Examining ESL students' vocabulary retention in an on-line environment using the mental effort hypothesis

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Examining ESL students’ vocabulary retention in an on-line environment
using the mental effort hypothesis

by

Jennifer Anne Oden

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
MASTER OF ARTS

Major: Teaching English as a Second Language/Applied Linguistics
(Computer Assisted Language Learning) and (Literacy in English as a Second Language)

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Signatures have been redacted for privacy
For Mom and Dad
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ABSTRACT

The advent of computer-assisted language learning (CALL) materials has revolutionized teaching as increasing numbers of educators realize the power of the medium. With the proliferation of these materials comes a need for developers to make informed choices about the materials they create. In studies using traditional print materials, researchers have discovered the importance of glossing difficult vocabulary words; however, the method of glossing varies greatly. More research is needed to inform the decisions educators make about the types of glosses to offer.

Hulstijn (1992) says that extra work may aid in learners' retention, due to the "mental effort" hypothesis. CALL materials provide an opportunity for learners to know immediately if their choice is correct or not, thus allowing a CALL study with the objective of determining if extra mental effort on the part of the learners affects vocabulary acquisition.

The research questions shaping this study are: 1) Does a multiple choice option that requires students to expend mental energy when discovering the meaning of an unknown vocabulary item increase retention of the word meaning? 2) Do students make use of provided vocabulary definitions when answering comprehension questions containing the target words? 3) Do students interact with an on-line reading passage in predictable ways?

The participants were twenty-four students enrolled at Iowa State University in 101R (a course for students who scored low on the reading section of the placement test), IEOP (Intensive English and Orientation Program) high intermediate reading, or IEOP low advanced reading. They participated in an online unit featuring reading passages with two types of vocabulary glosses, traditional and multiple-choice. The subjects answered
comprehension questions and completed a vocabulary pre-test, post-test, and delayed post-test to measure their knowledge of the target items. The screen-capture recordings, questionnaires, and six retrospective interviews were used to analyze the results.

Results show that both the traditional glosses and the multiple-choice glosses were effective for learning vocabulary; however, neither method was superior to a degree that would be statistically significant. This study aims to understand the purposes with which the students approached the text.
CHAPTER 1. INTRODUCTION

Before the advent of computer technology, English as a Second Language students used print materials supplemented by aural instruction for reading tasks and vocabulary learning. These print materials included books, magazines, workbooks, as well as traditional classroom materials such as blackboards and chalk. Now that computer technology has increased in its capabilities and decreased in its expense, it is increasingly examined for its use in language learning. The advent of the internet allows for instructional designers to maximize the exposure of their materials to students. Students can use the internet to access the traditional print materials of the past; however, the internet and website creation software provide opportunities for students to engage with texts in ways that were not previously possible. This study examines a new way of accessing vocabulary glosses and aims to inform the discussion regarding the possibilities and limitations of new technologies in the field of vocabulary acquisition.

Purpose of the Study

This study’s purpose is to reveal more about the potential of vocabulary assistance for learners when using a computer-delivered activity, with the goal of increased acquisition of vocabulary items. The study will examine whether students who are required to perform mental work to find the correct definition for an unknown word when given a multiple choice option in a reading comprehension task have increased retention of the target words’ meanings. This experimental group will be compared to a control group of students who are given a traditional gloss rather than the multiple choice option.
The project relies heavily on the interaction hypothesis as a theoretical basis. The hypothesis states that interaction is needed for acquisition of a language. Interaction has two different, but related meanings, according to Ellis (1999). First, interaction is a social behavior that occurs between people. Secondly, interaction takes place within the mind as it processes information to make meaning or formulate a response (p. 1). Comprehensible input, that is language accessible to the learners, is necessary for new linguistic information to become available for intake, i.e. integration into a learner’s inter-language (IL). The inter-language is a combination of vocabulary, grammar, and syntax known by the learner. It grows and changes based on experience with the language. Because modification, or changes made to accommodate the learner in an effort to communicate, of difficult input is necessary for comprehensibility, a computer, when compared to traditional print materials, can be an excellent way of providing comprehensible input on demand. Because of the technology, students could receive immediate feedback regarding the correctness of their choices, as well as their score on the comprehension questions.

Rationale

The advent of Computer-Assisted Language Learning (CALL) materials has revolutionized teaching as increasing numbers of educators realize the power of the medium. With the proliferation of these materials comes a need for developers to make informed choices about the materials they create. For example, in a study using traditional print materials, Watanabe (1997) found one way of presenting modified input to learners within a traditional text was better than others. Appositive definitions were least valuable, while multiple choice definitions and marginal glosses were both effective, with the latter showing
the best evidence of vocabulary retention. However, some have criticized the study because the subjects exposed to the multiple choice treatment did not have a clear idea of the correct definitions, inhibiting item acquisition.

Hulstijn (1992) said that extra work may aid in learners' retention, due to the "mental effort" hypothesis. He conducted a series of four studies in which he compared traditional glosses with multiple-choice glosses. He found that the effects of the multiple-choice glosses were more beneficial than traditional glosses. CALL materials provide an opportunity for learners to know immediately if their choice is correct or not, thus creating a need for a CALL study with the objective of determining if extra mental effort on the part of the learners affects vocabulary acquisition. The extra mental effort occurs as a result of multiple-choice vocabulary glosses. When the students click for assistance with an unknown word, they are asked to make a choice between two possible definitions. The hypothesis is that the extra mental work of finding the correct meaning will lead to increased retention of the vocabulary items. This experimental group will be compared to a control group who are simply given the definitions.

**Research Questions**

Watanabe’s (1997) study and Hulstijn’s (1992) study raise interesting questions with regard to vocabulary acquisition. The advancements in modern technology have made it possible to extend Watanabe’s study by allowing the subjects to get immediate feedback regarding the correctness of their choices, thus the multiple-choice gloss could prove more effective than Watanabe found in his study. By incorporating Hulstijn’s idea about mental effort, this study will address a gap in the research on vocabulary acquisition in an online
environment. This study aims to investigate the power of the medium by using the following questions.

1. Does a multiple choice option that requires students to expend mental energy when discovering the meaning of an unknown vocabulary item increase retention of the word meaning?

2. Do students make use of provided vocabulary definitions when answering comprehension questions containing the target words?

3. Do students interact with an online reading passage in predictable ways?

In order to determine if a multiple choice option increases retention of the word meaning, student performance on all the vocabulary tests will be analyzed and the two groups, one with multiple choice options and one without, will be compared. To determine if students make use of provided vocabulary definitions when answering comprehension questions containing the target words, the researcher and the student will watch Camtasia recordings and the students will report how they answered the comprehension questions, focusing on their use or lack of use of the vocabulary annotations. At this point, the students will know that the researcher is interested in their use of the glosses and their vocabulary retention, rather than their performance on the multiple-choice questions. Open-ended questions during the retrospective interviews may reveal insights into how students interact with online reading materials that provide feedback.

Organization of the Study

The next chapter, Chapter 2, presents a research overview that provides a theoretical basis for this study. The research is divided into several sections, each focusing on a different
quality of vocabulary learning and/or learning in an online environment. The chapter ends with a discussion of the mental effort hypothesis, one of the foundational concepts for this study. Chapter 3 includes a description of the participants and materials, procedures followed, and methods of analysis used in the study. Chapter 4 explains the results of the study and gives the answers to the research questions as revealed by the task recordings, vocabulary quizzes, and retrospective interviews. Chapter 5 gives a summary of the results and a conclusion for the study. Recommendations and directions for further research will also be included.
CHAPTER 2. LITERATURE REVIEW

This chapter examines research related to the main areas of interest for this study comparing the effectiveness of two types of vocabulary glosses, traditional glosses and multiple choice glosses, when trying to learn English as a second language. The theory in second language acquisition is that interaction assists with language learning. The hypothesis is that interacting with vocabulary glosses, i.e. using the multiple-choice glosses, will allow acquisition of the meaning of the target words and lead to retention of the items, as shown on a delayed post-test. Research on vocabulary learning will be presented with a related discussion of research-based methods of developing the lexicon. Types of glosses will be examined, particularly as they relate to incidental vocabulary learning.

Two previous studies form the basis for this study and will be examined in-depth. Watanabe (1997) found that traditional glosses were more effective than multiple-choice glosses, an idea that this study re-examines. Watanabe used traditional print materials and three different gloss conditions, appositive, multiple choice, and marginal (called “traditional” in the present study). The appositive definitions were synonyms placed within parentheses that directly followed the target word in the flow of the text. The marginal glosses were featured to the side of the text with a mark after the target word to signal that assistance was available for it. The multiple-choice glosses were presented in a similar way; however, the synonym and an alternate meaning of the word were available in the margin. This created a situation that encouraged the reader to infer the meaning of the target word.

Others have contributed to the body of research regarding mental effort and vocabulary. Hulstijn (1992) suggested that when a learner completes extra work to find a meaning for a word, the word will be retained longer, according to the “mental effort”
hypothesis. He completed four separate studies in which meaning-given glosses and meaning-inferred glosses were compared. The results were mixed, but one study indicated that perhaps the multiple-choice glosses were more effective. The present study attempts to build on this research and investigate meaning-inferred glosses in an online context.

**How a Second Language is Acquired**

The interactionist theory and the related noticing hypothesis are the theoretical bases of this second language acquisition study. The interaction hypothesis investigates how native speakers fix breakdowns that occur in communication. Schegloff, Jefferson, and Sacks (1997, in Ellis, 1999) and Hatchs (1978b, in Ellis, 1999) all concluded that learners could learn a second language through the process of interacting rather than just manifesting what they have already learned in interaction (Ellis, 1999). This means that the process of interaction is a valuable language learning activity. Through the process of engaging in conversation or a written interaction, language elements can be learned. Comprehensible input is necessary for new linguistic information to become available for intake, i.e. integration into a learner’s inter-language (IL) (Ellis, 1999; Hegelheimer & Chapelle, 2000). Only input that can be understood by the learner is eligible to become available for intake. If the content is “over the student’s head” then it will not become part of the IL. The students must be ready to comprehend the new material and make sense of it before it can be learned.

The input hypothesis states that learners will acquire an L2 (second language) when they have access to comprehensible input and when their ‘affective filter’ is low (i.e., they are motivated to learn and are not anxious) so that the comprehended input is made available to the internal acquisitional mechanisms for processing (Ellis, 1999). The study described in
these pages attempts to capitalize on the need for a low affective filter by making a good performance on the task, i.e. a high score on the comprehension questions result in a good grade for the participants in their class; consequently, the participants may have paid more attention to the research task. When the affective filter is low and the input is comprehensible, it is possible that the linguistic knowledge can become “intake,” the linguistic elements noticed by the students and taken into short term memory. Intake may be subsequently incorporated into the learner’s interlanguage system and become part of long-term memory. However, this does not always happen (Ellis, 1999).

During interaction, students rely on their language knowledge, often leading to the realization that their abilities do not match the input provided by more competent speakers of the language; this is called “noticing the gap” (Swain, 1995, in Doughty, 2001, p. 225; Schmidt & Frota, 1986). By “noticing the gap” and seeking input modification, a learner can make appropriate changes to narrow the gap and move the inter-language closer to both full understanding and comprehensible production.

In CALL situations, noticing can be inferred to have happened when a learner requests assistance from electronic resources. If a student is reading a passage online and the teacher has pointed out that help is available in the form of vocabulary glosses, the student may click on a target word for assistance. When this happens, noticing has occurred. The student saw the word was available with a gloss, decided that he or she wanted to see the gloss, and made the decision to click. In most cases, this is a conscious decision made by a student who wants assistance with reading. In some cases, the student is engaged in clicking that is not easily explained. When viewing the recording or assessing the data, it becomes obvious that not a lot of time was spent reviewing the material in the gloss and the reader
instead moves on to click something else. It may be a quick review of information or it may be “click happy” behavior (Roby, 1999) that did not result in learning, but rather interaction with the technology for some other purpose.

In a CALL environment, the interaction between a learner and a web-delivered reading passage can occur with vocabulary glosses serving as input modification. The interaction happens when the students click on the highlighted words and receive vocabulary help; thus, the computer is viewed as a participant in the learning task. Ellis (1999, p. 51) said that interaction may assist learners’ vocabulary acquisition in two ways: 1) increasing input quantity and 2) including information not present in the original text, i.e. it allows for elaboration that results in clearer meaning. Ellis was not pointing to computer interaction, but in the context of a CALL study, the interaction between a person and a computer may enrich the input and facilitate word acquisition.

Students are exposed to language daily in many contexts, but only the language which is apperceived has a chance of being eventually worked into the inter-language (Schmidt, 2001; Gass, 1997). It is the responsibility of the teacher or materials designer to create situations where noticing is most likely to happen in order to encourage the students with the process. Glossing difficult words may allow for students to notice the items and give them the assistance they need when they ask for it, so that they can continue reading and making meaning without interrupting the flow of the text.

