The Impact of Externalizing Readers’ Mental Representation on the Comprehension of Online Texts

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ABSTRACT

This study reports on our design of a computer system which supports the understanding of how students construct their mental representation of references and how the construction failures impede their reading comprehension. Three modules, User interface, Recording, and Feedback were implemented. The recording module traced all students’ reading process when they tried to link sentences together by references. Results showed that more-proficient readers’ mental process in resolving references was constructed to be a complete and coherent network. When they encountered reading difficulty, they usually engaged in comprehension monitoring to read and reread the related sentences to find out contextual clues. They also asked for a feedback tool for assistance. All these helped them grasp the main idea of a text and solve lexical ambiguities. In contrast, average and less-proficient readers often resolved the references separately or mismatched them to an incorrect subject which led to partial understanding of textual information. Their unsuccessful resolution of references in previous sentences often hindered their interpretation of subsequent sentences. This caused repeated reading failures in the comprehension of an online text. The mental maps and reading process shown in this study clearly explain students’ reading success and failure. The discussion of these maps and processes between the teacher and students will be one of the ways to promote latter’s awareness in employing comprehension monitoring and referring strategy.

Keywords
Mental representation, Referential resolution, Reading failure, Process data, and Main idea

Introduction

In the information age, reading enormous information resources provided by internet underpin professional success. That is why the development of information processing abilities is one of the primary objectives in higher education; particularly, college reading is considered an information-processing skill that a student should internalize for meaning construction (Yang, 2007). In college, reading is not only essential to academic learning in all content areas but also to professional success and, indeed, to lifelong learning (Levine, Ferenz, & Reves, 2000; Pritchard, Romeo, Muller, 1999). Nevertheless, many students who register for undergraduate study are under-prepared for university education and have low levels of reading proficiency (Dreyer & Nel, 2003). This is particularly true for college students who learn English as a Foreign Language (EFL) in Taiwan.

Many EFL college students in Taiwan were found to lack reading skills necessary for success in highly demanding college courses (Huang, 2005; Yang, 2003, 2004). They often encountered difficulties and failures in the process of reading comprehension. According to Chen, You, Yang, & Huang’s study (2004), 35.5% of them failed the reading section at the elementary level of General English Proficiency Test, a nationwide screening test. That is, many of them did not have the required ability for college reading, since their reading proficiency was identified as being equivalent to junior high school level.

When pressed to read, EFL college students often selected ineffective and inefficient strategies with little strategic intent (Wood, Motz, and Willoughby, 1998). Often this was due to their low level of reading strategy knowledge and lack of comprehension monitoring engagement (Dreyer, 1998). Another factor might be their inexperience coming from the limited task demands of high school and the focus of traditional reading instruction on the teacher’s one-way lecture and knowledge reproduction (Dreyer and Nel, 2003). As a result, some students would not engage in reading strategy or comprehension monitoring unless they were asked to think about their reading process through activities or instruction (Hartley, 2001).

The computer assisted learning environment was shown to greatly support the reader’s engagement of reading strategy and comprehension monitoring for it provided explicit modeling and individualized scaffolding (Potelle & Rouet, 2003). The modeling and scaffolding assisted the reader to manage and monitor his/her own process in
reading various texts. This is fundamentally important for EFL college readers in Taiwan for there are about 45 or more students of varying language proficiency levels involved in one class. The large class size limits the classroom teacher to provide the individualized support, guidance, and monitoring required for each reader’s progress.

