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What comes with technological convenience? Exploring the behaviors and performances of learning with computer-mediated dictionaries

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ABSTRACT

As technology develops, the prevalence of conventional book dictionaries has slowly declined due to advancements in computer-mediated aids, such as online type-in dictionaries and program-installed pop-up aids. The goal of this study was to examine how technology "may" have changed the long-standing pedagogical practice of book dictionary usage by identifying the learning processes associated with various dictionaries and verifying how these processes are related to learning. Cognitive load theory was applied to generate predictions about learning performance and, therefore, to determine the nature of these processes. Information contained in each dictionary was specifically controlled, and thus we focused on the effect of the learning process alone. In the experiment, students first read a simulated online text in one of four conditions: pop-up, type-in, book dictionaries or no aid. They were later tested for reading comprehension and vocabulary learning. Results indicated that all dictionaries enhanced vocabulary learning but not comprehension. Close examination revealed that vocabulary-learning efficiency was significantly higher for the pop-up dictionary than the other two aids. In addition, a complex relationship existed between reading comprehension and vocabulary learning. This study has important implications for future dictionary design and pedagogical advice regarding dictionary usage.

1. Introduction

Reading authentic texts has long been recognized as an essential part of accumulating knowledge and developing language ability (Gilmore, 2007; Krashen, 1989), and the dictionary is the most common type of reading aid. If an individual reads text and encounters an unfamiliar word, it is likely that he or she will refer to a dictionary if it is necessary to understand the word and its definition cannot be inferred from the text. While the primary goal is for the reader to understand the meaning of the text, many words can be unintentionally "pick(ed) up" (Hulstijn, Hollander, & Greidanus, 1996; Krashen, 1982, 1989; Laufer & Hulstijn, 2001). This "pick up" is usually referred to as incidental vocabulary learning and is considered a popular theory of language acquisition as a result of comprehensible input (Krashen, 1989). Therefore, the use of a dictionary while reading has the potential to assist learners not only in reading comprehension but also in incidental vocabulary learning.

As web-based technology rapidly develops, the availability of authentic materials on the Internet has expanded exponentially. This, in turn, has made online reading an increasingly popular way of learning (Abraham, 2008). Computer-mediated aids have become particularly important, as they are now often built in or are accessible using digitalized-article reading devices. Therefore, the development of a computer-mediated dictionary has received considerable interest due to its promising potential and increasingly prevalent and broad applications (Kramsch & Anderson, 1999).

Type-in and pop-up dictionaries are two major computer-mediated aids used today. They enable word definition consultation at an individual's fingertips. Type-in dictionary aids are generally in the form of computer software or online dictionary websites, which allow the desired word to be typed into an entry window while the original material is still visible on the screen. Pop-up dictionaries allow readers to double-click on any given word in a text to bring up a definition adjacent to or above the chosen word. Although the two computer-mediated dictionary forms serve the same purpose as a conventional book dictionary, the method of searching for information is quite different.

Without a doubt, in comparison with conventional paper-based dictionaries, type-in and pop-up forms of computer-mediated dictionaries provide learners with a more convenient way to search for words. This convenience may be thought of in terms of the reduction in the search effort for the target words. However, "convenience", as a consequence, could potentially eliminate any positive

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learning process altogether. For example, when using a conventional book dictionary, the user must temporarily utilize his or her working memory (WM) by mentally holding the word while actively searching through the pages. This continuous rehearsal could potentially be helpful for incidental vocabulary learning. It is generally agreed upon that before a memory can become durable and recallable, additional processes (e.g., deep processing, elaboration, or cognitive effort) are usually involved (Anderson, 1995; Baddeley, 1998; Craik & Lockhart, 1972; Hulstijn, 2001). However, according to cognitive load theory (CLT), such occupation of the WM could leave fewer resources available for meta-cognitive processes, which could potentially impede reading comprehension (Sweller, van Merriënboer, & Paas, 1998). Therefore, it is possible that the convenience afforded by computer-mediated aids could potentially free up more cognitive resources for comprehension. The other apparent advantage of the advanced aids is the learning opportunities associated with their use. Due to the convenience, readers might be more willing to use computer-mediated dictionaries, thereby exposing themselves to more words.

However, little is known about the consequences of technological convenience. The exact nature of this information immediacy and how it affects the subsequent usage behavior, cognitive processes and learning performance remain unknown, despite the fact that these are important and interesting research issues. Although some studies on e-dictionaries have attempted to compare the effects of dictionary type on subsequent learning (e.g., Knight, 1994; Leffa, 1992), the lack of experimental control and data collection on usage behaviors limits the information necessary to answer the questions that we are interested in investigating. By avoiding the problems mentioned above, our study aims at understanding how technological convenience changes the long-standing pedagogical practice of dictionary usage and learning.