Focus on Form

Focus on form refers to the allocation of learners’ attentional resources (Long & Robinson, 1998, in Hegelheimer & Chapelle, 2000, p. 43). Focus on form involves learners
briefly and perhaps simultaneously attending to form, meaning, and use at the same time (Doughty, 2001). In order for students’ attention to be focused on form, their attention must shift from meaning to a problem with the specific code features. Gass and Varonis (1994, in Schmidt, 2001) claimed that interaction draws learners’ attention to form, particularly when there is perceived difficulty in the communication. When investigating vocabulary acquisition, subjects can request input modification when the unknown words impede understanding. Gass and Varonis referred to the source of a communication problem as the “trigger” and stated that the trigger is usually lexical in nature (1985, in Ellis, 1999). This indicates that vocabulary can be problematic.

Vocabulary glosses should be presented in an unobtrusive way according to Doughty (2001). Focus on form begins with the idea that educational interventions (such as glosses) that are overly intrusive may actually hinder the learning process. She states that focus on form is unobtrusive when the developer creates a task in which a) the main focus of the activity is on meaning, b) the focus on form target occurs in an incidental learning situation, and c) the learner pays attention to the forms “briefly and perhaps overtly” (p. 227). This means that the glosses should be noticeable, but should not become overly intrusive by dominating the appearance of the text passage.

The question of how to present glosses in an unobtrusive way has generated a field of research of its own. De Ridder (2002) investigated the effects of highlighting vocabulary items in an online unit on text comprehension and incidental vocabulary acquisition. She had two general texts and two specific texts (more specialized reading) prepared online with glosses in one of two conditions, either marked or unmarked. The marked glosses were highlighted in blue and underlined, the common way to symbolize that text is clickable
online. The unmarked text included vocabulary links that were not highlighted in any way. The subjects used the glosses in the highlighted text much more frequently than in the unhighlighted condition, revealing that highlighted vocabulary glosses are more effective at drawing students’ attention than invisible ones. De Ridder also found that this large amount of clicking did not slow down the rate of reading (the two groups finished the reading in roughly the same time), it did not affect text comprehension, and it did not increase the incidental vocabulary learned, perhaps because in this incidental vocabulary learning experiment, the students were clicking on many words and could not remember them all.

The Importance of Vocabulary

Vocabulary comprises the building blocks of language. This study focuses on a vocabulary-building task because of the importance of this area of language learning. Without knowledge of at least a few words, communication is the second language is impossible. Nation (2001) compiled research that suggests that “educated speakers of English know around 20,000 word families” (p. 9). A word family includes a base word, its inflected forms, and any closely derived forms. The amount of word families a non-native speaker needs to know varies greatly upon what the speaker wants to do in the L2. The goal of many of the subjects for this project is to be able to function in an academic environment at an American university. Each student needed to know the high frequency words (around 2,000 word families); however, the academic vocabulary needed depended upon the course of study the student wished to pursue.

For reading, Hirsh and Nation (1992) suggested a receptive vocabulary of 98%-99% for pleasurable fiction reading and 95% for academic reading. “To reach 95% coverage of
academic text, a vocabulary size of around 4,000 word families would be needed, consisting of 2,000 high-frequency general service words, about 570 general academic words (the Academic Word List) and 1,000 or more technical words, proper nouns and low-frequency words." (p.147) These figures demonstrate the enormity of the task for both the students and the teacher for learning and teaching vocabulary in a second language.

Knowing a Word

Zimmerman (1997) said that in order to truly know a word, a student must know a lot about the word such as how frequently it is used, what “syntactic and situational limitations” it has, “its generalizability, its collocational probabilities, its underlying form, its derived forms, and its semantic features” (Aitchison, 1987; Channell, 1981 in Zimmerman, 1997, p. 122). In terms of reading, a learner must be able to recall a word’s meaning and synthesize this meaning with the other words around it to create a contextual significance to the word. Ability to pronounce the word correctly and recognize it when it is spoken is also useful, but not necessary to the reading skill. To effectively teach a word, a multifaceted approach to exposure to the word, as well as an understanding of how the learner will be required to manipulate the new word is best. The context should be meaningful and rich in what it reveals about the target words.

Nation (2001) succinctly described what is necessary to classify a word as “known” in the form of a chart, reproduced in Table 2.1. Each of these elements must be present for a word to be truly part of a learner’s vocabulary. Knowledge of a word’s form, including the sound, pronunciation, appearance, spelling, and word parts must be in place. Knowing the word’s meaning, concepts, and associations is also necessary. The final component
encompasses usage of the word. The patterns of recognizing and producing the word are included, as well as its collocations and restraints on its use. In order to truly know a word, one must know when, where, how often it can be used. This study does not measure all aspects of knowing a word included in this table. In fact, only the ability to recognize the word and match it with a synonymous meaning is tested. This is not a measure of whether the word is truly known by the participants in the study.

Table 2.1 What is involved in knowing a word

<table>
<thead>
<tr>
<th>Form</th>
<th>Spoken</th>
<th>R</th>
<th>What does the word sound like?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>P How is the word pronounced?</td>
</tr>
<tr>
<td>Written</td>
<td></td>
<td></td>
<td>R What does the word look like?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P How is the word written and spelled?</td>
</tr>
<tr>
<td>Word parts</td>
<td></td>
<td></td>
<td>R What parts are recognizable in this word?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P What word parts are needed to express the meaning?</td>
</tr>
<tr>
<td>Meaning</td>
<td>Form and meaning</td>
<td>R</td>
<td>What meaning does this word form signal?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P What word form can be used to express this meaning?</td>
</tr>
<tr>
<td></td>
<td>Concept and referents</td>
<td>R</td>
<td>What is included in the concept?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P What items can the concept refer to?</td>
</tr>
<tr>
<td></td>
<td>Associations</td>
<td>R</td>
<td>What other words does this makes us think of?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P What items can we use instead of this one?</td>
</tr>
<tr>
<td>Use</td>
<td>Grammatical functions</td>
<td>R</td>
<td>In what patterns does the word occur?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R In what patterns must we use this word?</td>
</tr>
<tr>
<td></td>
<td>Collocations</td>
<td>R</td>
<td>What words of types of words occur with this one?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P What words or types of words must we use with this one?</td>
</tr>
<tr>
<td></td>
<td>Constraints on use (register, frequency…)</td>
<td>R</td>
<td>Where, when, and how often would we expect to meet this word?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P Where, when, and how often can we use this word?</td>
</tr>
</tbody>
</table>

Note: In column 3, R = receptive knowledge, P = productive knowledge.

(Nation, 2001: 27)
Learning a word is a process that continues through frequent exposure to the word item. According to Groot (2000), the steps involved are: 1) noticing various properties of the new word such as morphological and phonological, syntactic, semantic, stylistic, and collocational qualities; 2) storage in the internal lexicon in networks of relationships that correspond to the properties described in (1); 3) Consolidation of the storage described in (2) by means of further exposure to the word in a variety of contexts that illustrate its various properties. The word becomes more deeply entrenched in the long-term memory when this repeated exposure occurs. (Groot, p. 64) The implications of this are that teachers and materials designers should create materials and/or classroom situations that repeatedly expose the learners to the target vocabulary.

How to Learn Vocabulary

Because vocabulary learning is integral to the process of learning a language, many researchers have sought to contribute to the body of research regarding the most effective ways this process can be done. Groot (2000) discussed the problem of vocabulary learning, emphasizing the need for a systematic approach to such a huge task. He pointed out that bilingual word lists seem like a great alternative to the more time-consuming task of producing contextual presentations for target vocabulary; however, the long-term retention rates for simple approaches such as bilingual word lists is disappointing. He pointed to Craik and Lockhart’s (1972) description of “levels of processing” theory to indicate that more effective learning takes place when vocabulary is contextualized. This theory states that “rates of forgetting are a function of the type and depth of encoding” information (p. 65). Thus, the deeper the information is encoded, the more safely it will be stored for retrieval
later. The general consensus among language researchers has been that a relationship exists between retention and intensity or elaborateness (Anderson, 1990, in Groot, 2000).

In Groot’s (2000) study, he tested Craik and Lockhart’s (1972) theory using the CAVOCA (Computer Assisted VOCabulary Acquisition) program. This is a program that provides concise texts focused around one vocabulary item for students to learn. The vocabulary items are chosen very purposefully to ensure their relevancy to the students and the context-rich texts provide optimal exposure to the target words. Both of these elements are critical, according to Groot. The students must learn words that are relevant to them and the corpus they will experience every day and the presentation of the words must be effective for learning, i.e. context-rich. He tested his CAVOCA program in a number of experimental settings with a “paired associates” method of learning new words, meaning learning new vocabulary from a bilingual word list.

Groot (2000) claimed programs such as CAVOCA are necessary because there are a few problems with the idea that texts written for native speakers are suitable for teaching vocabulary to non-native learners of English. One stems from the fact that using texts for this reason can be inefficient because the texts were not developed for ESL purposes. The target words occur fairly infrequently because beyond the most common 2,000 words, the words that a learner needs to know varies greatly by what he or she wants to be able to do in English. The corpus will vary depending on the context within which the learner is placed. Thus, L2 texts will not likely have the targeted vocabulary individual learners will need.

Secondly, according to Groot (2000), when using authentic language situations with learners, much time will be taken to create these experiences and provide the students with adequate background knowledge so they will understand the context. If corners are cut, the
students could end up more confused and less likely to contribute a sufficient effort toward learning vocabulary. The experience could seem pointless and would therefore not be motivating.

The most important reason why authentic L2 texts may be undesirable to use with non-native English speaking students is that there may be many more words, beyond the target words, that are unknown in the text. This creates a situation in which students have nothing to hold on to in a text. They encounter more and more words they do not know and eventually end up feeling that the effort is pointless. (Groot, p. 63)

How Students Prefer to Learn Vocabulary

Some of the most interesting data from Zimmerman's (1997) study were the results from the student questionnaires. In her study, she investigated the effects of reading and vocabulary instruction on students who were studying for entrance exams to US colleges. She was looking specifically for increased acquisition of non-technical English words. Students engaged in self-selected and course-related readings, as well as vocabulary instruction. On the questionnaires, students ranked the value of studying root words and affixes as well as using bilingual dictionaries the lowest in terms of effectiveness of vocabulary study. They ranked encountering words in natural contexts the highest with memorizing lists of words not far behind. The most effective strategy they felt was reading an interesting and engaging text and gleaning useful words from it. It is unclear how the teacher encouraged vocabulary learning from the students beyond providing interesting reading material. Students want clear expectations from the teacher and comprehensible assignments with no guessing about which vocabulary is the most important for them to
Incidental Vocabulary Acquisition

Much vocabulary learning occurs incidentally, i.e. when the learner is engaged in another activity and not concentrating on learning vocabulary. Because this is a common occurrence, researchers have spent time trying to understand this process and its implications for language learning. Hulstijn, Hollander, and Greidanus (1996) looked at the influence of marginal glosses, dictionary usage, and reoccurrence of unknown words on incidental vocabulary learning in their study. Learners expand their L2 vocabularies through a variety of intentional word learning experiences and incidental means as well (Hulstijn et al., 1996). Incidental vocabulary learning means that the student is not purposefully studying vocabulary items, but instead is learning the items during the reading process for the purpose of completing a task, usually some sort of a comprehension check. Hulstijn et al. (1996) provided many reason why readers fail to learn the meanings of previously unknown words including: 1) Sometimes the learners do not pay attention to the unfamiliar words or believe that they know the word when they actually do not; 2) Sometimes learners ignore the unknown words; 3) Students may be so busy making meaning from the text that they do not mentally associate the word form with the meaning, i.e. they get a sense of the meaning and move on; 4) The meaning of the word cannot be inferred by the context or the student makes the wrong inference; 5) Students do not look up the words in a dictionary, particularly if the text is long; and 6) One exposure to the word is not enough to learn it. Multiple contacts are necessary.
Hulstijn et al., (1996) also synthesized available research to list factors that encourage incidental vocabulary acquisition. These factors included: 1) Elaborating on the meaning of the unknown word to allow for more processing of the word’s meaning; 2) Perceiving a word as relevant and taking time to learn it; 3) “Picking up” words incidentally (more effective is the reader has high verbal ability); 4) Using a dictionary; 5) Using marginal glosses; 6) Using L1 cues or comprehensible L2 cues; 7) Being exposed to words frequently in the text. The more often the words appear, the better the chance of the learners remembering it (Hulstijn, et al. 1996). Teachers and materials designers should be aware that each of these encourages vocabulary acquisition.

Incidental vocabulary learning is not the most efficient way to learn unknown words. The process is time-consuming and the progress is measured in increments. The challenge for researchers is to discover how to make this process more efficient. Hopefully, this research can inform materials developers and teachers and lead to well-crafted instructional materials and better-informed instructional practices that will positively affect the way students “pick up” words from their surroundings.

