. This test was carried out outside a classroom context.

The questions were presented on an A4 sheet of paper, with sufficient space left between each question for them to write down the answer(s). The time allowed to complete the activitý was free. They proceeded at their own pace. They all started with challenge 1 and were allowed to change activity/question whenever they wanted. Students were placed so that they could not see other students' screens.

## RESULTS

This usage-level data collection allows us to identify the processes that 8–13-year-old students engage in and the decisions they make when conducting online searches.

### *What are the online information search strategies of 8–13-year-old students?*

To answer the main research question, we rely on the descriptive analysis of the average frequencies of occurrence of the different strategies identified in our coding grid. In order to structure our analyses, they are divided according to the five components of the IPS-I model.

*Defining the problem*

**TABLE 2**

*Average frequencies of occurrence of the sub-skill "Define the problem"*

| Task1 | | Gr 1 - 8-9 years N=80 | | | Gr 2 - 10-11 years N=77 | | | Gr 3 - 12-13 years N=75 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Task1 | Task2 | Task3 | Task1 | Task2 | Task3 | Task1 | Task2 | Task3 |
| Reading the problem | M<br>σ | 1,21<br>0,54 | 1,05<br>0,31 | 1,04<br>0,42 | 1,04<br>0,15 | 1,01<br>0,27 | 1,06<br>0,35 | 1,04<br>0,16 | 1,00<br>0,26 | 1,05<br>0,35 |
| Write on the paper | M<br>σ | - | - | - | - | - | - | - | - | - |
| Asks questions of the experimenter | M<br>σ | 0,83<br>0,40 | 0,34<br>0,32 | 0,15<br>0,19 | 0,08<br>0,11 | 0,14<br>0,31 | 0,05<br>0,21 | - | 0,05<br>0,30 | - |
| Change the challenge | M<br>σ | - | - | - | - | - | - | - | - | - |

The analysis of Table 2 informs us that the participants read the problem posed at least once regardless of the research task requested (frequency of occurrence ranging from 1.00 to 1.21). During this first stage, several students needed clarification of certain vocabulary terms and therefore requested our intervention (Asking the experimenter questions: average frequency of occurrence ranging from 0.05 to 0.83). However, none of the students highlighted the important elements of the problem posed, by annotating or highlighting on their paper. At this stage, none of the students decided to change their challenge. As shown in Table 2, there was no frequency of occurrence for these two strategies.

*Searching for information*

**TABLE 3**

*Average frequencies of occurrence of the sub-competence "Search for information"*

