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Commentary

Evaluating text-based information on the World Wide Web

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Abstract

This special section contributes to an inclusive cognitive model of information problem solving (IPS) activity, touches briefly IPS learning, and brings to the notice methodological pitfalls related to uncovering IPS processes. Instead of focusing on the IPS process as a whole, the contributing articles turn their attention to what is regarded the heart of IPS, namely the evaluation of information. In this commentary we reflect on theoretical, methodological, and instructional design issues. Results are commented upon and future research is addressed. A vignette is presented to illustrate the aforementioned issues.

Keywords: Information problem solving; Evaluation; Text; World Wide Web

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1. Introduction

Suppose you live in a country where swine influenza is spreading fast. And suppose the authorities just decided to recommend immediate vaccination for children aged six months through five years. You have a child six months old who is in perfectly good health. Do you take the authorities' advice and decide to vaccinate, or do you disregard this advice and trust information on negative side effects and subsequent health risks? In order to make a balanced decision you would probably try to find a multiple set of reliable information sources on swine flu vaccination and health risks. And, provided you have an internet connection, you would most likely search the World Wide Web to find this set of sources (Lemire, Paré, Sicotte, & Harvey, 2008). You would probably open an internet search engine and perform a key word search using keywords like 'swine flu' and 'vaccination'. Figure 1 is an example of a search engine results page (SERP) that might be presented to you (retrieved December 9, 2009).

Insert Figure 1 about here

You would presumably iteratively evaluate information presented by the SERP, select sources from the SERP, and evaluate the information presented by the sources, until you think you have enough information to make your decision. Prior knowledge regarding the topic (e.g., vaccination and flu) and Web-based publishing (e.g., everyone with an internet connection can provide information on the Web) would most likely affect your selection of information. Further, your belief how medical knowledge comes about could be decisive when you select sources. Most likely your Web search will provide you information that can help you make a decision. However, it is also possible that a proper decision is beyond reach because you are "forced" to end the Web-based search due to time constraints or frustration as a result of getting "lost" in cyberspace and/or you are not able to find or infer a univocal answer.

The vignette presented above covers a process frequently referred to as information problem solving (IPS; Brand-Gruwel, Wopereis, & Vermetten, 2005; Eisenberg & Berkowitz, 1990; Moore, 1995). This process includes activities such as searching, scanning, processing, organizing**,** and (if necessary) presenting information—activities which are typically performed in an iterative fashion to fulfill a (pre-)defined information need. With the advent of internet in education (Hill & Hannafin, 2001), IPS gained special attention in educational research. This resulted in updated (descriptive) IPS models (Brand-Gruwel, Wopereis, & Walraven, 2009; Hill, 1999) and, more interestingly, better understanding of effective instructional support for learning IPS skills (Brand-Gruwel & Gerjets, 2008; Graesser et al., 2007; Stadtler & Bromme, 2007). However, as Lazonder and Rouet (2008) argue, some aspects of the IPS (learning) process, like metacognitive mediation and collaborative search, are relatively underexposed in (educational) IPS research. According to Rouet, Ros, Goumi, Macedo-Rouet, and Dinet (YEAR: PROVIDED BY ELSEVIER) an even more serious concern is the absence of a comprehensive model of the cognitive processes involved in IPS activity. A statement which is by no means out of the ordinary, since the internet (and corresponding usability research) is relatively young and above all evolving at a great pace (Leiner et al., 2009).

The present special section contributes to an inclusive cognitive model of IPS activity, touches briefly IPS learning, and brings to the notice methodological pitfalls related to uncovering IPS processes. Instead of focusing on the IPS process as a whole, the contributing articles turn their attention to what is regarded the heart of IPS, namely the evaluation of information (Lazonder & Rouet, 2008). Rouet et al. (YEAR: PROVIDED BY ELSEVIER) scrutinized students' source selection strategies in simulated SERPs. Bråten, Strømsø, and Salmerón (YEAR: PROVIDED BY ELSEVIER) examined how readers judge the trustworthiness of authentic source materials on a complex topic (i.e., climate change). Kienhues, Bromme, and Stadtler (YEAR: PROVIDED BY ELSEVIER) investigated whether and how conflicting and consistent Web-based information influences epistemic beliefs and decision making (cf. the aforementioned vignette). Finally, Gerjets, Kammerer, and Werner (YEAR: PROVIDED BY ELSEVIER) researched methods used to uncover evaluation processes during IPS. Table 1 presents an overview of the four papers in this special section. In this commentary we will reflect on theoretical, methodological, and instructional design issues. Before reflecting, we will analyze the contributions in light of the central topic of this special section (evaluation) and the dimensions of IPS activity (cf. Lazonder & Rouet, 2008).