Hulstijn et al.’s (1996) study included 78 Dutch first-year university students of French who were categorized as “advanced learners.” These students were asked to read a short story by Guy de Maupassant entitled “Menuet.” They completed the reading in one of three research conditions: with the aid of marginal glosses (vocabulary assistance appearing in the margin), with the aid of a dictionary, or with no help (control group). The reading was modified to make it more “reader friendly,” including removing some portions of difficult reading and building in repetition of the target vocabulary items. The students believed they were completing the task with the end result being comprehension questions. Instead, they
completed a vocabulary quiz that tested their recognition of the items and their ability to write down what the items meant.

The authors found that there was “substantial incidental vocabulary learning in its most modest form,” meaning the students were often able to recognize that the words had appeared in the reading, particularly the ones that had been purposely repeated in the text (Hulstijn et al., p. 329). They also found that overall, marginal glosses resulted in much better retention scores than offering dictionaries to the students. In fact, these students only looked up 12% of the target words. However, when they did look up the words, their chances of remembering the meaning were better than the average retention of the marginal gloss group. Perhaps the increased effort of looking up the word allowed for more processing of the meaning, and thus better retention of the item. The authors came up with a few reasons why the students did not look up the words in their dictionaries. They may not have viewed the words as relevant to their reading purpose or they may not have wanted to go to the trouble of looking up the words as it would interrupt their flow of reading and their comprehension of the whole text.

The pedagogical recommendations given at the end of the article include: 1) Give readers interesting texts that are motivating to read; 2) Facilitate dictionary use by providing an easily accessed dictionary when creating electronic materials or marginal glosses for paper materials; 3) Repeat important words in the reading (modify the text); 4) Create a list of important vocabulary or have learners create their own lists and then refer back to them often. Do not replace incidental learning with intentional learning, but follow up on incidental learning to maximize the chances of retention of those items (Hulstijn et al. 1996).
While developing the present study, these factors were considered. For example, the two reading passages were chosen for their interest factor as well as their reading level. Where appropriate, the text was modified to accommodate the participants’ level of English. The marginal glosses were easy to access and the most important or difficult words from the text were modified.

Vocabulary Learning in a Multimedia Environment

Considering the importance of vocabulary learning, many CALL researchers have investigated the use of computers and other electronic resources for the purpose of vocabulary instruction. Ghadirian (2002) posited that using technology to control the exposure of language learners to target vocabulary through careful screening and arranging of texts can increase students’ vocabulary knowledge. He cited Krashen’s (1989) argument that extensive reading is the only way for a learner to gain complete and non-superficial knowledge of a word as a rationale for the reading-based strategy he was supporting. Krashen and Ghadirian believed that continued encounters with a word will increase the likelihood that the student will remember that word. The more times a student can have meaningful contact with a target vocabulary word, the better. Ghadirian’s program is called Textladder. It sorts teacher-selected texts and arranges them for viewing by the students.

Other researchers have taken a more student-centered approach. Nikolova (2002) found that student authoring of multimedia materials was an effective, but not efficient, way for students to learn vocabulary. One group of students created multimedia glosses using text, audio, and pictures for a list of target words pulled from a text. The control group simply interacted with the unit after it was already made. The group who participated in the
authoring received greater vocabulary gains than the group who only used the materials. This increased interaction with the items occurs when actually creating a project rather than simply using it. The results of the study pointed to increased vocabulary learning when the subjects participated in the creation of an instructional module. Consciousness-raising activities such as this one increase the amount of "noticing" that takes place. The researcher emphasized that this is not an efficient way to teach vocabulary since the experimental group spent much more time constructing the unit, than the control group did in using the unit. Also, much of the group work time was not directly related to dealing with the vocabulary; instead, time was spent solving problems with the technology and organizing themselves and the work. Although the authoring treatment was not an efficient task, it was significantly better in terms of vocabulary acquisition than the non-authoring treatment.

Student awareness of the purpose of a task can also be beneficial. More cooperation from the students could depend on what the student believes is the purpose of the activity. Duquette, Renie, and Laurier (1998) investigated vocabulary acquisition when learning French as a second language using multimedia materials. This study dealt with explicit and implicit learning. In explicit learning, the learner's language acquisition is a conscious process (Ellis, 1999). In the case of implicit learning, the learner is not aware of what has been learned; that is, the change to the interlanguage occurs without consciousness (Ellis, 1999). The researchers found that a mixed approach using both explicit and implicit vocabulary learning is better for learning in a multimedia environment than two control groups, one of which used video support. They also found that nouns were acquired more often than verbs; the more frequently a word appeared, the better the chance it would be
retained; and the more contextual cues exist in the text, the greater the chance a word will be picked up.

Other factors such as learning style and language ability also affect how best the students learn vocabulary. Chun and Plass (1997) reviewed current research on text comprehension in multimedia environments and found that many factors influence the comprehensibility of text in an online environment. Not the least of these is a student’s learning style and language ability level. The multimedia environment makes it possible to cater to various learning styles, as well as provide supports for the lowest level students through the use of vocabulary glosses in the form of pictures, text, animation, and video in various combinations. Presenting information in various modes may facilitate comprehension of the text because it caters to various learning preferences. Chun and Plass say a deeper level of processing may occur if the students can access information in the way their brain stores it most efficiently and effectively. Visual aids may provide the structure that poorer readers need to help make sense of a difficult reading (p. 67). “Multimedia aids should support learners’ individual differences, such as prior knowledge, abilities, preferences, strategies, and affective factors” (p. 68). Taking into account students’ learning styles may pay off in improved teaching and better learning on the students’ part.

In sum, vocabulary learning in an online environment can be achieved in a variety of ways; however, factors specific to the student population must be considered. Ghadian’s (2002) study showed that careful exposure to texts can benefit the vocabulary acquisition of learners. A more student-centered approach was taken by Nikolova (2002), whose study showed the effects of web authoring projects on language learning to be very positive. Duquette et al. (1998) discovered that a mixture of explicit and implicit learning benefits
language learners' vocabulary acquisition the most. Chun and Plass (1997) found in their literature survey that multimedia vocabulary supports can be modified to suit a student’s first language background, current English level, as well as his or her preferred mode of learning, whether it is through audio, video, or visual delivery. Each of these delivery methods appeals to a different type of student, so discovering a student’s learning style may be the best place to start when designing or selecting materials for vocabulary learning.

Vocabulary Glosses

Vocabulary glosses are often incorporated into texts as a way to address difficult vocabulary. Simplification and elaboration are also used. For example, Yano, Long, and Ross (1994) investigated the use of simplified and elaborated texts in terms of their effectiveness for reading comprehension. Their argument was that if non-native English speakers are constantly reading texts that are simply linguistically simplified, then they will not be exposed to the language forms that they need to hear in order to become more competent users of English. The linguistically simplified texts sounded stilted and unnatural, while the elaborated texts, although wordy, were much closer to actual speech and some forms of writing that would be encountered on an every day basis. They compared the two types of text with a baseline unaltered text that native English speakers would read. They found that both the simplified and elaborated texts produced better reading comprehension; however, the elaborated texts did not produce a statistically significant degree of reading comprehension above what a simplified text could do. However, reading an elaborated text as opposed to a simplified text may meet the intellectual and maturity level of an adult English learner more appropriately than some of the simplified texts, such as graded or
leveled readers. In addition, complex language is present in an elaborated text, which is needed to push acquisition.

Although the area of research dealing with simplified and elaborated texts also yields promising insights into assisting learners with vocabulary acquisition, this study focuses on the use of vocabulary glosses as a way to achieve this goal. Lomicka (1998) completed a study that was designed to address the question about the usefulness of glosses by asking whether glossing improves L2 reading comprehension and whether or not it hinders fluency in L2 reading. The subjects were 12 native English–speaking university students in Pennsylvania who were enrolled in a French course. She designed her study to have three levels of glossing: a no-gloss condition, a limited gloss condition (translations from French to English), and a full gloss condition that included the definition in French, as well as images, references, questions, pronunciation, and translations in English.

Four students were randomly assigned to each of the three conditions. They then completed the online introductory passage and the text in French, while completing a think aloud, which the author of the study recorded. The author then transcribed these recordings and analyzed them for uses of reading strategies. She found that the students struggled with the vocabulary of the text and depended on the English translation feature, when it was provided. The students did not use the other features of the program nearly as much as they made use of the English translations. Lomicka commented that this could be because of habit or “perhaps students were satisfied with the construction of a textbase level.” (p. 49).

Students did not seem eager to complete the extra work of looking at references, questions, pronunciation tips, etc. The students were not interested in performing the extra mental work needed to form strong associations with these unknown vocabulary words.
Roby (1999) wrote a response to Lomicka’s article for the purpose of clarifying her terminology and encouraged others to produce studies similar to hers. He created a taxonomy for glosses that included most any type of gloss, which is presented below in the form of flow charts.

**Taxonomy of Glosses**

![Flowchart of Gloss Authorship](Image)

**Figure 2.1** Gloss Authorship (Roby, 1999: 96)

The area of gloss authorship refers to who is creating the glosses. In the present study, the researcher created all the glosses. However, with the ease of use involved with most versions of web-authoring software available today, it is not impossible to imagine teachers creating their own online materials and including glosses. One of Roby’s suggestions for further study is the idea of student-generated glosses. Electronic resources now give students a chance to write glosses for themselves by writing in the margins, etc. with all the conveniences of electronic text such as simple manipulation of the text, easy editing features, and storage.
Figure 2.2 Gloss Presentation (Roby, 1999: 96)

Gloss presentation deals with when and how the glosses are presented. A priming glossary would serve as an advance organizer before beginning an activity. A prompting gloss would be vocabulary assistance provided on demand and just in time for learning. The glosses in my study were prompting in nature.

Figure 2.3 Gloss Functions (Roby, 1999: 96)
Gloss functions are an area related to what the glosses say or do for the reader. Information regarding a skill would be considered procedural while declarative glosses would provide some sort of factual knowledge. The glosses in my study provided factual information of a linguistic nature. The glosses provided “value,” the meaning of the words from the text rather than the significance of the word.

Figure 2.4 Gloss Focus (Roby, 1999: 96)

Gloss focus describes where the gloss points the reader. Textual glosses direct the reader back to the text, while extratextual glosses bring new information to the reader. In my study, the glosses were textual.

Figure 2.5 Gloss Language (Roby, 1999: 96)
Gloss language simply refers to which language is used in the gloss. In the present study, the language was English, the participants’ L2.

**Figure 2.6 Gloss Form (Roby, 1999: 96)**

Gloss form describes how the gloss works for the reader. Some are verbal, while others are visual or simply have audio. In terms of visual glosses, many varieties are possible including simply an image or a video including sound. Any combination of these is possible as well. Any type of gloss can fit into this chart. My glosses were verbal, consisting of written words with a synonymous meaning to the target vocabulary word.

The flow charts above give the reader an idea of the possibilities yet to be explored within the research area of vocabulary glosses. The glosses themselves serve as a way to deal with difficult words in a text, as well as bring more information to the reader to explain the reading. In the present study, the glosses served as a vocabulary support to assist the readers with difficult words.
Some researchers study the possibilities of tailoring glosses to address students’ learning styles. Chun and Plass (1996b) conducted a two-tiered investigation addressing the relationship between comprehension and both top-down and bottom-up reading strategies. The top-down strategy involved the use of advance organizers, while the bottom-up strategy was the availability of glosses in an online reading task (part of CyberBuch, a multimedia application developed by the authors).

They found that a dynamic visual advance organizer did help students with their overall understanding of the reading. Also, annotations that include both visual and verbal information were the most effective for vocabulary learning. In fact, including annotations that were only verbal were less effective than having no annotations at all. The reason for this was the difficulty of the texts chosen for the various gloss conditions. The authors’ results were inconclusive when trying to find a relationship between students’ look-up behavior and their overall comprehension, measured by using a vocabulary test as well as a comprehension check in the form of a recall protocol. This is because good readers with large vocabularies will not look-up many words and will still perform well on the vocabulary test. Whereas poorer readers will look up many words, but still not be able to produce the correct answers on the vocabulary check. This is only one example of a study investigating the effects of multi-modal glosses. More research in this area could yield results that could alter the way glosses are constructed. Al-Seghayer (2001) has suggested that a video segment is more effective for teaching unknown vocabulary than a still picture. Chun and Plass (1996) believe that presenting lexical information in a variety of modes allows for deeper processing of the information and greater ability to recall the information later by building two types of recall cues in the memory.
Mental Effort Hypothesis

The design of the on-line task for this project was an amalgamation of the studies conducted by two researchers who had conflicting findings about the mental effort hypothesis. Watanabe (1997) found that traditional glosses were more effective than multiple-choice glosses, an idea that this study aims to examine. Watanabe used traditional print materials in appositive, multiple choice, and marginal gloss conditions. The appositive definitions were synonyms placed in the flow of the text within parentheses directly following the target word. The marginal glosses appeared to the side of the text with a mark after the target word to signal that assistance was available for it. The multiple-choice glosses were presented in a similar way; however, the synonym and an alternate meaning of the word were available in the margin. This created a situation that encouraged the reader to infer the meaning of the target word from the context. Watanabe found that appositive definitions were least valuable, while multiple choice definitions and marginal glosses were both effective, with the latter showing the best evidence of vocabulary retention. The data pointed to better retention of the target items after exposure to the marginal glosses, called “traditional” glosses in this study. However, some have criticized the study because the subjects exposed to the multiple choice treatment did not have a clear idea of the correct definitions, inhibiting item acquisition.