| | | | Gr 1 - 8-9 years N=80 | | | Gr 2 - 10-11 years N=77 | | | Gr 3 - 12-13 years N=75 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Task 1 | Task 2 | Task 3 | Task 1 | Task 2 | Task 3 | Task 1 | Task 2 | Task 3 |
| Enter a query | Defines 1 keyword | M | 0,14 | 0,11 | 0,18 | - | 0,03 | 0,13 | - | - | 0,34 |
| | | σ | 0,34 | 0,27 | 0.33 | | 0,15 | 0,29 | | | 0,35 |
| | Defines 2 keywords | M | 0,58 | 0,09 | 0,59 | 0,91 | - | 0,49 | 1,00 | - | 0,49 |
| | | σ | 0,50 | 0,15 | 0.44 | 0,50 | | 0,47 | 0,49 | | 0,48 |
| | Defines 3 keywords | M | 0,48 | 0,08 | 0,11 | 0,53 | 0,19 | 0,30 | 0,84 | 0,18 | 0,32 |
| | | σ | 0,44 | 0,14 | 0.34 | 0,46 | 0,35 | 0,37 | 0,48 | 0,31 | 0,38 |
| | Defines 4 or more keywords | M | 1,68 | 0,85 | 0,66 | 2,39 | 1,14 | 1,22 | 1,36 | 1,01 | 1,34 |
| | | σ | 0,49 | 0,44 | 1,23 | 0,48 | 0,48 | 0,50 | 0,48 | 0,46 | 0,50 |
| | Copy a sentence from the statement | M | 0,48 | 0,23 | 0,03 | 0,47 | 0,23 | 0,08 | 0,34 | 0,20 | 0,08 |
| | | σ | 0,45 | 0,13 | 0,10 | 0,43 | 0,37 | 0,23 | 0,42 | 0,38 | 0,22 |
| | Writes a question | M | 0,89 | 0,45 | 0,53 | 0,78 | 0,90 | 1,01 | 0,50 | 0,66 | 0,70 |
| | | σ | 0,49 | 1,17 | 0,88 | 0,48 | 0,50 | 0,50 | 0,47 | 0,50 | 0,49 |
| | Writes a new sentence | M | 0,28 | 0,11 | 0,20 | 0,08 | 0,16 | 0,18 | 0,15 | 0,09 | 0,30 |
| | | σ | 0,33 | 0,21 | 0,47 | 0,15 | 0,32 | 0,35 | 0,27 | 0,29 | 0,35 |
| | Makes spelling mistakes | M | 0,38 | 0,21 | 0,40 | 0,60 | 0,51 | 0,40 | 0,34 | 0,12 | 0,31 |
| | | σ | 0,43 | 0,12 | 0,37 | 0,44 | 0,38 | 0,41 | 0,43 | 0,36 | 0,40 |
| | Uses Boolean operators | M | - | - | - | - | - | - | 0,03 | 0,03 | 0,01 |
| | | σ | | | | | | | 0,21 | 0,21 | 0,19 |
| | Uses proximity operators | M | - | - | - | - | - | - | 0,05 | - | 0,01 |
| | | σ | | | | | | | 0,23 | | 0,19 |
| | Uses contractures | M | - | - | - | - | - | - | - | - | - |
| | | σ | | | | | | | | | |
| Choose a link to consult | Click on the "All" tab | M | 5,89 | 2,65 | 3,04 | 4,40 | 2,19 | 2,26 | 3,27 | 2,30 | 2,64 |
| | | σ | 1,46 | 1,11 | 1,99 | 1,56 | 0,98 | 1,09 | 1,12 | 1,21 | 1,44 |
| | Click on the "Image" tab | M | 0,58 | 0,13 | 0,16 | 0,60 | 0,09 | 0,18 | 0,30 | 0,05 | 0,42 |
| | | σ | 0,43 | 0,09 | 0,29 | 0,44 | 0,25 | 0,35 | 0,26 | 0,24 | 0,38 |
| | Click on the "Videos" tab | M | 0,19 | 0,03 | 0,14 | - | - | - | - | - | - |
| | | σ | 0,16 | 0,01 | 0,27 | | | | | | |
| | Choose the 1st link in the list | M | 1,18 | 0,65 | 0,80 | 1,04 | 0,65 | 0,61 | 0,95 | 0,61 | 0,69 |
| | | σ | 0,50 | 0,98 | 0,98 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 |
| | Choose the 2nd or 3rd link in the list | M | 0,76 | 0,39 | 0,33 | 0,79 | 0,25 | 0,29 | 0,40 | 0,43 | 0,38 |
| | | σ | 0,48 | 0,37 | 0,50 | 0,59 | 0,50 | 0,34 | 0,48 | 0,50 | 0,50 |
| | Choose the link in bold | M | 0,74 | 0,44 | 0,15 | 0,51 | 0,23 | 0,05 | 0,42 | 0,31 | 0,05 |
| | | σ | 0,50 | 0,33 | 0,31 | 0,45 | 0,36 | 0,15 | 0,48 | 0,43 | 0,21 |

**TABLE 3**

| | | | Gr 1 - 8-9 years N=80 | | | Gr 2 - 10-11 years N=77 | | | Gr 3 - 12-13 years N=75 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Task 1 | Task 2 | Task 3 | Task 1 | Task 2 | Task 3 | Task 1 | Task 2 | Task 3 |
| Choose a link to consult | Choose a "Social networks" link | M | - | - | - | - | - | - | - | - | - |
| | | σ | | | | | | | | | |
| | Choose the link Wikipedia, Wikimini | M | 2,70 | 0,15 | 0,64 | 2,66 | - | 0,44 | 1,95 | - | 0,66 |
| | | σ | 1,42 | 0,10 | 0,80 | 0,45 | | 0,46 | 0,42 | | 0,48 |
| | View an advertising link | M | 0,13 | 0,04 | 0,19 | - | - | 0,05 | - | - | 0,09 |
| | | σ | 0,31 | 0,00 | 0,33 | | | 0,18 | | | |
| | View the advertisement on the search page | M | - | - | - | - | - | - | - | - | - |
| | | σ | | | | | | | | | |
| | Choose a forum link | M | - | 0,60 | - | - | 0,87 | - | - | 0,68 | - |
| | | σ | | 0,10 | | | 0,50 | | | 0,50 | |
| | Choose a relevant link | M | 3,31 | 1,59 | 1,96 | 2,58 | 1,14 | 1,06 | 1,97 | 1,43 | 1,59 |
| | | σ | 0,50 | 0,45 | 0,67 | 0,47 | 0,50 | 0,49 | 0,41 | 0,50 | 0,50 |
| | Selects an irrelevant link | M | 2,51 | 1,04 | 1,35 | 1,78 | 1,01 | 1,36 | 1,18 | 0,86 | 1,30 |
| | | σ | 1,46 | 0,95 | 1,09 | 0,50 | 0,50 | 0,18 | 0,49 | 0,49 | 0,49 |
| | Returns to a previously viewed link | M | 1,58 | 0,44 | 0,75 | 1,21 | 0,38 | 0,43 | 0,46 | 0,14 | 0,36 |
| | | σ | 0,50 | 0,34 | 0,55 | 0,47 | 0,29 | 0,44 | 0,34 | 0,22 | 0,25 |
| | Modifies the search terms | M | 2,19 | 0,26 | 0,78 | 2,88 | 0,47 | 1,25 | 2,24 | 0,23 | 1,64 |
| | | σ | 0,49 | 0,12 | 1,45 | 0,47 | 0,35 | 0,50 | 0,47 | 0,35 | 0,49 |
| | Asks the experimenter questions | M | 0,44 | 0,30 | - | - | - | - | - | - | - |
| | | σ | 0,32 | 0,21 | | | | | | | |
| | Changes the challenge | M | 0,34 | 0,29 | 0,09 | 0,23 | 0,17 | 0,09 | 0,07 | 0,08 | 0,01 |
| | | σ | 0,32 | 0,20 | 0,15 | 0,39 | 0,35 | 0,14 | 0,27 | 0,35 | 0,17 |