To monitor readers’ progress, Chang, Sung, and Chen (2002) investigated the effects of concept-mapping strategies in a computer system. They designed three approaches—map correction, scaffold fading, and map generation—to enhance students’ text comprehension and summarization abilities. The experimental results showed that the map-correction method enhanced text comprehension and summarization abilities and that the scaffold-fading method facilitated summarization ability. Chang et al. addressed that graphic strategies, such as graphic organizers and knowledge maps, had proved useful for text comprehension. In addition, Vakilifard, Armand, and Baron (2006) examined whether concept maps enhanced the second language students’ reading comprehension in the first language context. Their results showed that the early presentation of concept maps before reading texts led students in experimental group to understand the texts effectively. Positive results of using concept maps in various subject areas could be found in Hazzan’s (2004), Kwon and Cifuentes’ (2007), Ruiz-Primo, Schultz, Li, and Shavelson’s (2001) studies.

In the literature reviewed, very few studies addressed college students’ mental representation of reading process (Yang, Yeh, Wong, and Lee, 2008). The process data were rarely found to indicate how students read and reread a sentence, how they selected, deleted, and reselected a text element, and how they integrated different sentences by building connections between text elements. These important data were even hardly reported back to the teacher and the individual student (Schacter, Herl, Chung, Dennis, and O’Neil, 1999). The teacher got no chance to monitor his/her students’ reading process in details. Similarly, the individual student lost the opportunity to reflect on their own process. This study reports on our design of a computer system that supports the understanding of how students construct their mental representation of references and how the construction failures impede their reading comprehension. In the system, each student’s reading behavior and process were recorded by a recording module. It made the intangible reading process visible to the teacher. This also enabled the teacher to observe the difficulties that his/her students encountered and the differences in performance among students with various English reading proficiencies. Based on this information, the teacher was able to modify his/her follow-up instruction to help students overcome their difficulties and better develop their processing skills in reading.

In this study, mental representation is defined as the mental map that demonstrates the reader’s cognitive structures for establishing the relationships among the references in different parts of a text. In the mental map, references are represented as nodes and connected by lines. The connecting lines express the relationships among the references and make the mental map more meaningful by showing how the student relates references to each other in his/her cognitive structure. This is also called co-reference or referential resolution (Walsh & John-Laird, 2004). Referential resolution is a reading strategy applied by the reader to interpret the references that have the same meanings as other elements in the text, such as “he” refers to “John.” While resolving the references, the reader is actually engaged in comprehension monitoring which he/she monitors, regulates, and evaluates his/her own reading process (Hartman, 2001). The management and regulation of one’s own reading process is helpful for meaning construction of text (Paris and Winograd, 1990).

**Method**

**Participants**

A total of 92 junior and senior college students were recruited from three reading classes in a technological university in central Taiwan. Their language proficiency levels were identified by their reading scores in a simulated online exam Testing of English for International Communication (TOEIC) at http://140.125.169.80. The maximum score in the reading section of the online exam was 200.

The frequency distribution of all the participants’ score was used to divide the participants into three groups of readers. The frequency distribution is shown in Figure 1.
As shown in Figure 1, the highest frequency falls in the two intervals, 101-110 (8 students) and 151-160 (8 students). These two intervals provide the benchmarks for dividing the participants into three groups of readers. Participants with reading scores above 151 were identified as the more-proficient readers and those with reading scores below 101 were the less-proficient readers. Participants with reading scores between 101 and 151 were identified as the average readers.

Thus, 29 more-proficient readers, 32 average readers, and 31 less-proficient readers were identified in this study. The more-proficient readers showed a mean score of 175.52 with a standard deviation of 14.60, the average readers a mean score of 126.41 with a standard deviation of 15.09, and the less-proficient readers a mean score of 74.03 with a standard deviation of 17.53.

**Material**

The online referential resolution practice used four texts to examine the participants’ reading comprehension. The four texts were selected from *College Reading Workshop* (Malarcher, 2005) based on the following four criteria: abundance of references for reading practice, similar length, similar readability level, texts written for EFL college students. The four texts were *Ideas about Beauty* (number of words: 582; number of referring words: 25), *Fast Food and Teen Workers* (number of words: 583; number of referring words: 25), *Adventure Tours for Charity* (number of words: 599; number of referring words: 43), and *Traditional Markets vs. Modern Markets* (number of words: 577; number of referring words: 31).

