Constructing mental representation of reference by feedback in a computer system

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Abstract

This study reports on the design of a computer system which helps English as a Foreign Language (EFL) college students construct a mental representation of reference in reading. Three modules, User Interface, Recording, and Feedback, are implemented. 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 referential device that needs correction back to students when they encounter difficulties figuring out the relationship between two words. This system aims to identify and understand how students perform and what thinking process is involved in reading. Results showed that more proficient readers integrated referential words in different parts of a text to form a coherent network of textual information, whereas less-proficient readers had difficulty constructing them. Negative correlations between feedback frequency and the number of errors and between feedback frequency and the missed rate of referring were also found. In other words, when students asked for more feedbacks, their percentage of incorrect and missed references decreased. Some recommendations for future improvement are discussed.

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Keywords: Mental representation; Reference; Reading process; Scaffolding; Feedback
1. Introduction

A major task in reading is to identify whether people or objects appearing in different parts of a text refer to the same entity. Such reference is frequently signaled by the use of anaphors, such as definite noun phrases (e.g., the patient) and pronouns (e.g., I, you, they), which commonly take their meanings from earlier or later phrases in a text (Paterson, Sanford, Moxey, & Dawydiak, 1998). In identifying references and searching for the relationships among these references, readers have to construct a comprehensible and coherent mental representation of textual information (Broek & Kremer, 1998; Daniel & Uwe, 2006; Walsh & Johnson-Laird, 2004). The mental representation shows a network of nodes that indicate individual text elements and connections that show the meaningful relations between nodes (Hoefi, Jentsch, Harper, Evans, & Bowers, 2003; Trabasso, Secco, & van den Broek, 1984; van den Broek, 1990). Without the construction and integration of mental representation of textual information, readers’ comprehension will be hindered. The mental representation mechanism is thus designed to document readers’ mental product of text comprehension.

Some studies found that EFL college students lack reading skills necessary for success in highly demanding college courses in Taiwan (Huang, 2005; Yang, 2003, 2004). They often experienced difficulties and failures in the process of reading comprehension. According to the results of Bensoussan and Laufer’s study (1984), the major reading difficulty that ESL or EFL college students encountered while reading was the inability to recognize the connections among sentences in texts. In addition, Chu, Swaffar, and Charney (2002) found that most Taiwanese EFL students were less aware of cohesive devices while reading English texts as these devices occur less often in Chinese. In other words, Taiwanese EFL students rarely used cohesive or referential devices for integrating textual information (Chen, 2003; Sharp, 2003). The difficulty in identifying references and finding out the relationships among these references in a text could account for their lower English reading proficiency.

To help EFL college students overcome their reading difficulty, instructors provide scaffolding that assists them to read progressively. Scaffolding, according to Wood, Bruner, and Ross (1976), refers to the process that enables a reader to solve a problem, carry out a task or achieve a goal which would be beyond his skill level when no assistance is provided. Scaffolding is what teachers do to facilitate readers to complete complex mental tasks that they could not complete by themselves (Pearson & Fielding, 1991). Graves and Braaten (1996) specified scaffolding as the process by which an expert provides temporary support to a reader to help bridge the gap between what the reader can do and what he needs to do in order to accomplish a particular reading task.

Rogoff (1990) further described scaffolding as the supported situations in which readers can extend their current skills and knowledge to a higher level of competence. Four stages of scaffolding instruction are proposed to enhance students’ reading comprehension; they are modeling, practicing, fading, and independent application. Modeling refers to the description or demonstration that the teacher or expert readers offer for the novice ones. The description or demonstration prepares the novice readers for the following reading tasks and help them develop greater awareness of how to approach the tasks. Practicing means the opportunities given to the novice readers for developing their reading skills after the description or demonstration from the teacher or expert readers. Fading means that the teacher or expert readers gradually decrease their support and assistance to the novice
ones. The novice readers are expected to take over the responsibilities of their own reading process. Independent application refers to the situation that the novice readers can approach the reading tasks independently without any help from the teacher or expert readers.