To enter a query in the search bar (Table 3), learners enter one or more keywords or they write a sentence (question or sentence from the problem or not). The analysis of the Table allows us to see that the sub-skill most often implemented by our sample is the definition of "4 or more keywords" whatever the age or the challenge (f Defines 4 or more keywords varies from 0.66 to 2.39). Queries with "one keyword" and writing "a sentence that is not included in the problem" are the least used (f Defines 1 keyword varies from 0.03 to 0.34; f Writes a new sentence varies from 0.09 to 0.30). In the various queries written by the students, we note the presence of spelling errors, regardless of their age (f Spells from 0.12 to 0.60).

Few students used technical strategies. Only two students in group 3 (12-13 years-

old) used the operators 'and' (Boolean operator) and ' " " ' (proximity operator) several times to refine their spelling (proximity operator) to refine their keywords.

When they have to choose a link to consult, they turn more frequently to the 'All' tab offered by Google. This links page (where all media are present) is consulted on average more than twice per search task (between 2.19 and 5.89 times). The "Image" page is also chosen but to a lesser extent (on average less than once: f Click on the "Image" tab from 0.05 to 0.58). The "Videos" page, on the other hand, is only very rarely examined (f Click on the "Video" tab from 0.04 to 0.19) and only by 8-9 years-old.

When selecting links, it seems that learners favour so-called heuristic cues to make their choice. Indeed, learners frequently opt for the "first link" in the list (f Chooses the 1st link in the list from 0.61 to 1.18). The second or third links in the list are also selected (f Chooses the 2nd or 3rd link in the list from 0.25 to 0.79) as well as the link we chose to put in bold (f Chooses the bold link in the list from 0.05 to 0.74).

If we look at the nature of the links they select, we notice that the Wikipedia link (f Chooses the Wikipedia, wikimini from 0.15 to 2.66) is often consulted. However, it is very rarely consulted for search task 2 (no frequency of appearance for groups 2 and 3; f Choose Wikipedia, wikimini (group 1) = 0.15). Advertising links were rarely selected by our sample, with a predominance for search task 3 (f Chooses an advertising link from 0.04 to 0.19). Forum-type links were only used in task 2 (f Chooses a forum link (task 2) from 0.60 to 0.87). In contrast, none of the students directed themselves to resources that were placed on the results page to distract them (Facebook page and an advertisement on the right side of the results page).

Our sample more often consulted relevant and reliable links (f Chooses a relevant link from 1.06 to 3.31) that met their information needs than links that were not (f Chooses an irrelevant link from 0.86 to 2.51). It should also be noted that learners return to links they have already consulted (f Returns to a previously consulted link from 0.14 to 1.58). We hypothesise that they do not realise this or that they want to re-read the information they have already consulted.

In terms of metacognitive strategies, only a few students still ask questions. Indeed, the average frequencies of occurrence are only present for group 1 (f Poses questions to the experimenter from 0.30 to 0.44). When this is the case, the requests are oriented towards technical questions (use of the keyboard). It happens that at this point in the search, some learners of all ages modify their request because they feel that it does not correspond to their needs (f Modifies the search terms from 0.22 to 2.88). Finally, few students decide to change their challenge to see what is asked in the other challenges or to go back to one of them that they have not completed (f Change challenge from 0.01 to 0.34).

