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Comprehension effects of signalling relationships between documents in search engines

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ABSTRACT

A key task for students learning about a complex topic from multiple documents on the web is to establish the existing rhetorical relations between the documents. Traditional search engines such as Google® display the search results in a listed format, without signalling any relationship between the documents retrieved. New search engines such as Kartoo® go a step further, displaying the results as a constellation of documents, in which the existing relations between pages are made explicit. This presentation format is based on previous studies of single-text comprehension, which demonstrate that providing a graphical overview of the text contents and their relation boosts readers' comprehension of the topic. We investigated the assumption that graphical overviews can also facilitate multiple-documents comprehension. The present study revealed that undergraduate students reading a set of web pages on climate change comprehended them better when using a search engine that makes explicit the relationships between documents (i.e. Kartoo-like) than when working with a list-like presentation of the same documents (i.e. Google-like). The facilitative effect of a graphical-overview interface was reflected in inter-textual inferential tasks, which required students to integrate key information between documents, even after controlling for readers' topic interest and background knowledge.

1. Introduction

When students search the Internet to learn about a particular topic, search engines provide them with entries to multiple web documents on the topic. In this learning scenario, students' global comprehension of the topic goes beyond the comprehension of each retrieved web document. As students read through the web documents, they construct a mental representation of the topic that consolidates new information with information that they already know. This process of integrating information is inherent to learning from the Internet, because web documents are usually less complete than their corresponding paper documents (Bhavnani, Jacob, Nardine, & Peck, 2003; Britt & Gabrys, 2001). Indeed, web documents usually focus on a particular issue (e.g. origins of a phenomenon, its effects...), and at best they provide links to additional sources that allow students to complete their learning assignment.

Traditional search engines place the burden of the integration process entirely on the student, because they just display a list of web documents without providing any information about the relationships between them (e.g. list-like interface by Google®). New search engines, however, are exploring the possibility of providing students with rhetorical information about the relations between web documents (e.g. graphical interface by Kartoo®), in order to help them integrate information from the documents. For example, upon the search query "influenza", the search engine can visually group the retrieved web documents under the labels "symptoms, causes, prevention and treatment". Currently, there is no evidence that this way of displaying web results may influence students' learning. The goal of this study was to provide insights into this issue.

2. Integration of multiple documents

Perfetti, Rouet, and Britt (1999) proposed a cognitive model to describe how advanced students comprehend and integrate information from multiple documents. In their view, the comprehension of multiple documents at the local level involves the same processes as the comprehension of a single text, i.e. constructing a model of the situation described in the text (Kintsch, 1998). The models that students create for each document can relate in various ways, for example containing overlapping, complementary or even contradictory information. For this reason, in the context of learning from multiple documents, students have to construct an additional representation called the documents model, where they

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can store additional information reflecting the general situation described across the documents (Situations Model) as well as information about how the documents relate to each other (Intertext Model). The Intertext Model represents relevant information for each document, including main ideas presented in the text, information about the source (author, year, linguistic style), and the rhetorical objectives of the document (audience addressed and purpose of the author), as well as information about the existing relations between the texts.

Research in the context of multiple documents has studied several interface factors that might facilitate students' integration of information. This process can be fostered by displaying the web documents simultaneously in a two-windowed browser (Wiley, 2001), by avoiding using too many embedded links in a text (Britt & Gabrys, 2002), or by showing the web document and the student's writing file at the same time (Olive, Rouet, François, & Zampa, 2008). Finally, a potential way of helping students to integrate information from different web documents consists of signalling the rhetorical relations between documents as is done by new search engines such as Kartoo®. Although this solution has been found to foster the comprehension of related sections from a single document (e.g. Ruddell & Boyle, 1989), efforts to empirically validate this issue in the context of multiple documents are scarce.