**System development**

The system built for this study includes three modules, a *user interface*, a *recording module*, and a *feedback module*. Figure 2 shows the interface and module of referential resolution.
As shown in Figure 2, the interface and modules of referential resolution include five sections. They are described and shown in details below.

A. **Instruction.** There is a detail description of the referential resolution task. The student has to first identify the references and then resolves them by drawing a mental map to establish the relationship between the references. The instruction prepares and guides the student to approach the task.

B. **References.** All references are marked with numerical numbers. The student has to distinguish the accurate references from the distracters which are not references. He/she then decides what these references refer to, and clicks and drags them to the **canvas** to construct a mental map that illustrates the relationships between the references. When a reference is selected, it is highlighted in the **text field**.

C. **Text field.** This area is used to display the text. Students can select a word or a sentence as a text element and then drag to the canvas directly when they comprehend the relations between the references. When a sentence is selected, it will be highlighted.

D. **Toolbar.** This includes many graphic tools. **Connection tool** is used to establish meaningful relations between referential devices. **Feedback tool** compares students’ initial graph and that of the expert. It then informs students what has been done correctly in referential resolution and provides students with three candidate references to correct their errors. Students can decide if they want to activate this tool. Other tools are *cut, copy, paste, erase, group, ungroup, zoom in, zoom out, undo,* and *redo.*

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

The user interface includes a teacher interface and a student interface. The teacher interface enables the teacher to manage course data, provide required reading texts, and observe students’ reading process and behavior. The student interface provides space for the student to draw a graph indicating the relationships between references and answer an online open-ended questionnaire (see Figure 3).

Recording Module

The system uses a recording module tracing students’ reading process. From the data, the teacher can observe and identify the difficulties students encounter and difference in performance among various reading proficiency groups. The records are helpful for the teacher to modify his/her instruction according to the demonstrated strengths and weaknesses. An example how the recording module traces students’ reading process is shown in Figure 4.

Feedback Module

While students encounter difficulties in constructing their initial maps, they can request feedback. The feedback module compares the initial map with the correct one. The results will then indicate those references which are incorrect and offer three candidate references for each incorrect answer. Figure 5 shows the feedback received by the student.
Devendra Singh, a psychologist at the University of Texas at Austin, conducted an experiment in 1993 to find out if different men found different female body shapes attractive. Dr. Singh gave drawings of different female body shapes to a variety of men and asked them(5) to choose the most attractive body shape. Even though the men(6) came from a wide range of cultural backgrounds, they(7) all tended to rate the "hourglass" body shape as the most attractive. In fact, Dr. Singh found that(8) any woman whose waist is 70% as wide as her(9) hips is judged as attractive by most men no matter how big the woman(10) is overall. Body shape, not weight, seemed to be viewed as the critical factor(11) for attractiveness by men in this(12) survey.
As shown in Figure 5, the three candidate references are highlighted for the student to make a second attempt at the correct answer. Then, the student connects the chosen reference to the referent in the mental map (see Figure 6).

The comparison of the student’s answer and the expert’s referential resolution result is processed in the following way. First, the module transforms the correct graph and the student’s graph into predicates. Next, the module lists all references from the student’s predicates and compares them with the correct ones. 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 at the right answer. Table 1 shows the comparison in the system.

Table 1. The comparison between the student’s graph and the correct framework

<table>
<thead>
<tr>
<th>Correct Map</th>
<th>Predicates</th>
<th>Student’s Map</th>
<th>Predicates</th>
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<tr>
<td>Map</td>
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<td>Map</td>
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</tr>
<tr>
<td>A —&gt; B</td>
<td>Add a cell: [A]</td>
<td>A —&gt; C</td>
<td>Add a cell: [A]</td>
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<tr>
<td></td>
<td>Add a cell: [B]</td>
<td></td>
<td>Add a cell: [C]</td>
</tr>
<tr>
<td></td>
<td>Referring: [A][B]</td>
<td></td>
<td>Referring: [A][C]</td>
</tr>
</tbody>
</table>

In the table, the feedback module compares a student’s graph with that of the expert and identifies the resolution of the referential device A to be incorrect. 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.