In this study, one of the scaffoldings is provided by a feedback module when EFL college students have difficulties in identifying references and figuring out the relationships among these references. This scaffolding helps students guess from textual clues and reflect on their previous incorrect selection in order to make a correct choice this time. Particularly, this scaffolding assists them to manage and monitor their own process in reading various texts. The goal of this study is thus to implement a computer system of referring practice by providing scaffolding while students are constructing their mental representation of textual information in reading.

In the literature reviewed, only few studies addressed students’ thinking process (e.g., Yang, 2002) and even fewer system developers report the reading process back to teachers and students. The major methods used to document students’ thinking processes were mainly naturalistic observation, interviews, or think-aloud protocols (Schacter, Herl, Chung, Dennis, & O’Neil, 1999; Shu, 2003). These methods are usually time consuming and labor intensive. Furthermore, the thinking process might be too loosely defined with these methods. This study reports on our design of a computer-based referring system that aims to identify and understand how students perform differently with assistance from the feedback module and what thinking process is involved in reading. The system intends to provide students with immediate feedback to raise their awareness of referring and further reports their reading process back to students and the teacher.

2. Method

2.1. Participants

A total of 90 junior and senior college students were recruited from two reading classes in a technological university in central Taiwan. Their language proficiency levels were defined by their reading scores in a simulated online exam Testing of English for International Communication (TOEIC) at http://140.125.169.148. The maximum achievable score in the reading section of the online exam was 200.

Based on the frequency distribution of their scores, the participants were divided into three groups of readers. It was found that the highest frequencies fell in two score intervals, 81–90 (8 students) and 131–140 (8 students). These two intervals provide the benchmarks for dividing the participants into various groups. Participants with reading scores below 90/200 were identified as less-proficient readers and participants whose reading scores were above 130/200 were grouped as more proficient readers. Participants whose scores fell in between were grouped as average readers and they were not the target readers in this study. The frequency distribution of the participants recruited in the current study is shown in Fig. 1.

Thus, 38 more-proficient readers and 37 less-proficient readers were identified in this study. The mean score of the more-proficient readers is 157.89 with a standard deviation of 18.37. The mean score of the less-proficient readers is 57.84 with a standard deviation of 14.70.
2.2. Material

The online referring practice used three texts to examine the participants’ reading comprehension. The three texts were selected from College Reading Workshop (Malarcher, 2005) based on the following four criteria: abundance of referring words for reading practice, similar length, similar readability level, texts written for EFL college students. The three texts were *Freud and the Meaning of Dreams* (number of words: 614; number of referring words: 37), *The Tragedy of Echo and Narcissus* (number of words: 587; number of referring words: 65), and *Commerce through the Internet* (number of words: 594; number of referring words: 22).

2.3. System Development

The system built for this study includes three modules, *user interface, recording module, and feedback module*. The relationships among these three modules are shown in Fig. 2.
As shown in Fig. 2, the teacher designs the course, selects some required texts, and enters the texts to a database through the teacher interface. The recording module traces students’ reading process and behavior while they construct a mental map of referring. The traced data are then reported back to the teacher who identifies the difficulties students encounter. 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 back to students when they encounter difficulties figuring out the relationship between two words.

2.3.1. User interface

The user interface includes a teacher interface and a student interface. The teacher interface helps the teacher manage course data, provide required texts, and observe students’ reading process and behavior. The student interface provides space for the student to draw a map indicating the relationships between references. Fig. 3 shows the student interface.

For the online referring system, a referring interface, a recording module, and a feedback module are implemented. They will be described in detail below (Fig. 4).

(A) Toolbar: This includes many graphic tools. Connection tool can establish meaningful relations between referential devices. Feedback tool compares students’ initial map with that of the expert. It then informs the student what has been done incorrectly and provides students with three candidate references for each device that needs correction. Other tools include cut, copy, paste, erase, group, ungroup, zoom in, zoom out, undo, and redo.

(B) Text field: This area is used to show the text. Students can select a word or a sentence as a text element and then drag to the canvas directly when they identify the text element as a referential device. When a sentence is selected, it will be highlighted.