2. Evaluating text-based information on the Web

Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) distinguish three different types of evaluation processes when performing a Web-based IPS task, that is, the evaluation of (a) SERPs, (b) Web pages, and (c) document collections. This classification matches the three IPS evaluation skills described by Brand-Gruwel et al. (2005), namely "judging search results", "judging scanned information", and "judging processed information". Interestingly, the four contributing studies all address different (combinations of) evaluation types (see Table 1). The experiments of Rouet et al. (YEAR: PROVIDED BY ELSEVIER) focus on evaluating a (simulated) SERP. Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) zoom in on the evaluation of (simulated) SERPs and Web pages, and also touch on the evaluation of document collections. Kienhues et al. (YEAR: PROVIDED BY ELSEVIER) focus on the evaluation of (authentic) Web pages and document collections. Finally, Bråten et al. (YEAR: PROVIDED BY ELSEVIER) zoom in on the evaluation of different (authentic) document types, which could have been published on the internet (but actually were presented off-line to the students during the experiment). In sum, all relevant types of evaluation processes are covered in this special section.

Insert Table 1 about here

Beside different types of evaluation processes, the contributing articles address different evaluation frameworks to describe and measure the evaluation behavior of the participants in their studies. Bråten et al. (YEAR: PROVIDED BY ELSEVIER) focus on evaluating (judging) the trustworthiness of texts when reading multiple documents on a particular issue. To measure the trustworthiness of a text, the participating students rated whether they were influenced in their judgment by (a) the author of the text, (b) the text

publisher, (c) the type of text (source), (d) the content of the text, (e) their own opinion about the topic at issue, and (f) publishing date of the text. Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) based their coding scheme to analyze concurrent verbal protocols focusing evaluation behavior on information science research. This coding scheme consisted of two topic-related evaluation criteria (topicality and scope) and three quality-related criteria (credibility, up-to-dateness, and design). Rouet et al. (YEAR: PROVIDED BY ELSEVIER) researched students' use of surface cues (typographical cues, like underlined and/or capitalized keywords) and deep cues (semantic information in title, URL address, and excerpt) for selecting sources from SERPs. Although evaluation of information was central to the experimental tasks of Kienhues et al.'s (YEAR: PROVIDED BY ELSEVIER) study this was not measured in depth, since the authors were interested in the effect of consulting a set of conflicting information sources versus a set of consistent information sources on epistemic beliefs and decision making; it was sufficient for them to distinguish information consistency. However, due to the "time-on-task" constraint in the experimental task (30 minutes for consulting 15 sources, that is, 120 seconds for scanning each source) it is likely that participants consulted a selection of sources available. This might for instance have affected the results of the decision making task, a possibility which is recognized by Kienhues et al. (YEAR: PROVIDED BY ELSEVIER). Therefore it would be of interest for future research to analyze task performance in depth to elicit source selection. Cued-retrospective reporting could be an option (Van Gog, Paas, Van Merriënboer, & Witte, 2005). In sum, the studies described in this special section used different frameworks for describing and measuring evaluation behavior. This is partly due to the focus on different types of evaluation processes. Nevertheless, a unified framework for assessing Web-based information is important for describing all facets of information evaluation (see, e.g., Hilligoss & Rieh, 2008). This framework should also address task type or task complexity. The vignette presented in the introduction of the present commentary, for instance, presents a problem which has to be tackled within time limits. Time constraints, especially apparent in emergency management tasks, will most likely influence evaluation behavior and should, therefore, regarded a task complexity factor.

