THE EFFECT OF MEDIATED GLOSSES ON VOCABULARY RETENTION AND READING COMPREHENSION WITH ENGLISH LANGUAGE LEARNERS IN SAUDI ARABIA

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ABSTRACT

This study investigated the effectiveness of mediated glosses for understanding technical terms with foreign language learners. Previous research has found that online glosses improve information access, comprehension, vocabulary retention, and efficiency. Pavio's dual coding theory and Mayer's generative theory both posit that learning should improve when multiple coding systems are engaged through different media representations.

An expert panel in petroleum engineering identified critical technical terms (e.g. compress, velocity, and permeable). The designers then used an iterative process to refine definitions, pictures, and animations in developing three gloss conditions. For condition 1 (audio and text), the term was written in English and Arabic, pronounced in English and defined in English. Condition 2 (audio, text and picture) had condition 1 features with a picture. Condition 3 (audio, text and animation) had condition 1 features with an animation.

Participants were 222, 18-24 year-old male native Arabic speakers enrolled in petroleum engineering courses. Three groups under three gloss conditions read an online story in English with 50 glossed words, and completed a 22-item multiple-choice comprehension test. The three groups then reviewed 59 glossed terms without the story, and completed a vocabulary test immediately following and two weeks later. Demographic and attitude questionnaires were administered.

Results found that, when controlling for language ability, those who received audio, text, and picture glosses (M=9.72) had higher comprehension scores than the text-based group (M=8.35), $F(2,218) = 3.07$, $p < .05$. Those who received the audio, text, and picture gloss (M=3.88) agreed that "Online texts are better than paper-based texts" more than the audio and

text group (M=3.41); F (2,216) =3.10, $p<.05$. There was a positive relationship between students' language-learning anxiety and reading comprehension ($r=.203$, $p<.05$), immediate vocabulary test ($r=.229$, $p<.05$), and delayed vocabulary test ($r=.207$, $p<.05$). Moderate anxiety levels seem to facilitate language learning.

Online glosses with dynamic pictures were found to be more effective in supporting comprehension and were rated higher than text-based glosses. The design process revealed that pictorial and animated representations should include negative and positive examples. Dynamic pictures may often be as effective as animations. Further mediated gloss research with more advanced language learners is warranted.

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CHAPTER ONE

INTRODUCTION

Background of the Study

Many foreign language or second language (FL/L2) learning educators consider the acquisition of words to be the most important aspect of FL/L2 learning and teaching (Knight, 1994). When FL/L2 learners are faced with a difficult text, their first challenge is its vocabulary. If that text has many new words, FL/L2 learners quickly become disheartened. However, when the vocabulary of the text is familiar to FL/L2 learners, they are more likely to continue with the reading process (Grabe & Stoller, 1997).

Researchers argue that, in order to develop linguistic abilities, FL/L2 readers need to reach a certain vocabulary threshold (Geva & Clifton, 1994; Brisbois, 1995; Kim, 1995; Lomicka, 1998). Research has shown that there is a strong relationship between vocabulary knowledge and reading comprehension (Laufer, 1997; Adams, 2000). Stahl (1983) describes the relationship between vocabulary knowledge and reading comprehension as "one of the best documented relationship in reading research" (p. 33). Adams (2000) investigated the relationship between reading comprehension, vocabulary knowledge, and fluency. He found that vocabulary knowledge was important for both reading comprehension and fluency. This association between vocabulary knowledge and reading comprehension has led many FL/L2 researchers to say that "a reader's general vocabulary knowledge is the best predictor of how well that reader can understand text" (Anderson & Freebody, 1981, p. 3). Stahl (2003) also states that vocabulary knowledge has been the "foremost predictor of a text's difficulty" (p. 241).

Laufer (1997) argues that FL/L2 learners who have acquired 3000 word families or 5000 lexical words can achieve a reading score of 56%, those who have acquired 4000 word families or 6400 lexical words can achieve a reading score of 63%, while those who have acquired 6000 word families or 9600 lexical words can achieve a reading score of 77%. This need for a large vocabulary explains the difficulties that FL/L2 learners encounter when reading FL/L2 texts. Therefore, FL/L2 teachers should do everything they can to ensure that their students substantially increase the size of their vocabularies.

As stated above, many researchers such as Knight (1994), Laufer (1997), and Yoshii and Flaitz (2000) consider vocabulary learning an important part of each FL/L2 learner's life. Other researchers such as Harley (1996), Groot (2000), and Ghabanchi and Anbarestani (2008) accept the importance of vocabulary learning in language proficiency and academic achievement; however, their ideas about how vocabulary is learned vary widely. They argue that one of the major concerns in FL/L2 vocabulary learning is the need to develop effective pedagogical methods for teaching FL/L2 vocabulary. They believe that traditional pedagogical methods (word-lists, dictionary use, workbooks, teacher-materials, and marginal glosses embedded in language textbooks) are no longer effective for teaching FL/L2 vocabulary. Therefore, FL/L2 learners need to develop strategies for coping with difficult words (Harley, 1996).

Some of the traditional pedagogical methods include the use of dictionaries and marginal glosses embedded in certain language textbooks (Harley, 1996; Groot, 2000; Ben Salem, 2006; Ghabanchi & Anbarestani, 2008). These two instructional methods are not convenient for FL/L2 learners who, in order to use the resources, have to interrupt their reading process and lose sight of the text while looking for the meanings of difficult words (Ben Salem, 2006). The use of dictionaries can make reading a text in FL/L2 learning a "three to four- hour ordeal" (Crow,

1986, p. 242). In order to efficiently use a dictionary, FL/L2 learners need special training because encountering several meanings for a single word can be difficult (Nation, 2001) and confusing (Luppescu & Day, 1993).

Despite the recognized importance of vocabulary learning, this essential component of language learning still causes headaches for many FL/L2 learners. They tend to forget newly learned words quickly and they have difficulty using them in either speaking or writing because of a lack of knowledge of pragmatics. However, the appearance of Computer-Assisted Language Learning (CALL) has provided a new means for learning vocabulary. With computers and the Internet becoming more and more popular, many CALL programs and online materials have flooded the area of language teaching and learning. These CALL programs provide FL/L2 learners with a variety of learning activities, which were only a dream decades ago (Jing-hua, 2009). The development of CALL had three phases: a) behaviorist CALL, b) communicative CALL, and c) integrative CALL. Each phase is marked by distinct theories of language learning and teaching (Warschauer, 1996a).

Behaviorist CALL, implemented in the 1960s and 1970s, was based on the dominant behaviorist theories of learning and teaching at that time. Programs in this phase emphasized the formation of speaking habits and focused on repetitive language exercises (Jing-hua, 2009). Communicative CALL emerged in the late 1970s to early 1980s, and it echoed the movement from grammatical competence towards expanding communicative competence, including sociolinguistic competence and strategic competence (Hymes, 1971; Canale & Swain, 1980). Experts at that time proposed that a language could be learned through contextualized, appropriate, and meaningful communication (Brumfit & Johnson, 1979; Savignon, 1983). Integrative CALL has been made possible due to the development of multimedia computers and

the Internet since the 1990s. Multimedia is defined as "presenting both words (such as spoken text or printed text) and pictures (such as illustrations, photos, animation, or video)". Multimedia resources facilitate a wide variety of text, graphics, sound, animations, and videos that can be integrated into a single program to create an integrative learning environment (Mayer, 2005, p. 2).

Among the concerns often raised regarding CALL is how to use the potential of a computer to enhance the language process and how to use different types of media in learning and teaching. These concerns have been narrowed to investigating the efficacy of presenting information using multiple modalities such as visual text, spoken word, still picture, and dynamic video in the field of Second Language Acquisition (SLA). The impact of glossing individual vocabulary via electronic glosses by different modes and media is an area that has recently received attention (Jing-hua, 2009).

Two prominent theories are believed to explain the value and impact of multimedia presentation in the language learning environment. These two theories are Wittrock's generative theory (1974) and Paivio's dual-coding theory (1986) (Al-Seghayer, 2001). Wittrock's generative theory (1974) states that learning is improved when information is presented in multiple forms so that the learner can select relevant information to them for constructing meaning (Mayer, 1997). Paivio's dual-coding theory (1986) claims that learning becomes even better when the information is received through two channels (verbal and nonverbal) to construct meaning (Paivio, 1986; Clark & Paivio, 1991; Mayer & Sims, 1994; Mayer, 1997). Words that are associated with actual objects or images are better acquired and recalled (Clark & Paivio, 1991).

Hypertexts are electronic texts that readers can access in a non-linear way using hyperlinks. Hypertexts provided with glosses help readers have control, immediate access, and no interruptions in the reading process (Davis & Lyman-Hager, 1997; Martinez-Lage, 1997). Research has shown that combining multiple forms of media such as text, sound, pictures, animated pictures, and video can aid vocabulary learning and facilitate reading comprehension (Chun & Plass, 1996a, 1996b, 1997; Al-Seghayer, 2001; Lomicka, 1998; Davis, 1998).

Chun and Plass (1996a, 1996b, 1997) investigated the impact of two combinations of gloss components (text-picture gloss and text-video gloss) on vocabulary learning among English-speaking learners enrolled in a second-semester German course. Results showed that words glossed with both text and picture helped participants recall more vocabulary than words glossed with text and video. In a study similar to the work of Chun and Plass (1996a, 1996b, 1997), Al-Seghayer (2001) examined the impact of dynamic video glosses versus still-picture glosses among ESL students at an American university. Participants were assigned to one of three different conditions: a) text and audio; b) text and picture; or c) text and video. Results showed that words that were glossed with text and picture and those with text and video were learned better than words with text-only glosses. However, words with text and video glosses were remembered better than words with text and picture. These results were the opposite of those obtained by Chun and Plass (1996a, 1996b, 1997), whose results showed that text and picture were more effective for recalling words than text and video glosses.

Lomicka (1998) studied the effectiveness of glosses on L2 reading comprehension by investigating whether glossed words facilitated or hindered reading comprehension among students enrolled in a second-semester French course. Participants were assigned to one of three different conditions: a) full glossing (L2 definition, L1 translation, L2 pronunciation, images,

references and questions); b) limited glossing (L2 definition, L1 translation); or c) no glossing. Results showed that computerized reading with full glossing promoted better text comprehension. Similarly, Davis (1998) examined whether marginal glosses improved comprehension of a literary text read in the FL by intermediate-level college students of French. Results showed that both presenting the students with a vocabulary guide before reading the text and providing glosses during the reading of the text helped students recall significantly more of the reading passage than those without resources.

Although the above studies are a good start to exploring the effectiveness of electronic glosses in FL/L2 learning, additional empirical studies regarding the impact of hypermedia glosses on vocabulary learning and reading comprehension are still needed (Kamil & Lane, 1998; Ben Salem, 2006). In fact, there is a need to examine which combinations of electronic gloss components are more effective in aiding vocabulary learning and reading comprehension. Although researchers have investigated different combinations of audio, text, picture, and animation media types, results are still mixed or inconsistent. Therefore, the current study aims to investigate the effects of three combinations of electronic gloss components (audio and text; audio, text, and picture; and audio, text, and animation) on vocabulary retention and reading comprehension.

Purpose of the Study

The purpose of this study is to investigate the effectiveness of three different combinations of electronic gloss components on vocabulary retention and reading comprehension. The types of glosses to be examined include three combinations: a) audio (L2

pronunciation of the key word) and text (L2 definition, L1 translation, and an example in FL); b) audio (L2 pronunciation of the key word), text (L2 definition, L1 translation, and an example in FL), and picture; and c) audio (L2 pronunciation of the key word), text (L2 definition, L1 translation, and an example in FL), and animation. Specifically, the current study will examine whether some combinations of electronic gloss components are more effective than others in teaching vocabulary and comprehension to English language learners in Saudi Arabia.

Hypotheses of the Study

The purpose of this study is to investigate the effects of three combinations of electronic gloss components (audio and text; audio, text, and picture; and audio, text, and animation) on vocabulary retention and reading comprehension. Therefore, the following hypotheses are addressed:

1. Students will perform differently on a test of reading comprehension depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation when measured immediately after the intervention.
2. Students will perform differently on a test of vocabulary depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation when measured immediately after the intervention.
3. Students will perform differently on a test of vocabulary depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio,

text, and picture; or c) audio, text, and animation when measured two weeks after the intervention.

4. Type of online gloss access will affect vocabulary retention as evidenced by group differences when measured two weeks after the intervention.
5. There is a relationship between students' level of anxiety regarding foreign language learning ability and their performance on English vocabulary and reading comprehension tests.
6. Students' demographic and background measures will predict their English vocabulary and reading comprehension test results.
7. Students will express different attitudes towards the different interventions depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation.

Research Questions

To achieve the purpose of this study, the following research questions will be pursued:

1. Do some combinations of electronic gloss components work better than others for increasing the English reading comprehension of native Arabic speakers?
2. Do some combinations of electronic gloss components work better than others for increasing the English vocabulary of native Arabic speakers?
3. Do some combinations of electronic gloss components work better than others for recalling the English vocabulary of native Arabic speakers?
4. Does the type of electronic gloss combination accessed affect vocabulary retention as evidenced by group differences when measured two weeks after the intervention?

5. Is there a relationship between participants' test performance and their anxiety regarding foreign language learning?
6. Will students' demographic and background measures predict their English vocabulary and reading comprehension test results?
7. Do students express different attitudes towards the different electronic glosses accessed during the intervention?

Significance of the Study

Despite the number of studies regarding the impact of different combinations of electronic gloss components on vocabulary retention and reading comprehension, the findings are mixed and inconsistent. For example, while the results of Chun and Plass's (1996a, 1996b, 1997) study showed that text and picture were more effective for recalling words than text and video glosses, the results of Al-Seghayer's (2001) study show opposite results. The Chun and Plass and Al-Seghayer studies employed within-subjects designs in which the same group of students was exposed to different types of glosses for different words. Thus, differences in learning outcomes might have been attributed to learning difficulties imposed by varied words rather than the type of glossing itself (Akbulut, 2007).

There are also limited numbers of studies that have examined the impact of audio as a useful media type that may enhance the effect of multimedia glosses. For example, Hoban and Van Ormer (1950) supported the advantage of sound-picture gloss. Their results were confirmed by Nugent (1982) who demonstrated that when the content was the same in visual, audio, and print channels, younger students learned equally well from all the three models, but combining pictures with print or audio generally maximized learning.

If the interaction between media type such as audio, text, picture, and animation presented to the learners is thought to be a considerable help in memorizing words (Dubois & Vial, 2000), then it becomes important to determine if combinations of audio and text, audio, text, and picture, or audio, text, and animation would best help students recall words, as that increases the number of input channels. As more and more FL/L2 learners are reading electronic texts from software or over the Internet, there is a need to guide the development of new glossed texts. Designers need to know which combination is the most efficient: is it a gloss that includes audio and text; audio, text, and picture; or audio, text, and animation? The use of these three combinations in a story created by the researcher is the first of several reasons that make this study significant and unique. Secondly, the story of this study will focus on English for Specific Purposes (ESP) and not on existing reading materials as many researchers have used. Therefore, the target words and story will be relevant to petroleum engineering in general and crude oil and natural gas pipeline maintenance in particular, as it will be presented to Saudi Arabian students who will be familiar with this topic, as they recognize Saudi Arabia's role as an important oil and natural gas producer and exporter in the world. The third reason this study is important is that the findings of this study will be helpful to teachers who are looking for appropriate ways to help students increase the size of their vocabulary knowledge and facilitate their reading comprehension.

Independent and Dependent Variables

The three combinations of electronic gloss components in the online reading passage are identified as the independent variable of the study: a) audio and text; b) audio, text, and picture; and c) audio, text, and animation). The dependent variables for this study are the participants' scores on vocabulary (immediate and delayed) and reading comprehension tests.

Operational Definitions

1. Gloss. Any kind of attempts "to supply what is perceived to be deficient in a reader's procedural or declarative knowledge." Glosses can take the form of verbal, visual (image, icon, video), and/or audio (Roby, 1999, p. 96).
2. Hypermedia. Any computer-based application that displays text, image, sound, animation, or video in a variety of different combinations. In a hypermedia environment, readers have access to and control over the media (Dugan, 1999).
3. Hypermedia Gloss. With the availability of multimedia technology, glosses can be presented in different forms, such as audio, text, still pictures, and dynamic videos (Ben Salem, 2006).
4. Hypertext. An electronic text that readers can access in a non-linear way using hyperlinks (Ben Salem, 2006).
5. Multimedia. "Information in the form of graphics, audio, videos, or movies. A multimedia document contains a media element other than plain text" (Greenlaw & Hepp, 1999, p. 44).
6. L1. The native language of the learner. The L1 in the current study is Arabic.

7. L2. The foreign language of a learner. The L2 in the current study is English.
8. Retention. The ability to provide the meaning of a word after a given period of time. In this study, the retention measure will be two weeks after the intervention.

Organization of the Study

The study is presented in five chapters. The first chapter introduces the background information, purpose of the study, hypotheses of the study, research questions, significance of the study, independent and dependent variables, operational definitions, and organization of the study. The second chapter reviews the previous research related to the current study. The third chapter describes the methods for selecting the participants, the reading materials, and the instruments used to collect the data. It also includes the testing procedures implemented during data collection. The fourth chapter contains the results for the statistical analyses of the data. The fifth chapter presents a summary and discussion of the findings. It also contains the limitations of the study and recommendations for further research as well as the pedagogical implications of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviews previous research relevant to the study. It consists of four sections. The first section discusses important topics related to FL/L2 models of reading, factors that influence FL/L2 text comprehension, vocabulary knowledge and reading comprehension, the Linguistic Threshold Hypothesis, and incidental and intentional vocabulary learning. The second section presents the theoretical background for the current study. This includes a) Wittrock's Generative Theory of Learning (1989), b) Paivio's Dual-Coding Theory (1986), c) Mayer's Generative Theory of Multimedia Learning (1997), and d) Sweller's Cognitive Load Theory (1988). The third section of the chapter reviews literature related to hypertext glossing in the FL/L2 environment. Included topics are the importance of mediated glosses, FL/L2 readers and gloss look-up behavior, glossing and dictionary use in FL/L2 learning, and hypertext in the FL/L2 environment. Last, the fourth section presents literature reviews of research regarding the effects of electronic glosses on vocabulary learning and reading comprehension.

Models of FL/L2 Reading Process

There are many theoretical models that have tried to explain the FL/L2 reading process using metaphors. The most widely known models in the literature are top-down, bottom-up, and integrative models (Silberstein, 1987; Swaffar et al., 1991). Two of these models (top-down and bottom-up) are metaphors borrowed from computer terminology (Smith, 1988).

Top-Down Processing Models

Top-down processing models emphasize the reader's interpretation and previous knowledge (Chun and Plass, 1997). They are deemed to conceptually driven (Rumelhart, 1980; Chun & Plass, 1997). Seen as a receptive process, reading starts with phonological or graphic display as input and ends with meaning as output. During the process, readers predict the meaning of a given text by relating it to their previous knowledge. Readers use other strategies in conjunction with the incoming information. They may refine, confirm, or reject the initial prediction. Top-down models theories focus on the importance of visual information on the printed page and on the reader's use of contextual information. The three types of contextual information that appear are syntactic constraints, semantic constraints, and discourse constraints (Cziko, 1977).

Bottom-Up Processing Models

Bottom-up processing models focus on the important role of the text, and proceed serially (Gasigitamrong, 2003). For example, Gough's (1972) model of reading states that the meaning of the text starts at the level of letters and words and that the development of the meaning is linear, from letters to speech to meaning. Although Gough and Wren (1998) assert that there is much more to reading than decoding, they confirm that decoding is an important part of reading, and that reading without decoding would not be reading. These models are considered to be data-driven (Rumelhart, 1980; Chun & Plass, 1997; Hudson, 1998).

Integrative Processing Models

Integrative processing models stress the interplay between lower-level processing skills such as identification or decoding, and higher-level comprehension and reasoning skills, like interpretation and making inferences (Chun & Plass, 1977). Those who have higher-level comprehension and reasoning skills are able to utilize both top-down and bottom-up processing methods, and successful comprehension of the given text is the result of an interaction or collaboration between these two types of processing (Eskey, 1988; Bernhardt, 1991). Bernhardt's model of FL/L2 (1991) accounts for both language-based (word recognition, phono-graphemic resources, characteristic features, syntactic processes) and knowledge-based (background knowledge, intertextual perceptions). Schema theories have pointed out that both top-down and bottom-up processing models occur simultaneously (Ben Salem, 2006).

Factors Influencing FL/L2 Reading Development

Although FL/L2 and L1 reading development can be explained by the three models of reading mentioned above, there are many factors that impact FL/L2 readers. Some of these factors are FL/L2 linguistic competence, L1 reading skills, previous knowledge, cultural background, and FL/L2 text structure. FL/L2 learning researchers conducted studies to examine whether the difficulties that FL/L2 readers face are a reading problem or a language problem. They have tried to examine whether L1 reading proficiency or FL/L2 linguistic competence is the factor that most influences FL/L2 reading (Gasigitamrong, 2003). The belief that L1 reading skills can be transferred to the FL/L2 is based on four hypotheses: a) Reading Universal Hypothesis (Goodman, 1973), b) Interdependent Hypothesis (Cummins, 1991), c) Transfer

Hypothesis of Reading (Eisling & Downing, 1998), and d) Linguistic Threshold Hypothesis (Clarke, 1979).

The Reading Universal Hypothesis (Goodman, 1973) argues that the reading process is the same for all languages, with minor differences in the writing systems and grammatical structures of each language. The Interdependence Hypothesis (Cummins, 1991) proposes that language operations like reading and writing are transferable and intertwined. According to Cummins, once a set of language operations has been acquired, they are also available within FL/L2 contexts. The Transferable Hypothesis of Reading (Eisling & Downing, 1986) argues that reading is a skill that can be developed in all languages through a universal pattern that consists of three overlapping stages: cognitive, mastering, and automaticity. However, Eisling and Downing (1986) believe that the transferability of reading skill is beyond formal or linguistic similarities and dissimilarities. Based on the ideas of the Transferability Hypothesis of Reading, Bernhadt (1991) states that reading skills can be developed and acquired gradually through intensive practice. According to Bernhadt, once reading skills are acquired, they can be applied to other different situations or contexts. The Linguistic Threshold Hypothesis (Clarke, 1979) suggests that while some form of the Universal Hypothesis may be justified, the role of language proficiency may be greater than what had been previously assumed. As maintained by Clarke (1979), good readers' limited control over the language resists their systems, causing them to be readers with poor strategies when faced with a difficult FL/L2 text. Reading appears to be a universal process that can be transferred from L1 to FL/L2 on the condition that a reader's linguistic proficiency has reached a certain threshold level, or that the limited FL/L2 competency will resist the reading skill transfer (Gasigitamrong, 2003).

Another factor that influences on FL/L2 reading comprehension is background knowledge. Readers may not have the relevant content schema, or readers may have the appropriate schema but are not able to access it because the clues in the given text may not be sufficient. Moreover, readers may use an incorrect schema, which leads to misunderstanding the given text (Rumelhart, 1977, 1980). A major explanation for FL/L2 readers' difficulty accessing the correct content schema are a lack of the appropriate schema and a lack of the specific cultural background knowledge necessary for comprehension (Gasigitamrong, 2003). Parry (1996) stated that cultural background was important in the formation of one's reading strategies. Markham and Latham (1987) concluded from their study that top-down cultural knowledge affected their participants' comprehension.

Textual structure is also a factor that affects reading comprehension. The way a text is organized and explained influences the reader's ability to acquire information from the text. In other words, how coherent the text is has an influence on the reader's ability to comprehend the content of the text (Ulijn & Slager-Meyer, 1998). Coherence is the "extent to which the sequencing of ideas in a text makes sense and the extent to which the language used to present those makes the nature of the ideas and the relationship between tem apparent" (Gasigitamrong, 2003, p. 30).

Like reading strategies used by FL/L2 readers, text structure awareness can also be transferred once readers master it in their L1 (Gasigitamrong, 2003). Hague (1989) stated that proficient FL/L2 readers who were aware of text structure in English were able to transfer their awareness to assist in the retention of ideas presented in a FL/L2 text. Moreover, Hague and Olejnik (1990) also stated in their study that there was a general tendency for FL/L2 readers to remember a greater proportion of important ideas as compared to minor details in a short reading

task. Research investigating the relationship between awareness of text structure and FL/L2 text comprehension has shown a positive relationship between these two factors (Hague, 1989; Hague & Olejnik, 1990; Carell, 1992). Other researchers such as Ulijn and Strother (1990) and Slager-Meyer (1991) have argued that there are other factors (familiarity, background knowledge, language knowledge) that have more influence on FL/L2 reading ability than awareness of text structure. The effect of textual awareness on FL/L2 text comprehension also applies to electronic texts (Labbo & Kuhn, 2000). Researchers such as Goldman and Rakestraw (2000) and Keep, McLaughlin, and Parrmar (2000) have emphasized the importance of readers' familiarity with text structure in order to comprehend the electronic texts they were reading.