(C) Referential device list: All referential devices are listed in this area. Students have to understand what these referential devices refer to, then drag and drop them to the canvas. When a referential device is selected, the referential device will also be highlighted in the text field.

Fig. 3. The student interface.
Feedback frame: This will inform students what has been done correctly and incorrectly in the referring practice. In addition, the feedback will provide three candidate references when the student has difficulties identifying the links between two words. Students can decide whether they want to activate this frame.

Canvas: Students add links to indicate the relationships between references on this canvas. They can add, erase, drag and drop elements on the canvas.

2.3.2. Recording module

The system uses a recording module to trace students’ reading process. The teacher can analyze the recorded data and identify the difficulties students encounter and the difference in performance among various reading proficiency groups. The records are helpful for the teacher to modify his instruction according to the demonstrated strengths and weaknesses of students. The module uses some predicates to record students’ behavior data. Table 1 shows some of the recording predicates.

<table>
<thead>
<tr>
<th>Predicates</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read a sentence: [T]</td>
<td>Select a sentence T which the student is reading in the text field</td>
</tr>
<tr>
<td>Add a cell: [X]</td>
<td>Add an element X on the canvas</td>
</tr>
<tr>
<td>Erase a cell: [X]</td>
<td>Erase an element X from the canvas</td>
</tr>
<tr>
<td>Referring: [X][Y]</td>
<td>Add a referential relation between X and Y</td>
</tr>
<tr>
<td>Erase referring: [X][Y]</td>
<td>Erase a relation between X and Y</td>
</tr>
<tr>
<td>Get feedback count: [N]</td>
<td>Request the feedback N times</td>
</tr>
<tr>
<td>Get feedback of: [X]</td>
<td>Request the feedback for the reference X</td>
</tr>
</tbody>
</table>

Table 1
Some of the recording predicates
An example of how the recording module traces students’ reading process is shown in Fig. 5.

2.3.3. Feedback module

While students encounter difficulties in constructing their initial maps, they can request feedback. The feedback module compares the initial map of a student with an expert’s map. The results will then indicate those references which are incorrect and the module will offer three candidate references for each incorrect answer. Fig. 6 shows the feedback received by the student.

The student’s referential map will be compared to the expert’s map. First, the module transforms the expert’s map and the student’s map into predicates. Next, the module lists all references from the student’s predicates and compares them with the expert’s. When the student’s references do not match the correct ones, the module will provide one correct reference and two distracters as candidate references for a new attempt to identify the correct reference. In the example in Fig. 6, the student referred “them (8)” to “Sigmund Freud”. This was incorrect so that the student asked for a feedback. The system provided
the correct reference “patients” and two distracters “that” and “his (9)”. Table 2 shows the comparison between a student’s map and the expert’s map in the system.

In the table, the feedback module compares a student’s map with that of the expert and finds the incorrect resolution of the referential device A. The module will then offer the correct reference B and two distracters D and E as candidate references for the student to make a new attempt.

2.4. Procedures of data collection

The present study was conducted between April 24th, 2006 and June 10th, 2006, with subjects of 90 college students who were asked to complete the online referring practice on the website http://140.125.32.148/reading in class. The online system recorded the participants’ reading behavior and performance.

For each text, the participants were required to do referring practice by selecting referential words and drawing the relationships between these words on the canvas. The online system grades the participants’ referring practice by giving one score point to each correct connection between two referential words.

2.5. Procedures of data analysis

The participants’ raw data were categorized into two types: reading process and reading product. Reading process refers to the participants’ construction of their mental maps and the trace results of their reading behavior. Reading product includes the participants’ scores of referring and feedback frequency. In referring practice, three results were differentiated: correct, incorrect, and missed. These were further analyzed with the Statistical Package for Social Science (SPSS) 12.0 Version.

3. Result

In this study, three types of reference, personal, demonstrative, and locative, are investigated since they appear more frequently in texts (Fortanet, 2004; Kennison, 2003). The student’s mental maps in drawing these three types of references will be illustrated below. In addition, the frequency of feedbacks will be shown in the tables.