3. Cognitive dimensions of IPS activity

According to Lazonder and Rouet (2008) a description of IPS in terms of cognitive dimensions helps to build up a comprehensive cognitive IPS model. They distinguish three dimensions: (a) individual variables like prior knowledge and personal epistemology, (b) contextual variables such as task conditions (i.e., time constraints; individual versus collaborative, etc.), and (c) resource variables like amount and type of information available. In the present commentary we will elaborate on the first dimension. Individual variables include the individual's prior knowledge, general skills, and personal epistemology. An extension of the aforementioned vignette illustrates that these variables affect the quality of the IPS process. Suppose the parent mentioned in the vignette is a general practitioner. Prior knowledge on spreading diseases, vaccination programs, and accompanying health risks will probably help him/her to select (additional) information from the Web to validate initial ideas on what to decide. In case the parent is a sculptor, reliable sources with up-to-date information have to be found to

compensate the lack of a medical knowledge base. In case a 5th-grade student is presented with this vaccination problem, it is most likely that his/her decision to vaccinate is based on information retrieved from the first comprehensible document selected in the SERP. Naïve knowledge regarding the trustworthiness of Web-based information ("everything on the Web is true") and an absolutist stance of knowledge will most likely determine his/her document and information selection.

As Bråten et al. (YEAR: PROVIDED BY ELSEVIER) state there is ample evidence that experts outperform novices on IPS tasks. This is because experts possess a large knowledge base and advanced general skills (like reading skills) that help them to free up working memory capacity for the execution of all sorts of IPS processes (including the evaluation of SERPs and sources). Further, since experts have normally a sophisticated view on knowledge and knowing, this will help them to assess information more accurately. Bråten et al. (YEAR: PROVIDED BY ELSEVIER) found that also novices in a certain domain who are relatively knowledgeable about a domain-specific topic, evaluate the information better. The relatively knowledgeable novices mistrusted less trustworthy sources more frequently and were less influenced by superficial text features than the "unknowledgeable" novices. Or, as the researchers put it eloquently, "the knowledge base of the readers may actually function as a bulwark against seduction."

Also basic skills like reading affect IPS in general and evaluation in particular. Rouet et al. (YEAR: PROVIDED BY ELSEVIER), for instance, found that reading skills are prerequisite for the acquisition of effective evaluation strategies (i.e., selecting sources based on reading semantic instead of superficial cues in SERPs; see also Mason, Boldrin, & Ariasi, in press-a, in press-b). Another interesting personal variable that affects IPS activity is personal epistemology (Hofer, 2001). Kienhues et al. (YEAR: PROVIDED BY ELSEVIER) focus on epistemic beliefs, a constituent of personal epistemology. Recent research on epistemic beliefs and IPS shows that advanced beliefs about the nature of knowledge (i.e., certainty and simplicity of knowledge) and the process of knowing (i.e., source of knowledge and justification for knowing) result in more efficient and effective IPS activity (Hofer, 2004; Mason et al., in press-a, in press-b). Kienhues et al. (YEAR: PROVIDED BY ELSEVIER) found proof that the relationship between epistemic beliefs and Web-based information search is also the other way round. Participants in their study who dealt with conflicting information (in multiple Web-based documents) showed evidence of (more) advanced (topic-related) epistemic beliefs. These are interesting results since they support, to a certain extent, arguments for the use of internet as an epistemological tool for learning (cf. Tsai, 2004).

4. Methodological issues

The (quasi) experimental designs described in the present section show rigor. However, we would like to address two methodological issues which according to our view jeopardize the findings of the studies, namely measurement of data and authenticity of experimental tasks.

Both Bråten et al. (YEAR: PROVIDED BY ELSEVIER) and Kienhues et al. (YEAR: PROVIDED BY ELSEVIER) used "paper-and-pencil" posttests to measure the dependent variables. Further, Kienhues et al. (YEAR: PROVIDED BY ELSEVIER) and

Rouet et al. (YEAR: PROVIDED BY ELSEVIER) analyzed task processing "products" (e.g., decisions or selections). The focus on indirect measurement of evaluation behavior can be criticized. Most of the aforementioned researchers acknowledge that it would be good to capture the evaluation process in order to elicit explanations for information and source selection. Thinking-aloud, trace, and eye-tracking methods are mentioned explicitly. Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) concurrently used thinking aloud and eye tracking as methods to capture information evaluation processes. Moreover, they compared two thinking-aloud versions, that is, a spontaneous version where individuals were just asked to perform a task and to think aloud, and an instructed version where individuals received instructions about the type of task (frequently used in information science studies). Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) claim that the instructed version influences student behavior. Therefore, the results inferred from these studies should be looked at in its perspective. Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) even question the standard thinking-aloud method, because this is "still not very close to a natural search situation". For capturing the evaluation processes of searchers, it would probably be wise to triangulate data and combine methods. An interesting suggestion put forward by Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) is the cued retrospective reporting method (see Van Gog et al., 2005).