One of the important issues related to vocabulary learning is the relationship between vocabulary knowledge and reading comprehension (Rashkovsky, 1999). Stahl (1983) described the relationship between vocabulary knowledge and reading comprehension as "one of the best documented relationships in reading research" (p. 33). This is because "vocabulary knowledge is fundamental to reading comprehension; one cannot understand text without knowing what most of the words mean" (Nagy, 1988, p. 1). Daneman (1988) suggests that since words are the building blocks of connected text, the success of searching for individual word meanings is key to constructing meaning from a text. Davis (1968) found that the factor correlated most highly with comprehension was knowledge of word meaning. Hague (1989) stated that "To read, a reader must know words" and "to be a better reader, a reader must know words" (p. 218). Stahl and Nagy (2006) argue that "having a big vocabulary makes you a better reader" (p. 9). Therefore, to have successful comprehension, a reader is required to have automatic recognition and decoding of 95% of words in a text (Laufer, 1997; Nation, 2001).

Empirical research has been conducted to examine the importance of vocabulary in reading comprehension. The findings show a strong relationship between students' vocabulary knowledge and their general reading skills (Ben Salem, 2006). Anderson and Freebody (1981) studied the effect of vocabulary knowledge on reading comprehension with eighth grade students. They found a strong correlation between participants' measures of vocabulary and comprehension. They stated that "a reader's general vocabulary knowledge is the single best predictor of how well that reader can understand text" (p. 3). Qian (1999) also explored the relationship between depth (learner's level of knowledge of various aspects of a given word) and breadth (vocabulary size) of vocabulary knowledge and reading comprehension among ESL students in two universities in Ontario. The results showed that for ESL students with a minimum vocabulary size of 3000 word families, vocabulary size, depth of vocabulary knowledge, and reading comprehension were highly and positively correlated; in addition, "scores on depth of vocabulary knowledge can make a unique contribution to the prediction of reading comprehension levels" (p. 241). In his study of 28 average fifth grade students, Stahl (1983) found that students who had vocabulary instruction achieved significantly higher scores on both vocabulary learning and reading comprehension.

When reading authentic texts, learners do not necessarily look up difficult words and may ignore these words (Qian, 2004). Also, readers may not necessarily recognize words that they do not know or guess incorrectly (Laufer & Yano, 2001). Some of the important variables that are identified for successful guessing while reading are learners' proficiency (Bengeleil & Paribahkt, 2004), learners' use of appropriate guessing strategies (Nassaji, 2003), the number of times difficult words occur in a text (Rott, 1999; Webb, 2007), learners' current level of vocabulary knowledge (Laufer, 1997; Nation, 2001), and the density of difficult words in a text (Nation,

2001). Although significant knowledge of vocabulary is essential for reading comprehension, research indicates that understanding difficult words in authentic texts presents significant challenges for readers (Abraham, 2008). Research that has examined the correlation between vocabulary knowledge and reading comprehension, even though mixed on the nature of this correlation and on the appropriate size of the lexicon, does conclude that vocabulary has a positive impact on reading comprehension (Rashkovsky, 1999).

The Linguistic Threshold Hypothesis

Growing out of the Reading Universal Hypothesis (Goodman, 1973), the Linguistic Threshold Hypothesis (Clarke, 1979) suggests that while some form of the Universal Hypothesis may be justified, the role of language proficiency may be greater than had previously been assumed. Good readers' limited control over the language short-circuits cause them to revert to poor strategies when faced with a difficult text in a FL/L2 (Clarke, 1979, 1980).

Clarke (1979, 1980) conducted a study to test Goodman's (1973) Reading Universal Hypothesis and ended up with the Short-Circuit Hypothesis. The participants were Spanish-speaking students enrolled in college-level intensive English programs. They were asked to take cloze tests (filling in the blanks) in Spanish (L1) and English (L2). The results showed that when reading in L2, good L1 readers did better on a cloze test than did poor L1 readers. However, good L1 readers did appear to do only slightly better than did the poor readers in producing high-quality guesses when faced with difficult blanks.

According to the Linguistic Threshold Hypothesis (1979), a certain level of linguistic ability in FL/L2 must be reached in order to have a successful FL/L2 reading (Bernhardt &

Kamil, 1995). Linguistic ability is necessary before L1 linguistic abilities can be transferred to the task of FL/L2 reading (Alderson, 1984). Laufer (1997) argued that the threshold for reading comprehension is lexical, and this means that readers will be able to transfer their L1 reading strategies to FL/L2 contexts only when they have at least 4,800 FL/L2 items in their lexicon (Laufer, 1992). Although a lack of FL/L2 linguistic competence cannot be compensated for by good reading abilities in L1, reading abilities in L1 definitely contribute to FL/L2 (Alderson, 1984; Bernhardt & Kamil, 1995).

Incidental and Intentional Vocabulary Learning

Researchers generally categorize vocabulary learning activities into two types: a) incidental vocabulary learning and b) intentional vocabulary learning (Nation, 2001). Greidanus (1996) defines incidental vocabulary learning as the "accidental learning of information without the intention of remembering that information" (p. 327). Intentional vocabulary learning is defined as "any activity geared at committing lexical information to memory" (Hulstijn, 2001, p. 271). Other researchers believe that the difference between incidental vocabulary learning and intentional vocabulary learning is the learner's type of attention to reading a text (Ben Salem, 2006). Ellis (1994) states that "whereas intentional learning requires focal attention to be placed on linguistic form, incidental learning requires focal attention to be placed on meaning (message content), but allows peripheral attention to be directed at form" (p. 2).

Research has been conducted to compare the efficiency of incidental vocabulary learning and intentional vocabulary learning (Ben Salem, 2006). Krashen (1989) reviewed a number of studies that dealt with the differences between these two types of vocabulary. He concluded that

incidental vocabulary learning leads to better results than does intentional vocabulary learning since "words in natural texts are encountered in a variety of contexts, which helps readers acquire their full semantic and syntactic prosperities" (p. 450). In support of Krashen's (1989) review, Nagy and Herman (1987) state that "explicit vocabulary instruction, even at its best, cannot produce substantial gains in overall vocabulary size or in reading. Major progress toward these goals can take place only by increasing incidental vocabulary learning" (p. 19). In the field of linguistics, it is believed that some, if not most, of FL/L2 learners' vocabulary is acquired incidentally (Gass, 1999).

There are, however, disadvantages to incidental vocabulary learning compared to more direct learning. Incidental vocabulary learning is not always effective or efficient (Nation, 1982; Mondria & Wit-de Boer, 1991; Hulstijn, 1992). Researchers such as Nation (1982), Mondria and Wit-de Boer (1991), and Hulstijn (1992) point out that contextual information is often ambiguous and not sufficiently reliable for L1 and FL/L2 learners to be able to make the correct inferences. To overcome these disadvantages, Hulstijn, Hollander, and Greidanus (1996) identified the use of marginal glosses as one way to enhance incidental vocabulary learning. Most studies examining the usefulness of electronic dictionaries and glosses have explored their impact on accidental vocabulary acquisition (Ben Salem, 2006). The following section discusses the major theoretical framework for the current study.

Theoretical Framework for the Study

The theoretical framework for the current study includes four theories: a) Wittrock's Generative Theory of Learning (1989), b) Paivio's Dual-Coding Theory (1986), c) Mayer's Generative Theory of Multimedia Learning (1997), and d) Sweller's Cognitive Load Theory (1988).

Generative Theory of Learning

According to Wittrock (1989), the generative theory of learning tries to explain how people process the information they receive. Based on Wittrock's (1989) theory, the learning process involves the four elements of generation, motivation, attention, and memory. Generation is the connections between the learner's incoming information and existing knowledge. Motivation is the internal factors that help learners achieve successful learning. Based on the importance of this element, students should become mentally active in the learning process, be responsible, and hold themselves accountable for connecting what they read with their previous knowledge. Therefore, instructors should enhance their students' motivation by encouraging students to be active in the learning process. Attention is the learner's ability to comprehend the received information. The more attention learners pay to the received information, the higher level of retention they achieve. One of the major goals of education is to help learners store the received information in long-term memory and to use it on later occasions in an effective way.

Dual-Coding Theory

Paivio's dual-coding theory (1986) explains how verbal and nonverbal information is processed. Research has shown that words that are associated with actual objects or images are better acquired and recalled (Clark & Paivio, 1991). This theory postulates that there are two

cognitive subsystems: verbal and nonverbal. While the verbal subsystem is specialized for processing language (text and audio), the nonverbal subsystem is for processing and representing nonverbal objects or events (pictures, animations, or video). The two subsystems are linked to each other through referential connections (Ben Salem, 2006).

According to Paivio (1991), there are three levels of processing for the two subsystems: representational, associational, and referential. Representational processing involves the perception and recognition of information in either the verbal subsystem or nonverbal subsystem. Associational processing refers to the connections within the verbal and nonverbal subsystems. The links between the two subsystems are referred to as referential connections. Paivio (1991) claims that pictures are thought to be more likely than words to activate the verbal and nonverbal subsystems upon processing. As a result, "mnemonic superiority of the image code over the verbal code" (p. 265) makes pictures easier to remember than words alone. The explanation of how learning occurs in the presence of verbal and nonverbal input has had important implications for FL/L2 learning (Ben Salem, 2006).

Generative Theory of Multimedia Learning

According to Mayer (1997), a generative theory of multimedia learning places the learner in the role of a "knowledge constructor who selects and connects visual and verbal knowledge" (p. 4). Mayer's generative theory of multimedia learning drew from Wittrock's generative theory (1989) and Paivio's dual-coding theory (1986) (Paivio, 1986; Clark & Paivio, 1991). Mayer (2001) states that learning takes place in the following sequence. Learners select relevant information and transfer it to working memory for processing. Then, the received information is organized into two separate mental models; words are stored in a verbal mental model and

images are stored in a visual mental model. The final step in learning is to connect the verbal and mental representations and integrate them into the learner's existing knowledge.

Mayer's generative theory of multimedia learning (1997) is based on three assumptions. First, visual and auditory information are processed by two separate channels. While the auditory or verbal channel processes the information received through the ear, the visual or pictorial channel processes the information received through the eyes. The second assumption of the theory states that each channel has a limited amount of information that it can process. Third, learners are actively processing the received information and connecting it with their previous knowledge (Wittrock, 1989).

Mayer (1997) argues that learners are likely to recall specific information better when the information has both verbal and visual formats simultaneously. The availability of these two sources of information at the same time helps establish a connection between verbal and visual models in working memory. Later, learners will have an increased possibility of retrieving that information stored in the long-term memory.

Cognitive Load Theory

It has been established that short-term memory has a limited capacity for processing received information (Miller, 1956). Sweller's (1988) cognitive load theory suggests that learning happens best under conditions that are placed with human cognitive architecture. The structure of human cognitive architecture is perceptible through the results of experimental research. Having depended upon Miller's (1956) research, which showed that short-term memory is limited in the number of elements it can hold simultaneously, Sweller (1988) built his

theory that treats combinations of elements as the cognitive structures that make up an individual's knowledge base.

Researchers have conducted a number of empirically-based studies on the limitations of short-term memory regarding instructional materials in computer-based and non-computer-based environments. Within this framework, the constraints of human information processing are operationalized in terms of cognitive load, which is the total amount of mental activity imposed on short-term memory at a given time. This theory addresses individual differences in processing abilities of text and visuals (Sweller, 1994; Sweller & Chandler, 1994).

Sweller and Chandler (1994) identified two sources of cognitive load in instructional materials: intrinsic cognitive load and extraneous cognitive load. Intrinsic cognitive load refers to the mental effort required by the inherent intellectual complexity of the materials, which is operationalized in terms of interactivity of the elements and learner expertise. Elementary interactivity is the degree to which components of a task must be perceived and processed simultaneously. Extraneous cognitive load is the mental activity imposed by instruction because of the way in which the material has been organized, designed, and presented.

The Importance of Marginal Glosses

Glosses, as defined by Roby (1999), refer to various kinds of "attempts to supply what is perceived to be deficient in a reader's procedural or declarative knowledge, "(p. 96). Roby emphasizes on the fact that glosses are much more than translations or explanations of difficult words. Based on a number of researchers, such as Stewart and Cross (1991), Blohm (1982), and Widdowson (1978), who coined various terms for different types of glosses, Roby (1999) tried to

classify the possible forms of glosses. According Roby (1999), glosses can be characterized by their authorship, presentation, functions, focus, language, and form.

Marginal glossing is one way to help a learner comprehend reading materials. By offering additional notes or information beyond the text in the margin on the same page or another page, marginal glossing acts as a mediator between the learner and the given text. Glosses have various functions such as helping the learner decode the text by providing additional knowledge in specific content, skills, strategies, and/or definitions of difficult words. In the FL/L2 environment, a gloss refers to additional information that is given on difficult words via definitions, translation, synonyms (Richgels & Mateja, 1984; Nation, 2001), or examples.

The two common reasons to use glossing are to assist vocabulary learning and increase reading comprehension (Ko, 2005). In general, there are many advantages for glossing. First, glosses can help readers understand new words more accurately by preventing incorrect guessing. Guessing from context can be difficult and risky because of reader's lack of language or reading strategies (Stein, 1993; Nation, 2001). The second advantage is that glosses do not interrupt the reading process, since the definition of the difficult words is easily available in the text. The third advantage is that glosses can help readers build a bridge between previous knowledge and new information from the text (Stewart & Cross, 1993). The fourth advantage of glossing is that glosses can make learners less dependent upon their teachers, allowing for autonomy. Since not all learners have the problems with the same words, they can look up the words they do not know (Nation, 1990; Jacobs, 1994).

Research has shown that the process of L1 reading comprehension is very complex. This complexity increases when reading in a FL/L2 environment. Therefore, glossing is important in

FL/L2 reading comprehension because it is an effective way for learners to understand what they read (Widdowson, 1978). Researchers such as Gettys, Imhof, and Kautz (2001) claim that glossing "enhances general comprehension, improves vocabulary recall, and saves students' time and effort in reading FL/L2 texts" (p. 91). The researchers added that glosses "provide fast and easy access to the meanings of unknown words, make up for insufficiently automatic bottom-up processes and deficiencies in processing capacity, and thus allow the reader to attend to top-down process" (p. 93). It has been suggested that hypermedia or multimedia glosses have the potential to aid vocabulary learning and facilitate reading comprehension due to their capacity to combine multiple forms of media such as sound, still pictures, animated pictures, and/or video in addition to textual explanations (Chun & Plass, 1996a, 1996b, 1997: Lomicka, 1998).

Davis (1989) states that many FL/L2 texts encountered by readers contain low-frequency words, and reading these FL/L2 texts becomes a stressful task because of needing to frequently use a dictionary. He points out that hypermedia or multimedia could be used to expand the amount of information available to the reader, and to individualize the learning experience by hiding the glossing until the reader feels the need to access it. Davis (1989) emphasizes that these types of media are "invisible and unobtrusive" (p. 42), which decrease the amount of extra information and increases the flow of reading due to the availability of immediate access to the necessary extra information for the reader.

Researchers generally agree that the use of glossed words in FL/L2 reading materials is a common practice and that glosses aid vocabulary learning and facilitate reading comprehension (Hong, 2010). In a summary of the advantages of glosses for vocabulary learning and reading comprehension, Nagata (1999) concluded that glosses have four main advantages. First, marginal glosses are easier to use than a dictionary. Second, they draw learner's attention to target words.

Third, glosses help readers connect words to their meanings immediately. Fourth, glosses encourage learners to processing lexically, which may contribute to an improved and increased recall of the target words.

Jacobs (1994) stated that electronic glosses are thought to be effective in aiding FL/L2 vocabulary learning and facilitating reading comprehension. He believes that both researchers and learners can benefit from computerized glosses. Learners are provided with an immediate access to glosses of unknown words and a list of the accessed words is created automatically. Researchers can examine the created list to obtain information about individual learners, such as their particular reading strategies and behaviors (Ben Salem, 2006).

Chun and Plass (1996a) emphasize that when words or phrases are presented together by different types of media, recall becomes easier. They also state that "foreign words associated with actual objects or imagery techniques are learned more easily than words without" (p. 183). Their claim is based on Paivio's dual-coding theory (1986) that words are coded in two modes, and that they are learned better than those coded only in one mode. They added that Paivio's dual-coding theory (1986) provides more channels for learning; therefore, the learner can have two types of cues for assisting in memorization of the learned words.

To examine whether marginal glosses would promote reading comprehension, Davis (1989) conducted a study involving 71 U.S. students in a French class. They read a short passage under one of three text conditions. In the first group, participants were asked to read the passage for 15 minutes, wrote what they could remember for 10 minutes, and then reread the passage for 5 minutes. In the second group, participants were given a vocabulary guide before they read the passage and then were guided through the passage by some questions and notes giving the

meanings for some new words. They studied the questions and notes for 10 minutes, read for 15 minutes, and then wrote what they remembered. In the third group, participants were given the same questions and meanings of the same new words in glossed form. Participants read the passage for 25 minutes, and then wrote what they remembered. The results showed that participants in the third condition who read the text with glossing performed significantly better than those in the other conditions who read the text without glossing.

Other researchers such as Hulstijn, Hollander, and Greidanus (1996) have confirmed that a gloss is more useful than no gloss for incidental vocabulary learning. They studied the influence of marginal glosses, dictionary use, and the reoccurrence of difficult words on incidental vocabulary learning. Participants who were learning French read a short text that had been adapted to one of three conditions: a) marginal glosses (L1), b) bilingual dictionary use (L1 and L2), or c) text- only. The results showed that marginal glosses (L1) were more effective than either bilingual dictionary use or text-only.

In summary, glosses enable readers to approach a given text globally rather than linearly. They also provide readers control, immediate access, and multiple presentation formats for information with no interruptions, none of which can be realized through any other conventional instructional media (Davis & Layman-Hager, 1997; Martinez-Lage, 1997). Thus, glosses can be used to make FL/L2 texts more interactive, easier to understand, and more manageable for FL/L2 learners (Ben Salem, 2006).

FL/L2 Readers and Gloss Look-up Behavior

Although the impact of glosses on FL/L2 vocabulary learning and reading comprehension is still debatable, there has been an increase in the use of these types of media as an aiding tool for FL/L2 texts. Furthermore, with computer technology it has become possible to provide glosses in various forms. Many studies regarding glossing have started to examine FL/L2 readers' behavior in accessing glosses when reading FL/L2 texts. While some researchers included FL/L2 readers' behavior in accessing glosses as part of their studies (Ko, 1995; Chun & Plass, 1996; Laufer & Hill, 2000; Bell & LeBlanc, 2000), others have looked at FL/L2 readers' behavior in accessing glosses as the main purpose of their studies (Yoshii, 2002). However, most researchers who have investigated FL/L2 readers gloss look-up behavior have used computerized log files to collect data. Following is a discussion of the research findings related to whether or not readers accessed glosses, factors influencing readers' decisions to access glosses, the types of glosses readers accessed, and the relationship of the glosses readers accessed to their vocabulary learning and reading comprehension.

To Click or Not to Click

Black, Wright, Black, and Norman (1992) reported that their participants looked up 95% of glossed words. In another study, Ko (1995) concluded that L2 readers with access to the L1 glosses looked up 69% of all the glossed words, while readers who had access to the L2 glosses looked up 92.5% of all the glossed words. Chun and Plass (1996) reported that L2 readers looked up multiple glosses when they were available. These studies show that there is a tendency for FL/L2 readers to look up glossed words, especially when they are available in an electronic format (Roby, 1991).

Five factors have been examined with regard to their impact on reader's selections of glosses. These factors are gender, previous knowledge of vocabulary, reading proficiency levels, text types, and highlighted words (Gasigitamrong, 2003). In terms of gender, Hegelheimer (1998) reported that female readers used glosses more often than did male readers. Bell and LeBlanc (2000) found that previous knowledge of vocabulary was not a significant factor in L2 readers' decisions to use glossed words. That is, L2 readers looked up some glossed words even though they were familiar with those words. In a study with ESL college students in the United States, Ercetin (2001) found that intermediate readers looked up glosses more frequently than did advanced readers. With respect to text types, Roby (1991) reported that readers who read hypertexts equipped with glossed words looked up more words than those who read printed texts provided with glosses. In terms of highlighted words, De Ridder (2000, 2002) reported that L2 readers looked up glossed words that were highlighted more than words that were not glossed.

Frequency of Gloss Selections

One of the main purposes for studies of readers' frequency of gloss selections is the examination of its relationship with FL/L2 vocabulary learning and reading comprehension (Gasigitamrong, 2003). In the area of gloss look-up behavior and FL/L2 vocabulary learning, Plass et al., (1998) concluded that L2 words were best learned when readers looked up both verbal and visual modes of instruction. Chun and Plass (1996) stated that the high frequency of gloss look-up did not necessarily result in better performance on word retention tests for L2 readers. Similarly, De Ridder (2002) indicated that the frequency of gloss access did not increase word retention. These studies suggest that frequency of gloss is not related to L2 vocabulary learning.

Bell and LeBlanc (2000) investigated gloss access behavior and FL/L2 reading comprehension by conducting a study with American college students enrolled in a third-semester Spanish class. Participants read a text with one of two types of glosses: L1 (English) and L2 (Spanish). The results showed that the L1-gloss group accessed approximately twice as many glosses as the L2-gloss group.

Glossing and Dictionary Use in FL/L2 Learning

Dictionaries designed to support FL/L2 learning can be classified into the two primary categories of bilingual dictionaries and monolingual dictionaries. Bilingual dictionaries provide both L1 translations and FL/L2 definitions (e.g., Arabic/English). Monolingual dictionaries present both the reference word and simplified definitions in the target language (Atkins, 1985). Most FL/L2 learners appear to prefer bilingual dictionaries. It is possible that this preference stems from a desire to gain a short-term understanding of the material FL/L2 learners are reading, as opposed to a longer-term mastering of FL/L2 (Aust, Kelley, & Roby, 1993).

Research has shown positive effects of dictionary use on vocabulary learning (Ben Salem, 2006). Luppescu and Day (1993) examined the impact of bilingual dictionary use on vocabulary learning with a study involving 293 Japanese university students who were studying English as a FL. The performance of students who were allowed to use English-Japanese dictionaries was compared to that of students who did not have access to dictionaries. The results showed that students who used dictionaries scored significantly better on the multiple-choice vocabulary test than students who did not have dictionaries.

In another study, Knight (1994) examined whether the use of electronic dictionaries would increase vocabulary learning and reading comprehension for L2-American college students learning Spanish as a FL. Participants were divided into two groups (low and high verbal ability students) based on their American College Test (ACT) verbal scores. One group read the text with access to a dictionary while the other group read the text without access to a dictionary. Participants were then administered definition recognition and definition production vocabulary tests. The results showed that students who used dictionaries learned more words and achieved higher reading comprehension scores than those who had no dictionary and were dependent upon inferring the meanings of words from the context. According to Knight (1994), the dictionary use was supportive for the low verbal ability participants who achieved a "similar or greater increase in vocabulary learning and in reading comprehension" (p. 295) compared to their higher verbal ability peers.

Although researchers have provided evidence of the advantage of using dictionaries, FL/L2 learners still require special training to use dictionaries since the availability of several meanings for a single word can be difficult (Nation, 2001) and confusing (Luppescu & Day, 1993). Moreover, dictionaries are thought to be useful for advanced FL/L2 learners, who tended to use successful word search strategies (Lantolf, Labarca, & den Tuinder, 1985).

Researchers have also investigated glossing as an effective way to help FL/L2 readers understand new words in a specific context (Gasigitamrong, 2003; Ben Salem, 2006). In Leffa's (1992) study, subjects were asked to read passages with one of two helping conditions, either an electronic glossary or a dictionary. The results showed that subjects scored 38% higher when reading the text with an electronic glossary than when reading the text with a dictionary. Roby (1991), on the other hand, conducted a study with American students learning Spanish as an L2.