Hulstijn (1992) claimed extra work aids learners' retention, due to the “mental effort” hypothesis and conducted a series of studies to test this hypothesis. In the series of experiments, the first three pertain to the present study and deal with whether inferred meanings are better than given meanings. In the first study, the participants were divided into groups and given a text to read. The first group read a text with marginal glosses featuring a
simple translation on the side. The second group was given a sentence with the target word in a concise context where the meaning of the target word could be easily inferred. The third group was given a multiple-choice gloss, similar to the one in this study, with four possible options. The fourth group was given no glosses at all. Hulstijn found that retention was better when the meaning of the target words was given to the learners.

The second experiment involved two conditions, a meaning-given group and a meaning-to-be-inferred group. The differences between the two groups in terms of retention were not significant. The third experiment most closely resembled the current study. The groups were given either a synonym for the target word or a multiple-choice gloss. Retention in the multiple-choice condition was “substantially and significantly higher than in the synonym condition” (p. 119). Although vocabulary gains in an incidental learning condition are always low, the gains made by the inferred meaning group were statistically significant. Hulstijn warned that the multiple-choice condition should be used under the supervision of a teacher because some of the distracters are appealing and could be learned by the students, even if it is the wrong meaning. He believed that this condition is unsuitable to individual learning and should be closely monitored by a teacher.

The idea that multiple-choice glosses could provide a way for vocabulary to be learned more completely is based on Craik and Lockhart’s (1972) article. These authors generated a framework for memory research based on a systematic understanding of the deep processing of information in their “levels of processing” framework. They posited that “rates of forgetting are a function of the type and depth of encoding” (p. 672), meaning the more deeply a vocabulary item is processed the more likely it will be retained in the long-term memory. So, processing many properties of a word, such as its semantic qualities as well as
its phonological qualities, will result in greater retention of the item. The implications for language teaching are abundant. Exposing students to vocabulary words in context is preferable to learning the words in isolation, for example. Many language researchers also believe that another important implication is that students should be encouraged to process words more deeply by engaging in more interaction with the text. Vocabulary glosses of any kind provide opportunities for interaction with text.

Other researchers have investigated the depth of processing model, as applied to language learning. Joe (1998) conducted a study based on the depth of processing model first proposed by Craik and Lockhart (1972). She investigated the effect of a generative task on incidental vocabulary acquisition. The generative model is based on the depth of processing model; however, it focuses only on semantic processing. The model posits that learning is a process which involves actively transferring, interpreting and constructing meaning for unfamiliar concepts, information and events according to one’s prior knowledge, experience, abilities, attitudes and background (Wittrock, 1974 in Joe, 1998). The task included reading and re-telling the events in a text. The vocabulary acquisition was measured using a pre-test/post-test design. She found that generative processing did lead to greater levels of vocabulary learning, but the depth of the generation had to be taken into account. For example, students who could barely read the text were not able to re-tell specific facts from the reading effectively; however, they perhaps did learn some vocabulary from the experience. This experience creates a high learning burden on the students, so this is not a task to be used routinely with students in a classroom.

Other researchers have been working in this area and have found results that conflict with Hulstijn’s “mental effort” hypothesis. Mondria (1996) indicated that the link between
cognitive effort and vocabulary learning is weak. He presented meanings of words in two ways, giving the meaning and asking the students to infer the meaning. He found that giving them the meaning took less time and the long-term benefits were the same. More research is needed in this area to determine if deeper retention does result from inferring word meanings during reading and, if so, how can the time it takes to efficiently read texts with multiple-choice glosses be reduced. Computer technology can assist in reducing the time because CALL materials provide an opportunity for learners to know immediately if their choice is correct or not. The objective of this CALL study is to determine if extra mental effort on the part of the learners affects vocabulary acquisition.

**Conclusion**

This chapter gave background information in the areas under investigation in this study, particularly regarding second language acquisition as applied to vocabulary learning, vocabulary glosses, especially in a multimedia environment, and the mental effort hypothesis. This information provided a backdrop for the present study which will examine vocabulary retention in an online environment. The following chapters will describe the study in more detail.
CHAPTER 3. METHODOLOGY

This chapter describes the methodology used to collect the data for this study. It is separated into five parts beginning with a description of a pilot study and a discussion of the changes made to the interface of the online task and the methodology of the study on the basis of the results. The second part describes the participants by giving the background of the research participants involved in the study. The third part details the materials used in the study, including the pre-tests, post-tests, comprehension questions, vocabulary glosses, exit interviews, as well as the software and hardware used to complete the project. The fourth part explains the procedures used, including the design and implementation of the materials for the study. The section ends with a description of the analyses used to address the research questions.

Pilot Study

The pilot study for this thesis was completed as class project in a Second Language Acquisition class; it was planned and carried out by the author and two classmates. The researchers constructed an online unit that included a reading passage, multiple choice glosses for key vocabulary items, and comprehension questions (See Appendix A). The vocabulary items were chosen by the researchers on the basis of their background knowledge from teaching non-native speakers of English.

The participants for the study were eleven students in a reading course taught by one of the researchers in Iowa State University’s Intensive English and Orientation Program (IEOP). The researchers created a reading passage with vocabulary items glossed using multiple-choice glosses. The experiment’s purpose was to see how the subjects would
interact with this type of gloss. Because one of the researchers was also the teacher of the class, she was instrumental in choosing which items would be glossed based on her knowledge of her students’ abilities. The subjects first took a vocabulary pre-test in which they were presented with the target vocabulary items out-of-context and two possible definitions. The two choices were the same ones available upon request in the online unit. Ten comprehension questions were also written in a way that the subjects would need to know the target words to answer the questions correctly, thus revealing more information about the subjects’ knowledge of these items. Correct answers for the questions depended on knowledge of the vocabulary item; however, the text and the glosses were available during this process. After the students read the passage, clicked on any vocabulary they wanted to, and completed the comprehension questions, they completed a vocabulary post-test. The post-test resembled the pre-test in that the items and choices remained the same; however, the items were jumbled and some of the multiple choice options were inverted.

Of the 11 students who participated, 8 had an improved score on the vocabulary post-test when compared with the pre-test; 2 had scores that remained the same, and 1 student’s score went down. All students scored at least 60% on the comprehension questions, with one student scoring 100%. The purpose of creating the online unit and setting up the experiment was to test the materials and to see how the students would interact with multiple choice glosses, so delayed post-tests were not administered and data were not kept regarding which comprehension questions were missed. Interview data were not collected. However, the information gathered regarding construction and administration of vocabulary quizzes, as well as the interface of the online unit was valuable. On the basis of the observed performance in this pilot, the researcher decided to modify the interface of the online unit.
The interface of the pilot materials featured the text on the left side of the screen and the glosses appearing on the right side in a frameset. This was revised for the thesis research, so that the glosses would appear in a “margin” on the left side of the text, even with the line in which the target word could be found. This more closely resembles an experience a student would have with a book, thus raising the comfort level of the students and perhaps making the glosses more noticeable, rather than making them appear on a different-colored background on the far right side of the screen. Changes in methodology were also made, specifically in the purpose of the study, which was extended to include the current research questions.

Participants

The participants for the thesis project were twenty-four students enrolled at Iowa State University in 101R (a course for students who scored low on the reading section of the placement test), IEOP (Intensive English and Orientation Program) high intermediate reading, or IEOP low advanced reading. They represented a wide variety of first language backgrounds. The L1s included Spanish, Arabic, Indonesian, Korean, Chinese, Japanese, Russian, and Turkish. Fourteen of the participants were males and ten were female. Ages ranged from eighteen years old, to one in his early forties. Most subjects were in their mid to late twenties or early thirties. Originally, the plan was to use only 101R students to maintain a similar level of ability between all the research participants, but much of the data from one of the 101R classes had to be discarded because of a mistake in the data collection. More research participants were needed and the students in the IEOP were asked to assist with the effort. Their teachers were consulted and agreed that the materials would be appropriate for
their classes if they were allowed more than one class period to complete the task. This accommodation was extended to the IEOP students.

**Materials**

The task contained two reading passages with a combined total of 443 different words, twenty-two of them glossed. Each passage had three comprehension questions for the students to answer as well. The students participated in a vocabulary pre-test, an immediate post-test and delayed post-test. They each completed a questionnaire in class regarding the unit and a selected few participated in an interview.

**Reading Task**

The focal topics of the reading passages were on research chimpanzees and AIDS in Africa, both of which were hypothesized to be interesting because the 101R class had just completed a unit about AIDS when they participated in this learning task; however, the IEOP students had not had this unit, so they could have had less background knowledge of the subject. The nature of the task required the students to conceptualize as they were reading to try to figure out the meanings of the glossed words. The reading passages were taken from an online source the participants were accustomed to using in other classes in IEOP.

The readings were chosen because of their topic, length, and level of difficulty. The passage about research chimps contained 200 different words and there were 243 different words in the passage about AIDS victims in Africa (See Appendix B). Both passages focus on a problem that has been lingering for many years and both report on positive steps being taken by one or more individuals to remedy the situation. Thus, neither passage is
discouraging in tone, but rather has a positive message. In the passage about research chimps, the author presents the problem that research chimps are being used and then euthanized when they are no longer useful for science experiments. It reports that a panel for the National Research Council now recommends a breeding moratorium and long term care for the chimps as they enter “retirement.” The other article addresses the current AIDS crisis in Africa and reports on a nurse in the United States who packs and sends surplus AIDS drugs from his hospital to needy AIDS patients in Africa.

**Vocabulary Glosses**

After the two reading passages were selected, a traditional gloss version and a multiple-choice gloss version were created for the two texts. The traditional glosses featured a synonym that would appear in the left margin of the text, next to the clicked word (see Figure 3.1). The multiple-choice glosses (see Figure 3.2) allowed the students to read both definitions and incorporate each meaning into the sentence, eventually choosing the correct answer. If students chose the wrong definition, a prompt would appear, informing them their selection was incorrect and encouraging them to click on the correct definition. If they chose the correct definition, they were assured that their response was correct and the target word was used in a sentence, revealing its meaning. Figures 3.1 and 3.2 show the glosses featured in the online unit.
The vocabulary words that were glossed in the materials were determined using VocabProfiler, an on-line tool that divides the words in a text into four categories: the 1,000 most commonly used, the 2,000 most commonly used, academic, and off-list (specialized vocabulary). The researcher then selected the words to be glossed, focusing on the academic word list and the off-list/specialized vocabulary words, incorporating the suggestions of the teachers who work with the research participants in class every day. Because the article dealt with a scientific topic, avoiding internationally used scientific words as target words (for example, “AIDS”) was important.
Comprehension Questions

Following each reading passage, regardless of the gloss condition, the students were presented with three comprehension questions. The students accessed the comprehension questions by clicking when they were ready to see them. The questions appeared in the bottom half of the frameset, which expanded so that they could see all of each question at once (See Appendix C). The questions were developed in a way that knowing the correct answer was dependent upon knowing one of the target vocabulary words. This was a way to get the students to click one more time on a word if they did not know it. It also provided more information about the possibility that a student was guessing the correct answers on the vocabulary quizzes instead of truly knowing the word. The questions were specific enough that students may have needed to refer to the reading again to find the answer. The text and the glosses remained available to them throughout this process. See Appendix D to read the comprehension questions.

Vocabulary Quizzes

The vocabulary quizzes were written with the input of the students’ instructors, particularly the 101R instructor. The IEOP instructors approved the quiz for their classes, meaning that it would be a fair assessment of their students’ vocabulary knowledge. Initially, the Vocabprofiler identified a plethora of potentially problematic words, that it became necessary to administer a vocabulary quiz to the subjects (two 101R sections at the time) to see which words were unknown to them. This quiz consisted of 30 items, fifteen each from the two texts. From their performance on this quiz, the researcher and the 101R teacher decided which would be the “target words.” In the “chimps” reading there were ten glossed
vocabulary words; in the “AIDS” reading, there were twelve glossed vocabulary words for a
total of twenty-two items on the quizzes. The items were presented in context; however, it
was not the same context as the reading in the unit. Then, one synonym and four distracters
for the underlined target word were presented. The correct answer was the same synonym
that was offered when the students clicked on the traditional gloss.

Questionnaire and Interviews

The reading questionnaire (See Appendix E) was offered to the students during the
week following their interaction with the unit. It was developed using input from the
classroom teachers. The teachers administered this questionnaire and placed the completed
papers in my mailbox. The idea for a questionnaire arose when one of the teachers mentioned
that she was curious about what the students thought about the unit. I decided that by having
the subjects answer questions on paper they could clarify their thoughts and perhaps give
better answers during the interview. I also used the results from the questionnaire as another
source of data to determine which target words they knew and remembered from the unit.
The questionnaires were also used to identify interview subjects as well.

