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Investigating readers' mental maps of references in an online system

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ABSTRACT

Referential identification and resolution are considered the keys to help readers grasp the main idea of a text and solve lexical ambiguities. The goal of this study is to design a computer system for helping college students who learn English as a Foreign Language (EFL) develop mental maps of referential identification and resolution in reading. Four modules, *Natural Language Processing (NLP), User Interface, Recording,* and *Feedback Tool,* are implemented in the system. Results of this study showed that the more-proficient EFL readers were able to identify and resolve most of the references to form a coherent mental map from different parts of a text. The less-proficient readers commonly resolved references by relying on grammatical rules instead of semantic contextual clues. They often referred references to incorrect objects. To overcome the difficulties in figuring out the relationship between two words, the less-proficient readers usually asked for more feedbacks. As students progressed in reading, they requested fewer feedbacks in the online system. Some recommendations for future studies are discussed.

1. Introduction

Successful reading comprehension depends on whether a reader is able to integrate and interpret textual information appropriately (Grabe & Stoller, 2002; Huang, Chern, & Lin, 2009). To achieve this, a reader should have the ability to identify and resolve cohesive ties for they are claimed to best serve as the contextual clues for connecting information presented in a text (Al-Jarf, 2001; Halliday & Hasan, 1976; Yuill & Oakhill, 1988). Five cohesive ties are considered to help a reader integrate textual meaning; they are reference, substitution, ellipsis, conjunction, and lexical cohesion (Halliday & Hasan, 1976; Pritchard & Nasr, 2004).

Among these five cohesive ties, referential identification and resolution are the keys to successful reading comprehension (Chung, 2000; Oakhill & Yuill, 1986). Nunan (1993) states that it is a prerequisite for a reader to identify the referential relationship among sentences in comprehending a text. The reader can further resolve the referential relationship based on his reading proficiency and linguistic competence (Al-Jarf, 2001). Eventually, he can construct a well-structured memory representation of the text. The mental representation allows the reader to have a deeper understanding of the text and enables him to answer questions about the text, to recall, or to summarize it (Potelle & Rouet, 2003).

According to Chen and Dai's study (2003), most Taiwanese EFL college students fail to identify pronouns and relative pronouns in texts. Huang's study (1993) also indicates that most EFL college students have difficulties in identifying cohesive ties for they lack instruction and practice in recognizing and resolving cohesive ties in their past learning experiences. It is clear that most EFL students in Taiwan lack skills in referential identification and resolution necessary for reading comprehension. They are more likely to encounter difficulties and failures in the process of reading.

The difficulties that EFL students encounter in processing cohesive ties have not been closely studied yet since traditional experiments fail to assess the complicated reading processes of referential ties (Al-Jarf, 2001; Chen, 2001). The major methods used to document students' reading processes are mainly naturalistic observation, interviews, or think-aloud protocols (Schacter, Herl, Chung, Dennis, & O'Neil, 1999). Researchers in traditional experiments most often implement think-aloud task or recall to understand a reader's comprehension by asking him to self report his reading process simultaneously or retrospectively. However, these methods are usually time consuming and labor intensive. The reader might be poor at verbally expressing his own reading process. As a result, the verbal report may lead to a shallow investigation.

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Online learning systems are proposed to better investigate students' learning process recently (Demetriadis, Papadopoulos, Stamelos, & Fischer, 2008; Ding, 2009; Martindale, Pearson, Curda, & Pilcher, 2005) since they can support higher-order learning, teach problem-solving skills to students who are struggling with learning difficulties, and have a positive impact on learning outcomes (Martindale et al., 2005; Mercier & Frederiksen, 2008). However, very few computer systems have been designed to examine the roles of referential identification and resolution in reading. How students encounter difficulties in resolving references, how they read and reread the sentences to select and reselect references, and how individual students are supported by feedback in a system are seldom investigated. Particularly, how to manage the process and the product of referential identification and resolution in reading has become a big challenge for both EFL students and teachers due to an average class size of more than 40 in Taiwan.