Procedures of Data Collection

The online system of referential resolution required students to follow these steps in reading a text: (1) to identify references, (2) to draw relationships between the references, and (3) to answer an open-ended questionnaire. The present study, conducted between October 2nd, 2006 and January 3rd, 2007, involved 92 college students who completed the online referential resolution practice on the website http://140.125.32.127/reading in class. The system recorded the reading behavior and process of participants.

Procedures of Data Analysis

Content analysis and constant comparative method were used to examine the data on participants’ mental maps of referential resolution, the feedback tool request, and the trace results of their reading process. Content analysis helped the researchers to discover and describe the focus of individual, group, institutional, or social attention and allowed the researcher to make inferences (Weber, 1990; Patton, 1990). Four steps of content analysis were conducted in this study; these were coding, categorization, description, and interpretation. The researchers first read through the transcription and identify the meaning units that can be sentences or passages. Next, the researchers tried to categorize the meaning units and build a system of coding categories. According to categorization, the researchers structure and present the data. The researchers finally interpreted the data by offering explanation, drawing conclusions, and making inferences.

In addition to content analysis, constant comparative method was also used to analyze the data. Comparing incidents applicable to each category was the first stage in which the researchers coded the data into categories and constantly refined the idea of the category as more data were recruited. The second stage was integrating categories and their properties. That is, the researchers focused on the properties of each category and continuously compared the properties among the categories. Then, the comparison enabled the researchers to have theoretical senses and generate the resulting theory. The third stage was delimiting the theory in which the researchers modified and concluded with a theory after comparing the categories. Then, the researchers revised the theory by stripping irrelevant properties of category away and integrating details of properties into an outline of interrelated category. A number of categories was reduced. The final stage was writing the theory in which the researchers finished categorizing and coding data, and developed a theoretical model. Analysis of data using the two research methods will be further explained in the following sections.
Result

The mental maps were drawn to illustrate the readers’ referential process and text comprehension. The analysis of mental maps showed the mental process of different readers with regard to the three types of reference investigated in this study: personal, demonstrative, and locative references. The differences in mental maps of the three types of references are described as follows.

Figure 7. Examples of more-proficient readers’ mental maps in personal reference
Mental Maps of Personal Reference

In the system, participants were asked to read texts and draw their mental maps. A text is shown below.

Those(10) who sign up then have to pay a deposit in order to hold their(11) space on the tour(12). People cannot get their(13) deposit back later if they(14) change their(15) mind and decide not to go on the tour(16), so they(17) had better be sure they(18) really want to go. The deposit(19) is usually between £200-300.

Based on the above text and the mental maps that students drew, it was found that the mental process of more-proficient readers in resolving the personal references constructed a network. The network shows a complete and coherent mental representation of textual information. This is illustrated in Figure 7.

In graph (a) and graph (c) of Figure 7, participant 5 referred the references directly to the same subject. Participant 22, in graph (b), further established the relationships among the references. She resolved items their (13), they(14), their(15), they(17) and Those(10) by associating they(17) and their(15) with they(14), Those(10) who sign up, and people to establish accurate relationships among these references and referents. In these three examples, networking helped the readers grasp the main idea which is necessary to the correct interpretation of subsequent paragraphs. For example, the trace results of participant 22 further show correct interpretation of follow-up references.

As shown in Figure 8, participant 22 read and reread the follow-up sentences for several times (e.g. lines 241–243). She then correctly referred they (18) to all the possible subjects in the text (e.g. lines 248, 255, 256, 257) as shown in her mental maps in Figure 9.
In contrast to the coherent network of more-proficient readers, the average and the less-proficient readers failed to develop organized maps. Figure 10 shows the mental maps of average and the less-proficient reader in personal reference.