Participants read a text in one of four different conditions: a) printed text with dictionary, b) printed text with dictionary and glossing, c) computerized text with dictionary, or d) computerized text with dictionary and glossing. The results showed that there was no significant difference between the four groups on the comprehension measure. However, both studies revealed that subjects spent less time reading texts with glosses than reading texts with dictionaries.

Jacobs, Dufon, and Hong (1994) studied the effects of vocabulary glossing on vocabulary learning and retention, as well as examining learners' preferences for glossing. Eighty-five native speakers of English enrolled in a college-level fourth-semester Spanish course participated in the study. They read a Spanish text under one of three treatment conditions: a) no gloss, b) English glosses (L1), or c) Spanish glosses (L2). They were then asked to write what they recalled of the text, translate a list of the glossed words, and complete a questionnaire. The translation task was repeated four weeks following the intervention. Results showed that glossing did not significantly affect participants' recall, but those with higher-than-average proficiency were able to recall more if they had read a glossed version of the text. Additionally, participants who had access to the L1 or L2 gloss performed better than participants who did not have access to a gloss on the translation task immediately after they had read the text. However, no significant difference was found on the delayed translation task. No significant correlation between participants' reading comprehension scores and vocabulary scores were found. Participants, according to the questionnaire, preferred marginal glosses with 52% favoring glosses in the L2 versus 47% who preferred L1 glosses.

The previous research conducted has indicated that when compared to dictionaries and no-help conditions, glosses tend to have better effects on L2 vocabulary learning. In terms of text

comprehension, the results are not conclusive. Luppescu and Day (1993) assert that dictionaries sometimes confuse L2 readers, especially those readers at lower proficiency levels. When L2 readers face a word with more than one meaning, they may have to spend time thinking about which meaning they should select, and sometimes they may end up choosing the wrong meaning.

Hyper-Reference and Hypertext Glossing in FL/L2 Learning

A hyper-reference is defined as an "online electronic aid that provides immediate access to adjunct information with a direct-return path to the target information" (Aust, Kelley, & Roby, 1993, p. 63). Electronic references that help FL/L2 learners understand text, namely dictionaries and glossaries, represent one of the most rapidly growing forms of electronic text (Wooldridge, 1991). Early proponents of automated dictionaries such as Miller (1980) and Fox, Bebel, and Parker (1980) recognized that the ability to immediately consult a reference and then return directly to the main reading text had implications for learning. Readers can use references frequently because the search takes place in a matter of seconds and involve fewer interruptions from the target text (Gasigitamrong, 2003).

The term hypertext describes "an array of emerging technologies for accessing, organizing, and relating electronic-based information" (Aust, Kelley, & Roby, 1993, p. 64). Nelson (1981) first used hypertext to describe a hypothetical electronic notebook for immediately consulting elaborations on any word or phrase by pointing to or clicking on information the user wishes to learn. Advances in computer hardware and software, such as HyperCard (Hill & Yamada, 1993) make hypertext accessible to a much broader range of developers (Halaz, 1987; Simth & Weiss, 1988).

Some recent hypertext innovations center on the mass storage capacity of videodiscs and CD-ROM to investigate media with enhanced implementations known as "hypermedia" (Kinzie & Berdel, 1990). This implemented hypermedia environment gives users unlimited access to diverse multimedia knowledge bases with unrestricted cross-referencing. To use a hypermedia reference, a learner can click on the glossed word, see its meaning, and have the option for its pronunciation (Aust, et al., 1993).

In a comparison study of hyper-reference and hypertext implementations conducted by Aust, et al. (1993), 80 undergraduate students learning Spanish in a fifth-semester Spanish course were assigned to one of four groups: a) hypertext plus English (L1)/Spanish (L2) dictionary; b) hypertext plus L2 dictionary; c) paper text plus L1/L2 dictionary; or d) paper text plus L2 dictionary. All words of the 420-word text were glossed with definitions in the hypertext version using HyperCard computer software. The researchers investigated the consultation frequency of the definitions, study time, efficiency (number of consultations per minute), and text comprehension. Tracking software monitored participants' interaction with the text, and a recall protocol measured reading comprehension. The results showed that hyper-reference users consulted over two times as many definitions as conventional paper users and that hyper-reference users achieved a higher efficiency rate by consulting more definitions per minute than did conventional dictionary users. Bilingual dictionary users consulted 25% more definitions than did participants who used a monolingual dictionary, and bilingual dictionary users were able to complete the reading task in 20% less time than monolingual dictionary users. There was no significant difference between the group's comprehension scores, but researchers suggested that using multiple choice and sentence-completion test forms might have generated different results.

Gettys, Imhof, and Kautz (2001) conducted a study with second-year American college students reading a text in Russian (L2). The target words in the first half of the passage were equipped with inferred-meaning glosses, whereas the target words in the second half of the passage were equipped with given-meaning glosses. The treatments were that when reading two texts, participants of the inferred-meaning glosses were given three alternatives of each target word in L1 while participants of the given-meaning glosses were a single L1 translation of each target word. The results showed that participants took more time to read a text with inferred-meaning glosses than given-meaning glosses. However, the participants did better on the inferred-meaning glossed words than on the given-meaning glossed words as measured by a vocabulary recall test, even though there was no significant difference between the types of glosses on L2 comprehension as measured by text recall and multiple-choice tests.

Mediated Glosses in FL/L2 Environment

Mediated glosses illustrate the meaning of a word or phrase with L1 translation and/or FL/L2 definition and at least one of the following types of media: audio, still pictures, animated pictures, or video. Mediated glossing has become a new way to enhance vocabulary learning and text comprehension. This technologically advanced tool offers features that are not attained through any other conventional instructional medium (Al-Seghayer, 2003). Davis (1989) notes that glossing is invisible and does not interrupt the reading process, and that readers can obtain as much or as little information as desired regarding a particular concept or word in a given text. Therefore, researchers have started investigating the impact of multimedia glosses on vocabulary learning and reading comprehension.

A number of studies have examined the effects of other types of glosses on incidental vocabulary learning. Neuman and Koskinen (1992) found that captioned video with sound provided a semantically-enriched context where the visual and the audio lent meaning to the printed words on the screen. Their study compared learning vocabulary by watching television, by reading and listening to a document, and by listening alone. The results showed that words were best learned and retained by watching television.

Lyman-Hager and Davis (1993) investigated the effects of an interactive computer-based reading program on vocabulary learning. The program employed the first 1754-word French story by Oyono (1956), *Une Vie de Boy*, with 660 glossed words. The program offered seven types of glosses: a) English translation; b) French definition; c) pronunciation in French; d) grammatical explanations; e) information related to the story characters; f) cultural notes; and g) pictures. Participants were divided into two groups. One group read the story via the computer program with access to multimedia glosses, and the other group read the story from a conventional-paper text with the same glosses provided by the computer program. Participants completed a vocabulary test one week after the intervention. Results showed that participants who used the computer program for completing the reading task scored significantly better on the vocabulary recall than did participants who used the conventional-paper text.

Other researchers have compared the effects of L1 glosses and L2 glosses on incidental vocabulary learning. Grace (1998) used sentence-level L1 translations to replace word definitions or explanations, and found that the translation glosses were very effective. Gettys, et al. (2002) on the other hand, compared the glosses of sentence-level L1 translation and the dictionary glosses from L1 translation. They found that the dictionary glosses were more effective than the sentence-level L1 translation glosses.

Kost, Foss, and Lenzini (1999) compared text-only (L1) glosses, picture-only glosses, and text (L1)-plus-picture glosses. Fifty-six American university students learning German as an L2 were asked to read a 272-word printed text containing 20 glossed words with one of three different gloss types. Participants took two vocabulary tests on 14 targeted words: one test immediately after reading and one test two weeks after the intervention. The tests consisted of multiple-choice definitions and supply-definitions. The results showed that the text and picture glosses were more effective than the picture-only or the text-only glosses.

Chen (2002) studied L1 and L2 glosses with 85 college freshmen students learning English as a FL in Taiwan. Participants were assigned to one of three conditions in which they received either an L1 (Chinese) gloss, an L2 (English) gloss, or no gloss. Participants were asked to read a 193-word English text with 20 glossed words. The results indicated that the L2 gloss group performed better than did the no gloss group and there was no significant difference between the L1 and L2 gloss groups.

Using a hypertext environment for teaching FL/L2 vocabulary, Svenconis and Kerst (1995) compared learning under three conditions. The first condition consisted of words formatted in a semantic mapping format alone, the second condition consisted of words presented in a semantic mapping formatted with words presented in lists, and the third condition consisted of words presented in lists with audio. In spite of the theoretical advantage of semantic mapping, the results did not show semantic format to be more effective for vocabulary learning. However, with the addition of the sound factor, semantic mapping was shown to be statistically more effective in helping students retain new vocabulary. The researchers also found that audio can be a powerful factor in producing better word retention when it is combined with a second factor, such as semantic mapping. In fact, the effect of the audio was so powerful that with the

passage of time and subsequent increase in forgetting, the effect of audio versus no audio was statistically significant while the method of presenting vocabulary (i.e., semantic mapping or lists) was not.

Siribodhi (1995) conducted a study on elementary-level Thai students learning English as a FL in order to explore the effect of graphics, text, and sound on vocabulary learning. Participants were divided into three groups. The first group had access to FL text, L1 text, and sound. The second group had access to FL text, picture, and sound. The third group had access to FL text, L1 text, picture, and sound. A vocabulary test was administered immediately after the treatment and a delayed vocabulary test was administered 72 hours later to measure the amount of vocabulary retention. The participants' task in the vocabulary test was word matching and picture matching. The results revealed a significant interaction between treatment condition and gender. That is, female participants in group one (FL text, L1 text, and sound) outscored female participants in the other two groups. The mean for males who had access to graphics was higher than the mean for males who did not have access to graphics, but there was no significant difference between the two means.

Chun and Plass (1996a, 1996b, 1997) conducted three studies with second-year students of German using a multimedia program called CyberBuch. This computerized program provided glosses through printed texts, still pictures, and videos. After reading a story, participants took a vocabulary test and completed a recall protocol. The results showed that words glossed with text and picture led to better vocabulary recall than words glossed with text and video or text alone. The researchers argued that these findings supported Paivio's dual-coding theory (1986), which states that information coded both verbally and visually is more effective for learning than information coded singularly.

Similar to the studies of Chun and Plass (1996a, 1996b, 1997), Al-Seghayer (2001) compared the impact of still pictures and dynamic videos in aiding vocabulary learning for college ESL students. Thirty participants were asked to read an online-narrative English text with one of three types of glosses: a) printed text definition alone, b) printed text definition plus still pictures, or c) printed text definition plus video clips. After reading the text, two vocabulary tests (recognition and production) were administered to assess participants' learning. The results showed that words glossed with text plus picture and words glossed with text plus video clips were better learned than words that were glossed with text only. Words that were glossed with text plus video were better remembered than words glossed with pictures. These results are the opposite of the Chun and Plass (1996a, 1996b, 1997) findings. Al-Seghayer (2001) suggested that the findings of his study could be explained by the fact that his participants had a different L1 and that the target language was different. In addition, the studies used different visual aids and different tests.

Yoshii and Flaitz (2002) compared the effects of text-only, picture-only, and a combination of text and picture glosses on incidental vocabulary learning and retention. Participants included 151 adult ESL learners representing thirty-eight countries and eighteen languages who were all enrolled in ESL courses in the English Language Institution at The University of Florida. Participants (beginning and intermediate students) were asked to read an online story created by the researchers that contained 14 glossed words. Participants at each level were randomly assigned to the text-only, picture-only, or text-and-picture gloss conditions. After reading the text, participants completed a brief comprehension test. This was followed by a number of immediate glossed vocabulary tests, which included a definition supply test, a picture recognition test, and a delayed vocabulary test. The results showed that participants who had

access to text and picture gloss outperformed participants who had access to text-only or picture-only glosses. The combination group outperformed the two other groups on both the immediate and delayed vocabulary tests. In terms of the rate of change between the immediate vocabulary test scores and the delayed vocabulary test scores, no significant differences were found among the three groups. Participants' scores on the delayed test declined equally from their scores on the immediate test.

Yeh and Wang (2003) examined the impact of three types of glosses on vocabulary learning among Taiwanese college students learning English as a FL. The first gloss was text-only (L1 and FL explanation of the word), the second was both text and a still picture, and the third was text, a still picture, and an audio pronunciation of the target word in the FL. The researchers were also interested in investigating if participants' learning styles had any effect on the effectiveness of a particular gloss type. Eighty-two freshmen participants who had completed six years of studying English at the secondary level were randomly assigned to a hypertext with one of the three types of glosses. A questionnaire regarding learning styles was administered before the reading task to explore participants' learning styles. Participants were asked to take a vocabulary pre-test that focused on definition of new words that would be covered later in the courseware. A post-test that included word association questions, multiple-choice questions on word meanings, and a cloze test was administered 4 to 14 days after the pre-test. The researchers did not find significant differences between the text gloss versus the text-picture gloss or between the text gloss versus the text-picture-audio gloss. Results did show that participants who had access to text plus picture glosses significantly outperformed participants who had access to text plus picture plus audio glosses. That is, the researchers did not find any positive effect for the audio glosses. They argued that Chinese ESL students seemed to have preference for visual

stimuli over auditory stimuli, but the results did not show any clear impact of the participants' perceptual preference learning style on the impact of vocabulary gloss types for vocabulary learning.

Yosshi (2006) discussed three questions: Do L1 and L2 glosses differ in their effectiveness on incidental vocabulary learning? Do picture glosses (text- plus- picture) and no picture glosses (text-only) differ in their effectiveness on incidental vocabulary learning? Are there any interaction effects present among the languages (L1 or L2), pictures (presence or absence), and tests (immediate and delayed)? The results showed that neither the definition-supply nor the recognition tests revealed significant differences between L1 and L2 glosses. The definition-supply tests approached significance for differences between picture glosses (text-plus-picture) and no picture glosses (text-only), but the recognition tests did not. The results showed that there was an interaction between language and test for both the definition-supply and recognition tests.

In Yanguas' (2009) study, 94 participants were asked to read a computerized text under one of four gloss conditions: a) textual, b) pictorial, c) textual-pictorial, or c) no gloss. Reading comprehension, recognition, and production measures were utilized in a pre-post design. The results showed that all multimedia gloss groups noticed and recognized significantly more of the target words than did the control group. No significant differences were found among the groups on the production of the target words, but the combination gloss group significantly outperformed all other groups on reading comprehension.

Other studies have examined whether or not glossing could improve comprehension of a text. Holley and King (1971) compared different types of glosses among 110 American students

who were learning German. Participants were asked to read the same passage, but with one of three positions for the glosses: appearance on the side-of-page, bottom-of-page, or glosses on an attached sheet. The results showed that the three different placements of glosses in the text did not make a significant difference on either vocabulary or reading comprehension tests.

Johnson (1982) compared the effects of vocabulary glosses under the four different conditions of a) no help with vocabulary, b) studying the definitions of words before reading, c) reading a text with the target words glossed, and d) studying the target words before reading then reading the text with glosses. After reading the text, 72 advanced ESL university students completed a cloze test, recalled the story in their L2, and were asked to recognize exact sentences from the passage. The results showed that background knowledge of the reading text facilitated reading comprehension but that exposure to the different types of vocabulary conditions did not significantly affect comprehension.

Leffa (1992) compared the effects of electronic glossing and conventional paper dictionaries on reading comprehension during a translation task. Twenty college participants who were beginning level ESL students took part in the study. They were divided into two groups: one group had access to hypertext glosses and the other group had access to a conventional paper bilingual dictionary. Five short passages (100 words each) were taken from an English newspaper and used for the reading comprehension task. The task was to translate the original passages from English into Portuguese. Each of the five passages were divided into units, and two independent scorers corrected the translations. Each participant completed two reading comprehension tasks. In one task, participants used electronic glosses while in the second task, participants used a paper bilingual dictionary. The results showed that participants were able to understand 86% of the passage when using the electronic dictionary and 62% when using the

conventional paper dictionary. The use of glosses proved to be more effective since the participants who used glosses required 50% less time to complete the translation task than participants who used a conventional dictionary.

Davis and Layman-Hager (1997) examined the relationship between the use of electronic glosses for reading comprehension and attitudes towards the use of electronic glosses. Forty-two intermediate-level French students were asked to read a literary passage glossed with English definitions, French translations, grammar explanations, pronunciation, cultural background information, and pictures. Reading comprehension was measured through a multiple-choice test and a recall protocol in English. The glosses were categorized as definitional glosses (English definitions) and non-definitional glosses (all other types). An examination of the participants' log data revealed that 85% of the information accessed were the English definitions of words. Multiple regression analysis showed that as the grade level increased, the scores on the two comprehension measures also increased.

Hong (1997) examined the impact of glosses on reading comprehension in a business Chinese course. Participants were randomly assigned to either a group using a multimedia software package or a group using traditional print texts, and were asked to read two texts. The results showed that participants who read the Chinese business texts achieved a higher comprehension rate in half the time when they utilized the multimedia glosses provided in the texts.

In a recent study, Ko (2005) investigated the impact of language glosses on reading comprehension. One hundred and six undergraduate students were asked to read an English text with either an L1 gloss, an L2 gloss, or no gloss at all. Qualitative analysis revealed that both

types of glosses made reading comprehension smoother and faster, and that 65% of learners favored the L2 glosses. Quantitative analysis indicated that only L2 glosses affected participants' measure of reading comprehension.

In Alessi and Dwyer's (2008) study, 76 American intermediate learners of Spanish were asked to read a Spanish article under one of four different conditions. One group of learners received a pre-reading activity (practice on the key vocabulary in the article); the second group received during-reading assistance (contextualized L1 translation in the form of hypertext glossing); the third group received both these previous treatments; and the fourth group received no help. The results showed that reading comprehension was significantly better for students receiving vocabulary assistance during reading but not for those who received it before reading.

Some researchers have examined the effects of glosses on both vocabulary learning and reading comprehension. Tozcu and Coady (2004) conducted a case study that examined the outcomes of vocabulary acquisition when using interactive computer-based texts as opposed to traditional materials. The aim was to determine the effects of direct vocabulary instruction via computer- assisted learning compared to traditional vocabulary instruction through print texts. The effect of this direct instruction on reading comprehension, word recognition speed, and reading rate were also analyzed. Fifty-six intermediate-level students from various L1 backgrounds who were studying English for university preparation participated in the study. The results suggested that the treatment group, who used computer-assisted courseware, outperformed the control group in vocabulary knowledge, reading comprehension, and reading speed. This suggests positive implications for integrating technology into the language classroom for reading instruction and vocabulary development.

Ben Salem (2006) investigated the impact of five electronic glosses on word retention and reading comprehension among second language (L2) Spanish learners. Ninety-three English-speaking college students enrolled in a third semester (intermediate level) Spanish course were asked to read a web-based passage in Spanish with 25 glossed words. Each participant read the passage under one of five conditions: a) no glossing; b) text (L1 translation); c) text and audio (pronunciation of key word in L1 and L2); d) text, audio, and picture; or e) text, audio, picture, and writing (writing down on a piece of paper the gloss that students consulted). Multiple-choice recognition and production vocabulary tests were administered after reading the text and again 2 weeks after the intervention. Participants' interaction with the text and glossed words was tracked using a computer program. The results showed that participants who used glossed words had higher reading comprehension and vocabulary scores than non-gloss users. No significant differences were found between the groups that had access to the various forms of glosses in terms of their performance in reading comprehension and vocabulary tests. The researcher concluded that the more frequently L2 learners consult glossed words, the better they will comprehend and acquire new words.

Chapter Summary

In previous studies, some researchers have examined the effects of glosses on vocabulary learning, others have explored the effects on reading comprehension, and still others have inquired as to the effects on both vocabulary learning and reading comprehension. Although the impact of electronic glossed words on FL/L2 vocabulary learning and text comprehension has been the focus of several studies, research has yielded conflicting or mixed results. Electronic

texts, however, allow more options for providing glosses than do printed texts. Consequently, new aspects of glossing are being investigated. With regard to hypermedia glosses, the results support Paivio's dual-coding theory (1986) and Sweller's cognitive load theory (1988). The current study is significant and unique in that it investigates the impact of all possible combinations of electronic gloss components (audio and text; audio, text, and picture; audio, text, and animation) on both vocabulary retention and reading comprehension.

CHAPTER THREE

METHODOLOGY

This chapter provides a description of the methods and procedures used in the current study. Included are the research questions, variables, and hypotheses of the study, as well as a description of the participants, and data collection methods, including instrumentation, procedures, and data analyses.

The primary objective of the current study was to compare the effects of three different combinations of electronic gloss components on vocabulary retention and reading comprehension. The three experimental conditions were:

a) audio (pronunciation of the key word in FL) and text (FL definition, L1 translation, and an example in FL)

b) audio (pronunciation of the key word in FL), text (FL definition, L1 translation, and an example in FL), and picture

c) audio (pronunciation of the key word in FL), text (FL definition, L1 translation, and an example in FL), and animation

Review of Research Questions

The researcher investigated these three experimental conditions to examine their impact on vocabulary retention and text comprehension of English language learners in Saudi Arabia. Accordingly, the following research questions were pursued:

1. Do some combinations of electronic gloss components work better than others for increasing the English reading comprehension of native Arabic speakers?

2. Do some combinations of electronic gloss components work better than others for increasing the English vocabulary of native Arabic speakers?

3. Do some combinations of electronic gloss components work better than others for recalling the English vocabulary of native Arabic speakers?

4. Does the type of electronic gloss combination accessed affect vocabulary retention as evidenced by group differences when measured two weeks after the intervention?

5. Is there a relationship between participants' test performance and their anxiety regarding foreign language learning?

6. Will students' demographic and background measures predict their English reading comprehension and vocabulary test results?

7. Do students express different attitudes towards the different electronic glosses accessed during the intervention?

Variables

The type of electronic gloss provided with the web-based text was identified as the independent variable. There were three combinations of electronic gloss components: a) audio and text; b) audio, text, and picture; and c) audio, text, and animation. The dependent variable

included participants' scores on the reading comprehension test, the immediate vocabulary test, and the delayed vocabulary test.

Hypotheses of the Study

The purpose of the current study was to explore whether certain combinations of electronic gloss components were better than others for aiding vocabulary retention and reading comprehension. Therefore, the following hypotheses were tested:

1. Students will perform differently on a test of reading comprehension depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation when measured immediately after the intervention.

2. Students will perform differently on a test of vocabulary depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation when measured immediately after the intervention.

3. Students will perform differently on a test of vocabulary depending upon whether they have had access to an online gloss that contains a) only audio and text, b) audio, text, and picture, or c) audio, text, and animation when measured two weeks after the intervention.

4. Type of online gloss access will affect vocabulary retention as evidenced by group differences when measured two weeks after the intervention.

5. There is a relationship between students' level of anxiety regarding foreign language learning ability and their performance on English vocabulary and reading comprehension tests.

6. Students' demographic and background measures will predict their English reading comprehension and vocabulary test results.

7. Students will express different attitudes towards the different interventions depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animations.

Participants

Participants in this study were Arabic students of intermediate-level English enrolled in one of four different levels of English courses at a major petroleum company or a major petroleum institution. The participants from the company were English Levels Two and Three and participants from the institution were English Levels Four and Five. While the English and Training Programs at the company are available for students from Level One to Level Seven, they are available to students from Level Two to Level Five only at the institution (Table 3.1). Applicants to the company and institution programs are all Saudi Arabian males who are non-native speakers of English. The range in age of participants at the company was 18 to 24, whereas participants at the institution ranged from age 18 to 23. All applicants were English language learners who had an interest in continuing their English and Training Programs. Most students had completed six years of English during their intermediate and high school educations

(Table 3.2). The purpose of establishing the company and institution was to meet the needs of the Petroleum Services Industry in the Kingdom of Saudi Arabia.

Table 3.1

Participant English Levels

	Frequency	Percent
1 EL02	35	15.8
1 EL03	107	48.2
2 EL04	52	23.4
2 EL05	28	12.6
Total	222	100

Note: (1) Company (2) Institution

Table 3.2

Participant Years of Studying English

	Frequency	Percent
6	121	54.5
7	71	32.0
8	23	10.4
9	3	1.4
10	1	0.5
11	1	0.5
13	1	0.5
14	1	0.5
Total	222	100

The researcher did not have access to participants' grades or overall performance in class while the study was conducted. However, the nature of the study was explained to the participants and they were informed that all the information collected during the study would be kept confidential; their scores would not be shared with their teachers and would not affect their

grades. Participants who volunteered to participate in the study were asked to review and sign a consent form (see Appendix A).