The evaluation process eliciting methods are time-consuming. Especially when you want to capture evaluation processes of authentic (complex) IPS tasks. Complex IPS tasks that include solving ill-structured problems take time. In case of the vignette, a non knowledgeable parent (in medicine) would probably take several hours to search, scan, and examine documents. Not imitating a true-to-life task situation in one's research method would probably lead up to biased results. Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) acknowledged this pitfall. The participants in their study only had 20 minutes to evaluate a SERP and thirty documents. Time pressure most likely influenced evaluation behavior. As mentioned earlier in this commentary, the same authenticity problem came to light in Kienhues et al.'s (YEAR: PROVIDED BY ELSEVIER) study. Also Bråten et al. (YEAR: PROVIDED BY ELSEVIER) and Rouet et al. (YEAR: PROVIDED BY ELSEVIER) note some shortcomings regarding authenticity or fidelity in their research. The simulated SERPs used in Rouet et al.'s (YEAR: PROVIDED BY ELSEVIER) study were not prototypical and the way Bråten et al. (YEAR: PROVIDED BY ELSEVIER) presented the documents to the students doesn't match reality. As a future direction in IPS research we recommend to aim for research that addresses the problem of ecological validity more seriously.

5. Instructional support

Although the studies in this special section did not explicitly focus on instructional support for learning IPS (i.e., the evaluation skills in particular), some remarks on evaluation skill acquisition were put forward by the researchers. These remarks will be commented upon.

Probably most of us have acquired IPS evaluation skills "on the job". We learn to evaluate digital information by performing search tasks in educational settings, at work, and while performing search tasks for leisure. The success and failure of these endeavors shape our knowledge and skills regarding the evaluation of SERPs, sources, and

information within sources. This discovery-based "learning-by-doing" approach might be complemented with goal-driven instructional activities (e.g., an on-line IPS course) or just-in-time instructional support (e.g., consulting a colleague). As the articles in the present special section show, advancing topic knowledge, procedural knowledge, and personal epistemology will also influence the effectiveness of information evaluation (and the search in general). Explicit support facilitates evaluation skill acquisition. Gerjets et al. (YEAR: PROVIDED BY ELSEVIER) found that encouraging learners to engage in quality-related evaluation processes helps learners to improve their Web-search performance. Rouet et al. (YEAR: PROVIDED BY ELSEVIER) found that pre-search elaboration of content can have a positive effect on students' IPS activity. Although this effect was only significant for good readers, performing a preparatory task might be a good instructional strategy (cf. activating prior knowledge in the initial stages of IPS). More extensive information on instructional support for learning evaluation skills is provided by Bråten et al. (YEAR: PROVIDED BY ELSEVIER). They point to special educational tools (Stadtler & Bromme, 2007) and units for learning evaluation skills (Graesser et al., 2007).

In educational settings where IPS is an integral part of the curriculum (e.g., resource-based learning curricula, or problem-based learning curricula) the issue of task complexity should be borne in mind. In the beginning of a curriculum learning tasks should be authentic, but relatively simple. At the end of a curriculum learning tasks should be authentic, but relatively complex (for a comprehensive view on instructional design for complex learning, see Van Merriënboer & Kirschner, 2007). The IPS constituent of learning tasks should also follow this simple-to-complex sequence. When students in the beginning of a curriculum are asked to search for information to solve a problem, task complexity could be reduced by offering a predefined set of Web-based resources (cf. Segers & Verhoeven, 2009). More advanced learning tasks at the end of the curriculum could include a full Web-based search with time constraints. For instance, when the vaccination problem presented in the vignette would be a learning task in a basic module in medical education (for aspirant general practitioners), students could be offered a predefined set of sources with conflicting information.

6. Conclusion

The four studies in the present special section contribute to an all-inclusive cognitive model of IPS activity. Previously unattached issues regarding evaluation, personal epistemology and research methodology were addressed in depth. The participating students in the special section's studies evaluated text-based information to solve their information problems. Since information on the Web is mainly text-based (or document-based; cf. Rouet, 2009) this focus is justifiable. However, it should be borne in mind that audio, video, and multimedia sources win ground on the Web and, as a result, are increasingly used for (personal) knowledge construction (Greenhow, Robelia, & Hughes, 2009). Future research should consider the evolution of the Web towards a predominantly multimedia-based information source.