Graph (a) of Figure 10 indicates that the average reader failed to relate the personal reference to the same subject. She often resolved the references individually, which might explain for her partial understanding of textual information. This also indicated that her textual comprehension was limited to a single sentence or paragraph.

As for the less-proficient reader, he not only referred the references to a subject separately but also mismatched the references with an incorrect subject. Graph (b) of Figure 10 illustrates his disassociation of plural words to the single subject. He mismatched they (17) with the former word, the tour(16). The separation or mismatch in referential resolution led the less-proficient reader to misinterpretation of the current sentence and the subsequent text. This resulted in overall miscomprehension of the text. For instance, Figure 11 shows participant 75’s mismatch of the subsequent reference.

As shown in Figure 11, participant 75 requested the feedback tool twice for referring this(22) to a subject (e.g. lines 74 and 76). However, he still mismatched this(22) with 1,500-2,500. Similar comprehension failures occurred repeatedly (e.g. lines 86–90).

**Mental Maps of Demonstrative Reference**

A text was also read by three groups of participants and it is shown below.

*Through his* (21) own survey, Dr. Yu found that (22) the men (23) in *this* (24) isolated community preferred heavier women with wider waists, and not particularly women with “hourglass” shapes.
Because this small community has lived apart from western mass communication, their own culture has not been influenced by outside standards of beauty. Dr. Yu points out that this group has experienced the same genetic evolution as all humans do, but a different standard. In order to check the reliability of his study, Dr. Yu surveyed two other groups of men from this same community. However, the second and third groups surveyed by Dr. Yu had had more exposure to Western media. The results of these later surveys showed that as men from this isolated community came into contact with Western media, their standards of beauty began to change more toward the Western standard of beauty.

![Figure 11](image)

While reading the above text, readers were drawing their mental maps. From the analysis of the readers’ mental maps, it was found that the more-proficient readers successfully related the demonstrative references in different parts of the text to the same subject in an integrative way. Examples of the more-proficient readers’ mental maps are presented in Figure 12.

As shown in graph (a) of Figure 12, participant 23 successively referred the demonstrative references to the same subject. In graph (b), participant 26 even correctly established the relationships between references. She correctly linked the shopper to the former reference, the shopper. A clear understanding of the relationships among references and textual information aided the more-proficient readers to resolve lexical ambiguities and better comprehended the text. This supported her to refer the subsequent references to the correct subjects. Figure 13 presents participant 26’s mental map of follow-up sentences.

In Figure 13, participant 26 correctly referred and integrated the references. Her successful resolution of references in previous sentences facilitated her correct interpretation of follow-up references and constructed relationships among sentences.
Conversely, the average readers commonly referred the demonstrative references either to part of the subject or incorrect ones and the less-proficient readers often mismatched the references to the incorrect subject. Examples of average readers’ mental maps are shown in Figure 14.

Figure 12. Examples of the more-proficient readers’ mental maps in demonstrative reference

Figure 13. Participant 26’s mental map of follow-up references

Figure 14. Examples of average readers’ mental maps in demonstrative reference
Graph (a) of Figure 14 indicates that the average reader could not match the references to a correct subject. Instead, she could only refer the references, this (24), this(25), and this(32) to the partial subject, isolated community. In graph (b), another average reader even linked the references to the incorrect subject. He mismatched the demonstrative references to mass communication. The incorrect or partial integration of references resulted in misunderstanding of these parts of the text, which, in turn, hindered comprehension of related information in the succeeding sentences or paragraphs. Figure 15 shows participant 42’s mental map of follow-up references.