3.1. Mental maps of personal references

Personal reference refers to individuals or objects by specifying their functions or roles in the speech situation (Halliday & Hasan, 1976), such as “I”, “me”, and “you”. From the
analysis of students’ mental maps, it was found that the more-proficient students’ referring processes in personal reference were constructed as a network, which indicated they had more complete and coherent mental representation of textual information (Fig. 7). The text read by students is presented in Appendix.

A mental map refers to a student’s cognitive structure in referring. The map that is collected in the system becomes a graph, which will be examined by a teacher. As shown in graphs (a) and (b) of Fig. 7, the more proficient readers were able to integrate personal references in different parts of the text to form a network. In contrast, graph (a) of Fig. 8 shows that the less-proficient readers missed many personal pronouns that refer to “Sigmund Freud”. Their referring processes were more inconsistent than those of the more proficient readers. Even though some of the less-proficient readers tried hard to complete the referring practice, many of their answers were incorrect. For example, graph (b) shows that one of the less-proficient readers referred plural pronouns to a singular subject. Graph (c) shows that the less-proficient reader referred the word “him (7)” to the former word “his (6)”, but he could not further connect “his (6)” to the subject “Sigmund Freud” to make the comprehension coherent. Graph (d) also displays a problem similar to graph (b).

Fig. 7. Examples of more proficient readers’ mental maps in personal references.
3.2. Mental maps of demonstrative references

Demonstrative reference acts as a form of verbal locating, such as “this”, “these”, and “that”. The speaker figures out the reference by means of location, on a scale of proximity. Fig. 9 further presents the map of demonstrative references of a more-proficient student and that of a less-proficient student. It showed that the more-proficient student was more skillful in identifying demonstrative references successfully. Conversely, the less-proficient students connected the demonstrative references more randomly.

3.3. Mental maps of locative references

Locative reference is used to indicate location, such as “here” and “there.” For example, the table in the sentence, “She put the book on the table”. Fig. 10 shows the map of locative references of a more proficient and that of a less-proficient student.

Fig. 10 shows that the referring maps of locative references are quite different between a more proficient student and a less-proficient student. Even though both of them knew which word the locative reference referred to, the more-proficient students referred the locative reference in a successive and integrated way, while the less-proficient student was unable to further relate “the unconscious mind” to “the place”, the locative reference, as the more-proficient student did.
3.4. Trace results of the student’s reading process

In the trace results, the more-proficient students asked for more feedbacks than their counterparts did during the reading process. The more proficient students asked for feedbacks especially when they were not sure what the referring was. Before or after requesting feedback, they would reread the text. They continually requested feedbacks until they clearly understood the referring. Fig. 11 shows a more-proficient student’s reading process.

As shown in Fig. 11, the more proficient student asked for 53 feedbacks when reading the passage (see line 436). After receiving a feedback, the student read and reread the
sentences to make sure his/her understanding was correct. While rereading the passage, the student was engaged in self correction and comprehension monitoring, such as adding or erasing a text element (e.g. line 433 and line 434). Fig. 11, furthermore, shows the student worked hard to read and reread between the lines. A total of 437 reading actions were documented for the teacher to understand the reader’s reading process and behaviors.

In contrast to the more proficient reader, the less-proficient reader did not ask for feedback when he could not find out the references during reading (Fig. 12). Apparently, merely 31 lines were documented as his reading process. As shown in Fig. 12, the less-proficient reader read the sentences repeatedly, but he seldom asked for feedback. He tried to guess what the referring words were, but he usually failed.

3.5. The feedback to the teacher and to the student

A summary of results in terms of a student’s referring practices were provided for both the teacher and the student to know what correct items, errors, and missed referential devices were produced by the student (Table 3).

In addition to a summary table of the student’s referring practice, another summary table was also provided for the teacher (Fig. 13). This feedback figure indicated the student’s performance, including the date, the time, the score of referring practice, and the frequency of asking for feedbacks.