*Scanning the information*

**TABLE 4**

*Frequency of occurrence of the sub-skill "Scanning information"*

| | | Gr 1 - 8-9 years N=80 | | | Gr 2 - 10-11 years N=77 | | | Gr 3 - 12-13 years N=75 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Task 1** | **Task 2** | **Task 3** | **Task 1** | **Task 2** | **Task 3** | **Task 1** | **Task 2** | **Task 3** |
| Scan the top of the page | M | 2,34 | 1,00 | 1,11 | 1,73 | 0,78 | 0,83 | 0,85 | 0,59 | 0,53 |
| | σ | 0,49 | 0,98 | 0,56 | 0,50 | 0,47 | 0,46 | 0,50 | 0,47 | 0,46 |
| Scans the whole page | M | 0,74 | 0,36 | 0,71 | 0,48 | 0,14 | 0,25 | 0,43 | 0,31 | 0,96 |
| | σ | 0,48 | 0,11 | 0,50 | 0,41 | 0,31 | 0,38 | 0,41 | 0,37 | 0,43 |
| Check reliability: look at author, date of publication | M | - | - | - | - | - | - | - | - | - |
| | σ | | | | | | | | | |
| Goes back to the links | M | 2,94 | 1,26 | 1,64 | 1,95 | 0,84 | 0,87 | 1,11 | 0,86 | 1,20 |
| | σ | 0,47 | 1,11 | 0,99 | 0,50 | 0,47 | 0,48 | 0,49 | 0,48 | 0,48 |
| Ask questions to the experimenter | M | - | - | - | - | - | - | - | - | - |
| | σ | | | | | | | | | |
| Modifies search terms | M | 0,25 | - | 0,14 | 0,26 | 0,05 | 0,12 | 0,08 | - | 0,11 |
| | σ | 0,12 | | 0,17 | 0,31 | 0,14 | 0,11 | 0,10 | | 0,06 |
| Takes notes | M | - | - | - | - | - | - | - | - | - |
| | σ | | | | | | | | | |
| Uses search function | M | - | - | - | - | - | - | - | - | - |
| | σ | | | | | | | | | |
| Bookmarks or favourites | M | - | - | - | - | - | - | - | - | - |
| | σ | | | | | | | | | |

For students who scroll the page, they scan the whole page less often ($f_{\text{Scan the whole page}}$ from 0.14 to 0.96) than just the first few lines ($f_{\text{Scan the beginning of the page}}$ from 0.53 to 2.34). In this step, no students take information about the reliability of the document they are consulting. And, no questions are asked.

After scanning the document, we notice that some of the students return to the links page ($f_{\text{Return to links page}}$ from 0.86 to 2.94) to select another one. However, few of them return to their query (words encoded in the search bar) in order to modify it.

We also observe that no technical strategy is implemented. Students do not use the search function (Crtl+f) to quickly find a word. Nor do they bookmark web pages that they think are relevant to make them easier to find when processing information.

*Processing information*

**TABLE 5**

*Frequency of occurrence of the sub-competence "Processing information"*

| | | Gr 1 - 8-9 years N=80 | | | Gr 2 - 10-11 years N=77 | | | Gr 3 - 12-13 years N=75 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Task 1** | **Task 2** | **Task 3** | **Task 1** | **Task 2** | **Task 3** | **Task 1** | **Task 2** | **Task 3** |
| Read a page | M<br>σ | 2,55<br>0,39 | 1,50<br>0,33 | 1,68<br>0,44 | 2,27<br>0,43 | 1,35<br>0,44 | 1,43<br>0,50 | 1,91<br>0,37 | 1,46<br>0,43 | 1,43<br>0,49 |
| Check the reliability: look at the author, the date of publication | M<br>σ | - | - | - | - | - | - | - | - | - |
| Click on a clickable link in the text | M<br>σ | 0,26<br>0,24 | 0,16<br>0,09 | 0,40<br>0,23 | 0,19<br>0,33 | 0,03<br>0,18 | 0,21<br>0,25 | 0,12<br>0,33 | - | 0,14<br>0,29 |
| Go back to links | M<br>σ | 1,58<br>0,45 | 0,44<br>0,32 | 0,75<br>0,54 | 1,65<br>0,50 | 0,99<br>0,50 | 0,79<br>0,48 | 1,50<br>0,48 | 1,09<br>0,49 | 1,07<br>0,49 |
| Modify search terms | M<br>σ | 0,23<br>0,14 | 0,06<br>0,07 | 0,13<br>0,17 | 0,43<br>0,38 | 0,09<br>0,11 | 0,12<br>0,29 | 0,15<br>0,26 | 0,01<br>0,11 | 0,05<br>0,06 |
| Ask questions of the experimenter | M<br>σ | - | - | - | - | - | - | - | - | - |
| Uses the search function | M<br>σ | - | - | - | - | - | - | 0,14<br>0,29 | - | - |
| Takes notes | M<br>σ | - | - | - | - | - | - | - | - | - |
| Bookmarks or favourites | M<br>σ | - | - | - | - | - | - | - | - | - |

On average, learners process the selected page at least once in depth (f Lis a page from 1.43 to 2.55). Very few activate a "clickable text" link to get additional information (f Click on a text link from 0.03 to 0.40). It should also be noted that none of the students assess the reliability or credibility of the information they are consulting throughout the process. They do not ask about the author of the article or the date of publication. Some go back to return to the links page (f Return to links page from 0.44 to 1.65) or to change their query (f Change search terms from 0.01 to 0.43) and perform a new search. None of the students took notes to keep track of important information or to start writing an answer. Nor do they use bookmarks or favourites to highlight pages of interest and avoid revisiting them. And only two 12-13 year olds (the same as those who used operators) use the search function (Ctrl+F) to identify the information they want more quickly.