![Figure 15. Participant 42’s mental maps of follow-up references](image)

In Figure 15, participant 42 constantly mismatched the references with incorrect subjects. These(34), which is a demonstrative reference referring to objects or events in the context, was matched with men from this(32) isolated community came into contact with Western media, their(33) standards of beauty began to change more toward the Western standard of beauty, which is a personal pronoun indicating an individual. It, which is a personal pronoun, was mismatched with find isolated communities, which is a verb phrase.

As for the less-proficient readers, they often referred several occurrences of the same referential word incorrectly to one subject. In graph (a) of Figure 16, the reference this in different parts of the texts was incorrectly referred to the subject southeast Peru. This incorrect referential resolution led the less-proficient reader to misinterpret southeast Peru and activated irrelevant background knowledge to interpret the subsequent sentence. In graph (b), another less-proficient reader also related the references to incorrect subjects. He incorrectly referred the demonstrative reference this (24) to a person referent heavier women.

![Figure 16. Examples of the less-proficient readers’ mental maps in demonstrative reference](image)

The mismatches shown in Figure 16 confused the reader in the organization of textual information, either by leading comprehension in the incorrect way or by misinterpreting the meaning of textual information. Figure 17 presents participant 69’s mental map of follow-up references.
In Figure 17, participant 69 not only failed to identify the correct references but also mismatched references with incorrect subjects. One (37), which was not a reference, was selected and mismatched. It (36), which is a personal pronoun, was connected to *o find isolated communities like the one (37) surveyed by Dr. Yu*, which is a verb phrase.

**Mental Maps of Referring in Locative Reference**

From mental maps of locative reference, the more-proficient readers were able to identify the references and referred them to the correct subject (see graph (a) of Figure 18) in reading the following text.

> One reason ferias are still popular is because people feel that(19) they(20) can get better fruits and vegetables at a better price there(21). While shopping at the feira, people can pick up the things they(22) might want to buy, smell the fruits and vegetables, and sometimes even taste them(23) before they(24) buy anything.

The correct identification and resolution facilitated the more-proficient reader to accurately interpret follow-up textual information and fully comprehend the text. The average readers, however, tended to refer the references to the incorrect subject due to their inaccurate comprehension of the text. In graph (b) of Figure 18, the average reader (participant 50) mismatched *there (21)* with *the feira* when *There (21)* is not associated with a specific feira. Hence, the average reader referred the locative reference to an incorrect semantic subject.

Similarly, the less-proficient readers were deficient in resolving locative reference. For example, in graph (a) of Figure 19, the less-proficient reader referred *ferias* to *there (21)*. It showed that the reader first recognized the word “ferias” and then linked the word to the reference *there (21)*. This mental process suggested that the reader had to spend time and effort on word recognition first. If she encountered unknown words in the following sentences, she would fail to refer the references correctly.

In addition, graph (b) of Figure 19 indicates that the less-proficient reader could not correctly identify the locative reference. She was confused by the references *the country (17)* and *there (21)* and referred them to the same subject. This misinterpretation continued in follow-up sentences that contained the two references. In graph (c), the less-proficient reader referred the locative reference to an incorrect subject. *There (21)*, which refers to a place, was mismatched with *a better price*, a noun indicating an amount of money.
The mismatch of earlier references could lead to comprehension failures of the subsequent text. For instance, participant 83 continuously matched the references in follow-up sentences to incorrect subjects, linking this (28) and their (35) to incorrect subjects (see Figure 20).

**An open-end questionnaire**

The open-ended questionnaire was designed to understand readers’ perception toward referential resolution and the online system. Before using the system, many readers stated that they did not know the referring strategy and seldom used it. The more-proficient readers expressed that they were only familiar with the pronouns. The less-proficient readers claimed that they seldom identified references in a text. After using the system, most readers stated that the system enhanced their knowledge and employment of referring strategy. In the following tables, MR refers to the more-proficient reader, AR the average reader, and LR the less-proficient reader. Text 1 indicates the text Ideas about Beauty, Text 2 Fast Food and Teen Workers, Text 3 Adventures Tours for Charities, and Text 4 Traditional Markets and Modern Markets.