Six students were selected for interviews based upon their interaction with the unit
and their answers on the reading questionnaire. A variety of students were selected, ones who
did not click on any of the words, ones who clicked a lot, and ones who clicked only when it
seemed a word was unknown. I also called in students to clarify their ideas on the reading
questionnaire.
Procedures

The study used a within-subjects research design, in which the groups were counterbalanced. The twenty-four participants were divided into four groups. The order of the texts and the type of vocabulary gloss varied between the four groups. For example, group 1 saw the “Chimps” text first in the traditional gloss condition and then saw the “AIDS” text in the multiple-choice gloss condition. Group 2 saw the “Chimps” text in the multiple-choice gloss condition before seeing the “AIDS” text in the traditional gloss condition. Group 3 first saw the “AIDS” text in the traditional gloss condition and then saw “Chimps” in the multiple-choice gloss condition. Group 4 saw the “AIDS” text in the multiple-choice gloss condition first, then the “Chimps” text in the traditional gloss condition. There was no benefit to one group over another in terms of which text was read first and which gloss type was read first.

The data collection took place over a period of six days. The 101R classes were able to read both passages and answer the comprehension questions, as well as take the pre and post-tests in one class period. The IEOP students were given extended time. They read one passage and answered the accompanying comprehension questions one day and completed the second half of the unit during the next class meeting. As a result, they took a vocabulary quiz over just the words they would see each day, thus dividing the task in half for each day. They were able to finish within their 50 minute class period easily. The subjects participated in this study in the research lab located in Ross Hall, Room 312, during their regular class time. This location was selected to facilitate the use of Camtasia, a screen-capturing software, to record the on-screen actions. Camtasia is a program that ran in the background while the students were completing the unit online. I started the recording when the students sat down
at the computer and shut off the recording as students finished. The program generates large computer files that play like a movie, complete with rewinding, fast forwarding, and pausing options. This made watching these movies at a later time very convenient.

The consent forms (See Appendix F) had been read and signed at an earlier time to give the subjects more time to complete the activity. Their classroom teacher had informed them that their performance on this reading task could replace one of their grades for a missing assignment in the class, an option the students were excited about. They asked their teacher, who was present, to confirm this before class began. In the hopes of stimulating motivation, the subjects were promised that if their performance on the comprehension questions was two or three out of three correct, the score would replace a missing assignment for the class. In addition, in the 101R class, the students were guaranteed that their attendance on the day of the experiment would also count for one missing homework assignment.

The students were each given a paragraph with instructions (See Appendix G) and any remaining consent letters were collected. I then showed the units to the students with the use of a projection system. The students were shown both of the reading passages, how the glosses work, and the differences between the two types of glosses. They were shown how to access the comprehension questions, as well as how to return to the home screen to begin their second reading passage, in the case of the 101R students. The IEOP students were shown how to exit the screen upon completion of the activity.

The students then took a vocabulary pre-test (except for the first 101R group) before moving to the computers to begin working online. The first 101R class did not take the pre-task quiz because the researcher forgot to administer it. Thus, their pre-test scores were based on an earlier quiz given to test which vocabulary items were the most difficult (described in
the previous section). Upon completion of the pre-test, the students moved to the computers and the researcher started the Camtasia recording. When they were finished, they moved back to the center table for the vocabulary post-test. The researcher shut off the Camtasia recording while the students took the quiz.

Two weeks after the treatment, the researcher came to the subjects’ classrooms and administered the delayed post-test, which included all twenty-two vocabulary items (from both reading passages), regardless of whether they completed the unit in one day or two. The following week, students completed a reading questionnaire in their class and from these answers, as well as the Camtasia recordings, six students were notified that they had been selected for an interview. Appointments were made with these students and, individually, they each came to the researcher’s office to complete this part of the requirement. The interviews took place within two weeks of the delayed post-test. They viewed the Camtasia recording of their interaction and explained what they were thinking as they were interacting with the unit. I asked them why they clicked or did not click on the given vocabulary assistance, as well as other questions about their interactions with the unit.

Analysis

After the students completed their part of the task, the researcher watched each of the Camtasia recordings and made notes of which words were clicked and in what order. Data were also kept regarding any unusual or interesting behaviors while reading online, such as highlighting text. Also, all quiz data were entered into an Excel spreadsheet. Notations were made regarding which of the quiz items were answered correctly and which were answered incorrectly. Then, each click of the mouse was noted on the Excel file and these data were
added to the quiz data. The mean difference between the pre-test and delayed post-test for the multiple-choice condition was determined and compared with the mean difference between the pre-test and delayed post-test for the traditional gloss condition.

The first research question addressed whether a multiple choice option that requires students to expend mental energy when discovering the meaning of an unknown vocabulary item increased retention of the word meaning. In order to answer this question, I had to see if the students clicked on the vocabulary words. Many of the students did click, although a few did not click on any of the words. An Excel file was created for recording the data about the multiple-choice glosses. The words were listed with space to the side for marking whether they knew the word on each of the three quizzes, as well as whether they clicked on the word and, if they did click in the multiple-choice condition, did they correctly identify the word initially. A similar spreadsheet was created featuring data on the traditional glosses. This included simply a record of whether they correctly identified a word on each of the quizzes and whether or not they clicked on that word.

The second question dealt with students’ use of provided vocabulary definitions when answering comprehension questions containing the target words. For this portion of the data organization, the Camtasia recordings were viewed and each time a subject would click on a word while engaged in answering a comprehension question, it would be noted. This was added as another column in the Excel spreadsheet.

The third question was whether students interact with an on-line reading passage in predictable ways or not. For this part of the data analysis, the Camtasia recordings were viewed and notes were kept as the student moved the cursor across the screen. These notes
were used when crafting interview questions for the students later on. The results for all of these questions are discussed in chapter 4.
CHAPTER 4. RESULTS AND DISCUSSION

This chapter presents the results as they address the three research questions. It examines the data gathered as a result of this study, both in quantitative and qualitative form. The first question addressed whether a multiple choice option that requires students to expend mental energy when discovering the meaning of an unknown vocabulary item increased retention of the word meaning. This is investigated using a combination of the quantitative results of the study and the qualitative results given on the reading questionnaire and during the retrospective interview. The questionnaire gave the students an opportunity to write the words they had learned and provide suggestions for ways the unit could be improved. Six students participated in an retrospective interview. These were students who seemed interested in the technology and willing to devote some time to reflect on the experience. The interview was a way to ask them about their interactions with the unit. The six students were Natasha*, from Turkey; Ying, from Taiwan; Sarah, from Jordan; Vinay, from India; Cesar, from Peru; and Jun, from Korea.

The second question addressed students’ use of provided vocabulary definitions when answering comprehension questions containing the target words. The final question asked in this study addressed whether or not students interact with an on-line reading passage in predictable ways. The task recordings and interview data provided insights for addressing both of these questions.

* All subjects’ names have been changed
Effectiveness of the Two Gloss Types

The answer to the first research question regarding the effectiveness of the multiple-choice glosses for vocabulary retention when compared with the traditional glosses can best be answered with a combination of quantitative and qualitative data. For the group, the difference between the two types of glosses was not statistically significant. The groups were counterbalanced to account for any effect due to the order of the texts or the order in which the type of gloss was experienced. Three of the participants scored 100% on one or both of the vocabulary pre-tests, so their data was not informative regarding gloss effectiveness. Because they had no room to learn, their performance does not inform the discussion regarding the effectiveness of the glosses; however, removing the scores of these three individuals did not change the conclusions.

In terms of learning, the data show that the students learned vocabulary from both the multiple-choice and traditional gloss conditions. Performance on the pre-test and immediate post-test under each gloss condition is shown in Table 4.1. Students improved their performance by 27% with the multiple-choice gloss and 28% for the traditional gloss. For both glosses, the differences were statistically significant (p < .05).

<table>
<thead>
<tr>
<th></th>
<th>Multiple-choice glosses</th>
<th>Traditional glosses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-test</td>
<td>.51</td>
<td>.20</td>
</tr>
<tr>
<td>Post test</td>
<td>.79</td>
<td>.20</td>
</tr>
<tr>
<td>Pre-test and post-test difference</td>
<td>.27</td>
<td>.20</td>
</tr>
<tr>
<td>t-test&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.62</td>
<td></td>
</tr>
</tbody>
</table>

Degrees of freedom = 20
In order to examine the retention of the items, an analysis of the delayed post-test data was necessary. Table 4.2 shows there was evidence of learning retained after a two-week period, although some forgetting occurred between the post-test and the delayed post-test. The delayed post-test scores are not statistically significantly different from the post-test scores \((p < .05)\).

<table>
<thead>
<tr>
<th></th>
<th>Multiple-choice glosses</th>
<th>Traditional glosses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Post test</td>
<td>.79</td>
<td>.20</td>
</tr>
<tr>
<td>Delayed post-test</td>
<td>.67</td>
<td>.20</td>
</tr>
<tr>
<td>Post-test and</td>
<td>.11</td>
<td>.19</td>
</tr>
<tr>
<td>delayed post-test</td>
<td>difference</td>
<td></td>
</tr>
<tr>
<td>t-test(^a)</td>
<td>3.09</td>
<td></td>
</tr>
</tbody>
</table>

Degrees of freedom = 20

The mean difference between the pre-test and delayed post-test for the multiple-choice condition was 11\% (SD = 19\%). The mean difference between the pre-test and delayed post-test for the traditional gloss condition was 10\% (SD = 15\%). The difference between the conditions was not significant.

The question of whether the glosses differed in terms of effectiveness is addressed in Table 4.3. Mean scores on the pre-test, post-test, and delayed post-test in each gloss condition are presented. The difference between the gloss conditions is presented in the rightmost columns. The pre-test data show that the two groups of participants did not differ in their performance on the pre-test. This means that they were at a similar level before beginning the treatment. The post-tests also show no difference, suggesting that the two types
of glosses were similar in effect. The delayed post-test showed no difference as well, suggesting that the participants’ retention was similar. Neither gloss appeared to be more effective than the other for learning or retention.

**Table 4.3** Means, standard deviations, and t-tests for both gloss types

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Multiple-choice gloss</th>
<th>Traditional gloss</th>
<th>Difference</th>
<th>t-test&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-test</td>
<td>.48</td>
<td>.16</td>
<td>.54</td>
<td>.19</td>
</tr>
<tr>
<td>Post-test</td>
<td>.79</td>
<td>.20</td>
<td>.83</td>
<td>.16</td>
</tr>
<tr>
<td>Delayed post-test</td>
<td>.67</td>
<td>.20</td>
<td>.73</td>
<td>.18</td>
</tr>
</tbody>
</table>

<sup>a</sup> Degrees of freedom = 20

The data show that the multiple-choice option was not better for retention of the target word meanings than the traditional gloss. Both of the groups learned words, but the difference between the two groups was not statistically significant.

Qualitative data are available to address the question of gloss effectiveness in the form of a reading questionnaire and retrospective interviews. The reading questionnaire was administered during a regular class meeting in the week following the delayed post-test. The teachers gave the participants time in class to complete the questionnaire. When asked if they learned any words as a result of interacting with the unit, 23 of the 24 students answered “yes.” The other student said that “almost all were known.” When asked to list the words they had learned, only four were unable to come up with any words from the reading, whether identified as target words or not. The others listed words, usually target words, from
the reading. The average number of words listed was three to four per participant. The words were spelled correctly; however, they were not asked to provide a meaning for these words.

Many of the students had a positive attitude toward the activity’s effectiveness. They felt they had learned words and that the time spent interacting with the unit was worthwhile. One student commented, “Of course, it helped me to read correctly. And I learned new words. It makes me to think again about the article. Then I can understand it more correctly.” One student said simply, “I would like to do more of this kind of reading.” Others commented that it was a quick and efficient way to get vocabulary definitions, saying “It has obviously reduced the time taken to look into the dictionary for these unknown words and hence improves the speed of reading.” One student did not feel the unit was effective for her. She said, “I don’t like it a lot; I prefer the unit in the class [with all print materials].”

**Use of Vocabulary Definitions when Answering Comprehension Questions**

In this study, the students generally did not make use of the provided vocabulary supports when they were answering the comprehension questions. This could be because of the way the questions were worded or because the students were testing themselves. Several students said during the interview that they purposely did not look at the definitions while answering the questions in order to test their comprehension of the reading passages. The majority of the students did not click on the target words as they were answering the comprehension questions. It was counted as a click when they went back to the text and clicked on the target word that was included in the comprehension question. Some students did not click on the vocabulary while answering the questions and were able to successfully
identify the correct answers. No student received a score of zero on the comprehension questions.