The 90 participants’ mean score and standard deviation of referring practice for each text are shown in Table 4. The full score of referring practice in text 1 (Freud and the Meaning of Dreams) is 38; that of text 2 (The Tragedy of Echo and Narcissus) is 62; and that of text 3 (Commerce Through the Internet) is 21. The three texts were read sequentially.
by students. As shown in Table 5, it was found that students made progress in three sequential referring practices as the percentage of correct referring increases from 55% (mean/full score) to about 70%.

A t-test was conducted to examine whether there were significant differences between the more-proficient and the less-proficient readers in their scores of referring practice and their frequency of using feedbacks. The results show that the p-value was less than .05. This result is similar to that of the feedback frequency. That is, the mean scores of the more proficient readers and the less-proficient readers in the referring practice were significantly different and their feedback frequencies were also significantly different. The
The feedback tool of the system was only provided when the student requested it actively. Since text 1, text 2, and text 3 are presented to the student sequentially, a comparison on the feedback frequencies for the three texts can show whether the student relied more, or less on the feedback tool as they worked on the referring practice. As shown in Table 5, students gradually asked for fewer feedbacks from text 1 to text 3 as the mean of feedback frequency decreased from 17.90 to 7.67. In other words, students became more independent and rely less on the feedback in three sequential reading tasks.

Table 6 presents the Pearson product-moment correlation coefficient between the number of errors and feedback frequency and between the number of missed references and participants' mean and standard deviation for each text in feedback frequency were shown in Table 5.

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Table 6 presents the Pearson product-moment correlation coefficient between the number of errors and feedback frequency and between the number of missed references and
feedback frequency in referring practice. The results show that the correlation between the number of errors and feedback frequency is negative for the more proficient readers. That is, when they asked for more feedbacks, they made fewer errors. This is also true for the relationship between the number of missed references and feedback frequency. In contrast, the correlation between the number of errors and feedback frequency is positive for the less-proficient readers. They did not actively ask for feedback and did not select the correct answer when the feedback provided candidate references.

4. Conclusion

In this study, the online system offers four stages of scaffolding instruction to assist EFL college students in identifying references and establishing relationships between references. The four stages are modeling, practicing, fading, and independent application. For modeling, the guiding instruction of the system explains the goal of the system and the types of references a student is asked to identify. This explanation helps the student understand how to do the referring tasks. For practicing, three practice sessions, one for each text, offer the student chances to perform the referring tasks with the system. By means of practicing, the student develops a better awareness of how to complete the referring task online. Then, scaffolding fades out after the practice. While the student is doing the referring tasks, he should be aware of his reading process and actively seek scaffolding by themselves. The system does not provide scaffolding automatically. Instead, the system provides scaffolding only when the student requests it. Eventually, when the student is capable of completing the referring tasks independently, no scaffolding is needed anymore.

The online reading system also automatically traces and records the student’s reading behavior and process. The trace results clearly illustrate the student’s performance in referential identification and resolution. That is, the student’s difficulties in resolving personal, demonstrative, and locative references can be identified and examined. Based on this examination, the reading teacher is able to design appropriate lesson plans and classroom activities to assist the struggling students in overcoming their difficulties and compensating their weaknesses. In other words, the trace results serve as a guide for the reading teacher to design and plan follow-up remedial courses.

Regarding suggestions for improvements, some new help functions could be added. First, after the student had done the referring practice, the system should not only provide the results of scoring but also the expert’s mental map. This will help the participants compare their initial mental map with that of the expert. By comparison, it will arouse their awareness and assist them to reflect on their own reading process. The precision and recall