When participants were asked their reading difficulties and solutions in the online system, some more-proficient readers expressed that they sometimes failed to identify references in a text (see participant 21’s response in Table 2). This was the same for the average and less-proficient readers who were unable to resolve the references in longer sentences (see participant 44’s and 62’s responses in Table 2). To overcome their difficulties, they read and reread related sentences to find out the contextual clues. They even requested the feedback tool for assistance. For instance, when reading the first text, participant 44 read and reread sentences for contextual clues. After this, she began to reflect on the possible solutions in the second and third texts. In the fourth text, she monitored her reading process and requested the feedback tool very often for assistance.

Participants commonly emphasized the importance of the feedback tool for their reading progress. For instance, the more-proficient readers relied on the feedback tool to verify whether the connections between references were correct in their mental maps (see participant 25’s response in Table 3). Both the average and the less-proficient readers asked help from the feedback tool to identify references and figure out the relationship between two words (see participant 41’s and 62’s responses in Table 3). For example, participant 25 began to clarify her referential resolution by connecting the references in the second text. After this, she sought help from the feedback tool to confirm the connections she made in the third and fourth text.
Table 2. Participants’ reading difficulties and resolutions in the system

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<tr>
<th>Group</th>
<th>Text</th>
<th>Response</th>
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<tr>
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Similar to the more-proficient reader, the average reader also expressed her perception in using the feedback tool. She indicated that the feedback tool assisted her to narrow down the possible answers when reading the first text. With the assistance of the feedback tool, she began to identify more references in the second text. In the third and fourth text, she was able to find out the correct references (see participant 41’s responses in Table 3).

The less-proficient reader’s perception toward the feedback tool is also illustrated in participant 62’s responses in Table 3. When reading the first text, she relied on the feedback tool to identify and refer the references. In the second and third texts, she was able to identify and refer the references based on the clues that the feedback tool offered. In the fourth text, she emphasized that the feedback tool aided her to identify and refer the references in longer texts.

Table 3. Participants’ perception towards the feedback tool

<table>
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<th>Response</th>
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<td>4</td>
<td>P62</td>
</tr>
</tbody>
</table>
When participants were asked how the referential resolution influenced their reading comprehension, most readers mentioned that it helped them reread a text and grasp the main idea. For example, participant 21 in Table 4 mentioned that referential resolution assisted her to grasp the main ideas and figure out the meanings of unfamiliar words in the first text. In the second and third text, she was able to read the texts faster. In the fourth text, she better comprehended the text and enlarged her vocabulary size. The average reader, participant 33’s response in Table 4, expressed that referential resolution was not very helpful in reading the first text. In the second text, he began to realize that it assisted him to understand the textual information and read faster. In the third text, he was able to grasp the main ideas. In the fourth text, he could correctly interpret the text. The less-proficient reader, participant 68’s response in Table 4, was also benefited from referential resolution. In the first and second texts, he claimed that it helped him understand the textual information. In the third text, he began to figure out the unfamiliar words by resolving the references. In the fourth text, he was able to understand the theme of the text (see participant 68’s response in Table 4).