*Organising information*

**TABLE 6**

*Frequency of occurrence of the sub-skill "Organising information"*

| | | Gr 1 - 8-9 years N=80 | | | Gr 2 - 10-11 years N=77 | | | Gr 3 - 12-13 years N=75 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Task 1** | **Task 2** | **Task 3** | **Task 1** | **Task 2** | **Task 3** | **Task 1** | **Task 2** | **Task 3** |
| Copies information word for word | M<br>σ | 2,01<br>0,35 | 0,84<br>0,23 | 0,60<br>0,21 | 2,21<br>0,36 | 1,16<br>0,41 | 0,58<br>0,50 | 2,18<br>0,33 | 1,51<br>0,44 | 0,64<br>0,50 |
| Rephrases information | M<br>σ | - | 0,23<br>0,15 | 0,11<br>0,17 | - | 0,05<br>0,21 | 0,22<br>0,38 | - | 0,22<br>0,35 | 0,28<br>0,38 |
| Cites sources | M<br>σ | - | - | - | - | - | - | - | - | - |
| Goes back to links | M<br>σ | 0,08<br>0,14 | 0,08<br>0,03 | 0,04<br>0,10 | - | - | - | - | - | - |
| Asks questions | M<br>σ | - | - | - | - | - | - | - | - | - |
| Writes a draft | M<br>σ | - | - | - | - | - | - | - | - | - |

The most used strategy is copying information word by word (f Copies information word by word from 0,58 to 1.65). Thus, they transcribe word by word the information collected more often than they reformulate it (f Reformulates the information from 0.05 to 0.28). The students do not think of doing a draft to structure the different information collected and none of them cite their source in the finished product. At the end of the research process, some young students decide to go back to the links page (f Return to links from 0.04 to 0.08) to reset the whole research process.

*Number of subjects*

Table 7 shows that the number of subjects differs for several stages of the research. Thus, we see that not all learners complete the entire research process and thus the 5 stages of the Brand-Gruwel et al. (2009).

**TABLE 7**

*Number of students for each stage of online research*

| | Gr 1 - 8-9 years N=80 | | | Gr 2 - 10-11 years N=77 | | | Gr 3 - 12-13 years N=75 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Task 1 N | Task 2 N | Task 3 N | Task 1 N | Task 2 N | Task 3 N | Task 1 N | Task 2 N | Task 3 N |
| Define the problem | 80 | 80 | 80 | 77 | 77 | 77 | 75 | 75 | 75 |
| Search for information | 80 | 80 | 80 | 77 | 77 | 77 | 75 | 75 | 75 |
| (Enter a query) | **68** | **68** | **68** | **71** | **71** | **71** | **71** | **71** | **71** |
| Search for information | **35** | **35** | **35** | **37** | **37** | **37** | **56** | **56** | **56** |
| (Choose a link) | 80 | 80 | 80 | 77 | 77 | 77 | 75 | 75 | 75 |
| Scan the information | **79** | **76** | **69** | **77** | **76** | **70** | **75** | **75** | **73** |
| Processing information | 80 | 80 | 80 | 77 | 77 | 77 | 75 | 75 | 75 |
| Organising information | 80 | 80 | 80 | 77 | 77 | 77 | 75 | 75 | 75 |

After formulating their query in the search bar, 90.6% (N= 212) of the students click on a link in the results page. The remaining 9.4% (N=22) (12 from group 1, 6 from group 2 and 4 from group 3) do not choose a link and process the information directly from the query page using the titles and descriptions as sources of information (Table 8).

Once the link is selected, not all students scan the page to check whether the information on the page is relevant to their search, i.e. they do not scroll down the page. Only 35 students in group 1 (43.75%), 37 students in group 2 (48.05%) and 56 students in group 3 (46.77%) go through this step.

However, it can be seen that not all learners answer the problem posed. Some write "/" (which means "no answer - I'll stop here - I don't know?") as an answer and therefore stop the process without completing this step. It can be seen that the further into the research tasks, the more learners do not enter an answer. For task 1, only one 8–9-year-old pupil did not obtain any frequency of appearance for the information organisation stage. For task 2, this was the case for 4 learners in group 1 and 1 learner in group 2. Finally, for search task 3, 11 subjects from 8-9 year olds, 7 from 10-11 year old and 2 from the group of 11-12 year old students.

***Do online search strategies differ according to the age of the learners?***

To answer this question, we relied on the p-value analysis of the Kruskall-Wallis tests for the comparison of the groups shown in Table 8.