A total of 222 participants took part in the study: 141 from the company and 81 from the institution (Table 3.3). Participants were administered the reading comprehension test (see Appendix B) after the intervention and completed a demographic and background questionnaire test (see Appendix C) following the comprehension test. An immediate vocabulary test was also administered to participants (see Appendix D) and each participant completed an attitude questionnaire (see Appendix E). Two weeks after the intervention, participants were administered a delayed vocabulary test (see Appendix F). All 222 participants in the study took the immediate and delayed vocabulary tests.

Table 3.3

Participants at Company and Institution

	Frequency	Percent
Company	141	63.5
Institution	81	36.5
Total	222	100.0

Materials

This section discusses the rationale behind the materials used in the study and the steps taken in designing those materials. This includes the selection of glossed words, the creation of the text, and constructing the host website.

Glossed Words Selection and Reading Passage Creation

The researcher made the decision to create an original text with consultation from an editorial board at the company, experts in language and teaching, and petroleum engineering in the School of Petroleum Engineering at the University of Kansas. There were several reasons for this choice. First, the purpose of this study was to measure the effects of different combinations of electronic gloss components, which included graphics and animated pictures, in addition to audio and textual glosses. Second, guessing the meaning of certain words from the context of the passage is possible in many existing reading materials and, hence, comprehending the text could be accomplished without consulting the glossed words (Ben Salem, 2006). Third, given a number over 200 participants with different levels of English, it was very likely that some of the glossed words might look familiar to students either because they were cognate or words that they had come across during the readings they had done while studying of English.

To increase the probability of participants using the glossed words provided in the passage, the following five original strategies were employed. The first strategy was that the 190 words suggested by the editorial board were rated by that board in terms of their difficulty for the target students on a scale of 1 to 10 (1 being an easy word and 10 being a very difficult word). Words that received an average difficulty rating of 7 or higher were selected to be the potential glossed words. Thus, 59 (see Appendix G) words were selected by the editorial board as the target words for the study. All of the target words selected by the board could be glossed using pictures and animations. Of these 59 words, only 50 (see Appendix H) ultimately appeared in the story. A separate list of 59 words was constructed outside the context of the story to give participants another opportunity to view the glossed words before they took the immediate vocabulary test.

The second strategy to increase the probability that participants accessed the glosses was that the researcher sought a designer's assistance for creating pictures and animations that depicted the meanings of the target words. The glossary design specifications for those pictures and animations included twenty-five design phases. All the design phases were marked with distinct changes and modifications. During the first five design phases, for example, each glossed word had three design levels and six design components. The three design levels were: a) audio, b) audio and graphic, and c) audio and animation. The six design components were: a) the English definition, b) the Arabic translation, c) an audio pronunciation of the terms in English, d) a static illustration showing two extreme examples of the term, and f) an example explaining the meaning of the term in English. In terms of static and animated illustrations, some words had multiple illustrations. The term "absorb," for example, had two graphics or states; one was on the left of the pop-up window and the other was on the right of the pop-up window (Figure 3.1). While the graphic on the left had a piece of steel with water pouring on it from a container, the graphic on the right had a piece of sponge with water pouring on from another container (Figure 3.2). During the later phases of design, in order to avoid any overloading or confusion, the extreme examples of the terms were replaced with negative arrow alternatives (Figure 3.3). As a result of these changes and modifications, all pictures matched the animations (Figure 3.4).

Figure 3.1

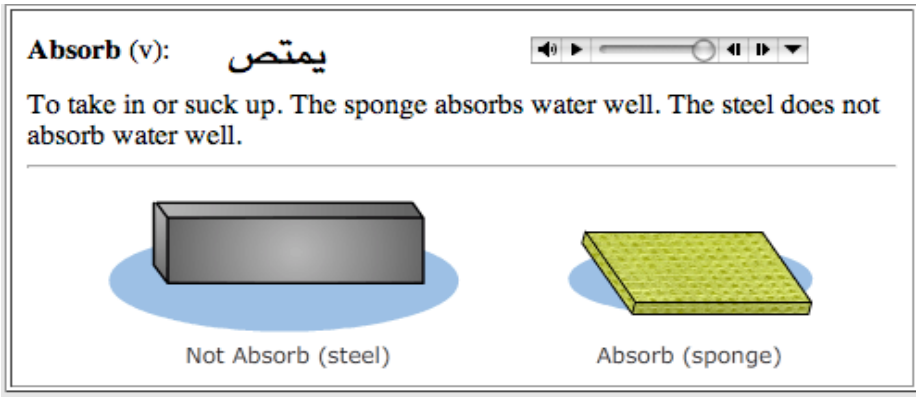


Figure 3.2

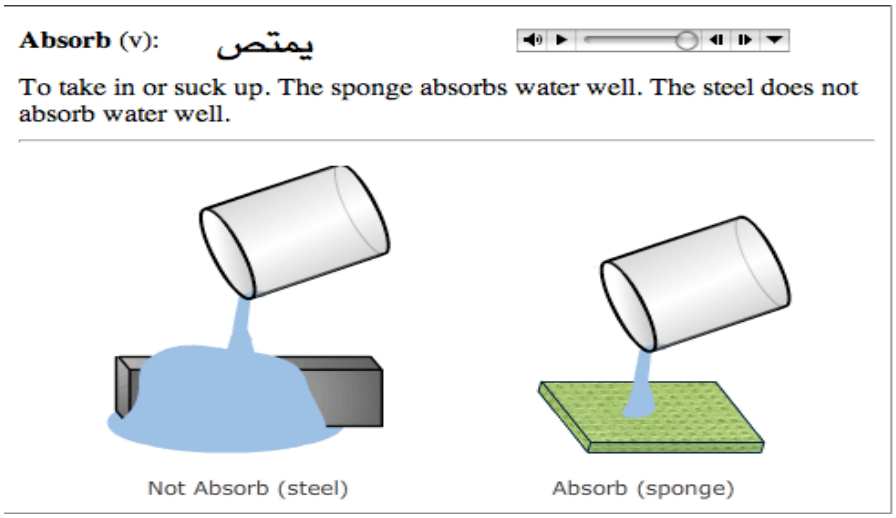


Figure 3.3

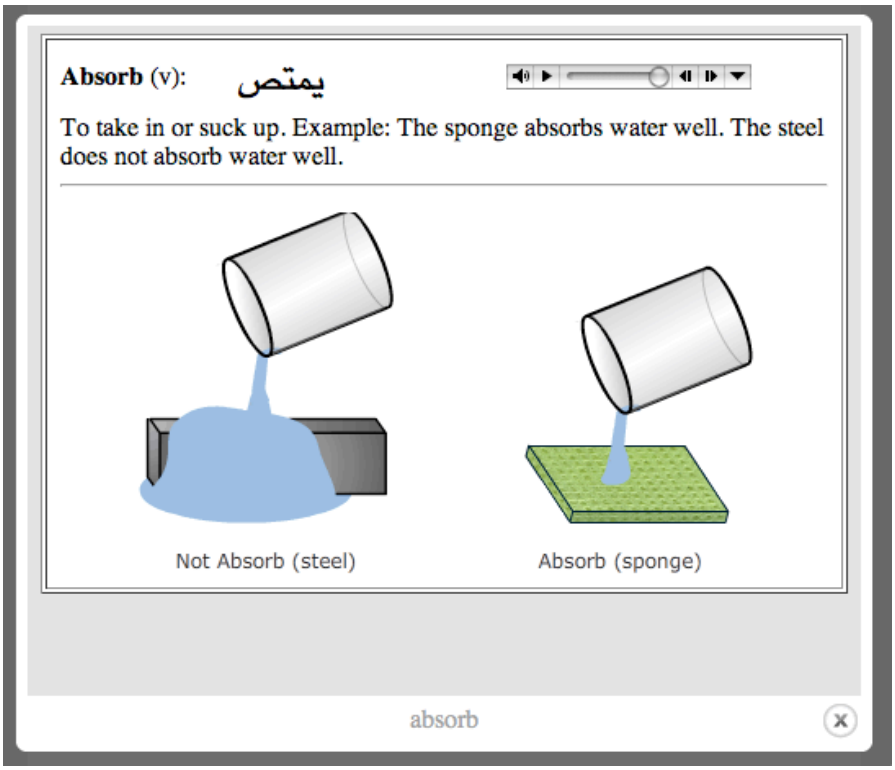
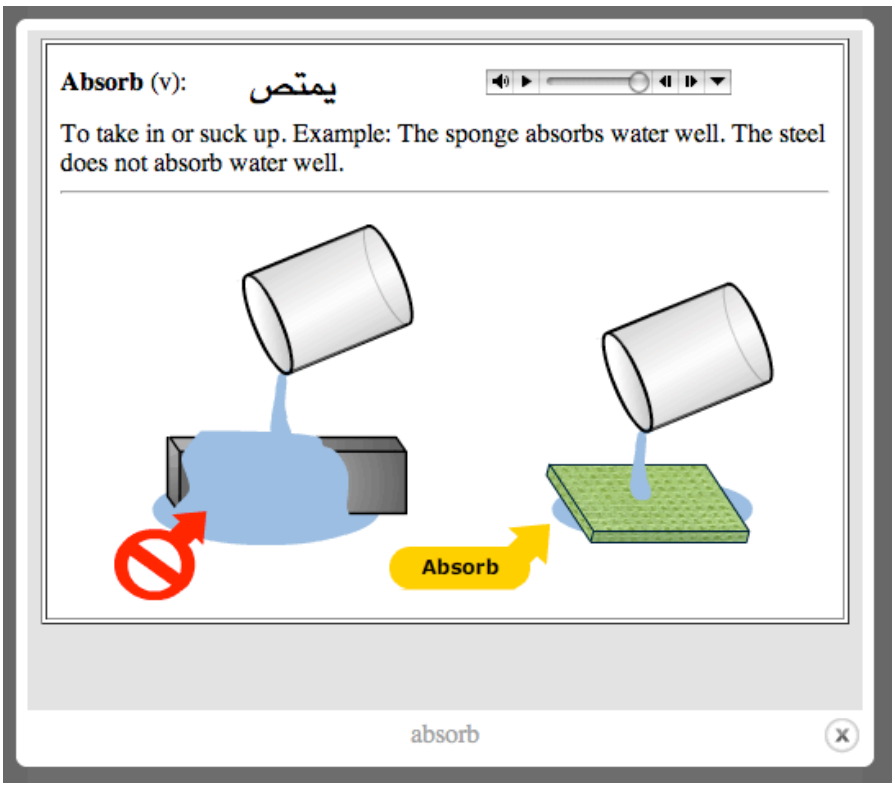


Figure 3.4



The third strategy to increase participants' use of the glosses was that a Glossary Animation Matching (see Appendix I) was administered to undergraduate students in the School of Education at the University of Kansas in order to evaluate the appropriateness of the animated pictures. Students were asked to select the term that best represented the numbered illustrations presented to them. The results of the Glossary Animation Matching were calculated and analyzed (see Appendix J).

The fourth strategy was that a Glossary Terms Matching (see Appendix K) was given to the same undergraduate students who took the Glossary Animation Matching. The participants

were asked to circle the term that matched the English definition. The results of the Glossary Terms Matching were calculated and analyzed (see Appendix L).

The fifth strategy for increasing the probability that participants accessed the glosses was that a Translation Accuracy Survey (see Appendix M) was given to five native-Arabic speakers studying petroleum engineering in the School of Engineering at the University of Kansas. They were asked to rate the clarity of the Arabic translations of the terms and were given an option to provide a better translation for each term if they knew of one. The results of the Translation Accuracy Survey were calculated and analyzed (see Appendix N). Based on the results of the three surveys administered, the researcher made revisions and adjustments to the materials to be used in the study.

Having created accurate graphics and animations for the terms, the researcher wrote a reading passage related to petroleum engineering in general and to crude oil and natural gas pipeline maintenance in particular (see Appendix O). The editorial board and other experts in petroleum engineering were consulted to evaluate the content and relevance of the passage. The final version of the English text used in the study was entitled "Khalid's Dreams for a Career in Oil and Natural Gas Pipeline Maintenance," and deals with a day of technical problems that Khalid faced in his job as a pipeline inspector for a major oil and natural gas company in the Kingdom of Saudi Arabia. While the reading passage contained 902 words and 50 glossed words, the separate list consisted of all the selected 59 glossed words. The glossed words of the story included 7 verbs, 21 nouns, and 22 adjectives (see Appendix P), which represented about 7% of total number of words in the text. The separate list of words, which consisted of 59 glossed words, included 8 verbs, 26 nouns, and 25 adjectives (see Appendix Q). The glossed words of the story and separate list were annotated using three different combinations of

electronic gloss components: a) audio and text, b) audio, text, and picture, and c) audio, text, and animation. The multimedia glosses were designed in a pop-up format and this decision was based on the results of a study by Yu (1993), who concluded that learners perceived a pop-up window as the most useful navigation tool in hypertext.

The Host Website

The researcher designed the final version of the text with the three different combinations of gloss types in an electronic format. The host website was designed based on the models and approaches suggested by Grab and Osman-Jouchoux (1996), Muter (1996), and the principles of web design as outlined by Nielsen (2000). Issues that affect the readability of hypertext, such as choice of page background color, layout, font type, and font size, were taken into consideration. Three versions of the text were created. The first version had the reading passage with only audio and textual glosses (Figure 3.5). The second version had the reading passage with audio, textual, and picture glosses (Figure 3.6). The third version had the reading passage with audio, textual, and animation glosses (Figure 3.7). The textual gloss consisted of the definition of the target word in English, the translation of the target word in Arabic, and an example explaining the meaning of the word. The dynamic pictures and animated pictures are presented in Appendix R. The reasons for choosing the English definition and the Arabic translation rather than concentrating on only one of these textual glosses were based on the mixed results of studies conducted by Jacobs, Dufon, and Fong (1994) and Bell and LeBlanc (2000).

Figure 3.5

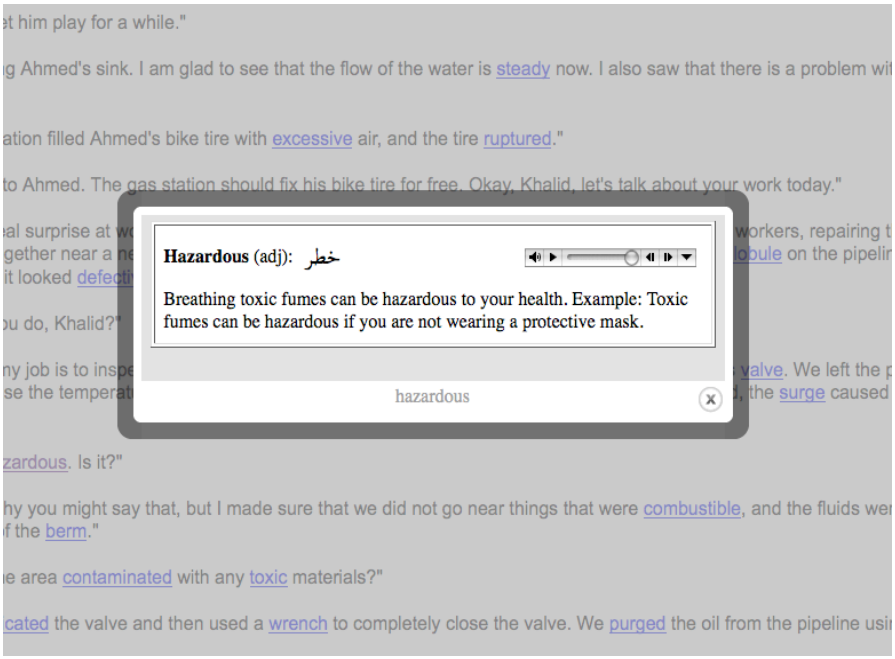


Figure 3.6

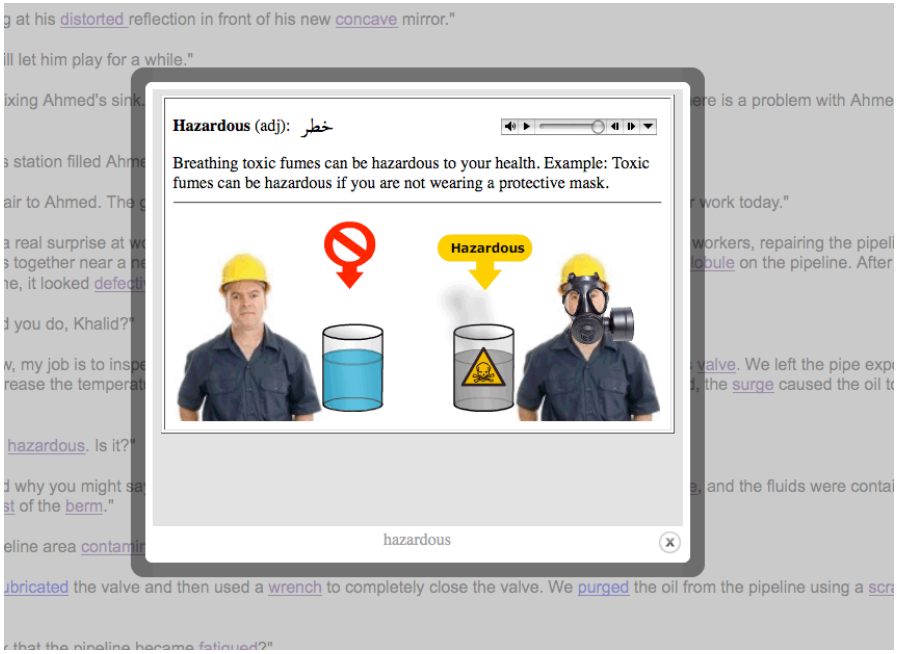
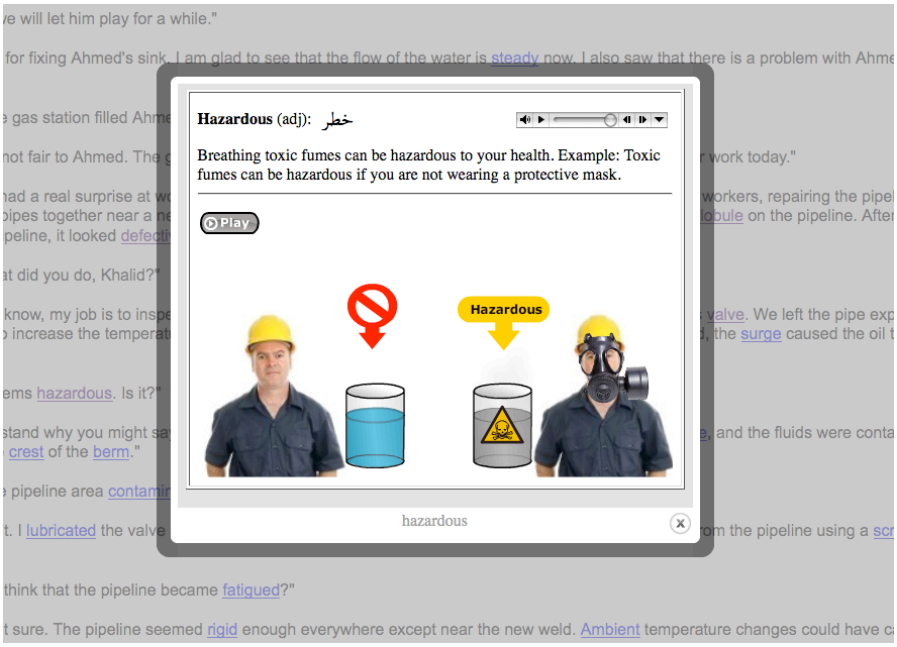


Figure 3.7



Jacobs, Dufon, and Fong (1994) investigated the impact of an L2 definition gloss, an L1 translation gloss, or no gloss on vocabulary learning and reading comprehension. The results showed that L2 definition gloss conditions were better than the no gloss conditions, but the difference between the L2 definition and L1 translation glosses was not significant. Participants in their study, though, expressed preference for L2 definition glosses over L1 translation glosses. Bell and LeBlanc (2000), on the other hand, studied learners' actual behavior to determine which glosses were used more frequently for computer-based reading. The results showed that the difference between the English gloss group and the Spanish gloss group was not statistically significant. However, participants in their study preferred L1 glosses over L2 glosses. Therefore, it was decided that participants of the current study would have the opportunity to view both L2 and L1 glosses.

One of the decisions that had to be made while creating the hypertext was to choose a method of making the hyperlinks visible. Instead of underlining the glossed word or inserting a symbol next to the glossed word, all hyperlinks were highlighted. This decision was based on the findings of De Ridder (2002) who claimed that even though highlighted hyperlinks did not increase vocabulary learning or facilitate reading comprehension, they tended to lead to increased consultation by readers.

In order to access the glossed word, participants had to click on the highlighted word using the mouse and a pop-up window with the glossed entry would then be displayed. The pop-up window appeared in the middle of the page in such a way that it would never distract the reader from going back to the passage. Therefore, it was possible for participants to refer to the text while viewing the glossed word since the pop-up window occupied only a small part of the middle of the page. To stimulate the learning process, participants could replay the animation and the pronunciation of the term. Three instructional designers were consulted to evaluate the website and provide their feedback in order to make any necessary adjustments before the study was piloted. They checked the audio recording, along with the pictures and animations. The website was also reviewed by several ESL doctoral students in the School of Education at the University of Kansas.

Design Phase Analysis

A design phase analysis was conducted to gain some insight into the research design, as well as the instruments used for the study. The focus of this design phase analysis was the data collection procedures and participants' usage and response to the instruments, rather than the outcome of their scores. Participants were three students enrolled in petroleum engineering

classes in the School of Engineering at the University of Kansas. Their ages ranged from 19 to 23 years old. A brief explanation was given to them before they performed the task. Each participant was assigned to one of the three conditions: a) audio and text; b) audio, text, and picture; or c) audio, text, and animation. They were asked to record how much time they spent reading the text and then participants were administered the reading comprehension test and the vocabulary tests. After that, participants were interviewed regarding their opinion about the level of difficulty of the text, the navigation of the site, and the content of the tests. All the three participants were satisfied with the appearance of the hypertext. The participants who had access to pictures thought that the pictures were very helpful in depicting the meaning of the words. Those who had access to animations also expressed positive attitudes towards the animated pictures. With respect to the audio, all participants said that hearing the word was important for them. In terms of textual glosses, all three participants reported that having both the English definitions and the Arabic translations was helpful in learning the vocabulary and comprehending the text.

Data Collection

Five instruments were used to investigate the impact of the three different combinations of electronic gloss components on vocabulary retention and reading comprehension: a multiple-choice reading comprehension test, a demographic and background questionnaire, a multiple-choice immediate vocabulary test, an attitude questionnaire, and a multiple-choice delayed vocabulary test. This section also includes the experimental procedures and data analyses.

Immediate Multiple-Choice Reading Comprehension Test

The researcher designed the reading comprehension test to measure the impact of the three combinations of electronic gloss components on reading comprehension. Specifically, this test aimed to determine if some combinations of electronic gloss components were more effective than others in facilitating reading comprehension. This test was administered immediately after the completion of the reading task. A non-writing assessment instrument, a multiple-choice reading comprehension test, was chosen to provide a more valid measure of receptive skill ability in the target language because this type of tests precludes the possibility that students' lack of writing ability might interfere with scoring (Hughes, 2003).

Many studies have used a recall protocol, in which the participants write down everything they remember from the text, to measure reading comprehension. However, FL/L2 learners' ability to comprehend reading materials is generally superior to their ability to produce it (Ben Salem, 2006). Lee (1986) argues that the assessment of FL/L2 comprehension via a written protocol measure may hinder students' ability to demonstrate true comprehension. This was the case for the participants in the current study who were intermediate-level English learners; that is, they did not have a high level of writing proficiency.

The reading comprehension test in this study included 22 items with four alternatives each, and had a coefficient alpha of .65. Each item asked the reader about one particular idea in the text. To be able to answer each question correctly, participants needed to know the meanings of the glossed words that were associated with the idea. None of the four alternatives featured the glossed words directly. Instead, a synonym of each glossed word was provided. The purpose of providing the synonyms was to avoid turning the reading comprehension test into a

memorization exercise. Participants received one point for each correct answer, and no points for an incorrect answer. There was no partial credit awarded. The maximum score possible for this test was 22. A similar test format was used by Al-Seghayer (2001) and Ben Salem (2006).

