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Novices' need for exploration: Effects of goal specificity on hypertext navigation and comprehension

Álvaro Jáñez*, Javier Rosales

Department of Developmental and Educational Psychology, University of Salamanca, Spain

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ABSTRACT

The present study examines the effects of general, medium specificity, and specific instructions on hypertext navigation and comprehension scores. Undergraduate students ($N = 45$) were assigned to the different hypertext conditions, and navigation patterns were extracted through cluster analysis. Control subjects ($N = 45$) performed the same tasks, but using paper texts. Our results suggest that novices are only affected by the specificity of instructions after an exploration phase. Also, an ANOVA showed no significant differences in comprehension scores across conditions, supporting the fact that hypertext comprehension is directly affected by navigation paths. Implications for research and education are discussed.

1. Introduction

In educational contexts, students are often asked to read a text to fulfil certain task demands. Reading instructions state the objectives that should be met in a reading session, and different reading goals derive in different learning outcomes (van den Broek, Lorch, Linderholm, & Gustafson, 2001) and use of reading strategies (Bråten & Samuelstuen, 2004). The effects of reading instructions have been widely investigated in traditional paper texts (see McCrudden & Schraw, 2007; for a review), but research on this topic using hypertext materials, such as Web pages, is scarce.

Recent studies showed how electronic texts do not hinder learning when compared to traditional texts (Rockinson-Szapkiw, Courduff, Carter, & Bennett, 2013) and how computer technologies can enhance learning if enough training and support are offered (Archer et al., 2014). However, we should not forget that hypertext reading requires new skills and strategies (Coiro & Dobler, 2007; Leu et al., 2009), and poses new cognitive and metacognitive demands on learners (Shapiro & Niederhauser, 2004). Therefore, investigation on this topic should be conducted through comprehensive experiments that keep in mind several important variables, due to their potential effects on navigation and/or learning performance, such as prior knowledge (*e. g.* Last, O'Donnell, & Kelly, 2001; Lawless & Kulikowich, 1996; Rezende & de Souza Barros, 2008), working memory capacity (DeStefano & LeFevre, 2007; Lee & Tedder, 2003), or hypertext design (*e.g.* McDonald & Stevenson, 1996; Nielsen, 2000; Potelle & Rouet, 2003). We will first explore how reading instructions affect reading strategies and comprehension scores (Section 1.1). Then, we will review some studies about hypertext navigation, in order to explain how to assess readers' behaviour through navigation patterns (Section 1.2). After that, we will state our objectives (Section 1.3). Finally, we will explain the experiment we conducted (Section 2), and the main findings (Section 3) and conclusions (Section 4).

1.1. Effects of reading instructions and goal specificity

Learning is supposed to be enhanced when students are told (through reading instructions) the relevant information they should focus on (McCrudden & Schraw, 2007). Previous research has showed how reading instructions have an impact on learning outcomes, reading behaviour, and strategy use. For example, Kaakinen, Hyönä, and Keenan (2002) found that students reading a text from different points of view (perspective manipulations) recalled significantly more information related to their designated perspective than irrelevant information. Kaakinen and Hyönä (2007), using eye-tracking technology, suggested that these learning benefits of perspective manipulations were caused by reading behaviour: students spent more time in the first and last words of relevant sentences, skipped words in irrelevant ones, and made more regressions in relevant sentences. They also found how

* Corresponding author. Department of Developmental and Educational Psychology, University of Salamanca, Av. de la Merced, 109-131, 37005, Salamanca, Spain.
E-mail address: alvarojg@usal.es (Á. Jáñez).

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perspective effects were influenced by prior knowledge: when reading a familiar text, perspective effects appeared at the end of sentences, whereas when reading an unfamiliar text, these effects were evenly distributed along the sentence. On the other hand, McCrudden, Magliano, and Schraw (2010) suggest that perspective manipulations affect reading comprehension and recall through readers' goals and strategies. They found that subjects in a control group (with a general instruction of reading for comprehension) used a *familiarity* strategy, spending more time on (and remembering better) information that they assessed as interesting or familiar. However, the experimental groups (under perspective manipulations) used two different strategies: either a *narrowing goal* strategy, reading exclusively relevant information; or a *broadening goal* strategy, focusing also on irrelevant information in order to compare and contrast with the relevant information. The latter strategy derived in more reading times and better recall for the irrelevant information.

Similar results have been found when using more specific instructions (a list of pre-reading questions or objectives) rather than the general perspective manipulations. For example, Reynolds, Trathen, Sawyer, and Shepard (1993) showed how good and poor sixth-grade readers, when given pre-reading objectives, recalled more relevant information than non-relevant text segments. McCrudden, Schraw, and Kambe (2005), using pre-reading questions, found similar results: learning was enhanced for information made relevant by pre-reading questions, and inhibited for non-relevant text.