For the Chimps text, no one clicked for vocabulary assistance while answering question 1 (0%), while one person clicked for help while answering question 2 (4%), and eleven people requested vocabulary assistance before answering question 3 (46%). This shows that either it was not necessary to click for assistance for the first two questions and the third question was more difficult or that the students were reluctant to refer to the text because they felt that it would be cheating. Twenty of the twenty-four participants correctly answered the first two comprehension questions (83%), while half of them correctly answered question 3 (50%).

For the AIDS text, there was also very little clicking. One of the 24 participants clicked for assistance with comprehension question 1 (4%), while three people clicked for vocabulary help for question 2 and question 3 (13%). In terms of success on the comprehension questions, fifteen of the 24 were able to correctly answer question 1 (63%), and eighteen were able to successfully answer question 2 (75%). Fifteen were able to answer question 3 correctly (63%). Overall, the participants did not click as much while answering questions for the AIDS text (thirteen clicks for the Chimps text and seven clicks for the AIDS text), perhaps revealing a greater comfort level with these words than the Chimps text.

The anticipated level of interest in this activity was high due to grade motivation because their classroom teacher told them their performance on the reading task could replace one of their grades for a missing assignment in the class. The subjects were promised that if their performance on the comprehension questions was two or three out of three correct, the score would replace a missing assignment for the class in the hopes of
stimulating motivation. However, this did not appear to be enough motivation to encourage them to click on the vocabulary words while answering the questions.

**Student Interaction with the On-line Reading Passage**

The students interacted with the unit in some surprising ways. I would have assumed that they would use the vocabulary help while answering the comprehension questions. I also would have assumed that all the students would have clicked on the vocabulary words they did not know. However, one student did not click at all in either text and some students clicked on every word in both texts, even if they clearly already knew the item. Table 4.4 summarizes the number of clicks made by each participant appears below. It shows the number of times a vocabulary item was clicked in either text. A total of 21 is possible since multiple clicks were not counted, although they did occur with a small number of the participants. The table shows that there were more participants who clicked and at least explored the vocabulary glosses than those who did not click. Also, most of the participants clicked on at least half of all the available clickable words. The table does not describe what the students did once the click was made, but instead, summarizes the clicking that occurred as a result of using the unit.

<table>
<thead>
<tr>
<th>Subject's Number</th>
<th>Clicks to access vocabulary glosses (both texts, 21 poss.)</th>
<th>Subject's Number</th>
<th>Clicks to access vocabulary glosses (both texts, 21 poss.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>14</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>02</td>
<td>0</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>03</td>
<td>21</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>04</td>
<td>5</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>05</td>
<td>7</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>06</td>
<td>21</td>
<td>18</td>
<td>19</td>
</tr>
</tbody>
</table>
Table 4.4 cont’d. Total clicks by each participant in both reading passages

<table>
<thead>
<tr>
<th></th>
<th>07</th>
<th>08</th>
<th>09</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>22</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>24</td>
<td>21</td>
</tr>
</tbody>
</table>

This section will focus on how the students interacted with the unit. I have chosen to present the complete information for the same six students who completed interviews in the hopes of presenting what they did, as well as why.

Natasha had an interesting suggestion on her reading questionnaire. She said, “You are using same documents for this activity. I think in third and fourth lesson you can use different documents. But they introduce same words. And in fifth lesson we can compare all the documents.” She is suggesting a scaffolding activity in which students are held responsible for previous learning, while being introduced to a small amount of new content. From Natasha’s interview, I learned that she was very confident about the meaning of most words in the texts. She felt that she had a good grasp of the overall meaning of the articles, as well as an understanding of the individual words. She would not say that she did not know any of the words in the texts before using the vocabulary glosses in this unit. However, when asked why she clicked on every word, she gave three reasons: she was checking to be sure of the meaning (for the purpose of reading comprehension), she was checking her answers from the quiz, and she was interested in the technology.

Natasha said she preferred the traditional gloss condition because “it’s easy...there is no need to think about what it can be.” She also said, “If I have to stop and think about this word, it distracts from reading.” She found the multiple-choice glosses distracting. Natasha
liked using technology for vocabulary glosses because "it is easier to pay attention because of the color and graphic appearance." Also, regarding the interface, she said it was "easy to go back to the reading. The definitions are in a good place." The placement of the definitions mirrored what their placement would be in a book, which all the subjects interviewed agreed was the most appropriate position.

Natasha’s clicks are recorded in Table 4.5 below. The first column lists the target vocabulary item, the second column indicates whether she correctly identified the synonym for that item on the pre-test, the third column shows whether she clicked on the item in the unit or not, and the final two columns indicate her correctness on the post-test and the delayed post-test when encountering the vocabulary item again.

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. advocates</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. euthanize</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>3. facility</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4. habitat</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. moratorium</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>6. panel</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. primates</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. rigorous</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. sanctuary</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

According to the pre-test, Natasha did not know “moratorium” in the first text, which she saw in a traditional gloss condition. After clicking on the word, she was able to correctly answer the item on the vocabulary quiz, but unable to come up with the correct answer on the
delayed vocabulary quiz. Since this is only one item, no real conclusions can be drawn regarding this interaction.

Table 4.6 below describes Natasha’s clicks and performance on target vocabulary items in the second text she saw, AIDS Drugs in Africa. For the tables reflecting the data from the multiple-choice gloss condition, an extra column was needed to be added to show whether or not the correct choice was made after the multiple-choice definitions were presented. Column 4 shows whether or not the correct choice was made about the definition and the data regarding the post-test and delayed post-test are shown in columns 5 and 6.

Table 4.6 Record of Natasha’s clicks and vocabulary test performance for the second text she saw, AIDS Drugs in Africa, in the multiple-choice gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Right or wrong?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. consulting</td>
<td>yes</td>
<td>yes</td>
<td>wrong</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. cramped</td>
<td>no</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>3. crusade</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4. dispense</td>
<td>no</td>
<td>yes</td>
<td>wrong</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>5. exceeded</td>
<td>no</td>
<td>yes</td>
<td>right</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>6. helter-skelter</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. humanitarian</td>
<td>no</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. institute</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. individuals</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>10. motivated</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>11. prolonged</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>12. prosecuted</td>
<td>no</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

After incorrectly answering the questions for “cramped,” “humanitarian,” and “prosecuted” on the pre-test, Natasha correctly identified the definition for each of these

** After choosing the wrong option, the subject was encouraged to select the correct choice. Natasha went back and chose the correct definition. In this section two stars (**) behind the word “wrong” in this context will denote that the subject went back and selected the correct definition. If the stars do not appear, the subject did not go back and make the correct selection.
items on both the post-test and delayed post-test after seeing their definitions as multiple-
choice glosses. Natasha learned words as a result of using both types of vocabulary glosses,
which is consistent with the data for the entire group.

Ying also provided interesting insights in her questionnaire and in her interview. She
wrote a suggestion on her questionnaire regarding the use of multi-modal approaches on the
quiz aspect of the unit. She said “I would like the online test to put more pictures to explain
the article.” In her interview, she said that she wanted “more pictures to explain the article
and maybe picture illustrations to help with the definitions.” Although Chun and Plass
(1996b) have begun conducting research in this area, her comment is valuable insight that
this area could benefit from more research.

This was not an easy reading task for Ying. She said that when she looked at the text,
she “didn’t know many meanings in the sentence.” In fact, she wanted more vocabulary help
than the unit offered. She clicked on words because she did not know them. She expended
some mental effort trying to make sense of the word before clicking as well. I asked her why
she paused before clicking, and she answered that she was trying to guess what the meaning
would be.

She enjoyed the activity, saying “I think this activity is good. We can keep the
vocabulary in our memory.” She considered this to be a valuable way to spend time trying to
learn English. When Ying finished reading, she went back to the text and began clicking on
several words again. She said she wanted to make sure she had clicked on everything. Thus,
she ended up clicking on many of the words more than once with no pause between the
clicks for reading; however, she may have been quickly scanning text that she had already
spent time reading.
Table 4.7 Record of Ying’s clicks and vocabulary test performance for the first text she saw, Unwanted Research Chimpanzees, in the multiple-choice gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Right or wrong?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. advocates</td>
<td>no</td>
<td>yes</td>
<td>right</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>2. euthanize</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>3. facility</td>
<td>no</td>
<td>yes</td>
<td>wrong**</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4. habitat</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. moratorium</td>
<td>no</td>
<td>yes</td>
<td>wrong**</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>6. panel</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. primates</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. rigorous</td>
<td>yes</td>
<td>yes</td>
<td>wrong**</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. sanctuary</td>
<td>no</td>
<td>yes</td>
<td>wrong**</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

** Note: After choosing the wrong option, the subject was encouraged to select the correct choice.

Although this treatment was not effective for one word, she was able to correctly identify two to three words. “Facility” and “sanctuary” were correctly answered on the immediate and delayed post-tests and she knew “moratorium” on the post-test, but not on the delayed post-test. She also seemed to learn one target word from context, “habitat,” since she did not know it on the pre-test and correctly answered it on both the post-test and the delayed post-test. In Table 4.8, Ying’s multiple clicks are noted with a (2) after the ones she clicked on twice.

Table 4.8 Record of Ying’s clicks and vocabulary test performance for the second text she saw, AIDS Drugs in Africa, in the traditional gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. consulting</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. cramped</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>3. crusade</td>
<td>yes</td>
<td>yes (2)</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4. dispense</td>
<td>yes</td>
<td>yes (2)</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. exceeded</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>6. helter-skelter</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. humanitarian</td>
<td>no</td>
<td>yes (2)</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. individuals</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>
Table 4.8 cont’d. Record of Ying’s clicks and vocabulary test performance for the second text she saw, AIDS Drugs in Africa, in the traditional gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Clicked</th>
<th>Correct</th>
<th>Yes/No</th>
<th>Yes (2)</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. institute</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>10. motivated</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>11. prolonged</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>12. prosecuted</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

Traditional glosses seemed to work for six of the words: “cramped,” “helter-skelter,” “humanitarian,” “individuals,” “motivated,” and “prosecuted.” She correctly answered all items on vocabulary quiz that she saw in the traditional gloss condition. She says she preferred the traditional glosses in her interview when she said they “save time” and she was “afraid she would remember the wrong meaning” in the multiple-choice gloss condition.

Sarah also had interesting comments on her reading questionnaire. She mentioned that the fact that you could not write notes on the computer during the task was one of the disadvantages of the unit. During the interview, she clarified that usually when she reads, she takes notes on the side. She underlines and highlights words she doesn’t know and writes the meanings to the side. This is difficult to do when sitting upright at a computer. She also likes to be comfortable while she reads, meaning she likes to lie down and maybe eat or drink, all things that are more difficult to do at a computer. She also says that books are more portable, even more so than a laptop because it is more difficult to “break a book.”

She says that highlighting words can “make the reading easier.” She suggested somehow letting the students highlight areas of the text in a lasting way. Also perhaps if the students could make notes that could be saved. Each of these problems could be addressed by software designers.
In Table 4.9, data is presented about Sarah’s clicks and her performance on the vocabulary quizzes. This is an instance of learning vocabulary through context since she did not click on any of the vocabulary in this reading passage.

Table 4.9 Record of Sarah’s clicks and vocabulary test performance for the first text she saw, AIDS Drugs in Africa, in the multiple-choice gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Right or wrong?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. consulting</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>2. cramped</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>3. crusade</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4. dispense</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>5. exceeded</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>6. helter-skelter</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>7. humanitarian</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>8. individuals</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. institute</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>10. motivated</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>11. prolonged</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>12. prosecuted</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

In the multiple-choice gloss condition, Sarah did not click on any of the vocabulary. Later, in the interview, I found out that she had not been paying attention during the instructions and did not read the directions that explained that vocabulary glosses were available. Although the clickable words appeared as underlined, blue text, she was not familiar with the conventions for marking clickable text. For the second text, another student had pointed out to her that she could click on the words. During the interview, she admitted that she is “not good at computers” and that she strongly prefers “paper and pencils.” These are valuable insights because what most students would consider as obvious, i.e. that blue, underlined text is clickable, was not at all apparent to this learner. Perhaps this fact should
have been advertised more in order for learners who are inexperienced with computers to understand the capabilities of the software or unit.

Table 4.10 Record of Sarah’s clicks and vocabulary test performance for the second text she saw, Unwanted Research Chimpanzees, in the traditional gloss

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Post-test</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. advocates</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. euthanize</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>3. facility</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>4. habitat</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. moratorium</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>6. panel</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. primates</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. rigorous</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>9. sanctuary</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Sarah clicked on the words that she did not know most of the time. When she did click for vocabulary help, she was successful in knowing the word at least until the immediate post-test, if not until the delayed post-test. Of the five words that she did not know on the pre-test, she clicked on three of them. One of those words, “primates,” she was able to retain for both post-tests. Another of the words, “moratorium,” she was not able to successfully answer on either post-test although she clicked on the word. She was able to correctly identify “facility” immediately after the treatment, but had lost the ability for the delayed post-test.