Demographic and Background Questionnaire

Participants filled out a demographic and background questionnaire after they had taken the reading comprehension test. The background questionnaire used a 5-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree) and consisted of 10 statements such as "I have anxiety about studying English." The background questionnaire allowed the researcher to collect not only biographical information related to participants' ages and English levels, but also to collect very useful information about their future majors, years of English studied, English-speaking countries visited, FL/L2 learning ability, FL/L2 and L1 reading ability, computer skills, self-assessment of FL/L2 learning anxiety, and dictionary use.

In order to give the participants another opportunity to learn the target words, they were asked to view the separate list of 59 glossed words outside the context of the reading passage after completing the reading comprehension test and demographic and background questionnaire but before taking the immediate vocabulary test.

Immediate Multiple-Choice Vocabulary Test

The researcher designed the immediate vocabulary test to measure the effect of the three different combinations of electronic gloss components on vocabulary retention. Specifically, this test aimed to determine if some combinations of electronic gloss components were more effective than others in aiding vocabulary retention. Participants were given this test after they had viewed the separate list of glossed words. The test included 59 recognition items and had a

coefficient alpha of .88. Participants received one point for each correct answer and no points for an incorrect answer. The maximum score possible was 59. A similar testing format was used by Al-Seghayer (2001) and Ben Salem (2006).

Attitude Questionnaire

The researcher developed an attitude questionnaire to measure participants' reactions to the web-based text and their experiences with the glossed words. The attitude questionnaire used a 5-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree) and consisted of 9 statements such as "Online texts are better than paper-based texts." Eight of the statements were positively worded (expressing a positive attitude) and one was negatively worded. Responses to the negatively worded item were reverse-coded for analysis. Reliability analysis showed internal consistency of this scale with a coefficient alpha of .77. Participants completed the attitude questionnaire after taking the immediate vocabulary test. This questionnaire allowed the researcher to obtain information about participants' experiences with the hypermedia reading text and their perceptions regarding the usefulness of the electronic glosses.

Delayed Multiple-Choice Vocabulary Test

The delayed multiple-choice vocabulary test was identical to the immediate test but with the items in a different order. It was administered two weeks after the intervention. The delayed multiple-choice vocabulary test allowed the researcher to determine whether or not the participants were able to recall the learned words two weeks after the intervention. Participants' scores on the delayed vocabulary test were compared to their scores on the immediate

vocabulary test. Several researchers such as Jones (2004) and Ben Salem (2006) used delayed vocabulary tests to measure word retention.

Procedures

The current study took place between November of 2010 and January of 2011 in two different computer labs at the company and institution where only the researcher and participants were present. While the company had 18 Window PCs with 17-inch flat monitors and headphones, the institution had 21 Window PCs with 17-inch flat monitors and headphones. The computer stations at the company and institution were very fast and in excellent condition. The data collection procedures were conducted in twelve separate sessions of 120 minutes each. Eight sessions took place at the company and four sessions at the institution. The time allotted for each session was based on a study by Keep, et al. (2000) stating that the two factors that influence hypertext reading, besides the structure of the hypertext, are the amount of time that readers have to complete the task and the readers' familiarity with the hypertext. Thus, the participants in this study were allowed to have 120 minutes to perform the whole task (see Appendix S).

Data collection procedures at the company were conducted in eight sessions on two consecutive days. Participants who participated in the study on the first day were asked not to share the content of the study with their peers in order to avoid data contamination. A total of 141 participants from the company took part in the study. The following steps summarize the data collection procedures at the company.

First, a list of random numbers generated at http://random.org was used to assign participants to one of the three conditions: a) audio and text (AT); audio, text, and picture (ATP); or c) audio, text, and animation (ATA). The computer stations were labeled according to these three glossing conditions.

Second, when participants entered the computer lab, each was assigned a computer number that corresponded to one of the three possible conditions. The numbers distributed to the participants of the first session were: 1AT, 2AT, 3AT, 4AT, 5AT, 6AT (subgroup A), 7AT, 8AT, 9AT, 10AT, 11AT, 12AT (subgroup B), and 13AT, 14AT, 15AT, 16AT, 17AT, 18AT (subgroup C). These numbers were also given to participants in the other seven sessions at the company, respectively (see Appendix T).

Third, participants received a consent form describing the research project which they reviewed and signed prior to the onset of the reading task.

Fourth, the researcher explained the reading task to each session group and demonstrated for participants how to access the glossed words in the three experimental conditions. Participants in subgroup A (AT) read the text with only audio and text. Participants in subgroup B (ATP) read the text with audio, text, and picture. Participants in subgroup C (ATA) read the text with audio, text, and animation. All the participants in the three subgroups were asked to look up information about highlighted words by clicking on them with the mouse to get the meanings of the target words appearing in the text.

Fifth, when participants were ready to read the passage, they logged on to the hypertext that corresponded to their subgroup and condition. They were given 40 minutes to read the text. Participants were reminded that they could access the glossed words as many times as they

wished. They were asked to record the start time and end time for their reading of the text. When they finished reading the text, they were instructed to log off their computers and were administered the immediate multiple-choice reading comprehension test followed by the demographic and background questionnaire. After that, participants were asked to view the separate list of 59 glossed words outside the reading passage context, and then complete the immediate multiple-choice vocabulary test followed by the attitude questionnaire.

The sixth step in the procedure occurred two weeks after the intervention, when participants were administered the delayed multiple-choice vocabulary test in their individual classes to determine to what extent they had retained the target words. These six procedures were followed for the other seven sessions at the company.

Having finished conducting the first part of the study at the company, the researcher began conducting the second part of the study at the institution. Data collection procedures at the institution took place in four sessions on two consecutive days: two sessions on the first day and the other two on the second day. The numbers distributed to the participants of the first session at the institution were: 1AT, 2AT, 3AT, 4AT, 5AT, 6AT, 7AT (subgroup A), 8ATP, 9ATP, 10ATP, 11ATP, 12ATP, 13ATP, 14ATP (subgroup B), and 15ATA, 16ATA, 17ATA, 18ATA, 19ATA, 20ATA, 21ATA (subgroup C). These numbers were also given to participants in the other three sessions, respectively (see Appendix U). A total of 81 participants took part in the study. The six procedures, which were followed for collecting data at the company, were also followed for the four sessions at the institution.

Data Analysis

The following section discusses the manipulation and analyses of data obtained from the reading comprehension test, demographic and background questionnaire, immediate vocabulary test, attitude measures of gloss types, and delayed vocabulary test.

Review of Research Questions

The research questions which guided this study were:

1. Do some combinations of electronic gloss components work better than others for increasing the English reading comprehension of native Arabic speakers?

2. Do some combinations of electronic gloss components work better than others for increasing the English vocabulary of native Arabic speakers?

3. Do some combinations of electronic gloss components work better than others for recalling the English vocabulary of native Arabic speakers?

4. Does the type of electronic gloss combination accessed affect vocabulary retention as evidenced by group differences when measured two weeks after the intervention?

5. Is there a relationship between participants' test performance and their anxiety regarding foreign language learning?

6. Will students' demographic and background measures predict their English comprehension and vocabulary test results?

7. Do students express different attitudes towards the different electronic glosses accessed during the intervention?

Research questions One (reading comprehension test), Two (immediate vocabulary test), and Three (delayed vocabulary test) asked if participants' English language learning was differentially affected by the type of electronic gloss presented to the learners. Three separate analyses of variance (ANOVAs) were conducted to examine the effects of media presentation on the reading comprehension test, the immediate vocabulary text, and the delayed vocabulary test. Four univariate analyses of covariate (ANCOVAs) were used to test the hypotheses. These ANCOVAs used the three measures of learning: the reading comprehension test, the immediate vocabulary test, and the delayed vocabulary test as the dependent variables. The electronic gloss combination: audio and text (AT), audio, text, and picture (ATP), or audio, text, and animation (ATA) was the independent variable in each ANCOVA. Language Learning Ability (LL), English Level (EL), English Reading Ability (ER), and Years of Speaking English (YE) were used as covariates in each of these analyses to adjust for differences between the three groups in terms of relevant skills.

Research question Four concerned the change in participants' vocabulary scores over time. A 2 x 3 repeated measures ANOVA was conducted to investigate the effects of media type on the change in vocabulary scores from the immediate vocabulary test to the delayed vocabulary test. The repeated measure was the vocabulary scores administered immediately after the intervention and then administered again after a two-week delay. The combination of electronic gloss types or condition was the between-subjects variable in this analysis, and this variable had three levels (audio and text; audio, text, and picture; or audio, text, and animation).

Research question Five concerned whether or not there was a relationship between participants' test scores and their anxiety level regarding foreign language learning. Correlational analysis was used to examine the relationship between test scores and anxiety.

Research question Six concerned the predictive nature of participants' demographic and background variables with regard to their test scores. Regressional analyses were conducted on the reading comprehension, the immediate vocabulary test, and the delayed vocabulary test using four of participants' demographic and background variables: LL, EL, ER, and YE.

Research question Seven concerned participants' attitudes regarding the combinations of electronic gloss combinations. A One-Way Analysis of Variance (ANOVA) was conducted to test the effects of gloss combination type on participants' attitudes.

Descriptive statistics (means, frequencies, and standard deviations) were computed and used to describe the participants' demographic and background information and attitudes towards the gloss combination type. The Statistical Package for the Social Science (SPSS) for Windows 18 was used to conduct the statistical analyses for the current study.

Chapter Summary

Focused on the methodology of the study, this chapter discussed how the data were collected and analyzed. The criteria used to select participants, words to be glossed, and the creation of a passage to host these glossed words were first explained. Then, a discussion of the instruments used was included and the procedures for collecting data were described. Finally, the manipulation and analysis of each set of data was explained. The following chapter will include

the hypotheses related to each research question and the results of the study. A discussion of the results will follow.

CHAPTER FOUR

RESULTS

Introduction

The purpose of this study was to examine the impact of three different combinations of electronic gloss components on vocabulary retention and reading comprehension. More specifically, it tried to determine which of the combinations of electronic gloss components (audio and text; audio, text, and picture; or audio, text, and animation) had a greater influence on word recall and reading comprehension. The study also explored the change in vocabulary scores over time, the relationship between participants' test scores and their anxiety regarding foreign language learning, the predictive nature of the participants' demographic and background measures, and the effects of media type on participants' attitudes. The purpose of this chapter is to report the demographic and background information for the participants and to present the results of the statistical analyses for each of the seven hypotheses formulated in Chapter 1.

Demographic and Background Descriptions of Participants

All participants for the current study were enrolled in the English and Training Programs at the major petroleum company or a nearby major petroleum institution. The total number of participants was 222: 141 students (63.5%) from the company and 81 students (36.5%) from the institution. In terms of the distribution of age for participants, 79% were between the ages of 18 and 20, while 20% were between the ages of 21 and 23. One participant was age 17, and one was age 24 (Table 4.1).

Table 4.1

Participants' Age Distribution

	Frequency	Percent
17	1	0.5
18	49	22.1
19	79	35.6
20	48	21.6
21	28	12.6
22	12	5.4
23	4	1.8
24	1	0.5
Total	222	100

Participants were intermediate-level students of English enrolled in Levels Two (15.8%) and Three (48.2%) at the company, or Levels Four (23.4%) and Five (12.6%) at the institution. In terms of years of studying English, the majority of the participants (54%) reported that they had completed six years of English through their intermediate and high school educations. Other participants indicated that they had completed seven years, and 14% of the participants reported that they had completed eight or more years. The vast majority of the participants (95.0%) indicted that they had not visited any English-speaking countries and 3.6% of the participants reported that they had visited one English-speaking country. Only .5% of the participants indicted that they had visited three English-speaking countries (Table 4.2). With regard to their future majors, eight different majors were reported: operators, electrical maintenance, welding, mechanical maintenance, instrument, pipefitting, and technical metal forming. The most commonly reported majors were oil and gas operators with 44% of participants, and mechanical maintenance with 22% of participants (Table 4.3).

Table 4.2

English Speaking Countries Visited

	Frequency	Percent
0	213	95.9
1	8	3.6
3	1	0.5
Total	222	100

Table 4.3

Participants' Future Majors

	Frequency	Percent
Operation	98	44.1
Electrical Maintenance	26	11.7
Welding	19	8.6
Mechanical Maintenance	49	22.1
Instrument	4	1.8
Pipefitting	16	7.2
Drilling	3	1.4
Technical Metal Forming	7	3.2
Total	222	100

On a 5-point Likert scale, ranging from 1 to 5 (1 = Poor, 2 = Passing, 3 = Average, 4 = Good, and 5 = Excellent), 40.1% of the participants rated themselves as Average foreign language learners, 32.4% rated themselves as Good foreign language learners, and 22.1% rated themselves as either Passing or Poor foreign language learners. Only 5.4% rated themselves as Excellent foreign language learners (Table 4.4). When asked to rate their English reading ability, 55.4% of the participants rated their English reading ability as Good or Excellent, while 35.3% reported that they were Average English readers. The rest of the participants (9.1%) rated

themselves as Passing or Poor English readers (Table 4.5). With regard to their computer skills, the majority of the participants (60.3%) indicated that they had had Good or Excellent computer skills, 28.8% reported that they had Average computer skills, 8.6% reported Passing, and 1.8% Poor (Table 4.6).

Table 4.4

Foreign Language Learning Ability as Reported by Participants

	Frequency	Percent
1 Poor	8	3.6
2 Passing	41	18.5
3 Average	89	40.1
4 Good	72	32.4
5 Excellent	12	5.4
Total	222	100

Table 4.5

English Reading Ability as Reported by Participants

	Frequency	Percent
1 Poor	3	1.4
2 Passing	17	7.7
3 Average	78	35.1
4 Good	102	45.9
5 Excellent	21	9.5
Total	221	99.5
Missing System	1	0.5
Total	222	100

Table 4.6

Computer Skills as Reported by Participants

	Frequency	Percent
1 Poor	4	1.8
2 Passing	19	8.6
3 Average	64	28.8
4 Good	90	40.5
5 Excellent	44	19.8
Total	221	99.5
Missing System	1	0.5
Total	222	100

On a second 5-point Likert scale, ranging from 1 to 5 (1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, and 5 = Strongly Disagree), participants were asked to indicate their level of foreign language anxiety. While 19.9% of the participants reported Strongly Agree or Agree to having anxiety when studying a foreign language, 54.9% reported Disagree or Strongly Disagree and approximately 25% of the participants chose Neutral (Table 4.7).

Table 4.7

Participants' Anxiety Regarding Foreign Language Learning Ability

	Frequency	Percent
1 Poor	64	6.8
2 Passing	58	13.1
3 Average	56	25.2
4 Good	29	26.1
5 Excellent	15	28.8
Total	222	100

On a third 5-point Likert scale, ranging from 1 to 5 (1 = Often, 2 = Usually, 3 = Sometimes, 4 = Rarely, 5 = Never), 48.6% of the participants responded Sometimes for using a dictionary when studying English and 24.8% responded Rarely . The rest of the participants responded Usually (12.6%) or Often (3.2%) to using a dictionary when studying English (Table 4.8).

Table 4.8

Dictionary Use as Reported by Participants

	Frequency	Percent
1 Often	7	3.2
2 Usually	28	12.6
3 Sometimes	108	48.6
4 Rarely	55	24.8
5 Never	23	10.4
Total	221	99.5
Missing System	1	0.5
Total	222	100

Participants were randomly assigned to one of three experimental conditions: a) only audio and text (74 participants); b) audio, text, and picture (74 participants); or audio, text, and animation (74 participants) (Table 4.9).

Table 4.9

Experimental Conditions for Media Type

	Frequency	Percent
Audio and Text (AT)	74	33.3
Audio, Text, and Picture (ATP)	74	33.3
Audio, Text, and Animation (ATA)	74	33.3
Total	222	100

Results of the Hypotheses Analyses

This section presents the results of the seven hypotheses formulated in Chapter 1. The hypotheses tested by the current study and analysis results are presented.

H 1: Students will perform differently on a test of reading comprehension depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation when measured immediately after the intervention.

H 2: Students will perform differently on a test of vocabulary depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation when measured immediately after the intervention.

H 3: Students will perform differently on a test of vocabulary depending upon whether they have had access to an online gloss that contains a) only audio and text; b) audio, text, and picture; or c) audio, text, and animation when measured two weeks after the intervention.

To evaluate the first three hypotheses pertaining to the effects of media type on the reading comprehension and vocabulary tests (immediate and delayed), several analyses were conducted. To address the first hypothesis (H1) that students will perform differently on the reading comprehension test depending upon their type of media exposure, a One-Way Analysis of Variance (ANOVA) was conducted. Results showed that there were not significant differences among the three media type groups [$F(2,221) = 2.418$, $p = .092$] on the reading comprehension test (Table 4.10). To examine the second hypothesis (H2) regarding the effects of media type on the immediate vocabulary test, another One-Way Analysis of Variance (ANOVA)

was used. Results indicated that there were no significant differences among the three media type groups, [F (2,221) = .547, p = .580] on the immediate vocabulary test (Table 4.11). To examine the third hypothesis (H3) pertaining to the effects of media type on the delayed vocabulary test, a third One-Way Analysis of Variance (ANOVA) was conducted. Results showed that there were no significant differences among the three media type groups, [F (2,221) = .265, p = .767] on the delayed vocabulary test (Table 4.12). The ANOVA results for H1, H2, and H3 are presented in Table 4.13.

Table 4.10

One-way ANOVA Results for Reading Comprehension by Media Type

	df	Mean Square	*F*	*p*
Between Groups	2	31.797	2.418	.092
Within Groups	219	13.152		
Total	221			

Table 4.11

One-way ANOVA Results for Immediate Vocabulary by Media Type

	df	Mean Square	*F*	*p*
Between Groups	2	57.041	.547	.580
Within Groups	219	104.35		
Total	221			

Table 4.12

One-way ANOVA Results for Delayed Vocabulary by Media Type

	df	Mean Square	*F*	*p*
Between Groups	2	26.95	.265	.767
Within Groups	219	101.633		
Total	221			

Table 4.13

One-way ANOVA Results for All Tests by Media Type

	df	*F*	*p*
Comprehension	2	2.42	.092
Immediate Vocabulary	2	.547	.580
Delayed Vocabulary	2	.265	.767

H 4: Type of online gloss access will affect vocabulary retention as evidenced by group differences when measured two weeks after the intervention.

As the vocabulary test was a singular test, administered to the participants immediately following the intervention and again two weeks after the intervention, a One-Way Repeated Measures ANOVA was utilized to evaluate the fourth hypothesis regarding the effect of media type on the vocabulary test at the two time points (H4). Results revealed that there was no

significant interaction between vocabulary tests and media type, [F (1,219) = .341, p = .721] (Table 4.14). The main effect of media type was not significant, [F (2,219) = .42, p = .66]; however, there was a significant main effect of time on the vocabulary test, [F (1,219) = 31.08, p < .001] (Table 4.15), with the immediate vocabulary test mean of 26.96 decreasing to 24.06 at the delayed administration. Because there was no interaction across media type, group comparisons would not be appropriate; however, results did show that all groups experienced significant decreases in scores from the immediate vocabulary testing to the delayed vocabulary testing (Table 4.16). This change in scores is indicative of immediate learning at the initial testing point, followed by a decrease in scores exhibited by all participants tested. Learned terms' rankings for the vocabulary (immediate and delayed) tests are presented in Appendix V.

Table 4.14

Repeated Measures ANOVA Results for Within-Subjects Factors on Vocabulary by Media Type (Sphericity Assumed)

	df	Mean Square	*F*	*p*
Vocabulary Test	1	942.813	31.082	<.001
Vocabulary Test*Media Type	2	10.333	.341	.721
Error	219	30.333		

Table 4.15

Repeated Measures ANOVA Results for Between-Subjects Effects on Vocabulary

	df	Mean Square	*F*	*p*
Media Type	2	73.658	.419	.658
Error	219	175.649		

Table 4.16

Mean Vocabulary Scores for Each Presentation Method by Time of Test, Immediate Versus Delayed

	Method	Mean	SD	N
Immediate Vocabulary Test	Text	27.45	9.94	74
	Picture	27.49	10.89	74
	Video	25.95	9.78	74
	Total	26.96	10.19	222
Delayed Vocabulary Test	Text	24.68	9.28	74
	Picture	23.99	9.78	74
	Video	23.47	10.28	74
	Total	24.05	10.05	222

Based on the bilingual aspects of the study and sample of participants, measured variables pertaining to English abilities were incorporated as covariates within subsequent ANCOVA analyses for all previous significance tests pertaining to the reading comprehension test, the immediate vocabulary test, and the delayed vocabulary test. The variables incorporated as covariates included Foreign Language Learner Ability (LL), English Learning Level (EL), English Reading Ability (ER), and Years of Speaking English (YE). Including these covariates allows for the evaluation of the effects of media type on reading comprehension and vocabulary tests (immediate and delayed) after accounting for variables within the participant pool that could be influencing the results.

Media type was found to have a significant effect on reading comprehension scores after accounting for Foreign Language Learning Ability (LL), [F (2,218) = 3.07, p = .049] (Table 4.17), and English Reading Ability (ER), [F (2,218) = 3.197, p = .043] (Table 4.18). This significance means that after accounting for a participant's LL and RE, participant performance on the reading comprehension test was different. Evaluating the estimated marginal mean values, it is apparent that the participants who were exposed to the audio, text, and picture (Mean = 9.72) scored significantly higher than the participants who were exposed to the audio and text only (Mean = 8.35). There were no significant differences found based on media type between the immediate vocabulary test and the delayed vocabulary test, even with the covariates included in the analysis. There was a significant difference noted for LL on the reading comprehension test, [F (1, 218) = 36.09, p <.001], the immediate vocabulary test, [F (1, 218) = 16.45, p < .001], and the delayed vocabulary test, [F (1, 218) = 21.99, p < .001]. These findings indicate that there were significant differences in the participants' Foreign Language Learning Ability (LL) which influenced their performance on the three tests.

Table 4.17

ANCOVA Results for Reading Comprehension Scores by Media Type after Accounting for Foreign Language Learning Abilities (LL)

	df	Mean Square	*F*	*p*
LL	1	409.079	36.088	<.001
Media Type	2	34.760	3.066	.049
Error	218	11.336		

Table 4.18

ANCOVA Results for Reading Comprehension Scores by Media Type after Accounting for English Reading Abilities (ER)

	df	Mean Square	*F*	*p*
ER	1	171.792	13.769	<.001
Media Type	2	39.881	3.197	.043
Error	217	12.476		

To evaluate the effect of participant English Learning Level (EL), the variable was included as a covariate. Results revealed that there was not a significant effect of media type on participant performance after accounting for EL, for the reading comprehension scores [F (2,218) = 2.42, p = .091] (Table 4.19), for the immediate vocabulary scores, [F (2,218) = .488, p = .641] (Table 4.20), and for the delayed vocabulary score, [F (2,218) = .290, p =.749] (Table 4.21). However, there was a significant finding for EL, on the reading comprehension test, [F (2,218) = .44.72, < .001], on the immediate vocabulary test, [F (2,218) = 57.22, p < .001], on the delayed vocabulary test, [F (2,218) = 47.55, p < .001]. This indicates that the difference in EL among the participants was an influential factor in performance on the three tests (reading comprehension test, immediate vocabulary test, and delayed vocabulary test).

Table 4.19

ANCOVA Results for Reading Comprehension Scores by Media Type after Accounting for English Learning Level (EL)

	df	Mean Square	*F*	*p*
EL	1	490.244	44.717	<.001
Media Type	2	26.536	2.42	.091
Error	218	10.963		

Table 4.20

ANCOVA Results for Immediate Vocabulary Scores by Media Type after Accounting for English Learning Level (EL)

	df	Mean Square	*F*	*p*
EL	1	4750.834	57.215	<.001
Media Type	2	40.536	.488	.641
Error	218	83.035		

Table 4.21

ANCOVA Results for Delayed Vocabulary Scores by Media Type after Accounting for English Learning Level (EL)

	df	Mean Square	*F*	*p*
EL	1	3985.694	47.553	<.001
Media Type	2	24.277	.290	.749
Error	218	83.816		

To evaluate the influence of Years of Speaking English (YE), the variable was included as a covariate. Results indicated that media type was not influential on participant performance after accounting for the number of Years of Speaking English (YE), for the reading comprehension test, [F (2,218) = 1.80, p = .17] (Table 4.22), for the immediate vocabulary test, [F (2,218) = .45, p = .64] (Table 4.23)for the delayed vocabulary test, [F (2,218) = .37, $p < .69$] (Table 4.24). However, there was a finding significance for YE, on the reading comprehension test, [F (2, 218) = 14.254, p <.001] on the immediate vocabulary test, [F (2,218) = 18.354, p <.001], and on the delayed vocabulary test, [F (2,218) = 8.46, p <.001]. This also indicates that there was a difference among the participants for number of Years Speaking English (YE) and that this difference was influential on participant performance on the three tests (reading comprehension test, immediate vocabulary test, and delayed vocabulary test).