As we can see, reading instructions have a direct impact on the reading process, and specificity of instructions seem to cause different outcomes. For example, both general perspective manipulations and specific pre-reading objectives/questions enhance learning of the information made relevant by the instructions, but only specific instructions inhibit learning of task-irrelevant information (McCrudden et al., 2005), whereas general instructions do not necessarily do so (McCrudden et al., 2010). These results support the *goal specificity effect* (Sweller, 1988): non-specific goals lead to higher performance than specific goals. The goal specificity effect has received support from a wide variety of studies using problem solving tasks, mostly in areas related to mathematics and physics (*e.g.* Burns & Vollmeyer, 2002; Paas, Camp, & Rikers, 2001; Sweller, 1988). The explanation proposed by Sweller (1988) for the goal specificity effect is that specific goals are likely to elicit a means-ends strategy. This strategy, despite its efficiency in achieving a problem goal, poses heavy demands on working memory capacity: problem solvers must simultaneously consider the current problem state, the goal state, the relation between the current problem state and the goal state, the relations between problem-solving operators, and every sub-goal that is created and/or achieved during the process. Handling all this information may leave no or little cognitive resources for learning, even if the problem is finally solved. On the other hand, non-specific goals do not specify any goal state, so means-ends analysis is not a valid option. According to the goal specificity effect framework, therefore, non-specific goals reduce the cognitive demands posed by means-ends analysis, facilitating schema acquisition, that is, learning.

There are almost no studies investigating goal specificity effects on hypertext reading comprehension tasks. However, a study by Vollmeyer and Burns (2002) suggests that goal specificity effects can be generalized to hypertext reading tasks. These authors used a hypermedia program about the outbreak of World War I, and gave subjects either a non-specific goal (to explain the reasons for the outbreak) or a specific goal (to fill in the dates for 20 specific events). Subjects under the non-specific goal showed a better performance answering factual and inferential questions, spent more time on average per page, and looked for extra information more often.

More research is needed to confirm and extend these results, and the present study is an attempt to contribute to the field by expanding our knowledge about the effects of goal specificity in hypertext learning.

1.2. Hypertext navigation

Hypertext navigation can be studied at two main levels: specific strategies used at precise moments in time, or global strategies that define a navigation behaviour during a task or a period of time. At the specific level stands out the study by Salmerón, Kintsch, and Cañas (2006), in which they created a hypertext isolating the hyperlink selection process, in order to analyze it closely. This way, at the end of each node the reader pressed a button to indicate he or she had finished reading. Then, a new screen appeared showing two hyperlinks towards non-visited sections (sections could be visited just once), and the reader had to choose one. After all nodes had been read, subjects were showed the selections they made during the reading session, and were asked to explain the reasons for selecting those hyperlinks. The authors found that subjects used mainly three hyperlink selection strategies: *coherence* (choosing the link that is more related to the last read node), *interest* (selecting the most interesting link, according to the reader's opinion), and *top link* (picking the first mentioned link; in their experiment, the one that appeared on top). These strategies were related to comprehension outcomes, and to readers' knowledge: low-knowledge readers showed better comprehension when following a coherence strategy than when following an interest one. Protopsaltis (2008) found the same strategies identified by Salmeron et al. (2006), but using a different method (think-aloud protocols), reinforcing the results.

At the global level of navigation strategies, a common way to analyze hypertext navigation behaviours is through cluster analysis (Barab, Bowdish, & Lawless, 1997; Lawless & Kulikowich, 1996; Puntambekar & Stylianou, 2005). Navigation data, such as time spent on each node or total number of transitions, is used to extract navigation patterns. Once navigation patterns (clusters) are identified, visual inspection of the navigation graphs associated to each cluster is very informative to assess similarities and differences across clusters. Navigation graphs show the reading order followed by a person during a reading session, as well as the time spent on each node of the hypertext. These reading orders, or navigation paths, are very important, since they have a direct impact on hypertext comprehension (Salmerón, Cañas, Kintsch, & Fajardo, 2005).

Many authors have used this kind of analysis with hypertext and hypermedia materials to assess readers' navigation behaviours. For example, Lawless and Kulikowich (1996) identified 3 navigation patterns: *knowledge seekers* focused on relevant information, navigating towards screens that enhanced comprehension and selecting coherent reading orders; *feature explorers* spent excessive time on the multimedia features, such as images or animations, they seemed more worried about the type of pages the hypertext contained than about gathering important information; and *apathetic hypertext users* spent very short intervals interacting with the system, showing no interest in gathering information or exploring the system, and navigating very linearly. Barab et al. (1997) found very similar patterns using a hypermedia program.

Puntambekar and Stylianou (2005), using a hypertext system on a science topic, obtained four navigation clusters. Students in cluster 1 visited all relevant concepts and were focused on task-relevant information (pulleys). Readers in cluster 2 were also focused on task-relevant concepts, but they didn't visit all of them. Instead, they