Vinay suggested that it would be helpful if the program would allow him to highlight important information while he was reading and then make that information available while he is answering the comprehension questions. During the interview, Vinay explained his methods of interaction with the unit.
Vinay found this text very easy to read. He said he did not click on any of the vocabulary because he was certain he knew what the words meant. He was not curious if he was correct on the quizzes because he was sure he was correct. He said that he was glad that the vocabulary was available, in case someone else was not sure of a word. He says that looking up a word in a dictionary, even one that is online and available as part of the unit, is a waste of his time. Instead, he preferred definitions available by simply clicking because “it improves the speed of reading.” His data are in Table 4.11.

**Table 4.11** Record of Vinay’s clicks and vocabulary test performance for the first text he saw, AIDS Drugs in Africa, in the traditional gloss

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. advocates</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. euthanize</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>3. facility</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>4. habitat</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. moratorium</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>6. panel</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. primates</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>8. rigorous</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. sanctuary</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

On the quiz for text 1, Vinay missed the words “euthanize,” “facility,” and “primates.” He did not see any vocabulary support for these words because he opted not to click on them. As a result, he did not acquire any new words from interacting with this unit. His answers on the post-test mirrored his answers on the pre-test and his post-test results were very similar also. He missed “moratorium” on the delayed post-test, while getting it correct on the two previous quizzes.
Table 4.12 Record of Vinay’s clicks and vocabulary test performance for the second text he saw, Unwanted Research Chimpanzees, in the multiple-choice gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Right or wrong?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. consulting</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. cramped</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>3. crusade</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>4. dispense</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. exceeded</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>6. helter-skelter</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. humanitarian</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. individuals</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. institute</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>10. motivated</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>11. prolonged</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>12. prosecuted</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

Vinay did not click on any of the words in the second text either, making his interactions with the unit purely a test of learning vocabulary through context. However, he successfully answered every item on the pre-test, thus any vocabulary he may have acquired through interacting with this unit was not tested by the researcher. He correctly assumed that he did not need assistance with the vocabulary words that were available. The fact that he missed three of these items on the delayed post-test indicates that perhaps he was in need of least reviewing these target words during the treatment.

Cesar, a Spanish speaker from Peru, suggested that a section allowing searches for definitions could be added to the unit. For Cesar, the traditional glosses were “easier to read” and understand. He said he was more interested in the subject matter of the second article, so he was “more careful” when reading. He liked the man in the article who was using his free time to help people in Africa who are dying of AIDS. He said the vocabulary was more difficult in the AIDS passage, causing more clicks.
Table 4.13 Record of Cesar’s clicks and vocabulary test performance for the first text he saw, Unwanted Research Chimpanzees, in the multiple-choice gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Right or wrong?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. advocates</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. euthanize</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>3. facility</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>4. habitat</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. moratorium</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>6. panel</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. primates</td>
<td>no</td>
<td>no</td>
<td>N/A</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>8. rigorous</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. sanctuary</td>
<td>yes</td>
<td>no</td>
<td>N/A</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Cesar answered all the pre-test questions correctly, except for “primates.” He did not click to receive help for this word and did not click on any of the available items. He missed “primates” on both post-tests. On the delayed post-test he also missed “euthanize” and “facility.” It is impossible to know if he would have remembered these items if he had clicked on them while reading. When students do not take advantage of provided vocabulary supports, an assumption could be made that they are unnecessary; Cesar’s post-test data would support this idea if he had received a perfect score on all three tests, but his assumption was wrong and he did need assistance on at least one word and possibly three. He said that he was interested in this text, but it was hard to understand. He said he did not want to stop to look at multiple-choice glosses because he thought he would get confused. He read the text a total of two times before starting the comprehension questions. He did not look back to the text to help with the questions because it was a “test of self-memory” for him.
Table 4.14 Record of Cesar’s clicks and vocabulary test performance for the second text he saw, AIDS Drugs for Africa, in the traditional gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. consulting</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>2. cramped</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>3. crusade</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4. dispense</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>5. exceeded</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>6. helter-skelter</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. humanitarian</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. individuals</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. institute</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>10. motivated</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>11. prolonged</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>12. prosecuted</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Of the three words he answered incorrectly on the pre-test ("cramped," "individuals," and "institute"), he clicked on all of them and correctly answered them on the post-test. He only answered one of the three, "individuals," correctly on the delayed post-test. He also correctly answered and clicked on three words in the passage, "helter-skelter," "prolonged," and "prosecuted." He answered each of these correctly on both post-tests. However, there were two words that Cesar knew on the pre-test, did not click on, knew on the post-test, and subsequently missed on the delayed post-test ("consulting" and "dispense"). This shows some confusion on his part regarding the meaning of the words since the distracters did not change on any of the tests, only the order in which they were presented.

Jun’s use of the unit is recorded in the charts below. Jun, a Korean student, wrote on his reading questionnaire that there should be more comprehension questions and they should be timed. He thought the vocabulary glosses should not be available the first time the passage is read. He wrote, “It’s better because we can expect the word’s meaning from the sentence.”
While it’s true that inferring the meaning of unknown words is useful, the glosses allow the reader to check their inference and make sure they are exposed to the correct meaning.

When asked to compare the two types of glosses, Jun replied, “When I solve the problem [of the multiple-choice glosses], it makes me think more carefully. The other one is easy, no work, but if I solve the multiple-choice thing more carefully, it is better.” This student clearly preferred the challenge of multiple-choice glosses, if given a choice.

**Table 4.15** Record of Jun’s clicks and vocabulary test performance for the second text he saw, Unwanted Research Chimpanzees, in the multiple-choice gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Right or wrong?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. advocates</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2. euthanize</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>3. facility</td>
<td>no</td>
<td>yes</td>
<td>wrong**</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>4. habitat</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. moratorium</td>
<td>no</td>
<td>yes</td>
<td>wrong**</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>6. panel</td>
<td>yes</td>
<td>yes</td>
<td>no selection</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. primates</td>
<td>no</td>
<td>yes</td>
<td>right</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>8. rigorous</td>
<td>yes</td>
<td>yes</td>
<td>right</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. sanctuary</td>
<td>yes</td>
<td>yes</td>
<td>wrong**</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

**Note:** After choosing the wrong option, the subject was encouraged to select the correct choice.

Jun missed “facility,” “moratorium,” and “primates” on the pre-test. He clicked for help with these words and initially chose the wrong definition for two of them, although he went back and chose the correct definition afterward. He answered one of the items correctly on the post-test, but answered all three items incorrectly on the delayed post-test, indicating the information did not remain accessible. As Jun was using the unit, he said that if he did not know a word, he tried to guess the meaning. Then he would click to be sure. He enjoyed the multiple choice glosses because he liked to “solve the problem” by deciding which definition worked in the sentence.
Table 4.16 Record of Jun’s clicks and vocabulary test performance for the second text he saw, AIDS Drugs for Africa, in the traditional gloss condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Correct on pre-test?</th>
<th>Clicked?</th>
<th>Post-test?</th>
<th>Delayed post-test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. consulting</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>2. cramped</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>3. crusade</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4. dispense</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>5. exceeded</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>6. helter-skelter</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7. humanitarian</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8. individuals</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9. institute</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>10. motivated</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>11. prolonged</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>12. prosecuted</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

Jun missed “consulting,” “individuals,” and “prosecuted” on the pre-test. He clicked on two of the words while reading and was able to give the correct answer for them on the post-test. He was able to answer one of the words correctly on the delayed post-test (“individuals”).

During the interviews I was able to uncover reasons for the participants’ behavior with the unit and understand some of their reasoning. The value of this qualitative data cannot be underestimated when undertaking a study of this nature. Some of the tables describing the data would have been impossible to interpret without the explanations from the participants themselves. Many of the students said they preferred the traditional glosses, with one, Cesar, purposely refusing to interact with the multiple-choice glosses for fear of remembering the wrong meaning. Natasha said they were “distracting.” Only one student, Jun, said he preferred solving the puzzle of the multiple-choice glosses.
Conclusion

This chapter presented the results of the study organized around the three research questions. Both quantitative and qualitative data were used in an attempt to answer the research questions. In terms of the effectiveness of multiple-choice glosses, it was determined that this type of gloss is no more effective than a traditional gloss. The second question dealing with students’ use of provided vocabulary definitions when answering comprehension questions containing the target words was also answered. It was determined that the students did not consistently make use of these supports. The final question asked in this study addressed how the participants used the online unit. It was determined that most used the unit in predictable ways. They read the passage, clicked the vocabulary, and answered the comprehension questions. At times, the interview data were necessary to determine the purposes behind their behaviors. The interview data also revealed students insights regarding the two types of glosses.
CHAPTER 5. CONCLUSION

As computer technology becomes more widely available, English as a Second Language teachers and students are exploring ways the technology can be used for language learning, including for reading tasks and vocabulary learning. Now that computer technology has increased in its capabilities and decreased in its expense, it is increasingly examined for its best uses. This study examined two types of vocabulary glosses in the hope of adding new knowledge to this area of research. The multiple-choice gloss did not prove more effective than the traditional gloss; however, the importance of glosses was underscored.

Summary of Results

The results of this study show that students learned vocabulary in both the traditional and multiple-choice gloss conditions; however, the data showed the multiple-choice condition was not more effective than the traditional glosses. Both conditions were effective for increasing the vocabulary of the subjects. Most interviewees preferred the traditional gloss condition because they believed they could have gotten confused when presented with a multiple-choice gloss. One expressed a fear of accidentally learning the wrong meaning of a word. The ease of discovering quickly whether they were right or wrong when choosing the definition was offset by their concern about always remembering their first choice as the "real" definition. One of the interviewees preferred the multiple-choice gloss condition. He thought that by solving the problem of which definition fit with the sentence, he would be able to remember the meaning of the target words better.

Preference for either a multiple-choice gloss or traditional gloss may depend in some part on the personality of the participant. Perhaps the students are more accustomed to the
traditional glosses and therefore find the multiple-choice glosses difficult to use initially. For example, Jun preferred the multiple-choice glosses because they were more work. He felt the multiple-choice glosses forced him to look more carefully at the meanings and therefore learn the word more completely. More research is needed before a conclusion can be drawn about this preference.

In terms of teaching in a classroom that includes students who strongly prefer one type of gloss over another, choices need to be made about methods of delivering vocabulary instruction both with and without a computer. Traditional glosses, and perhaps multiple-choice glosses, are good tools to incorporate into the classroom, but more research needs to be done to investigate the effectiveness of these two gloss types with all types of students.

Problems and Consequences

Technical Difficulties

No technical difficulties were experienced in the course of the study. However, there were a few students who were more accustomed to using computers than others. One significant way that this lack of experience affected the study, was in the knowledge about the “markers” given online to know when something is clickable. During the course of the interview process, I discovered that at least one student did not click any words in the passage because she did not know the text was clickable. Some people are unfamiliar with the convention of marking clickable text by making it blue and underlined. The unit was carefully planned to conform to standards within the internet community in this respect to reduce such instances.
Non-technical Difficulties

One major non-technical difficulty arose during the first computer data-gathering session. The researcher’s anxiousness to begin her research led to allowing the students to begin working on the unit before they had completed the vocabulary pre-test. Instead, pre-test data was used that had been collected from the students two weeks prior to the first session on the computer. The data was part of a process for determining the most difficult words in a passage. Because the students had seen these exact words two weeks before the treatment and there was no pre-test administered directly before their interaction with the unit, there may have been students who had independently learned these words in the time between the two encounters with the words. Due to the lack of a pre-test, it is not possible to know this.

Limitations of the Study

If this study were to be replicated, certain changes should be taken into account. For example, more rigorous testing of the items on the vocabulary quiz could have been conducted. One item was thrown out of the quiz because it was discovered after the research was completed that the item was unreliable. This was because the correct answer and one of the distracters were too closely related in meaning. It became impossible to tell whether the students knew the item or not because many of them chose one of the two closely related answers. A future study would also benefit from a complete report of each student’s interaction with the unit. Then, participants could be organized into subgroups based on their performance. Continued research on these subgroups could result is very useful information for pedagogical purposes.
Another limitation that is common when working with a population of English language learners in a college setting is their ability to memorize. These are high ability language-learning students who have a high capacity for memorization, so the immediate post-test results could be skewed. These results do not reflect what a different population of language learners may be able to do with the same type of task. The delayed post-test is a more useful tool for measuring student acquisition of the vocabulary items.

Suggestions for Further Research

Recommendations for future research which would improve the validity of the results include working with a larger sample of subjects and transcribing and analyzing the individual results of all the subjects. A larger sample of subjects would alleviate some of the concerns about the generalizability of these results. A study similar to this one with a larger number of subjects would yield interesting results and perhaps would find a statistically significant difference between the two types of glosses. Transcribing and analyzing the results of all the subjects would answer questions related to personal preference and may turn up interesting aspects of individualized learning. Subgroups may emerge that would lead to a better understanding of the effectiveness of these gloss types. Adopting a qualitative approach to researching this question would also be an interesting perspective. This was not explored in this study; however, a study could be designed to determine student attitudes toward one or both of the gloss types and see if these attitudes affected performance on the activity. This lends itself to the exploration of individual experiences with the unit and eventually to an understanding of how this gloss type could fit into the discussion of
students' individual learning preferences. Conducting interviews of all the research subjects would also yield interesting findings.