**TABLE 8**

*Comparison of strategies by age group (P value)*

| | **Task 1** | **Task 2** | **Task 3** |
|---|---|---|---|
| Defining the problem | | | |
| Reading the problem | 0.005 | 0.085 | 0.829 |
| Write on the paper | - | - | - |
| Asks questions of the experimenter | <.001 | <.001 | 0.033 |
| Change the challenge | - | - | - |
| **Searching for information** | | | |
| Defines 1 keyword | 0.002 | 0.015 | **0.059** |
| Defines 2 keywords | 0.002 | 0.022 | **0.412** |
| Defines 3 keywords | 0.001 | **0.140** | 0.007 |
| Defines 4 or more keywords | **0.062** | **0.146** | <.001 |
| Copy a sentence from the statement | **0.211** | **0.993** | **0.400** |
| Writes a question | **0.141** | 0.004 | 0.018 |
| Writes a new sentence | **0.228** | **0.380** | **0.933** |
| Uses Boolean operators | **0.119** | **0.119** | **0.346** |
| Uses proximity operators | **0.119** | - | **0.346** |
| Uses contractures | - | - | - |
| Makes spelling mistakes | **0.958** | **0.984** | **0.657** |
| Click on the "All" tab | **0.656** | **0.338** | **0.546** |
| Click on the "Image" tab | **0.114** | **0.079** | **0.244** |
| Click on the "Videos" tab | **0.538** | **0.189** | **0.092** |
| Choose the 1st link in the list | **0.130** | **0.057** | **0.074** |
| Choose the 2nd or 3rd link in the list | **0.102** | **0.895** | **0.853** |
| Choose the link in bold | **0.140** | **0.321** | **0.458** |
| Choose a "Social networks" link | - | - | - |
| Choose the link Wikipedia, Wikimini | <.001 | **0.485** | 0.028 |
| View an advertising link | - | **0.056** | - |
| View the advertisement on the search page | - | - | - |
| Choose a forum link | **0.103** | **0.187** | 0.412 |
| Choose a relevant link | **0.237** | **0.201** | 0.005 |
| Selects an irrelevant link | **0.105** | **0.150** | 0.148 |
| Returns to a previously viewed link | **0.384** | **0.749** | <.001 |
| Modifies the search terms | <.001 | <.001 | **0.070** |
| Asks the experimenter questions | <.001 | 0.010 | **0.175** |
| Changes the challenge | 0.002 | 0.015 | 0.039 |

**TABLE 8**

*Comparison of strategies by age group (P value)*

| **Scanning the information** | | | |
|---|---|---|---|
| Scan the top of the page | 0.036 | **0.394** | **0.314** |
| Scans the whole page | 0.030 | **0.084** | 0.007 |
| Goes back to the links | **0.021** | **0.229** | **0.510** |
| Modifies search terms | **0.278** | **0.134** | **0.902** |
| **Processing information** | | | |
| Read a page | **0.443** | **0.117** | **0.404** |
| Click on a clickable link in the text | **0.759** | **0.385** | **0.189** |
| Go back to links | **0.051** | **0.267** | **0.275** |
| Modify search terms | **0.268** | **0.146** | **0.533** |
| Uses the search function | **0.084** | **0.054** | **0.623** |
| **Organising information** | | | |
| Copies information word for word | **0.971** | 0.001 | **0.394** |
| Rephrases information | **0.336** | 0.004 | 0.028 |
| Goes back to links | **0.837** | **0.837** | **0.190** |

Table 8 shows that for the majority of the sub-skills performed by our sample, the strategies used by our three age groups are seen as identical. Indeed, a large proportion of the p-values are insignificant. Nevertheless, even if they are few in number, differences are perceived on certain sub-skills, and it is these that are explained below.

When reading the problem, only in task 1 do the three groups show different behaviours. The descriptive analysis shows that the youngest group read the problem the most (1.21 in Table 2). They are also the ones who ask questions most frequently, and this for each challenge. Indeed, the inferential analysis shows significant p-values for each task and the descriptive analysis indicates that the 8–9-year-old groups have the highest frequencies.

The same observation applies to the "Search for information" stage, with Table 8 showing significant differences for the encoding of key words and for metacognitive strategies. The descriptive analysis carried out previously (Table 3) shows us once again that it is the youngest students who encode keywords most often and who make numerous switches between the results pages, the keywords and the documents to be read (and this for each search task).

For the scanning stage, the difference is in scrolling. The youngest group scrolled more frequently than the other groups at the beginning of the activity (task 1), while the oldest group did so more frequently at the end of the activity (task 3).

Finally, we observe differences between the groups for the behaviours "Copy information word by word" and "Rephrase information". It seems that, for task 2, the older the student, the more he or she copies the information found. The same is true for task 3, where older students rephrase the information more than others do.