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Table 1
A selection of focal points of the contributing articles

Study	Participants	Research focus	Task focus	Criteria focus
Rouet et al. (YEAR)	Primary and secondary school students (Experiment 1: N =174; Experiment 2: N = 88)	Menu selection strategies	Evaluation of SERPs	Relevance, i.e., surface vs. deep cues
Bråten et al. (YEAR)	University students (N = 128)	Judgment of trustworthiness of information sources	Evaluation of information sources	Trustworthiness
Kienhues et al. (YEAR)	University students (N = 100)	Effect of conflicting and consistent information on epistemic beliefs and decision making	Evaluation of information sources	Topic-specific and discipline-related epistemic beliefs
Gerjets et al. (YEAR)	University students (N = 30)	Multi-method measurement of evaluation criteria	Evaluation of SERPs and information sources	Relevance, i.e. topic-related and quality-related criteria

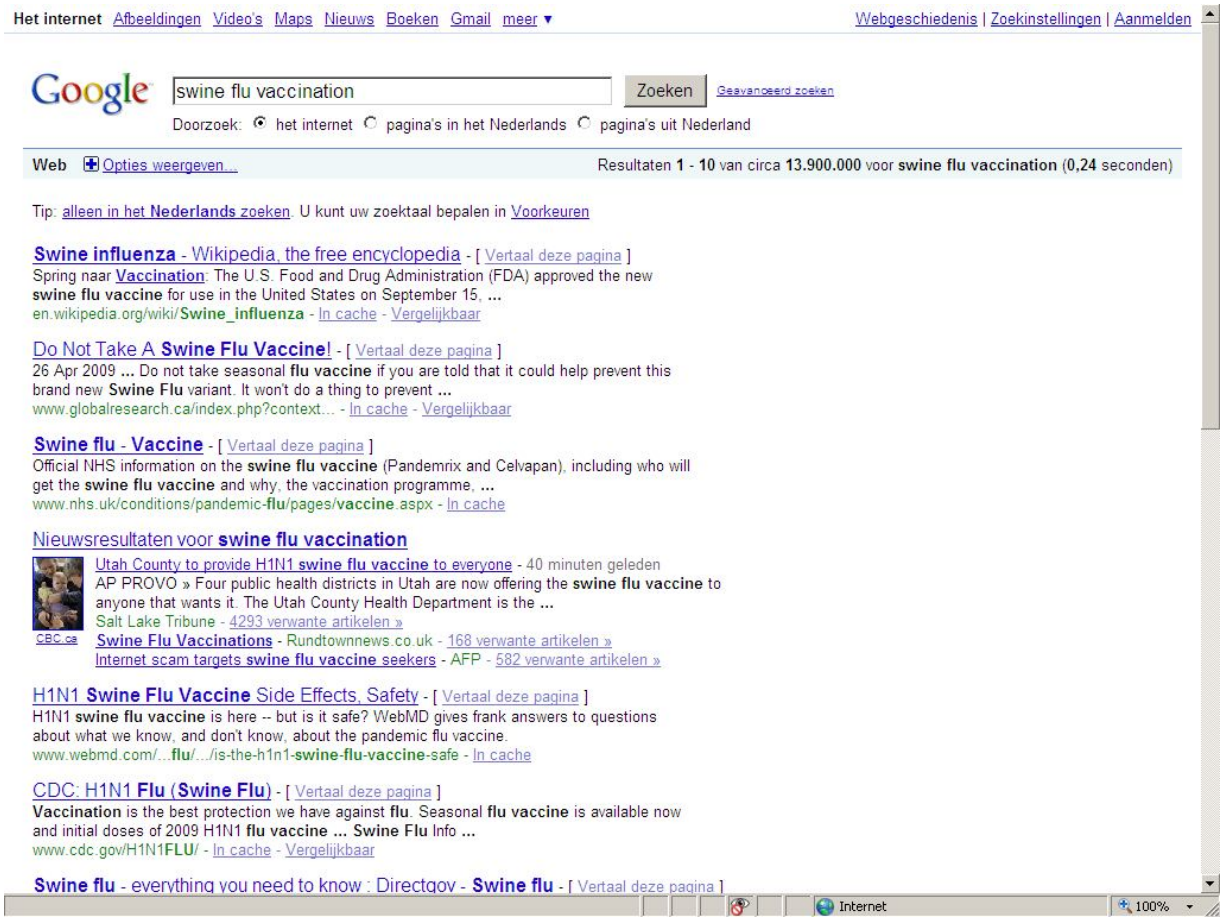

Fig. 1. Search engine results page for keyword search.