<table>
<thead>
<tr>
<th>Group</th>
<th>Text</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR</td>
<td>1 P21</td>
<td>It helped me understand the full text by grasping the main ideas and enlarging vocabulary size.</td>
</tr>
<tr>
<td></td>
<td>2 P21</td>
<td>It improved my reading comprehension and speeded up my reading pace.</td>
</tr>
<tr>
<td></td>
<td>3 P21</td>
<td>It aided me to read comprehensively.</td>
</tr>
<tr>
<td></td>
<td>4 P21</td>
<td>I could have deeper understanding about the text. I also enlarged my vocabulary size and better my reading pace and comprehension.</td>
</tr>
<tr>
<td>AR</td>
<td>1 P33</td>
<td>I thought it was not very helpful.</td>
</tr>
<tr>
<td></td>
<td>2 P33</td>
<td>It improved my reading pace and better comprehended the text.</td>
</tr>
<tr>
<td></td>
<td>3 P33</td>
<td>I could quickly grasp the main ideas of a text.</td>
</tr>
<tr>
<td></td>
<td>4 P33</td>
<td>I could fully comprehend a text.</td>
</tr>
<tr>
<td>LR</td>
<td>1 P68</td>
<td>It helped me better understand the textual information.</td>
</tr>
<tr>
<td></td>
<td>2 P68</td>
<td>It aided me to understand the text.</td>
</tr>
<tr>
<td></td>
<td>3 P68</td>
<td>It helped me to figure out the meanings of the unfamiliar words.</td>
</tr>
<tr>
<td></td>
<td>4 P68</td>
<td>It helped me understand the theme of the text.</td>
</tr>
</tbody>
</table>

The readers’ responses in the open-ended questionnaire indicated the different perceptions among the readers. It was found that the referential resolution facilitated the more-proficient readers to read faster and fully comprehend the text whereas it aided the average readers to grasp the main ideas. The less-proficient readers were particularly assisted to understand the meanings of unfamiliar words since they encountered greater difficulties in vocabulary than the more and average readers did. The readers’ different perceptions revealed their various difficulties in reading texts.

**Conclusion**

From the analysis of college students’ mental maps, reading process data, and perception in an open-ended questionnaire, several facts were found. First, the online system guided students to be engaged in comprehension monitoring and referring strategy when reading texts. To draw mental maps, the more-proficient students read and reread the previous sentence and subsequent ones repeatedly. In rereading, they were actually engaged in comprehension monitoring to establish the relationships between the former reference and the follow-up one. The understanding of relationships among the references and the textual information further aided them to resolve lexical ambiguities and grasp main idea. The average and less-proficient readers, in contrast, very often referred the references to partial subjects or incorrect ones. The mismatch of references caused their partial understanding of the text or complicated their text interpretation. This hindered their text comprehension as well as the storage of information in memory. It should be emphasized to these readers the benefits of using feedback tools and referring strategy.

Second, readers’ responses in the open-ended questionnaire also indicated their progress in referential resolution. For example, in the first text, the less-proficient reader had difficulties reading long sentences and using the computer system. She asked help from her peers to overcome her difficulty in using the system first. In the second text, she
only had problems in identifying correct references. In the third text, she developed her referential identification and resolution in reading but failed to this task when there were too many references in a text. In the fourth text, she continued to develop her referential identification and her difficulty was changed to referential resolution. She thought that she had to spend longer time on figuring out the relationship between two words.

Third, the computer system aided the teacher to identify students’ reading difficulties. In referential identification, the teacher was able to observe which reference items and types were difficult for his/her students. In referential resolution, for instance, the teacher could monitor students’ process and progress in establishing relationships between references through recorded data in the trace result. This recorded every action that the student took during the reading process and made the intangible process visible. It also enabled the teacher to design or modify her/his follow-up instruction to help the students overcome their difficulties and better develop their integrative skills in reading.

Finally, the implication is that reading process shares equal importance as the reading product in the manifestation of readers’ abilities. Traditionally, students’ performances are evaluated by the reading product as expressed in proficiency levels or comprehension scores. A single level or score does not reveal detail information on reading strengths, weaknesses, and difficulties. It gives the teacher very little clue on the substantial needs of less-proficient readers to design instructional intervention. This perpetuates less-proficient readers’ recurrence of comprehension failures in a text or in all reading tasks. As shown in this study, mental maps and reading processes clearly explain students’ reading success and failures. The discussion of these maps and processes between the teacher and students will be one of the ways to promote latter’s awareness of the need to employ comprehension monitoring and referring strategy.

References