To confirm these findings, we carry out Post Hoc Tests for each task performed. The latter informs us that there are no significant differences between our three age groups over the whole research process.

**TABLE 9**

*Post Hoc Test Comparisons (P value)*

| | Task 1 | Task 2 | Task 3 |
|---|---|---|---|
| Group 1 (8-9 years) vs Group 2 (10-11 years) | 0.811 | 0.654 | 0. 785 |
| Group 1 (8-9 years) vs Group 3 (12-13 years) | 0.238 | 0.489 | 0.254 |
| Group 2 (10-11 years) vs Group 3 (12-13 years) | 0.571 | 0.897 | 0.908 |

In summary, the inferential analyses show that the strategies used by our three age groups can be considered statistically identical. Differences only appear in certain sub-skills. The descriptive analysis allows us to observe that when these differences are present, it is the youngest students who adopt a different behaviour, showing higher frequencies of appearance of the strategy.

### *Visual synthesis*

This descriptive analysis identifies the processes in which three age groups of students engage and the decisions made in three online search tasks.

These different results have been schematised in a synthetic model where the strategies, the different age groups and the three challenges have been materialised in sticks (Figure 6). Thus, the horizontal sticks represent the challenges; the colour strata illustrate the groups; the size of the sticks shows the attempts; the arrows indicate the possibilities of chronological advancement in the search steps.

In Figure 6:

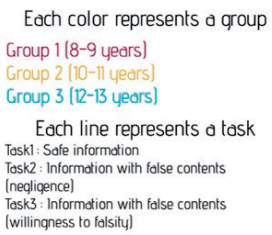
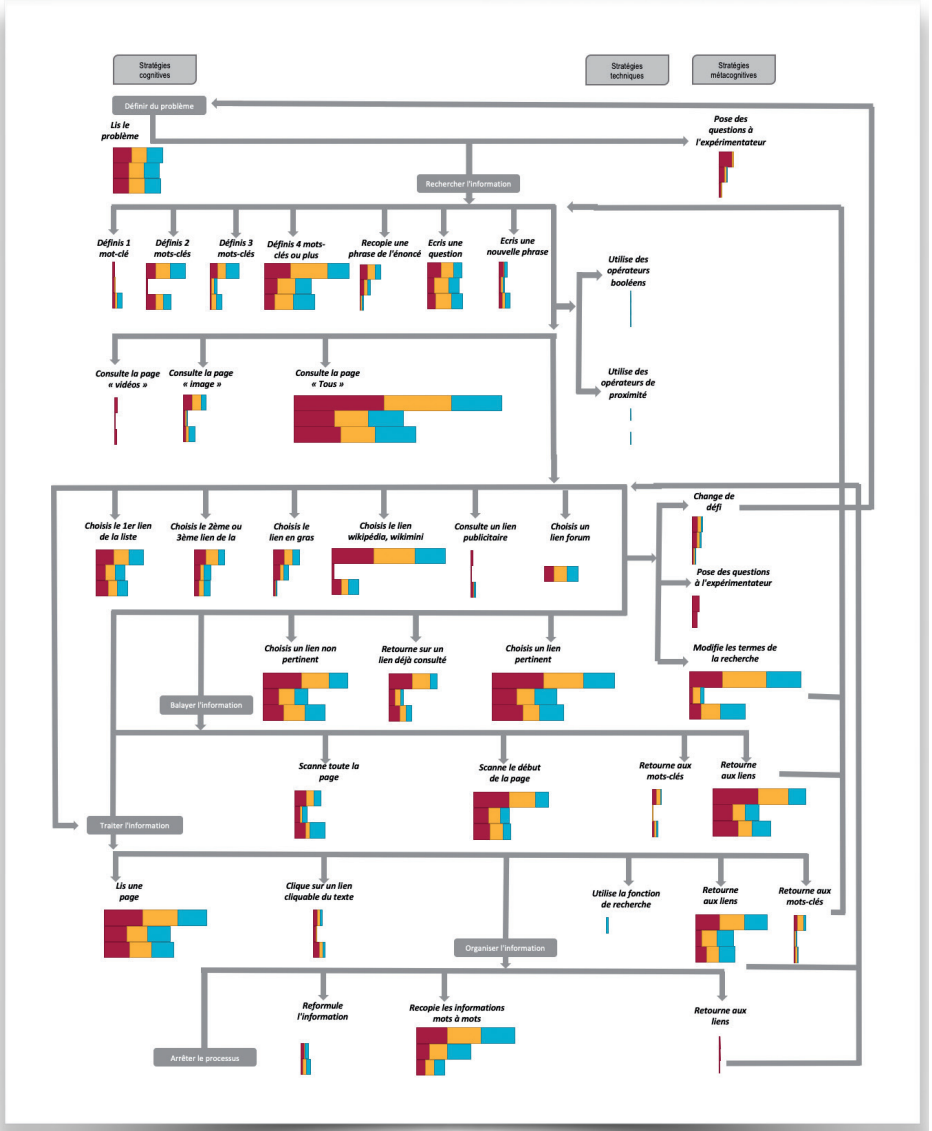


**FIGURE 6**




*Visual synthesis*

## DISCUSSION

The aim of our research was to determine the strategies employed by young users (8 to 13 years old) when searching for information on the Internet. The experimentation

carried out confirmed our initial hypothesis that the students use strategies similar to those of novices in searching for information online (Fleury, 2016; Gwidzka & Bilal, 2017; Vanderschantz et al., 2014). It also allowed us to bring out several interesting findings.