Table 4.22

ANCOVA Results for Reading Comprehension Scores by Media Type after Accounting for Years of Speaking English (YE)

	df	Mean Square	*F*	*p*
YE	1	176.768	14.254	<.001
Media Type	2	22.302	1.798	.168
Error	218	12.401		

Table 4.23

ANCOVA Results for Immediate Vocabulary Scores by Media Type after Accounting for Years Speaking English (YE)

	df	Mean Square	*F*	*p*
YE	1	1774.64	18.354	<.001
Media Type	2	43.824	.453	.636
Error	218	96.688		

Table 4.24

ANCOVA Results for Delayed Vocabulary Scores by Media Type after Accounting for Years Speaking English (YE)

	df	Mean Square	*F*	*p*
YE	1	831.482	8.46	<.001
Media Type	2	36.029	.367	.694
Error	218	98.285		

To evaluate the effect of English Reading Ability (ER), the variable was included as a covariate and test performance was again analyzed. For the reading comprehension test, the covariate English Reading Ability (ER) proved to be influential, resulting in significant differences for performance on the reading comprehension test based on media type, [F (2,17) = 3.20, p =.04] (Table 4.25). Examination of the estimated marginal means indicates that the participants in the audio, text, and picture gloss group (Mean = 9.79) scored significantly higher than the participants in the audio, text, and animation gloss group (Mean = 8.31). These results indicate that after accounting for the participant's English Reading Ability (ER), the presentation of pictures in conjunction with audio and text resulted in higher reading comprehension scores. Media type was not significant for the immediate vocabulary test, [F (2,217) = .80, p =.45] (Table 4.26), or for the delayed vocabulary test, [F (2,217) = .30, p = .74] (Table 4.27). However, there was a significant difference found for English Reading Ability (ER) on the immediate vocabulary test, [F (2,217) = 15.28, p < .001], and on the delayed vocabulary test, [F (2,217) = 13.62, p < .001]. These results indicate that there were significant differences detected within the participant pool for English Reading Ability (ER) and that these differences were influential factors in participant performance on the immediate and delayed vocabulary tests.

Table 4.25

ANCOVA Results for Reading Comprehension Scores by Media Type after Accounting for English Reading Abilities (ER)

	df	Mean Square	*F*	*p*
ER	1	171.792	13.769	<.001
Media Type	2	39.881	3.197	.043
Error	217	12.476		

Table 4.26

ANCOVA Results for Immediate Vocabulary Scores by Media Type after Accounting for English Reading Abilities (ER)

	df	Mean Square	*F*	*p*
ER	1	1500.764	15.284	<.001
Media Type	2	78.246	.797	.452
Error	217	98.195		

Table 4.27

ANCOVA Results for Delayed Vocabulary Scores by Media Type after Accounting for English Reading Abilities (ER)

	df	Mean Square	*F*	*p*
ER	1	1314.615	13.622	<.001
Media Type	2	29.219	.303	.739
Error	217	96.51		

H 5: There is a relationship between students' level of anxiety regarding foreign language learning ability and their performance on English vocabulary and reading comprehension tests.

To evaluate the relationship between participants' anxiety regarding foreign language learning ability and their test performance (H5), correlational analyses were conducted on the three test forms (reading comprehension test, immediate vocabulary test, and delayed vocabulary test). Results indicated positive linear relationships between anxiety and the three tests. For the reading comprehension test, ($r =. 203$, $p = .002$), for the immediate vocabulary test, ($r = .229$, $p = .001$), and for the delayed vocabulary test, ($r = .207$, $p = .002$). The positive nature of the relationship between anxiety and test performance indicates that elevated anxiety is associated with higher reading comprehension and vocabulary test scores. The three tests themselves were also positively related, for the reading comprehension test and immediate vocabulary tests, ($r = .547$, $p < .001$), for the reading comprehension and delayed vocabulary tests, ($r = .535$, $p < .001$), and for the immediate and delayed vocabulary tests, and ($r = .706$, $p < .001$) (Table 4.28).

Correlational analyses of test scores with each other and with participant anxiety level regarding foreign language learning are summarized in Table 4.29.

Table 4.28

Correlation Matrix of Test Scores with Each Other and with Subject Anxiety Regarding Foreign Language Learning Ability

		Comp	Voc1	Voc2	Anxiety
Comprehension Test	Pearson Correlation	1	.547**	.535**	.203**
	Sig. (2-tailed)		.000	.000	.002
	N	222	222	222	222
Immediate Vocabulary Test	Pearson Correlation	.547**	1	.706**	.229**
	Sig. (2-tailed)	.000		.000	.001
	N	222	222	222	222
Delayed Vocabulary Test	Pearson Correlation	.535**	.706**	1	.207**
	Sig. (2-tailed)	.000	.000		.002
	N	222	222	222	222
FL Anxiety	Pearson Correlation	.203**	.229**	.207**	1
	Sig. (2-tailed)	.002	.001	.002	
	N	222	222	222	222

Note: ** Correlation is significant at the 0.01 level (2-tailed)

Table 4.29

Correlation Matrix Summary

	Reading Comprehension	Immediate Vocabulary	Delayed Vocabulary	FL Anxiety
Reading Comprehension	X			
Immediate Vocabulary	0.547 p < 0.001	X		
Delayed Vocabulary	0.535 p < 0.001	0.706 p < 0.001	X	
FL Anxiety	0.203 p = 0.002	0.229 p = 0.002	0.207 p = 0.002	X

H 6: Students' demographic and background measures will predict their English vocabulary and reading comprehension test results.

To determine the predictive nature of the participant variables (H6) such as Foreign Language Learning (LL), English Level (EL), English Reading Ability (ER), and Years of Speaking English (YE), regressional analyses were conducted on the three test forms (reading comprehension test, immediate vocabulary test, and delayed vocabulary test). For the reading comprehension test, the regressional model was significant, $F(4,216) = 18.85$, ($p < .001$) with $R^2 = .265$ (Table 4.30), the significant predictors were EL, $t = 4.51$, ($p < .001$), and LL, $t = 4.29$, ($p < .001$) (Table 4.31). For the immediate administration of the vocabulary test, the regressional model was significant, $F(4,216) = 17.91$, ($p < .001$) with $R^2 = .249$ (Table 4.32), and the significant predictors were EL, $t = 5.35$, ($p < .001$), and LL, $t = 2.01$, ($p = .046$) (Table 4.33). For

the delayed administration of the vocabulary test, the regressional model was significant, F (4,216) = 16.53, ($p < .001$) with $R^2 = .234$ (Table 4.34), and the significant predictors of EL, t = 5.49, ($p < .001$), and LL, t = 2.78, ($p = .006$) (Table 4.35).

Table 4.30

Multiple Regression Results for Reading Comprehension and English Reading, Years of English, Language Learner, and English Level

	Sum of Squares	*df*	Mean Square	*F*	Sig
Regression	761.503	4	190.376	18.852	0.000[a]
Residual	2181.276	216	10.098		
Total	2942.778	220			

Table 4.31

Predictive Variables for Reading Comprehension

Predictors		Coefficients		
	R^2	B	β	t
Model: Reading Comprehension	.259*			
English Level		1.31	.32	4.51*
Years of English		.20	.05	.833NS
Language Learner		1.15	.28	4.29NS
English Reading		.091	.02	.30*

Note: *p<.05; NS not significant

Table 4.32

Multiple Regression Results for Immediate Vocabulary and English Reading, Years of English, Language Learner, and English Level

	Sum of Squares	*df*	Mean Square	*F*	Sig
Regression	5708.026	4	1427.006	17.911	0.000[a]
Residual	17208.816	216	79.670		
Total	22916.842	220			

Table 4.33

Predictive Variables for Immediate Vocabulary

Predictors		Immediate Vocabulary		
	R^2	B	β	t
Model:				
Immediate Vocabulary	.249*			
English Level		4.36	.38	5.35*
Years of English		.453	.04	.66NS
Language Learner		1.51	.13	2.01*
English Reading		1.28	.10	1.5NS

Note: *p<.05; NS not significant

Table 4.34

Multiple Regression Results for Delayed Vocabulary and Reading English, Years of English, Language Learner, and English Level

	Sum of Squares	*df*	Mean Square	*F*	Sig
Regression	5229.263	4	1307.316	16.531	0.000[a]
Residual	17082.284	216	79.085		
Total	22311.548	220			

Table 4.35

Predictive Variables for Delayed Vocabulary

Predictors	Delayed Vocabulary			
	R^2	B	β	t
Model:				
Delayed Vocabulary	.234*			
English Level		4.46	.395	5.49*
Years of English		-.46	-.04	-.69NS
Language Learner		2.08	.190	2.78*
English Reading		.95	.078	1.4NS

Note: *p<.05; NS not significant

H 7: Students will express different attitudes towards the different interventions depending upon whether they have had access to an online gloss which contains a) only audio and text, b) audio, text, and picture, or c) audio, text, and animation.

To evaluate the effect of media type on participant attitudes (H7), a One-Way Analysis of Variance (ANOVA) was conducted. Results revealed that of the eight attitudes measured, the statement "Online texts were better than paper-based texts," [F (2,216), = 3.10, p = .043] (Table 4.36) was found to be the only statement that resulted in a different response pattern. To evaluate where the difference was, Post hoc analysis revealed that the participants who were assigned to the audio, text, and picture gloss group (Mean = 3.88) rated this statement significantly higher than did the participants who were assigned to the audio and text gloss group (Mean = 3.41) (Table 4.37). This is not surprising, as online delivery of text is very similar to paper-based delivery, therefore, participants viewing the text would not have had the advantage of including media within delivery.

Table 4.36
One-way ANOVA Results for Attitude toward Media Type

	df	*F*	*p*
The online glosses helped me learn the new words	2	.372	.689
The online glosses helped me understand the passage	2	.362	.697
The online glosses were clear and understandable	2	2.869	.059
I liked reading this passage	2	1.514	.222
The online glosses distracted me from reading this passage	2	2.450	.089
Online glosses are better than paper-based dictionaries	2	.844	.432
Online text are better than paper-based texts	2	3.197	.043
I would read more books for pleasure if they used online glosses	2	.278	.757

Table 4.37

Mean Attitude Scores by Media Type

		Mean	SD	N
The online glosses helped me learn the new words	Text	4.09	.847	.098
	Picture	4.01	1.041	.123
	Video	4.15	.981	.115
The online glosses helped me understand the passage	Text	3.85	.753	.088
	Picture	3.86	1.104	.130
	Video	3.97	.986	.115
The online glosses were clear and understandable	Text	3.76	.991	.115
	Picture	3.69	1.029	.123
	Video	4.07	1.045	.122
I liked reading this passage	Text	3.81	.917	.107
	Picture	3.86	.877	.103
	Video	3.59	1.188	.139
The online glosses distracted me from reading this passage	Text	3.50	1.024	.119
	Picture	3.11	1.145	.135
	Video	3.39	1.115	.132
Online glosses are better than paper-based dictionaries	Text	3.82	1.139	.132
	Picture	3.88	1.310	.154
	Video	4.07	1.147	.134
Online text are better than paper-based texts	Text	3.41	1.084	.126
	Picture	3.88	1.113	.131
	Video	3.67	1.179	.138
I would read more books for pleasure if they used online glosses	Text	3.77	.973	.113
	Picture	3.71	1.054	.124
	Video	3.84	1.054	.123

Chapter Summary

The initial results indicate that there no significant differences were found in reading comprehension scores across the media type groups, while there was a significant finding across time for the vocabulary tests. Regardless of media type condition, all media type groups experienced decreases in vocabulary scores from the initial administration to the subsequent administration two weeks after the intervention. This finding indicates that participants experienced an immediate learning effect, which appears to have dissipated over time. Because

the participants have bilingual capabilities, it was important to account for these variations in their English abilities. When accounting for participants' self-reported English reading ability (ER) and Foreign Language Learning Ability (LL), results indicated that media type was a significant factor for reading comprehension scores. Regressional analysis indicated that two variables, English Level (EL) and Foreign Language Learning Ability (LL), were significant predictors for all the three test forms administered in the study. Considering these variables in the context of the study and the measures used, it is feasible to presume that participants' confidence in their abilities to learn a foreign language would account for some portion of their English comprehension and vocabulary retention scores. Of the eight attitudes measured, the statement "Online texts are better than paper-based texts" was found to be the only statement that resulted in a significantly different response pattern. Examining this difference more closely revealed that when exposed to the audio-text-picture glosses, the participants responded that the online delivery of texts was better than the paper-based texts modes. This is not a surprise because online delivery of text is very similar to paper-based delivery; therefore, participants viewing only the text would not have been had the advantage of including media within delivery.

CHAPTER FIVE

Discussion

Introduction

The purpose of this chapter is to summarize the findings from the statistical analyses of data presented in Chapter 4, and discuss how these findings can be related to the previous research. The limitations of the study, the pedagogical implications of the study, and the direction for future research will also be discussed.

This study investigated the effects of three different combinations of electronic gloss components on vocabulary retention and reading comprehension among English FL learners in Saudi Arabia. Participants read the hypertext under one of the three gloss conditions: a) audio (pronunciation of key word in English) and text (FL definition, L1 translation, and an example in FL); b) audio (pronunciation of key word in FL), text (FL definition, L1 translation, and an example in FL), and picture; or c) audio (pronunciation of key word in FL), text (FL definition in FL, L1 translation, and an example in FL), and animation.

Instruments used to collect data included a reading comprehension test, a demographic and background questionnaire, an immediate multiple-choice vocabulary test, an attitude questionnaire, and a delayed multiple-choice vocabulary test. Participants completed the immediate multiple-choice reading comprehension test after the intervention. The immediate multiple-choice vocabulary test was followed by the attitude questionnaire. Two weeks after the intervention, the delayed multiple-choice vocabulary test was administered to measure word retention. Participants were asked to record their start time and end time for reading the text on a separate paper.

Findings and Discussion

Reading Comprehension

The results found that online glosses with dynamic pictures were more effective in supporting comprehension. Online glosses with dynamic pictures were also rated higher than text-based glosses. No significant differences were found between the text, audio and animation and the other gloss conditions on comprehension. Based on the bilingual capabilities of participant sample, it was important to account for these variations in English abilities.

When controlling for English abilities such as Foreign Language Learning (LL) and English Reading Ability (ER), results indicated that media type was a significant factor in participants' reading comprehension scores. The participants in the audio, text, and picture gloss group (M = 9.72) scored significantly higher than those in the audio and text gloss group (M = 8.35). When using the measures of Foreign Language Learning Ability (LL), English Reading Ability (ER), English Level (EL), and Years of Speaking English (YE) to determine the predictive nature of participants' demographic and background measures, regressional analyses indicated that two measures, LL and EL, were significant predictors of participants' reading comprehension scores. The findings related to EL are consistent with a study conducted by Davis and Lyman-Hager (1977), in which multiple regressional analyses showed that as the grade level of the participants increased, their scores on the two reading comprehension tests (multiple-choice and recall protocol tests) also increased. This was the case with the participants in this study. That is, the higher their English level placements, the higher the scores they achieved on the reading comprehension test.

When evaluating the relationship between participants' anxiety regarding foreign language learning and their test performance, correlational analyses indicated a positive relationship between FL anxiety and participants' reading comprehension scores. The positive nature of this relationship indicates that participants with moderate anxiety achieved higher scores. The reading comprehension test was positively related to the immediate vocabulary test and the delayed vocabulary test. When evaluating the effect of media type on participants' attitudes regarding the gloss types, an ANOVA analysis revealed that the statement "Online texts are better than paper-based texts" indicated a significant difference among the three types of media. The post hoc analysis revealed that the participants who were exposed to the audio, text, and picture gloss (M = 3.88) rated this statement significantly higher than the participants who were exposed to the audio and text gloss (M = 3.41).

Vocabulary Retention

This study did not show a significant effect of media type (audio and text, audio, text, and picture, or audio, text, and animation) on either immediate or delayed vocabulary tests. The means of the three types of media conditions, for the audio-text gloss group, (Immediate Mean = 27.36 and Delayed Mean = 24.68), for the audio-text-picture gloss group, (Immediate Mean = 27.49 and Delayed Mean = 23.99), and for the audio-text-animation gloss group, (Immediate Mean = 25.95 and Delayed Mean = 23.47) did not reach a significant difference. Although the types of media did not result in significant differences on either the immediate or delayed vocabulary tests, there was a significant main effect present for the administration time of the vocabulary tests, with the immediate vocabulary test mean noted as 26.06 while the delayed vocabulary test mean was 24.06. This indicates that there was an initial learning effect that

appears to have decreased over time. This result is consistent with the findings of some previous studies, which also did not show significant differences for media type on vocabulary retention.

Chen (2002), for example, studied L1 and L2 glosses with 85 college freshmen students learning English as a FL in Taiwan. Participants were assigned to one of three conditions in which they received either an L1 (Chinese) gloss, L2 (English) gloss, or no gloss. Participants were asked to read a 193-word English text with 20 glossed words. Results indicated that the L2 gloss group performed better than did the no gloss group, but there was no significant difference between the L1 and L2 gloss groups.

Yoshii and Flaitz (2002) compared the effects of text-only, picture-only, and a combination of text and picture glosses on incidental vocabulary retention. Results showed that participants who had access to the combination of text and picture glosses outperformed participants who had access to text-only or picture-only glosses. Participants' scores on the delayed test declined equally from their scores on the immediate test. This study did find that online gloss with dynamic picture and text and audio had significantly higher comprehension scores than the text and audio only glosses; however, unlike Yoshii and Flaitz's results, this finding was not repeated with the vocabulary acquisition scores. Further studies on online mediated glosses and vocabularies are needed with learners who have different levels of English abilities.

Based on the bilingual capabilities of the participants in this study, it was important to account for these variations in their English abilities. When controlling for their English abilities, by holding constant the variables of Foreign Language Learning Ability (LL), English Level (EL), English Reading Ability (ER), and Years of Speaking English (YE), no significant

differences found based on media type for the vocabulary tests, immediate and delayed, even with the inclusion of the covariates. Using the same English abilities variables, the regressional analyses indicated that two variables, LL and EL, were significant predictors of participants' vocabulary tests, immediate and delayed. Furthermore, when evaluating the relationship between anxiety regarding Foreign Language Learning Ability (LL) and participants' vocabulary scores (immediate and delayed), correlational analysis revealed that there was a positive relationship between anxiety and vocabulary scores. The positive nature of this relationship indicates that elevated anxiety is associated with higher vocabulary scores. There was also a positive relationship between the immediate and delayed vocabulary scores, and between the vocabulary scores and the reading comprehension scores.

It is worth mentioning that a significant decrease in means from the immediate vocabulary scores (M = 26.96) to the delayed vocabulary scores (M = 24.06) is not a surprising result since participants had only one chance to read the 902-word passage and access 50 glossed words within 40 minutes. Coady (1993) argues that there is only a 5-15% probability that a new word could be learned after a single exposure. Coady's argument may explain the results of Hulstijn (1992), who found that students who were exposed to new vocabulary only once had a low rate of recall. In the same vein, Nagat (1999) argues that lower-than-expected performance on vocabulary tests can be explained by the fact that "a one-day lesson is not sufficient to establish long-term retention" (p. 476).

One important factor that might have affected the results of this study is the various learning styles and individual differences of the participants. Previous research on L2 vocabulary learning with learning style functioning as the mediator has examined several factors such as visualizer-verbalizer preferences, high-achievement versus low-achievement learners (Knight,

1994), and cognitive load (Chun & Payne, 2004). Plass, et al. (1998) found that visual learners are helped by graphic presentation, but learners with low-spatial ability are not aided by visual glosses of difficult words. These learners benefit from text translations more than learners with high-verbal ability, but processing words both verbally and visually is taxing and does not improve their acquisition of new words due to the high cognitive load (Plass, et al. 2003).

Dillon and Jobst (2005) argue that individual differences such as preexisting knowledge can have a significant impact on the learner's performance. The current study did not control for participants' learning styles or their prior knowledge. High visual learners might have benefited from the animation and picture gloss conditions more than low visual learners. When participants had to process both verbal and visual presentations, the resulting high cognitive load might have led to insufficient cognitive resources for making connections between the verbal and visual presentation and caused decreased learning, which is in accordance with Mayer's generative theory of multimedia learning (1997, 2001) and cognitive load theory (Sweller, 1988). This may explain why the audio, text, and animation gloss group did not benefit from the animation clues since they did not receive information in their preferred verbal mode.

With regard to individual differences in reading comprehension, Plass, et al. (1998) examined recalling important proportions of a German short text with L2 learners using a multimedia program. They found that verbal learners, who looked up text definitions of difficult words, performed well on reading comprehension measures, while visual learners, who looked up visual glosses (pictures or videos), only performed well when they looked up both visual and verbal glosses instead of verbal alone. Other studies have shown that cognitive load imposed by multimedia glosses (Plass, et al. 2003) or by additional explanatory notes (Yeunng, et al. 1998) can result in decreased reading comprehension. For this study, the visual glosses might have

imposed a high cognitive load on the audio, text, and animation gloss participants, resulting in a negative effect on their reading comprehension and vocabulary test scores.

Some affective factors such as participants' motivation, interest, and energy level could have affected their test scores. The intervention and tests were administered in sessions that occurred from the early morning to the late afternoon. Those with sessions in the late afternoon might have experienced a lower energy level than those who had sessions earlier in the morning

Limitations of the Study

This study poses several limitations. First, participants' reading comprehension was tested at the recognition level with multiple-choice items. A combination of multiple-choice test and another task such as open-ended questions or recall protocols might have yielded different results.

Second, the assessment of participants' vocabulary learning was also measured only at the recognition level with multiple-choice items. A combination of multiple-choice items, along with recognition and production vocabulary tests might have yielded different outcomes for the vocabulary tests. Results could also have been different if the participants' tasks on the vocabulary tests had been matching words and pictures.

Third, a user-behavior tracking program was not used to track participants' interaction with the text while completing the reading task. Such a program would provide information about the frequency and type of glossed words readers consulted as well as the length of time spent on the glosses accessed. These same features were provided by the tracking program used

by Lomicka (1998) and Ben Salem (2006). The use of these programs to track a reader's interaction with online texts is common among researchers because of its reliability, and the ability to generate important information without hindering the participants' reading process (Aust, et al. 1993; Bland et al., 1990; Hulstijn, 2000).

Fourth, only short-term retention was studied. It would be interesting to investigate the impact of different combinations of electronic gloss components on long-term retention. Finally, in this study, participants experienced a computerized reading environment, but were tested with traditional pencil-paper testing methods. Using on-screen tests where the visual elements are incorporated would have been suitable for use in a hypermedia environment.

Recommendations for Further Research

Future research may need to replicate aspects of this study in order to identify which combinations of electronic gloss components (audio and text; audio, text, and picture; or audio, text, and animation) are more effective on vocabulary retention and reading comprehension. Additionally, the aim of future research may be extended to determine which of these combinations are most beneficial to FL/L2 learners with different levels of language proficiency, different linguistic abilities (low-ability learners or high-ability learners), and different learning styles (visual learners or verbal learners). It is also recommended that future research replicate the same methods of selecting glossed words and creating a reading passage focusing on English for Specific Purposes (ESP). Another aspect of multimedia glosses to be investigated are abstract items that can be represented by visual or non-visual glosses. Also, more research should be conducted in other areas of language learning, such as how electronic glosses affect ESL/EFL

grammar, pronunciation, and spelling. Further mediated gloss research with more advanced language learners is warranted.

Pedagogical Implications of the Study

The design process of this study revealed that when illustrating technical terms, pictorial and animated representations may benefit from the inclusion of both negative and positive examples and the use of dynamic cues. In many cases, dynamic pictures may be as effective as animations. However, it is important to note that in this case, the dynamic pictures that eventually emerged were developed in the context of designing animations. That is, the process of designing the animations facilitated the development of the dynamic cues in the pictures.