This study aims to design a computer system for helping EFL college students develop mental maps of referential identification and resolution in reading. Referential resolution, in this study, is defined as a reading strategy applied by a reader to accurately interpret references in texts. It occurs when the reader identifies persons and objects in different parts of a text pointing to the same entity (Walsh & Johnson-Laird, 2004). Mental maps of references are represented as nodes and connected by lines to indicate how a reader figures out the relationships among references. Taking the following sentences as examples, "Sigmund Freud was a doctor of psychology in Vienna, Austria at the end of the nineteenth century. He treated many patients with nervous problems through his cure talk." "He" in the second sentence refers to "Sigmund Freud" in the first sentence. That is, referential resolution can be used to establish the relationships among text elements that have the same meaning. Based on our research purpose, three research questions are addressed: (1) How is the system developed to support students in referential identification and resolution? (2) How do students present their mental maps of referential identification and resolution in the system? (3) How do students progress in their referential identification and resolutions in the system?

2. System development

In the system, students are required to follow two steps in reading a text: (1) to identify references generated by the system, (2) to establish the relationships among the references to form mental maps. Key functions are provided to offer students apprenticeship in a reading environment; they are system-guided instruction, warm-up practice, referential interface, and feedback. System-guided instruction informs students the goal of the system and prepares them for the following practices. Warm-up practice provides students initial attempts to develop their skills in referential identification and resolution. The practice is also a guide for shaping and supporting students' referential strategy development. Feedback serves as a scaffold to help students guess from textual clues and reflect on their incorrect answers of referential identification and resolution in order to make correct choices.

The system built for this study includes four modules, *natural language processing (NLP), user interface, recording, and feedback*. Fig. 1 shows the system architecture of this study. The teacher designs the course, selects texts which students have to read, and types in the texts to the *NLP module* through the *teacher interface* (Fig. 1). The *NLP module* picks the referential devices from each text and segments the text into sentences. The selected referential devices and the split sentences are then saved in the database.

The *recording module* traces students' reading process and behavior while they are constructing mental maps in referential identification and resolution. These traced data are then studied by the teacher to identify the difficulties students encounter and the performances among different reading proficiency groups. The *feedback module* compares students' initial maps with that of an expert while students are constructing their mental maps. It then provides three candidate references for each device that needs correction to students whenever they encounter difficulties figuring out the relationship between two words.

2.1. NLP module

In the system, a reader is asked to find out three types of references, personal, demonstrative, and locative pronouns since they appear more frequently in texts (e.g., Fortanet, 2004; Kennison, 2003). Personal references refer to individuals or objects by specifying their functions or roles in the speech situation (Halliday & Hasan, 1976), such as "I," "me," and "you." Demonstrative references act as forms of verbal location, such as "this," "these," and "that." The speaker figures out the reference by means of location on a scale of proximity. Locative

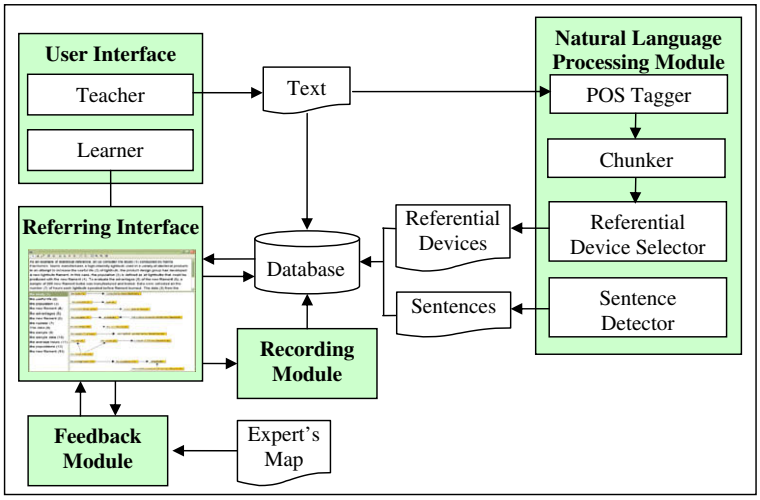

Fig. 1. System architecture for referential identification and resolution.