Firstly, the results show that the IPS-I model (Brand-Gruwel et al., 2009) can be applied to the vast majority of our sample, even though the model was originally designed to analyse the behaviour of adults. Nevertheless, not all students follow the five competences that make up the model. Some of them do not click on any links and process the information directly in the link descriptions on the query page. Others do not scan the information beforehand to see if it meets their needs. In addition, some students, despite having completed the whole process, do not find an answer to the question and therefore do not complete the last step (organising the information). Some students also do not carry out all the regulatory activities provided for in the model. Indeed, none of the students evaluate the relevance of the information selected from the Internet nor do they structure the information gathered throughout their research (note taking, answer plan, bookmarks to mark an interesting page). However, our results also confirm that the IPS-I process is not to be perceived as a linear process, but as an iterative one (Brand-Gruwel et al., 2009). Subjects, regardless of age or challenge, often went backwards. After an initial search, they either selected a site from the list of results or adjusted their search term and started a new search. A lot of backtracking is also done when processing information. If students followed a "define-search-scan-process-organise" sequence, the frequencies observed for each of the skills would be identical. Since the frequencies of the "search" and "process" stages are higher, it can be assumed that several iterations are performed between these two stages. This finding confirms the results of Fleury (2016) who mentions a rather exploratory navigation for young students who opt for trial-and-error oriented strategies.

In accordance with the literature, students do not select the information to be consulted in a reasoned manner. They use many keywords (Rouet et al., 2011) or copy the question they are asked to introduce their query (Vanderschantz et al., 2014). Their reading of menus is cursory and they often select references marked by heuristic cues such as position in the list or different typography (Rouet et al., 2011). They also make extensive use of word-for-word copying of information found online (Rinck & Mansour, 2013). It should also be noted that they showed no particular signs of distraction during their research.

It also appears that the students have only a very moderate command of the technical skills involved in online research. Several young students needed help to validate their keyword and to navigate from page to page. It is also noticeable that some never activated a clickable link, presumably due to a lack of knowledge of this hypertext reading process. Finally, only two students used operators to refine their search. Our results therefore confirm a difficulty in formulating queries and manipulating interfaces

(Macedo-Rouet et al., 2019). While the comparison of the age groups showed that the students used the same strategies overall, regardless of their age. When this is the case, the youngest pupils seem to act differently. They are the ones who make the most iterations and actions in the process.

It also appears that the information-seeking behaviours of pupils aged 8 to 13 are sometimes inconsistent. Indeed, when we compare the strategies used during each challenge, we notice that, when the information to be consulted is said to be "safe", they will introduce more requests and consult more documents. On the other hand, for needs that refer to information taking into account anecdotes or that are intentionally falsified to promote tourism, the students do not confront their sources.

## Conclusion

Several interesting findings emerge from our observations. First of all, it seems that in the absence of preparatory work on research objectives and practice (as is the case for our subjects), students tend to select websites that seem relevant based on superficial clues and never check their reliability. In terms of pedagogical perspectives, it seems obvious that teachers should be made aware of the need to teach certain prerequisite skills before being able to rely on the web as a directly usable source of information for students, and that they should be trained in the design of learning situations for these skills. These include teaching the various ways in which relevance can be assessed in reading situations; making students aware of superficial semantic cues and pre-crafting queries before starting computer searches; providing a range of (process and metacognitive) cues while performing the task; using Boolean operators... To support the students' task, this can be through solved and commented examples or examples to be completed (Renkl, 2014).

Thus, although participants use a variety of strategies at each stage of the information retrieval and processing process, they rely on the easiest solutions for solving, which require little cognitive engagement. This is what Merrill and Twitchell refer to as the 'Push Down Principle' (p. 55, 1994). Learners have an innate tendency to reduce cognitive load as much as possible.

While digital tools offer multiple opportunities to learn and reflect on many and varied topics, this wealth of information is matched by the need for an increased requirement to develop critical thinking skills to assess the quality of information in terms of both content and source. This study adds to a growing body of evidence indicating that mere exposure to digital media is not enough for students to develop relevant skills. These results justify an increased effort to design specific and effective educational interventions. Indeed, due to the non-linear nature of online reading, learning needs to be guided along a continuum to develop effective internet search skills.

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