This study found that online glosses with dynamic pictures are more effective in supporting comprehension and were rated higher than text-based glosses. Instructional designers should consider embedding online glosses with dynamic pictures in most learning resources. This is especially true when designing educational resources in technical fields where the learners must understand many concrete terms and the underling meanings to successfully execute job tasks and work safely in carrying out their professional responsibilities.

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APPENDIX A

Adult Informed Consent Statement

Approved by the Human Subjects Committee University of Kansas, Lawrence Campus (HSCL). Approval expires one year from 10/20/2010. HSCL #18926

NAME OF THE STUDY

The Effect of Mediated Glosses on Vocabulary Recall and Text Comprehension with English Language Learners in Saudi Arabia

PERSONS IN CHARGE

Dr. Ron Aust (Supervisor) aust@ku.edu, telephone (785-864-3466) and Mansour Al Ghafli (Student Researcher) mhg@ku.edu, telephone (785-979-2672).

INTRODUCTION

The Department of Educational Leadership & Policy Studies at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, and the services it may provide to you.

PURPOSE OF THE STUDY

The primary objective of this study is to investigate the impact of three different combinations of gloss components in a hypermedia reading text: audio and text, audio and text and picture, and audio and text and animation. The researcher will investigate the use of these multimedia

components to increase English vocabulary learning and text comprehension of English learners in Saudi Arabia.

Participant Procedures

If you agree to take part in this study, you will be asked to read through a text in English on the computer. (The entire class will be involved in this project as a regular class activity). Then, you will answer some vocabulary and comprehension questions. Your participation in this study will take about an hour for the first phase of this study. A short delayed vocabulary test will be administrated 2 or 3 weeks later. This delayed test will take about 15 to 20 minutes.

RISKS

This study involves no risks to your physical or mental health beyond those encountered in the normal course of everyday life.

BENEFITS

Your participation in this study may be educationally beneficial for you. The activity may provide you with additional opportunities to practice and enhance your vocabulary and reading comprehension skills.

PAYMENT TO PARTICIPANTS

Your participation in this study is voluntary; you will not be paid for your participation by the researcher or any other organization.

PARTICIPANT CONFIDENTIALITY

Your participation in this study is confidential. Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless required by law or you give written permission. There is no expiration date for this study and its findings. For example, "Permission granted on this date to use and disclose your information remains in effect

indefinitely. By signing this form, you give permission for the use and disclose of your information for purposes of this study at any time in the future."

REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the educational establishment you are belong to or to participate in any of its programs or events. However, if you refuse to sign, you cannot participate in this study.

CANCELLATION THIS CONSENT AND AUTHORIZATION

You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to the address stated at the end of this consent form. If you cancel permission to use your information, the researcher will stop collecting additional information about you. However, the researcher may use and disclose information that was gathered before the researcher received your cancellation, as described above.

QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher listed at the end of this consent form.

PARTICIPANT CERTIFICATION

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a researcher participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email mdenning@ku.edu.

I agree to take part in this study as a research participant. By my signature, I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

_____ _____

Participant's Name Date

_____

Participant's Signature

RESEARCHER

I certify that the informed consent procedure has been followed, and that I have answered any questions from the participant above as fully as possible.

Mansour Hussain Al Ghafli

_____

Name

_____ _____

Signature Date

APPENDIX B

Immediate Multiple-Choice Reading Comprehension Test

Select the best answer:

1. How did the mirror show Ahmed's image?
   A) It showed a curved reflection of his image.
   B) It showed an upside down reflection of his image.
   C) It showed a true reflection of his image.
   D) It showed no reflection of his image.

2. How was the flow of water in Ahmed's sink after it was fixed?
   A) It was no longer dirty.
   B) It was leaking.
   C) Only the hot water was flowing.
   D) It was consistent.

3. What did the gas station do to Ahmed's bike tire?
   A) They bent the wheel and the tire.
   B) They accidentally cut the tire with a knife and it leaked.
   C) They accidentally released the air and the tire went flat.
   D) They filled the tire with too much air and it burst.

4. What was the worker, Faisal, doing early in the morning?
   A) He was cleaning two pipes.
   B) He was linking two pipes.
   C) He was painting the top of two pipes.
   D) He was putting caps on the end of two pipes.

5. Why did Khalid think that there might be a problem with the way Faisal used the flux?
   A) Faisal did not stick the flux caps on the ends of the two pipes before joining them.
   B) Faisal did not paint the flux on the pipes properly before joining them.
   C) Faisal did not send the flux report to the manager before releasing the oil.
   D) Faisal did not adjust the flux pressure properly before pouring the oil in the pipeline.

6. How did the pipes look after Faisal worked on them?
   A) They looked as if there was something wrong with the joint.

B) They were painted different colors for different purposes.
C) They were buried under the ground so you could not see them.
D) They were raised more than six feet above the ground.

7. When Khalid saw a globule on the pipeline, what did he think was the problem?
   A) The globule showed that there was too much oil pressure in the pipeline.
   B) The globule meant that the pipeline might have not been joined properly.
   C) The globule on the ground could be a hazard to animals and plants.
   D) The globule meant the pipeline was beginning to rust from the rain.

8. Why did Khalid and the workers expose the pipes to the sun?
   A) To prevent the pipes from rusting.
   B) To increase the amount of the oil in the pipes.
   C) To make the oil thinner in the pipes.
   D) To make the oil thicker in the pipes.

9. When the speed of the oil increased, what happened to the oil in the pipeline?
   A) The oil became hotter in the pipeline.
   B) The oil became colder in the pipeline.
   C) The oil forced the valve open.
   D) The oil started leaking from the pipe joint.

10. What did Khalid say to Salma to reduce her concern that he might be hurt?
    A) Khalid said to Salma that he would not do anything until the danger had passed.
    B) Khalid said to Salma that he had completed all the school's safety courses.
    C) Khalid said to Salma that he avoided materials that might explode into flames.
    D) Khalid said to Salma that he always wore a helmet when he was at work.

11. What did Khalid think that might have stressed the joints of the pipeline?
    A) Exposure to the blowing sand might have weakened the pipes.
    B) Heavy equipment might have accidentally backed into the pipes.
    C) Surrounding temperature changes might have stressed the pipes.
    D) Harsh chemicals might have fallen on the pipes.

12. Where was the oil spilling?
    A) It was spilling from the valve.
    B) It was spilling from the end of the pipeline.
    C) It was spilling from the mouth of the pipeline.
    D) It was spilling where the pipes were linked.

13. How did Khalid and the workers stop the flow of oil?
    A) They called the manager and told him to stop the flow of oil in the pipeline.
    B) They put tape around the end of the pipeline to stop the loss of oil
    C) They used a tool to close off the flow of oil in the pipeline's valve.
    D) They used a plastic sheet around the end of the pipeline to stop the loss of oil.

14. What kind of clothes did Khalid and the workers wear at work?
    A) They wore military clothes to protect the pipeline.
    B) They wore clothes to protect against fire and chemicals.
    C) They wore sports clothes to protect the pipeline.
    D) They wore colorful clothes so that they could be seen safely.

15. What did Salma notice about the soup while she was talking with her husband, Khalid?
    A) She noticed that the soup had fallen off of the stove.
    B) She noticed that the soup was tasteless so she added spices to the soup.
    C) She noticed that there was a wave in the soup indicating that it was about to boil.
    D) She noticed that something had fallen in the soup that was not healthy.

16. Why did Khalid and the workers label the buried pipes?
    A) They labeled the buried pipes to make sure that the pipes would be laid in the correct order when they were moved.
    B) They labeled the pipes to warn people that the pipes may contain dangerous fluids.
    C) They labeled the buried pipes to reduce the chance that vehicles will drive over them.
    D) They labeled the buried pipes to clearly define who owns the pipes.

17. What did the workers suggest to their manager?
    A) They suggested that the color of the pipes should be changed.
    B) They suggested that the pipes should be kept as cold as possible.
    C) They suggested that the pipes should be put on stands above the ground.
    D) They suggested that the pipes should be buried in ditches.

18. Why did Salma ask Khalid to check the oven's gas bottle?
    A) To find out if the oven's gas bottle was secure and not dangerous for Ahmed.
    B) To find out if the tank's valve was leaking.
    C) To find out if the oven's gas bottle was nearly empty.
    D) To find out if the oven's gas bottle was connected properly.

19. What did Khalid's boss tell Khalid?
    A) He told him that he must connect many new pipes this week.
    B) He told him that he would be getting a new job.

C) He told him that an object had fallen and damaged one of the main pipes.
D) He told him that the workers would be getting a raise.

20. Why are pipes made of alloys?
A) To improve the flow of oil in the pipes.
B) To stretch the pipes easily.
C) To make the pipes as strong as possible.
D) To make the cost of the pipes cheaper.

21. What happens when water and oil are poured in the same container?
A) The water and oil blend together to form a brownish color.
B) The water and oil remain in separate layers.
C) The container may be destroyed by acid that is formed when oil and water are mixed.
D) The mixture of water and oil releases very strong and dangerous fumes.

22. What does it mean to say that the ground is permeable?
A) It means that the ground is not dangerous to the pipes over time.
B) It means that the ground is below the sea level.
C) It means that liquids flow easily through the ground.
D) It means that the ground is very hard.

Thank You

Answer Sheet

Reading Comprehension Test

Question #	Correct Answer
1	**1**
2	**4**
3	**4**
4	**2**
5	**2**
6	**1**
7	**2**
8	**3**
9	**4**
10	**3**
11	**3**
12	**4**
13	**3**
14	**2**
15	**3**
16	**3**
17	**4**

18	**3**
19	**3**
20	**3**
21	**2**
22	**3**

APPENDIX C

Demographic and Background Questionnaire

A. Your age: _____ B. Your English Level: _____

C. Your future major: _____

D. Number of years you have studied English: ___

E. Number of English speaking countries you have visited: ___

Check the number that best describes you:

1:Poor, 2: Passing, 3: Average, 4:Good, 5:Excellent

F. Foreign language learner: 1__ 2__ 3__ 4 __ 5__

G. Reading in English: 1__ 2__ 3__ 4 __ 5__

H. Reading in Arabic. 1__ 2__ 3__ 4 __ 5__

I. Computer Skills. 1__ 2__ 3__ 4 __ 5__

Check the number that best describes you:

1: Strongly Agree, 2: Agree, 3: Neutral, 4: Disagree, 5: Strongly Disagree

J. I have anxiety about studying English. 1__ 2__ 3__ 4 __ 5__

K. I use a dictionary when studying in English?Often_, Usually_, Sometimes_, Rarely_, Never_

APPENDIX D

Immediate Multiple-Choice Vocabulary Test

Check the term that matches the definition:

1. "to deform or falsify”
   __ compress __ weld __ distort __ elongate

2. "rounded like the inside of a bowl”
   __ transverse __ steady __ retardant __ concave

3. "continuous; a state that is considered over time”
   __ transverse __ steady __ concave __ vulnerable

4. "going beyond what is necessary”
   __ excessive __ toxic __ rigid __ deposit

5. "to burst or break”
   __ deplete __ rupture __ elongate __ compress

6. "a collar or rim on a wheel or pipe that is used to keep an object in place”
   __ globule __ flange __ hub __ crest

7. "to join pieces of metal by heating”
   __ rupture __ deplete __ weld __ elongate

8. "a small drop of liquid in the shape of a ball”
   __ berm __ alloy __ scraper __ globule

9. "a substance used to help when joining metals”
   __ tensile __ trench __ flux __ fatigue

10. "not perfect in form or function”
    __ defective __ hazardous __ combustible __ sharp

11. "a movable part that controls the flow of a liquid or gas”
    __ flange __ globule __ valve __ crest

12. "a measure of thickness or stickiness; a measure of the resistance of a fluid which is being deformed under stress”

__ viscosity __ hazardous __ ion __ ripple

13. "the speed of motion or action”

__ flux __ surge __ velocity __ sharp

14. "a sudden increase in pressure of movement”

__ surge __ flux __ velocity __ ion

15. "to leak slowly”

__ flex __ surge __ seep __ elongate

16. "dangerous”

__ permeable __ tensile __ vulnerable __ hazardous

17. "highly flammable”

__ combustible __ retardant __ steady __ sharp

18. "the top, high point or peak”

__ flange __ fusion __ crest __ hub

19. "a ridge of soil”

__ valve __ rack __ flange __ berm

20. "containing undesired components”

__ linear __ vulnerable __ contaminated __ steady

21. "containing poisonous materials capable of causing death to humans, animals, or plants”

__ sharp __ toxic __ permeable __ excessive

22. "to make slippery or smooth”

__ absorb __ elongate __ contaminate __ lubricate

23. "a tool used to adjust nuts, bolts, or pipes fitting”

__ wrench __ valve __ viscosity __ debris

24. "to remove something unwanted”

__ purge __ elongate __ flex __ absorb

25. "a tool used to remove waste materials”

__ globule __ rack __ scraper __ debris

26. "a weakening of a substance caused by continued bending or deformation”
__ fatigue __ flange __ debris __ trench

27. "does not bend easily”
__ retardant __ hazardous __ rigid __ combustible

28. "surrounding on all sides”
__ impervious __ linear __ ambient __ linear

29. "to extend the length by stretching”
__ elongate __ deplete __ rupture __ purge

30. "a process or result of becoming less or smaller”
__ alloy __ shrinkage __ velocity __ debris

31. "can be stretched or extended”
__ tensile __ hazardous __ immiscible __ destructive

32. "something that delays or reduces the effect”
__ retardant __ hazardous __ rigid __ combustible

33. "a small wave on the surface of a liquid”
__ flux __ wrench __ ripple __ viscosity

34. "a frame for holding or hanging objects”
__ valve __ ripple __ flux __ rack

35. "to empty wholly or partly”
__ elongate __ rupture __ lubricate __ deplete

36. "causing too much damage”
__ vulnerable __ linear __ destructive __ tensile

37. "end point; a place where something ends or is complete”
__ globule __ crest __ terminus __ scraper

38. "the shaft or central point around which things revolve”
__ rack __ hub __ flange __ debris

39. "rubble or wreckage that remains when something is broken or destroyed”
__ berm __ debris __ trench __ velocity

40. "a long, narrow ditch dug in the earth”
__ trench __ rack __ berm __ valve

41. "open to damage”
__ impervious __ contaminated __ vulnerable __ concave

42. "to bend; to enlarge and contract”
__ lubricate __ flex __ weld __ absorb

43. "not rounded”
__ sharp __ combustible __ transverse __ steady

44. "to press or squeeze together; to force into less space”
__ weld __ compress __ purge __ seep

45. "to take in or suck up”
__ weld __ elongate __ rupture __ absorb

46. "having pores or openings that permit liquids or gases to pass through”
__ rigid __ permeable __ defective __ fatigue

47. "mixing of metals, or a metal and a nonmetal, to reach a desired quality”
__ scraper __ fusion __ alloy __ debris

48. "not allowing penetration; allowing no passage”
__ impervious __ linear __ permeable __ tensile

49. "an atom or molecule which has an electronic charge as a result of losing or gaining one or more electrons”
__ velocity __ viscosity __ ripple __ ion

50. "cannot be mixed or blended together”
__ permeable __ combustible __ rigid __ immiscible

51. "periodical movement between two positions”
__ velocity __ viscosity __ oscillation __ alloy

52. "stopping for a time and beginning again”
__ steady __ intermittent __ impervious __ transverse

53. "resembling or following a straight line or path”

__ sharp __ linear __ steady __ impervious

54. "melting or blending together"

__ debris __ berm __ globule __ fusion

55. "lying across; crosswise”

__ impervious __ combustible __ steady __ transverse

56. "a balanced state; equal force or action”

__ crest __ flux __ equilibrium __ hub

57. "a shape that spreads outward”

__ linear __ steady __ flare __ impervious

58. "a sponge or cloth used to absorb liquids”

__ rack __ globule __ swab __ valve

59. "to lay down or add material”

__ posit __ elongate __ surge __ flex

Thank You

Answer Sheet

Immediate Vocabulary Test

Question #	Correct Answer
1	**3**
2	**4**
3	**2**
4	**1**
5	**2**
6	**2**
7	**3**
8	**4**
9	**3**
10	**1**
11	**3**
12	**1**
13	**3**
14	**1**
15	**3**
16	**4**
17	**1**
18	**3**

19	**4**
20	**3**
21	**2**
22	**4**
23	**1**
24	**1**
25	**3**
26	**1**
27	**3**
28	**3**
29	**1**
30	**2**
31	**1**
32	**1**
33	**3**
34	**4**
35	**4**
36	**3**
37	**3**
38	**2**
39	**2**
40	**1**
41	**3**

42	**2**
43	**1**
44	**2**
45	**4**
46	**2**
47	**3**
48	**1**
49	**4**
50	**4**
51	**3**
52	**2**
53	**2**
54	**4**
55	**4**
56	**3**
57	**3**
58	**3**
59	**1**

APPENDIX E

Attitude Questionnaire towards Online Glosses

In an effort to help us understand how students succeed in learning with online glosses, we would appreciate your answers to the following items. Your responses will be kept confidential and used for research purposes only.

Rate your reaction to the following statements by circling the response, which is the closest to how you feel.

1: Strongly Agree, 2: Agree, 3: Neutral, 4: Disagree, 5: Strongly Disagree

1. The online glosses helped me learn the new words.	1__ 2__ 3__ 4 __ 5__
2. The online glosses helped me understand the passage.	1__ 2__ 3__ 4 __ 5__
3. The online glosses were clear and understandable.	1__ 2__ 3__ 4 __ 5__
4. I liked reading this passage.	1__ 2__ 3__ 4 __ 5__
5. The online glosses distracted me from reading this passage.	1__ 2__ 3__ 4 __ 5__
6. Online glosses are better than paper-based dictionaries.	1__ 2__ 3__ 4 __ 5__
7. Online texts are better than paper-based texts.	1__ 2__ 3__ 4 __ 5__
8. I would read more books for pleasure if they used online glosses.	1__ 2__ 3__ 4 __ 5__

9. How often do you use online glosses? Often_, Usually_, Sometimes_, Rarely_, Never_

APPENDIX F

Delayed Multiple-Choice Vocabulary Test

Check the term that matches the definition:

1. "can be stretched or extended”
   __ tensile __ hazardous __ immiscible __ destructive

2. "something that delays or reduces the effect”
   __ retardant __ hazardous __ rigid __ combustible

3. "a small wave on the surface of a liquid”
   __ flux __ wrench __ ripple __ viscosity

4. "a frame for holding or hanging objects”
   __ valve __ ripple __ flux __ rack

5. "to empty wholly or partly”
   __ elongate __ rupture __ lubricate __ deplete

6. "causing too much damage”
   __ vulnerable __ linear __ destructive __ tensile

7. "end point; a place where something ends or is complete”
   __ globule __ crest __ terminus __ scraper

8. "the shaft or central point around which things revolve”
   __ rack __ hub __ flange __ debris

9. "rubble or wreckage that remains when something is broken or destroyed”
   __ berm __ debris __ trench __ velocity

10. "a long, narrow ditch dug in the earth”
    __ trench __ rack __ berm __ valve

11. "open to damage”
    __ impervious __ contaminated __ vulnerable __ concave

12. "to bend; to enlarge and contract”
    __ lubricate __ flex __ weld __ absorb

13. "not rounded”
__ sharp __ combustible __ transverse __ steady

14. "to press or squeeze together; to force into less space”
__ weld __ compress __ purge __ seep

15. "to take in or suck up”
__ weld __ elongate __ rupture __ absorb

16. "having pores or openings that permit liquids or gases to pass through”
__ rigid __ permeable __ defective __ fatigue

17. "mixing of metals, or a metal and a nonmetal, to reach a desired quality”
__ scraper __ fusion __ alloy __ debris

18. "not allowing penetration; allowing no passage”
__ impervious __ linear __ permeable __ tensile

19. "an atom or molecule which has an electronic charge as a result of losing or gaining one or more electrons”
__ velocity __ viscosity __ ripple __ ion

20. "cannot be mixed or blended together”
__ permeable __ combustible __ rigid __ immiscible

21. "periodical movement between two positions”
__ velocity __ viscosity __ oscillation __ alloy

22. "stopping for a time and beginning again”
__ steady __ intermittent __ impervious __ transverse

23. "resembling or following a straight line or path”
__ sharp __ linear __ steady __ impervious

24. "melting or blending together"
__ debris __ berm __ globule __ fusion

25. "lying across; crosswise”
__ impervious __ combustible __ steady __ transverse

26. "a balanced state; equal force or action”
__ crest __ flux __ equilibrium __ hub

27. "a shape that spreads outward”
__ linear __ steady __ flare __ impervious

28. "a sponge or cloth used to absorb liquids”
__ rack __ globule __ swab __ valve

29. "to lay down or add material”
__ posit __ elongate __ surge __ flex

30. "to deform or falsify”
__ compress __ weld __ distort __ elongate

31. "rounded like the inside of a bowl”
__ transverse __ steady __ retardant __ concave

32. "continuous; a state that is considered over time”
__ transverse __ steady __ concave __ vulnerable

33. "going beyond what is necessary”
__ excessive __ toxic __ rigid __ deposit

34. "to burst or break”
__ deplete __ rupture __ elongate __ compress

35. "a collar or rim on a wheel or pipe that is used to keep an object in place”
__ globule __ flange __ hub __ crest

36. "to join pieces of metal by heating”
__ rupture __ deplete __ weld __ elongate

37. "a small drop of liquid in the shape of a ball”
__ berm __ alloy __ scraper __ globule

38. "a substance used to help when joining metals”
__ tensile __ trench __ flux __ fatigue

39. "not perfect in form or function”
__ defective __ hazardous __ combustible __ sharp

40. "a movable part that controls the flow of a liquid or gas”
__ flange __ globule __ valve __ crest

41. "a measure of thickness or stickiness; a measure of the resistance of a fluid which is being deformed under stress”
__ viscosity __ hazardous __ ion __ ripple

42. "the speed of motion or action”
__ flux __ surge __ velocity __ sharp

43. "a sudden increase in pressure of movement”
__ surge __ flux __ velocity __ ion

44. "to leak slowly”
__ flex __ surge __ seep __ elongate

45. "dangerous”
__ permeable __ tensile __ vulnerable __ hazardous

46. "highly flammable”
__ combustible __ retardant __ steady __ sharp

47. "the top, high point or peak”
__ flange __ fusion __ crest __ hub

48. "a ridge of soil”
__ valve __ rack __ flange __ berm

49. "containing undesired components”
__ linear __ vulnerable __ contaminated __ steady

50. "containing poisonous materials capable of causing death to humans, animals, or plants”
__ sharp __ toxic __ permeable __ excessive

51. "to make slippery or smooth”
__ absorb __ elongate __ contaminate __ lubricate

52. "a tool used to adjust nuts, bolts, or pipes fitting”
__ wrench __ valve __ viscosity __ debris

53. "to remove something unwanted”
__ purge __ elongate __ flex __ absorb

54. "a tool used to remove waste materials”

__ globule __ rack __ scraper __ debris

55. "a weakening of a substance caused by continued bending or deformation”

__ fatigue __ flange __ debris __ trench

56. "does not bend easily”

__ retardant __ hazardous __ rigid __ combustible

57. "surrounding on all sides”

__ impervious __ linear __ ambient __ linear

58. "to extend the length by stretching”

__ elongate __ deplete __ rupture __ purge

59. "a process or result of becoming less or smaller”

__ alloy __ shrinkage __ velocity __ debris

Thank You

Answer Sheet

Delayed Vocabulary Test

Question #	Correct Answer
1	**1**
2	**1**
3	**3**
4	**4**
5	**4**
6	**3**
7	**3**
8	**2**
9	**2**
10	**1**
11	**3**
12	**2**
13	**1**
14	**2**
15	**4**
16	**2**
17	**3**
18	**1**

19	**4**
20	**4**
21	**3**
22	**2**
23	**2**
24	**4**
25	**4**
26	**3**
27	**3**
28	**3**
29	**1**
30	**3**
31	**4**
32	**2**
33	**1**
34	**2**
35	**2**
36	**3**
37	**4**
38	**3**
39	**1**
40	**3**
41	**1**

42	**3**
43	**1**
44	**3**
45	**4**
46	**1**
47	**3**
48	**4**
49	**3**
50	**2**
51	**4**
52	**1**
53	**1**
54	**3**
55	**1**
56	**3**
57	**3**
58	**1**
59	**2**

APPENDIX G

In-List Glossed Words

Glossed Words
rupture
seep
lubricate
purge
elongate
flex
compress
deposit
ion
alloy
trench
debris
hub
terminus
rack
ripple
shrinkage
scraper
wrench

berm

crest

surge

velocity

viscosity

valve

globule

flux

weld

flange

equilibrium

flare

fusion

oscillation

swab

immiscible

impervious

permeable

absorbed

vulnerable

destructive

depleted

retardant

tensile

ambient

rigid

fatigued

sharp

contaminated

hazardous

toxic

defective

excessive

steady

concave

distorted

combustible

intermittent

linear

transverse

APPENDIX H

In-Text Glossed Words

Glossed Words
rupture
seep
lubricate
purge
elongate
flex
compress
ion
alloy
trench
debris
hub
terminus
rack
ripple
shrinkage
scraper
wrench
berm

crest

surge

velocity

viscosity

valve

globule

flux

weld

flange

immiscible

impervious

permeable

absorbed

vulnerable

destructive

depleted

retardant

tensile

ambient

rigid

fatigued

sharp

contaminated

hazardous
toxic
defective
excessive
steady
concave
distorted
combustible

APPENDIX I

Glossary Animation Matching

***Part A**: Circle your native language:*

English, Spanish, Arabic, Chinese, Japanese, French, Other _____

***Part B**: Select the term that best represents the numbered animation we present.*

Please, raise you hand if you wish to see the animation again.