A teacher or a materials designer should continue to include vocabulary glosses when designing online materials. However, this study provides no clear answers about which kinds of glosses to include. More research is needed in the area of individual preferences and vocabulary glosses before definitive recommendations can be given.
APPENDIX A. SCREENSHOT OF THE ONLINE UNIT FOR THE PILOT STUDY

AUTUMN'S CRIMSON TIDE
Turns out that the red is nature's sunscreen
By Charles W. Pettit

As fall’s foliage wave of crimson and gold moves south into New England, Boston-area resident Michele “Missy” Holbrook can’t wait to get out to marvel at this splendid display of nature’s sunscreen. Holbrook, a botanist at Harvard University, views the show this way because she’s among the scientists whose recent work may have solved the puzzle of why trees turn red in autumn.

An expert in how plants transport water, she says that a few years ago, “I was shocked to learn nobody had really studied why the reds appear.” Botanists had long known that the more common yellow of soon-to-drop leaves is always there. In summer it is masked by green chlorophyll, but it comes into view in fall, when the tree breaks down chlorophyll to resorb such nutrients as nitrogen. Scientists did know that the reds—pigments called anthocyanins—are made fresh in the fall. But no one knew why.

So Holbrook and colleagues made some measurements on a typical red-turning species, a dogwood variety. They learned that the anthocyanin pigments screen out the blue light that normally drives photosynthesis in the chlorophyll-containing layers of the leaf, turning off the reaction. Like unplugging an electric motor before taking it apart, this eases the tree’s task of recycling the goodies from its doomed leaves.

1. The “crimson tide” in the title refers to what?
   - red waves
   - green trees
   - fall foliage
   - cold weather

Click on the correct definition for nutrients.

1. Very small pieces or parts, tiny portions or specks
2. Chemicals or food that provide what is needed to live and grow
APPENDIX B. THE TWO READING PASSAGES

Unwanted Research Chimps
From a news story by CNN San Francisco Reporter Rusty Dornin

They look like us, sometimes act like us, and are close relatives. That is why a federally funded panel says chimpanzees should be treated differently than other laboratory animals when they are no longer needed for medical research.

Dr. Peter Theran explains, "You can't just kill them, there are ethical and moral issues involved here. They didn't feel it was right to euthanize them just because they were no longer needed for research."

Fifteen hundred chimpanzees in the U.S. are housed in research facilities. Too many for current research needs. A panel for the National Research Council now recommends a breeding moratorium and long term care for the primates. Animal rights advocates still oppose using chimps for research but applaud the effort.

"They recognized our moral responsibility to these very special animals. They've also recommended that retirement be recommended as a possible solution to this surplus of chimps" says Peggy Cunniff.

The chimps were bred for an expected increase in demand for AIDS research. They weren't good models for studying the disease, and demand dropped. Now research centers are worrying about paying for ongoing care for the animals.

Tom Gordon of the Yerkes Primate Research facility says, "Animals who reproduced in the breeding program in the National Institute of Health of the past decade have thirty or forty years of life remaining and that's a very long time to have the resources to maintain them."

A number of the chimps have already been given to zoos, but the study recommends any sanctuary or facility caring for the animals meet rigorous standards. The study suggested standards like those at the Yerkes Primate Center, where the chimps can play outdoors everyday.

Dr. Peter Theran says, "They could have been living in their own complex social environment in their own habitat so we have an obligation now to try to do that for them ... to try to create a facility that comes close to matching that."

Matching their natural habitat won't come cheap. The federal government already spends more than seven million dollars a year to care for the chimps. A small price, says scientists, for the priceless research data the chimps have provided.
Saving AIDS Drugs for African Victims
From a news story by CNN San Francisco Reporter Greg Lefevre

In some African countries, the cost of treating an AIDS patient may exceed his or her entire annual income. Here in the U.S., some hospitals and clinics routinely destroy huge quantities of the life saving drugs. That prompted one man to launch a crusade.

From his cramped, one bedroom San Francisco apartment, Lee Wildes almost single handedly takes on one the biggest problems in the world, AIDS in Africa.

Refills of AIDS drugs that were needed in Africa were available in the U.S. because of the surplus, or leftovers, from clinics, or hospitals, or from the survivors of those who died from AIDS.

Lee Wildes says, 'I knew, having been a nurse, that I had thrown away millions and millions of dollars worth of drugs. And that no nurse likes to do it.'

Five years ago, after learning he was HIV positive, Wildes took a vacation in Africa and he saw first hand the scale of its AIDS epidemic. When he returned to the United States, he learned new drugs were prolonging lives of those with AIDS and began a personal campaign to get the drugs to Africa.

Lee Wildes says, 'We're not just putting medicine in a box, helter skelter, and hoping it gets to the same patient.'

Consulting with African doctors by mail, e-mail and telephone, Wildes acts as case manager for a hundred patients in six African countries.

He carefully fills doctors' prescriptions and documents the medications. Once a year, he goes to Africa to work in clinics. 'Once I met a man who was so confused and disoriented and so sick I was certain he wouldn't make it, and right now he's a metal worker doing heavy steel work, doing work that I couldn't do,' says Wildes.

Dispensing drugs without a license is illegal, but it's not likely Wildes will be prosecuted for his humanitarian effort.

With more than 25 million Africans infected with the AIDS virus, Wildes' 100 patients may seem like a small success but it is a success admired by those trying to fight AIDS on a global scale.

Dr. Richard Feacham of the University of California San Francisco Institute for Global Health says, 'In the face of the enormity and horror of the epidemic, and in the face of such little action, it's very natural that individuals who really care about this problem become motivated and active to do something about it.'

Wildes says he's not only helping a few but creating a treatment model he hopes will show governments and drug companies what can be done.
APPENDIX C. SCREENSHOTS OF THE TWO READING PASSAGES WITH COMPREHENSION QUESTIONS

Unwanted Research Chimps
From a news story by CNN San Francisco Reporter Rusty Dornin

They look like us, sometimes act like us, and are close relatives. That is why a federally funded panel says chimpanzees should be treated differently than other laboratory animals when they are no longer needed for medical research.

Dr. Peter Thran explains, "You can't just kill them, there are ethical and moral issues involved. They didn't feel it was right to euthanize them just because they were no longer needed for research."

Name: ____________________________

Please answer the following questions.

1. Why does Dr. Peter Thran feel that it is not right to euthanize former research chimps?
   - They are cute and cuddly animals.
   - They look like us and act like us.
   - There are moral and ethical issues involved.
   - They are treated differently than other laboratory animals.

Saving AIDS Drugs for African Victims
From a news story by CNN San Francisco Reporter Greg LeFevre

In some African countries, the cost of treating an AIDS patient may exceed his or her entire annual income. Here in the U.S., some hospitals and clinics routinely destroy huge quantities of the life-saving drugs that prompted one man to launch a crusade.

From his cramped, one bedroom San Francisco apartment, Lee Wildes almost single-handedly tackles one of the biggest problems in the world, AIDS in Africa.

Refills of AIDS drugs that were needed in Africa were available in the U.S. because of the

Name: ____________________________

Please answer the following questions.

1. Why did Lee Wildes decide to launch his crusade?
   - He learned that he had AIDS.
   - He knew that AIDS drugs are not expensive in the U.S.
   - He used to be a nurse.
   - He knew that large quantities of AIDS drugs are often destroyed in the U.S.

2. When Lee Wildes puts the drugs in the mail...
APPENDIX D. COMPREHENSION QUESTIONS

Questions for “Research Chimps” text:

Name: ________________________

Please answer the following questions.

1. Why does Dr. Peter Theran feel that it is not right to euthanize former research chimps?
   - They are cute and cuddly animals.
   - They look like us and act like us.
   - There are moral and ethical issues involved.
   - They are treated differently than other laboratory animals.

2. Who are "the primates" mentioned in paragraph 3?
   - all research animals
   - groups of people who care for the chimps
   - humans and lemurs
   - research chimpanzees

3. According to the article, why is it important for chimps to play outside everyday?
   - so they can feel comfortable in their home
   - so they can interact in something close to their own habitat
   - so they can use up energy and sleep better
   - so humans can fulfill their obligation to the animals

First, check your answers. You have correctly answered ____out of 3 questions. Please go back to the index.
Questions for “AIDS in Africa” text:

Name: _________________________

Please answer the following questions.

1. Why did Lee Wildes decide to launch his crusade?
   - He learned that he had AIDS.
   - He knew that AIDS drugs are not expensive in the U.S.
   - He used to be a nurse.
   - He knew that large quantities of AIDS drugs are often destroyed in the U.S.

2. When Lee Wildes puts the drugs in the mail...
   - he doesn't know when they will arrive in Africa.
   - he is filling doctors' prescriptions
   - he is consulting with patients
   - he is fulfilling his dream

3. Wildes hopes his efforts will...
   - provide a model to show what can be done to help AIDS victims in Africa
   - save the lives of thousands of Africans
   - inspire other people to participate in his program
   - help him win an award.

First, check your answers. You correctly answered [ ] out of 3 questions.
Please go back to the index.
APPENDIX E. READING QUESTIONNAIRE

This questionnaire aims at getting feedback on the online reading activity you did in class. Please complete the following questions. Use the back if necessary.

1. You could look at the explanations of unknown words while reading the text online. How did that influence your reading?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2. Did you learn any new words from the unit? How many?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

3. List some of the new words you learned.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

4. Apart from the explanations of new words, what else could help you read online?

________________________________________________________________________

________________________________________________________________________

What do you think about this type of reading activity?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

5. Your comments and suggestions for the improvement of the online activity.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
APPENDIX F. CONSENT LETTER

Consent Letter

You are invited to participate in a research project about online reading and vocabulary learning. This project will be conducted by Jennifer Oden, a graduate student in the English department at Iowa State University.

As part of this project, you will first take a preliminary quiz. Then, you will complete an online reading activity, take another quiz, and fill out a questionnaire. This will take place during your regular reading class. In two weeks, you will take another quiz during your class time and you will be asked to meet with me to talk about how you completed the activity. This is an opportunity for you to practice reading online and learn some vocabulary that could be important for your academic work here at Iowa State university. Students often find these activities useful for gaining insight into how they learn.

All data collected during this research project will be kept confidential. Your participation in this project is completely voluntary, and you are free to withdraw at any time for any reason without penalty.

If you have any questions about this research project, please contact Jennifer Oden by phone (515) 572-4080 or by e-mail at joden@iastate.edu. You can also contact the advisor for the project, Dr. Carol Chapelle, by phone at (515) 294-7274 or by e-mail at carolc@iastate.edu.

----------------------------------------

I have read and understand the above information and voluntarily agree to participate in the research project described above. I have been offered a copy of this consent form.

----------------------------------------

Signature Date
APPENDIX G. INSTRUCTIONS GIVEN TO STUDENTS

Instructions given to 101R students

Instructions:

Today you are going to complete an on-line reading activity. Please use the computer that matches your number on the top of this paper. When you are at your computer, please find your name in the menu for reading activity 1. Once you find your name, click “go” to see your first reading passage. After reading and answering the comprehension questions, you will come back to this index page. When you come back, you will find your name in the menu for reading activity 2 and click “go” again. This will make the second reading passage come up. You have 40 minutes to complete all the reading and comprehension questions, so please work quickly and efficiently.

** Please do not close any screens!
** Please wait for me to start the recording before you start!
** When you are finished reading, let me know so I can stop the recording.

Thank you

Instructions given to IEOP students

Instructions:

Today you are going to complete an on-line reading activity. Please use the computer that matches your number on the top of this paper. When you are at your computer, please find your name in the menu. Once you find your name, click “go” to see your reading passage. After reading and answering the comprehension questions, you will come back to this index page. You should raise your hand and I will come over to help you. You have 40 minutes to complete all the reading and comprehension questions, so please work quickly and efficiently.

** Please do not close any screens!
** Please wait for me to start the recording before you start!
** When you are finished reading, let me know so I can stop the recording.

Thank you
REFERENCES


ACKNOWLEDGEMENTS

I would first like to thank my major professor, Dr. Carol Chapelle, for her work in helping me complete this project. She read each draft I gave her and provided many useful comments and insights. Her hard work and encouragement assisted me greatly, particularly in the final stages of this project. I would like to thank Dr. Volker Hegelheimer for his assistance throughout my time at Iowa State and for his friendship. I would like to thank Dr. Veronica Dark for her keen editor's eye, as well as her willingness to devote time to this project as an outside committee member. I would not have been able to make sense of this data without her assistance.

I would also like to thank Stacey Dent and Jennifer DeBoest for allowing me to take our class project for 517 and turn it into my thesis project. They worked hard at the beginning stages and set a strong foundation to begin the investigation.

I would also like to thank my husband, Derek, for his continued support of my education, and my parents for their love and support.