In this study, we compared type-in and pop-up dictionaries to conventional paper-based dictionaries and a situation in which no aid was available. The research presented herein was guided and motivated by three specific questions: (1) What cognitive processes are associated with different types of aids? (2) Do differences in accessing various types of dictionaries lead to differential reading comprehension and incidental vocabulary learning? (3) What are the relationships between cognitive processes and learning performance?

2. Theoretical background

A review of previous research and cognitive load theory (CLT) is presented below. This section summarizes foundational research and integrates CLT with the predictions of this study.

2.1. Effects of computer-mediated aids on reading and vocabulary learning

Although use of computer-mediated aids (e.g., dictionaries, glossaries, annotations, etc.) has the rational appeal of enhancing reading comprehension and incidental vocabulary learning, results regarding their effectiveness are mixed. Some researchers have examined the availability of annotations on reading and found improvements in learning (e.g., Chun & Plass, 1996; Jones & Plass, 2002), whereas others did not observe improvements (e.g., Brünken, Plass, & Leutner, 2004; Plass, Chun, Mayer, & Leutner, 2003). For instance, Leffa's (1992) examined the effectiveness of electronic dictionaries compared with conventional dictionaries and found better comprehension performance and faster translation writing speed using the electronic dictionary. Knight (1994) also found the occurrence of incidental vocabulary learning and improved comprehension when participants used an electronic dictionary during a reading task (compared with not using an aid). However, other studies on computer-mediated aids and conventional book dictionaries failed to find any differential effect on comprehension or vocabulary learning. For example, Bensoussan, Sim, and Weiss (1984) questioned the benefit of dictionary usage on reading comprehension when comparing advanced students' English reading performance with and without aids. Aust, Kelley, and Roby (1993) showed that participants who used an electronic dictionary looked up twice as many words as those who used a conventional dictionary, although no differences were found in comprehension.

One potential explanation for the variations in findings could be methodological limitations. First, many of the studies noted above did not control for the amount of information presented in the dictionaries. In other words, whether the differences observed in performance were due to differences in the amount of information presented or were attributable to differences in learning processes cannot be distinguished. For example, in Leffa's (1992) experiment, the types of conventional dictionaries (e.g., desk or pocket dictionaries) students bought and used in the experiment were not restricted. The amount of information (e.g., definitions and examples) presented could influence the search effort put forth to find the definition fitting the context, an elaborative process that others argue is related to reading comprehension (Hulstijn, 2001). Thus, to investigate the effects of learning processes on performance, we controlled for the information contained in various aids and attempted to distinguish the effects mediated by differences in learning processes rather than differences in content.

Second, a detail and thorough log file on dictionary usage behaviors is usually absent in previous studies. Few studies did provide additional information on the frequency of usage and overall reading time (Aust et al., 1993; Chun, 2001), but other important information is still missing (e.g., which words the participants looked up, vocabulary search time, definition reading time, and text reading time). These are some of the important insights that should be taken into account when considering the usage behaviors involved in using a dictionary. We believe that the learning process of using dictionary may be subdivided to several behavioral processes that we categorized. More rigorous research methodology on tracking learners' "look-up" behaviors could provide clues to the cognitive processes involved in using various types of dictionary and how these processes may contribute to subsequent learning.

Moreover, both comprehension and vocabulary-learning performance should be considered when examining the effects of aids. A recent meta-analysis conducted by Abraham (2008) included 11 reports on computer-mediated glossaries in second language reading and found an overall medium effect size for comprehension and a large effect size for incidental vocabulary learning, suggesting variations in comprehension and vocabulary performance. We believe that an examination of the effect of aids should not be based merely on performance in one area. Complex relationships may exist between reading comprehension and vocabulary learning with different types of aids and, therefore, measuring both types of performance could provide an overarching picture of the effects of dictionary aids.

By controlling dictionary content across conditions and having a rigorous collection of detailed information on cognitive processes, comprehension, and vocabulary learning, this study can ultimately help to explain differences in reported by previous studies. In addition, CLT was incorporated in this study to provide guidance and a framework for our hypotheses and predictions.

2.2. Cognitive load theory

CLT suggests that learning performance is based on the interaction between the task, learners' prior knowledge, and learners'