<table>
<thead>
<tr>
<th>Readers</th>
<th>Text 1</th>
<th>Text 2</th>
<th>Text 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Error/missed</td>
<td>Error/missed</td>
<td>Error/missed</td>
</tr>
<tr>
<td></td>
<td>feedback</td>
<td>feedback</td>
<td>feedback</td>
</tr>
<tr>
<td>More-proficient</td>
<td>-.43</td>
<td>-.38</td>
<td>-.87</td>
</tr>
<tr>
<td>readers</td>
<td>Less-proficient</td>
<td>readers</td>
<td>readers</td>
</tr>
<tr>
<td></td>
<td>.19</td>
<td>-.81</td>
<td>.14</td>
</tr>
</tbody>
</table>
rate of the student’s mental maps should also be derived, so that the student’s mental maps
in referring practice can be further analyzed.
Second, the student’s self-assessment should be taken into consideration for the next
implementation of the system. The student should have more freedom in terms of the type
and the number of texts he intends to read based on his specific needs. A reader’s portfolio
could also be adopted in the system that allows the student to set up a reading plan for a
whole semester. Another consideration is to have low achievers use the system for bonus
credit purposes, rather than requiring the whole class to complete the same amount of
tasks.

Acknowledgements

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wan (NSC 96-2411-H-224-014). The research grant made the completion and continuation
of this study possible.

Appendix

Sigmund Freud was a doctor of psychology in Vienna, Austria at the end of the 19th
century. He (3) treated many patients with nervous problems through his (4) “talk cure.”
For this (5) type of treatment, Freud simply let his (6) patients talk to him (7) about any-
thing that was bothering them (8). While treating his (9) patients, he (10) began to realize
that although there (11) were events in a patient’s past that she or he (12) might not
remember consciously, these (14) events could affect the person’s (15) actions in her or
his (16) present life. Freud called the place (18) where past memories were hidden the
unconscious mind (19). Images from the unconscious mind (20) might show up in a per-
son’s dreams or through the person’s (21) actions. Freud wrote a book about his (22) the-
ories about the unconscious mind (23) and dreaming in 1899. The title of the book was
The Interpretation of Dreams.

Freud discussed several different theories about dreams other than just his (26) own in
the book. The theory (27) that (28) most doctors and scientists at that (29) time seemed to
prefer was that (30) most of the brain’s activity (31) during the day (32) was “turned off” at
night. Dreams did not have any kind of use or importance in their (33) opinion. Dreams
were simply seen as part of the process of the brain turning off and then turning on again
in the morning (36).

A few researchers, however, said that dreams had a more useful function. Some
researchers thought that dreams were actually the way (37) the brain (38) cleaned itself
(39). During the day (40), people have thousands of different thoughts and impressions
from what they (41) see and hear. Not all of these (42) impressions can be fully processed
by the brain (43). People are distracted from processing many of these (44) impressions by
more important thoughts or impressions. At night when a person is dreaming, the half-
impressions (45) from the day (46) are processed and thrown away by the brain (47).
Because the brain (48) only has a half-impression to process, the mind (49) uses a person’s
imagination to complete the impression (50). According to this (51) theory, dreams are
seen as half real and half fantasy.

A third theory discussed in Freud’s book says that dreams are really impressions
or memories, but the dreamer (52) does not recognize them (53) because they (54) were
unimportant impressions from the past (55). For example, during a person’s honeymoon, the person (56) rarely dreams about her (57) husband or his (58) wife. That (59) is because the new husband or wife (60) has importance in the person’s (61) thoughts. It (62) is all the other unimportant impressions from the person’s honeymoon (63) or past life that (64) show up in dreams. But because these (65) impressions were unimportant when first seen, the person (66) does not recognize them (67) in the dream (68). This (69) theory also explains how impressions or thoughts that a person tries to bury in her or his (70) mind can show up in dreams.

A final theory that (72) Freud discusses in his (73) book is the theory (74) that dreams are sort of play of the mind (75). In dreaming, the mind (76) can take all of the images (77) from a person’s present or past life and build something new from these (78) images. This (79) construction is pure fantasy. During sleep, all of the patterns of thought that usually control the mind (81) are relaxed. Dreams do not have to make sense because there (82) are no rules to follow. Through this (83) kind of play, the mind relaxes (84) and refreshes itself (85).

Freud admitted in his (86) book that more research into dreams was needed before science could choose the correct theory (87). But from his (88) point of view, the unconscious mind (89) was the source of many of the images (91) in dreams. Although Sigmund Freud had many opponents to his (92) theories, his (93) research helped further the development of modern psychiatry and became the basis (95) for a school of counseling.

References