3. Signalling rhetorical relations and multiple-documents comprehension

Perfetti and colleagues' model provides a useful framework for the study of multiple-documents comprehension. However, the model currently operates at a rather descriptive level, and does not provide much insight into the mechanisms that promote integration of documents at the level of the Intertext Model. Further elaboration of this issue may build on two important theoretical models that were originally proposed to account for the effects of signalling relationships with graphical overviews on single-document comprehension. The well-known Assimilation Theory of Mayer (1979) states that graphical overviews enable readers to construct an accurate mental representation of the text, as reflected in the overviews, and thus provide an organizational framework. In other words, a graphical-overview increases the salience of the text structure that might be part of the situation model representation for the text, thereby enhancing memory of the text structure. This effect appears when the content of the text is quite difficult and the students do not possess prior knowledge about the text topic (Lorch & Lorch, 1996; Salmerón, Baccino, Cañas, Madrid, & Fajardo, 2009). In the context of multiple-documents comprehension, the Assimilation Theory would imply that when students read a graphical overview, it acts as an initial schema for inter-textual organization, allowing the reader to incorporate subsequent information from the isolated documents into an existing representation. Readers with no previous knowledge of the topic, or those faced with difficult texts, will not be overloaded by the need to build an initial frame for the inter-textual information. This structural 'preparation' might simplify the operations related to linking related information between documents, which might be reflected in a richer inter-textual model. This hypothesis resembles the top-down process of integration proposed by Kurby, Britt, and Magliano (2005). Those authors proposed that when students read related documents the content of the already read texts is automatically activated while reading a subsequent document. In order to determine the interrelations between documents, readers must evaluate to what extent the activated knowledge is related to the current document. Kurby et al. (2005) proposed that a potential cue for this process is the title of the document. A label signalling the relations between documents might also serve this purpose.

Alternatively, the Active Processing Model (Hofman & van Oostendorp, 1999; Shapiro, 1998) suggests that structured overviews may inhibit the use of comprehension strategies by readers. Although readers generate causal inferences between text ideas as part of the normal course of comprehension (e.g. Graesser, Singer, & Trabasso, 1994), it may be simpler for students who read the overview to perceive the text structure without putting a tremendous amount of thought into discovering the relations between sections (Shapiro, 1998). In contrast, a text without an overview may require a deeper level of processing of the information in order to make sense of the material. In the context of multiple-documents comprehension, the Active Processing Model might stress prior results showing that undergraduate students are normally active integrating information across documents (Kurby et al., 2005). If students are provided with a graphical-overview signalling the rhetorical relations between documents, however, they do not need to be active in order to discover the relations between documents for themselves, which will result in poorer inter-textual comprehension.

Currently, based on existing theoretical models for single-text comprehension, it is unclear whether signalling rhetorical relations between documents will enable readers to construct a more adequate Intertext Model, inhibit strategic processing of interrelations between documents, or some combination of the two.

To the best of our knowledge, the only attempts to empirically evaluate the impact of signalling rhetorical relations on multiple-documents comprehension have been performed by Britt, Rouet, and Perfetti (1996) and by Stadtler and Bromme (2008) (Note 1). Britt et al. (1996) presented undergraduate students with varying experience in history with a hypertext which contained nine conflicting documents on the topic of the history of the Panama Canal. Students read the documents with the goal of 'understanding the controversy' concerning the topic. They were provided with a table of contents and a navigable hierarchical map. An important variable considered was the organization of the table and map. In the 'structured' condition, the table of contents presented the documents grouped under two main topics: 'Planning of the revolution' and 'Execution of the revolution'. The table also included the title of each text, the author's name, the year of publication and the page of the document in the system. The map presented the titles and authors of the documents organized in a manner that corresponded to the hierarchical structure of the information. At a first level it identified the two main topics discussed (i.e. "planning" and "execution" of the revolution). At a second level in the hierarchy, it signalled rhetorical information regarding conflicting views on the two main topics, such as 'US military intervention not justified' vs. 'US military intervention justified'. Finally, at a third level it displayed primary documents used by authors of the above mentioned texts to back their arguments. In the 'scrambled' condition, the documents were organized in a random order that conveyed no information about how the documents related to each other in a hierarchical structure. Results showed that participants using the 'structured' version recalled more map items (titles and author names), correct page numbers, and arguments and evidence that the author gave to support their claims. These data fit well with the implications of the Assimilation Theory for multiple-documents comprehension: students could have used the structured map as a schema in which to integrate different information about the relationships between documents.

In sum, the results of Britt et al. (1996) suggest the importance of signalling the existing relationships between texts for effective learning in a multiple-documents scenario. However, this conclusion should be taken cautiously due to two main seasons. First, the 'scrambled' condition used by Britt et al. (1996) may not represent a clear control group in which no rhetorical information is imposed onto the documents, because the 'scrambled' table of