1.	**A**. hazardous	**B**. flare	**C**. steady	**D**. viscosity
2.	**A**. velocity	**B**. tensile	**C**. fatigue	**D**. ion
3.	**A**. elongate	**B**. swab	**C**. flux	**D**. velocity
4.	**A**. velocity	**B**. condense	**C**. hazardous	**D**. concave
5.	**A**. fatigue	**B**. tensile	**C**. alloy	**D**. oscillation
6.	**A**. combustible	**B**. trench	**C**. toxic	**D**. hub
7.	**A**. concave	**B**. transverse	**C**. retardant	**D**. steady
8.	**A**. velocity	**B**. lubricate	**C**. linear	**D**. contaminated
9.	**A**. surge	**B**. weld	**C**. ripple	**D**. excessive
10.	**A**. sharp	**B**. fatigue	**C**. surge	**D**. deposit
11.	**A**. flux	**B**. intermittent	**C**. shrinkage	**D**. concave
12.	**A**. lubricate	**B**. elongate	**C**. velocity	**D**. immiscible
13.	**A**. trench	**B**. destructive	**C**. fatigue	**D**. flex
14.	**A**. tensile	**B**. purge	**C**. flux	**D**. flex

15.	**A**. deposit	**B**. flare	**C**. ripple	**D**. viscosity
16.	**A**. hazardous	**B**. defective	**C**. combustible	**D**. sharp
17.	**A**. fatigue	**B**. retardant	**C**. elongate	**D**. hazardous
18.	**A**. purge	**B**. toxic	**C**. wrench	**D**. rigid
19.	**A**. distort	**B**. globule	**C**. valve	**D**. toxic
20.	**A**. deposit	**B**. intermittent	**C**. excessive	**D**. velocity
21.	**A**. rupture	**B**. flare	**C**. immiscible	**D**. transverse
22.	**A**. condense	**B**. viscosity	**C**. permeable	**D**. swab
23.	**A**. seep	**B**. steady	**C**. shrinkage	**D**. impervious
24.	**A**. deplete	**B**. sharp	**C**. berm	**D**. globule
25.	**A**. ambient	**B**. viscosity	**C**. lubricate	**D**. elongate
26.	**A**. rigid	**B**. debris	**C**. absorb	**D**. lubricate
27.	**A**. impervious	**B**. retardant	**C**. tensile	**D**. lubricate
28.	**A**. velocity	**B**. debris	**C**. scraper	**D**. vulnerable
29.	**A**. permeable	**B**. weld	**C**. scraper	**D**. hazardous
30.	**A**. scraper	**B**. destructive	**C**. alloy	**D**. fatigue
31.	**A**. permeable	**B**. purge	**C**. immiscible	**D**. linear
32.	**A**. steady	**B**. condense	**C**. flare	**D**. sharp

33.	**A**. transverse	**B**. fusion	**C**. flare	**D**. lubricate
34.	**A**. absorb	**B**. combustible	**C**. transverse	**D**. oscillation
35.	**A**. combustible	**B**. terminus	**C**. transverse	**D**. destructive
36.	**A**. wrench	**B**. purge	**C**. vulnerable	**D**. destructive
37.	**A**. wrench	**B**. urgent	**C**. ambient	**D**. alloy
38.	**A**. crest	**B**. flux	**C**. impervious	**D**. hub
39.	**A**. crest	**B**. steady	**C**. globule	**D**. equilibrium
40.	**A**. hazardous	**B**. deplete	**C**. crest	**D**. concave
41.	**A**. flange	**B**. valve	**C**. globule	**D**. permeable
42.	**A**. vulnerable	**B**. terminus	**C**. hub	**D**. flange
43.	**A**. ion	**B**. flux	**C**. surge	**D**. weld
44.	**A**. hazardous	**B**. linear	**C**. fusion	**D**. rupture
45.	**A**. flange	**B**. shrinkage	**C**. trench	**D**. crest
46.	**A**. tensile	**B**. wrench	**C**. flare	**D**. rupture
47.	**A**. shrinkage	**B**. equilibrium	**C**. terminus	**D**. globule
48.	**A**. seep	**B**. combustible	**C**. deposit	**D**. destructive
49.	**A**. debris	**B**. flange	**C**. urgent	**D**. seep
50.	**A**. trench	**B**. concave	**C**. contaminated	**D**. sharp

51.	**A**. excessive	**B**. swab	**C**. viscosity	**D**. hub
52.	**A**. terminus	**B**. purge	**C**. valve	**D**. excessive
53.	**A**. wrench	**B**. lubricate	**C**. viscosity	**D**. valve
54.	**A**. urgent	**B**. rack	**C**. contaminated	**D**. swab
55.	**A**. hazardous	**B**. absorb	**C**. rack	**D**. purge
56.	**A**. excessive	**B**. scraper	**C**. globule	**D**. debris
57.	**A**. valve	**B**. berm	**C**. flange	**D**. concave
58.	**A**. flex	**B**. debris	**C**. deplete	**D**. berm
59.	**A**. elongate	**B**. crest	**C**. berm	**D**. trench
60.	**A**. elongate	**B**. tensile	**C**. flex	**D**. shrinkage

Thank You

APPENDIX J

Results of Glossary Animation Matching

#	Terms	# of Participants	Answer Key	Total of Correct Answers	%
1	Sharp	30	D	29	96.67
2	Equilibrium	30	D	27	90.00
3	Excessive	30	C	27	90.00
4	Shrinkage	30	C	27	90.00
5	Absorb	30	A	26	86.67
6	Condense	30	B	26	86.67
7	Ion	30	D	26	86.67
8	Scraper	30	B	26	86.67
9	Alloy	30	C	25	83.33
10	Defective	30	B	25	83.33
11	Swab	30	D	25	83.33
12	Toxic	30	B	25	83.33
13	Flex	30	C	24	80.00
14	Hazardous	30	D	24	80.00
15	Seep	30	A	24	80.00
16	Tensile	30	C	24	80.00
17	Impervious	30	C	23	76.67
18	Oscillation	30	D	23	76.67
19	Permeable	30	C	23	76.67
20	Rupture	30	D	23	76.67
21	Combustible	30	A	22	73.33
22	Deplete	30	B	22	73.33
23	Distort	30	A	22	73.33
24	Elongate	30	B	22	73.33
25	Rigid	30	A	22	73.33
26	Viscosity	30	D	22	73.33
27	Contaminated	30	D	21	70.00
28	Hub	30	D	21	70.00
29	Linear	30	D	21	70.00
30	Rack	30	C	21	70.00
31	Transverse	30	C	21	70.00
32	Weld	30	B	21	70.00
33	Immiscible	30	C	20	66.67
34	Lubricate	30	C	20	66.67
35	Steady	30	A	20	66.67
36	Terminus	30	C	20	66.67

37	Trench	30	D	20	66.67
38	Valve	30	B	20	66.67
39	Velocity	30	D	20	66.67
40	Ambient	30	C	19	63.33
41	Concave	30	A	19	63.33
42	Fusion	30	B	19	63.33
43	Intermittent	30	B	19	63.33
44	Destructive	30	D	18	60.00
45	Purge	30	B	17	56.67
46	Surge	30	C	17	56.67
47	Vulnerable	30	D	17	56.67
48	Wrench	30	A	17	56.67
49	Berm	30	B	16	53.33
50	Retardant	30	B	16	53.33
51	Debris	30	B	15	50.00
52	Deposit	30	D	15	50.00
53	Crest	30	D	14	46.67
54	Flare	30	C	14	46.67
55	Fatigue	30	C	13	43.33
56	Globule	30	D	13	43.33
57	Ripple	30	C	13	43.33
58	Flange	30	D	10	33.33
59	Flux	30	C	7	23.33
60	Urgent	30	C	0	0.00

APPENDIX K

Glossary Terms Matching

Part A: *Circle your native language:*

English, Spanish, Arabic, Chinese, Japanese, French, Other ----------

Part B: *Circle the term that matches the definition:*

1. "A measure of thickness or stickiness. It is a measure of the resistance of a fluid which is being deformed under stress"
   A. Hazardous B. flare C. steady D. viscosity

2. "Atoms having an electronic charge as a result of losing or gaining one or more electronics"
   A. Velocity B. tensile C. fatigue D. ion

3. "The speed of motion or action"
   A. Elongate B. swab C. flux D. velocity

4. "To concentrate or compress a phase from the gaseous phase to liquid or solid"
   A. Velocity B. condense C. hazardous D. concave

5. "Regular movement between two positions"
   A. Fatigue B. tensile C. alloy D. oscillation

6. "Burns easily; highly flammable"
   A. Combustible B. trench C. toxic D. hub

7. "Rounded like the inside of a bowl"
   A. Concave B. transverse C. retardant D. steady

8. "Dirty; impure"
   A. Velocity B. lubricate C. linear D. contaminated

9. "To join pieces of metal by heating"
   A. Surge B. weld C. ripple D. excessive

10. “It is the setting of particles (atoms or molecules) or sediment from a solution, suspension and mixture or vapor onto a pre-existing surface”
    A. Sharp B. fatigue C. surge D. deposit

11. “Stopping for a time and beginning again”
    A. Flux B. intermittent C. shrinkage D. concave

12. “To extend the length”
    A. Lubricate B. elongate C. velocity D. immiscible

13. “A weakening caused by long or continued use”
    A. Trench B. destructive C. fatigue D. flex

14. “A substance used to help when joining metals”
    A. Tensile B. purge C. flux D. flex

15. “A small wave”
    A. Deposit B. flare C. ripple D. viscosity

16. “Not perfect; broken”
    A. Hazardous B. defective C. combustible D. sharp

17. “Something that delays or reduces the effect”
    A. Fatigue B. retardant C. elongate D. hazardous

18. “Containing poisonous materials capable of causing death”
    A. Purge B. toxic C. wrench D. rigid

19. “To deform or falsify; not accurate”
    A. Distort B. globule C. valve D. toxic

20. “Going beyond what is necessary; too much”
    A. Deposit B. intermittent C. excessive D. velocity

21. “Cannot be mixed or blended together”
    A. Rupture B. flare C. immiscible D. transverse

22. “Having pores or openings that permit liquids or gases to pass through”
    A. Condense B. viscosity C. permeable D. swab

23. “A process or result of becoming less or smaller”
A. Seep B. steady C. shrinkage D. globule

24. “A small drop of liquid in the shape of a ball typically immiscible in another liquid”
A. Deplete B. sharp C. berm D. globule

25. “To make slippery or smooth”
A. Ambient B. viscosity C. lubricate D. elongate

26. “Does not bend easily”
A. Rigid B. debris C. absorb D. lubricate

27. “Can be stretched or extended”
A. Impervious B. retardant C. tensile D. lubricate

28. “Open to damage”
A. Velocity B. debris C. scraper D. vulnerable

29. “Breathing toxic fumes can be hazardous to your health”
A. Permeable B. weld C. scraper D. hazardous

30. “Mixing of metals, or a metal and a nonmetal, to reach a desired quality”
A. Scraper B. destructive C. alloy D. fatigue

31. “Resembling or following a straight line or path”
A. Permeable B. purge C. immiscible D. linear

32. “Continuous; a state that is considered over time”
A. Steady B. condense C. flare D. sharp

33. “Melting or blending together”
A. Transverse B. fusion C. flare D. sharp

34. “To take in or suck up”
A. Absorb B. combustible C. transverse D. oscillation

35. “Lying across; crosswise”
A. Combustible B. terminus C. transverse D. destructive

36. “To damage or destroy”
A. Wrench B. purge C. vulnerable D. destructive

37. “Surrounding; on all sides”
A. Wrench B. urgent C. ambient D. alloy

38. “Not allowing penetration; allowing no passage”
A. Crest B. flux C. impervious D. hub

39. “A balanced state; equal force or action”
A. Crest B. steady C. globule D. equilibrium

40. “To empty wholly or partly”
A. Hazardous B. deplete C. crest D. concave

41. “A movable part that controls the flow of a liquid or gas”
A. Flange B. valve C. globule D. permeable

42. “A collar or rim on a wheel or pipe that is used to keep an object in place”
A. Vulnerable B. terminus C. hub D. flange

43. “A sudden increase in pressure or movement”
A. Ion B. flux C. surge D. weld

44. “To burst or break”
A. Hazardous B. linear C. fusion D. rupture

45. “The top, high point or peak”
A. Flange B. linear C. fusion D. rupture

46. “A shape that spreads outward”
A. Tensile B. wrench C. flare D. rupture

47. “End point; a place where something ends or is complete”
A. Shrinkage B. equilibrium C. terminus D. globule

48. “To leak slowly”
A. Seep B. combustible C. deposit D. destructive

49. “Demanding immediate action or attention”

A. Debris B. flange C. urgent D. seep

50. “Not rounded”

A. Trench B. concave C. contaminated D. sharp

51. “The shaft or central point around which things revolve”

A. Excessive B. swab C. viscosity D. hub

52. “To remove something unwanted”

A. Terminus B. purge C. valve D. excessive

53. “A tool used to adjust nuts, bolts, or pipes fitting”

A. Wrench B. lubricate C. viscosity D. valve

54. “A sponge, or cloth used to absorb liquids”

A. Urgent B. rack C. contaminated D. swab

55. “A frame for holding or hanging objects”

A. Hazardous B. absorb C. rack D. purge

56. “A tool used to remove waste materials”

A. Excessive B. scraper C. globule D. debris

57. “A ridge of soil”

A. Valve B. berm C. flange D. concave

58. “Rubble or wreckage that remains when something is broken or destroyed”

A. Flex B. debris C. deplete D. berm

59. “ A long, narrow ditch dug in the earth”

A. Elongate B. crest C. berm D. trench

60. “To bend; to enlarge and contract”

A. Elongate B. tensile C. flex D. shrinkage

Thank You

APPENDIX L

Results of Glossary Terms Matching

#	Terms	# of Participants	Answer Key	Total of Correct Answers	%
1	Excessive	30	C	28	93.33
2	Condense	30	B	27	90.00
3	Defective	30	B	27	90.00
4	Rigid	30	A	27	90.00
5	Alloy	30	C	26	86.67
6	Elongate	30	B	26	86.67
7	Shrinkage	30	C	26	86.67
8	Distort	30	A	25	83.33
9	Immiscible	30	C	25	83.33
10	Intermittent	30	B	25	83.33
11	Linear	30	D	25	83.33
12	Permeable	30	C	25	83.33
13	Rack	30	C	25	83.33
14	Scraper	30	B	25	83.33
15	Swab	30	D	25	83.33
16	Toxic	30	B	25	83.33
17	Urgent	30	C	25	83.33
18	Vulnerable	30	D	25	83.33
19	Weld	30	B	25	83.33
20	Deplete	30	B	24	80.00
21	Impervious	30	C	24	80.00
22	Ion	30	D	24	80.00
23	Lubricate	30	C	24	80.00
24	Oscillation	30	D	24	80.00
25	Transverse	30	C	24	80.00
26	Contaminate	30	D	23	76.67
27	Hazardous	30	D	23	76.67
28	Ripple	30	C	23	76.67
29	Steady	30	A	23	76.67
30	Terminus	30	C	23	76.67
31	Viscosity	30	D	23	76.67
32	Absorb	30	A	22	73.33
33	Combustible	30	A	22	73.33
34	Destructive	30	D	22	73.33
35	Fatigue	30	C	22	73.33
36	Fusion	30	B	22	73.33

37	Purge	30	B	22	73.33
38	Rupture	30	D	22	73.33
39	Seep	30	A	22	73.33
40	Velocity	30	D	22	73.33
41	Debris	30	B	21	70.00
42	Equilibrium	30	D	21	70.00
43	Globule	30	D	21	70.00
44	Berm	30	B	20	66.67
45	Concave	30	A	20	66.67
46	Deposit	30	D	20	66.67
47	Retardant	30	B	20	66.67
48	Tensile	30	C	20	66.67
49	Trench	30	D	20	66.67
50	Valve	30	B	20	66.67
51	Wrench	30	A	20	66.67
52	Hub	30	D	19	63.33
53	Ambient	30	C	18	60.00
54	Flex	30	C	18	60.00
55	Surge	30	C	17	56.67
56	Sharp	30	D	16	53.33
57	Flare	30	C	14	46.67
58	Flange	30	D	11	36.67
59	Flux	30	C	11	36.67
60	Crest	30	D	7	23.33

APPENDIX M

Translation Accuracy Survey

Rate the clarity of the Arabic translations for the following English terms related to pipeline maintenance. You also may provide a better translation if you have one (Optional): **1 = very clear; 2 = clear; 3 = ok; 4 = unclear; 5 = very unclear**

1. Viscosity (n) = لزوجة 1__ 2 __ 3__ 4__ 5 __

   Optional: A better translation is: _____

2. Ion (n) = جسيم أو ذرة 1__ 2 __ 3__ 4__ 5 __

   Optional: A better translation is: _____

3. Velocity (v) = سرعة 1__ 2 __ 3__ 4__ 5 __

   Optional: A better translation is: _____

4. Condense (v) = يضغط 1__ 2 __ 3__ 4__ 5 __

   Optional: A better translation is: _____

5. Oscillation (n) = تذبب منتظم 1__ 2 __ 3__ 4__ 5 __

   Optional: A better translation is: _____

6. Combustible (adj): قابل للاشتعال 1__ 2 __ 3__ 4__ 5 __

   Optional: A better translation is: _____

7. Concave (adj): سطح مقعر 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

8. Contaminated (adj): ملوث 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

9. Weld (v): يلحم أجزاء معدنية 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

10. Deposit (v): يترسب 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

11. Intermittent (adj): متقطع 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

12. Elongate (v): يمتد 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

13. Fatigue (adj): ضعيف 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

14. Flux (n): مادة تساعد علي لحام المعادن 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

15. Ripple (n): موجة صغيرة 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

16. Defective (adj): يحتوي علي عيب 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

17. Retardant (adj): عائق 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

18. Toxic (adj): سام 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

19. Distort (v): يحرف 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

20. Excessive (adj): مفرط 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

21. Immiscible (adj): غير قابل للامتزاج 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

22. Permeable (adj): غير قابل للنفاذ 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

23. Shrinkage (n): انكماش 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

24. Globule (n): كريات صغيرة 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

25. Lubricate (v): يدهن بمادة ملينة 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

26. Rigid (adj): صلب 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

27. Tensile (adj): قابل للامتداد 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

28. Vulnerable (adj): عرضة للضرر 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

29. Hazardous (adj): خطر 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

30. Alloy (n): معدن مخلوط 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

31. Linear (adj): خطي 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

32. Steady (adj): مستمر بشكل ثابت 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

33. Fusion (n): توصيل شيئين 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

34. Absorb (v): يمتص 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

35. Transverse (adj): مستعرض 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

36. Destructive (adj): محطم 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

37. Ambient (adj): محيط 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

38. Impervious (adj): غير قابل للنفاذ 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

39. Equilibrium (n): توازن 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

40. Deplete (v): يفرغ 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

41. Valve (n): صمام 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

42. Flange (n): الحافة 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

43. Surge (n): اندفاع 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

44. Rupture (v): ينفجر 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

45. Crest (n): قمة 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

46. Flare (n): شعلة ضوء 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

47. Terminus (n): حد أو نهاية 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

48. Seep (v): يتسرب 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

49. Urgent (adj): ملح أو أمر اضطراري 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

50. Sharp (adj): حاد 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

51. Hub (n): محور 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

52. Purge (v): ينظف 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

53. Wrench (n): مفتاح ربط 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

54. Swab (n): مسحة للتنظيف 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

55. Rack (n): رف أو حامل 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

56. Scraper (n): مكشطة 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

57. Berm (n): مرتفع من الرمل أو حاجز 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

58. Debris (n): حطام 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

59. Trench (n): خندق 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

60. Flex (n): يلوي 1__ 2 __ 3__ 4__ 5 __

Optional: A better translation is: _____

Are you a native Arabic speaker Yes _____ No_____

I have ____ years of training in the Arabic language.

What is your highest degree?

Bachelor _____ Master's Degree _____ Ph.D. _____

How many years of training have you had in petroleum engineering or related field?

1 year ___ 2 years ___ 3 years ___ 4 years ___ 5 years ___

Thank You

APPENDIX N

Results of Translation Accuracy Survey

			Translation Accuracy Rating				
#	Terms	# of Participants	Very Clear	Clear	OK	Unclear	Very Unclear
1	Crest	5	5	0	0	0	0
2	Oscillation	5	5	0	0	0	0
3	Sharp	5	5	0	0	0	0
4	Velocity	5	5	0	0	0	0
5	Viscosity	5	5	0	0	0	0
6	Absorb	5	4	1	0	0	0
7	Ambient	5	4	0	1	0	0
8	Combustible	5	4	1	0	0	0
9	Contaminate	5	4	1	0	0	0
10	Excessive	5	4	0	1	0	0
11	Immiscible	5	4	0	1	0	0
12	Linear	5	4	1	0	0	0
13	Scraper	5	4	1	0	0	0
14	Seep	5	4	0	1	0	0
15	Toxic	5	4	1	0	0	0
16	Urgent	5	4	1	0	0	0
17	Alloy	5	3	2	0	0	0
18	Concave	5	3	1	1	0	0
19	Deplete	5	3	1	0	0	1
20	Deposit	5	3	0	2	0	0
21	Destructive	5	3	2	0	0	0
22	Equilibrium	5	3	0	2	0	0
23	Flare	5	3	0	1	1	0
24	Globule	5	3	0	2	0	0
25	Hazardous	5	3	2	0	0	0
26	Lubricate	5	3	0	1	0	0
27	Ripple	5	3	1	1	0	0
28	Rupture	5	3	0	2	0	0
29	Shrinkage	5	3	2	0	0	0
30	Steady	5	3	2	0	0	0
31	Surge	5	3	1	1	0	0
32	Swab	5	3	1	0	1	0
33	Tensile	5	3	1	1	0	0
34	Terminus	5	3	0	1	1	0
35	Trench	5	3	1	1	0	0
36	Valve	5	3	1	1	0	0

37	Weld	5	3	0	2	0	0
38	Debris	5	2	0	3	0	0
39	Defective	5	2	1	2	0	0
40	Distort	5	2	1	1	1	0
41	Fatigue	5	2	1	1	1	0
42	Flex	5	2	2	1	0	0
43	Hub	5	2	2	1	0	0
44	Impervious	5	2	1	1	1	0
45	Intermittent	5	2	3	0	0	0
46	Purge	5	2	1	1	1	0
47	Rack	5	2	3	0	0	0
48	Retardant	5	2	1	1	1	0
49	Rigid	5	2	3	0	0	0
50	Transverse	5	2	2	0	1	0
51	Vulnerable	5	2	1	1	1	0
52	Wrench	5	2	3	0	0	0
53	Berm	5	1	0	2	2	0
54	Elongate	5	1	2	2	0	0
55	Flange	5	1	1	2	1	0
56	Flux	5	1	1	2	1	0
57	Fusion	5	1	2	0	1	1
58	Ion	5	1	3	0	1	0
59	Condense	5	0	0	0	1	4
60	Permeable	5	0	2	1	1	1

APPENDIX O

Khalid's Dreams for a Career in Oil and Natural Gas Pipeline Maintenance

Al-Salam was born in Dammam, Saudi Arabia, in 1987. He is married to his wife, Salma, and they have a five-year old child named Ahmed. Khalid has been working as a pipeline inspector for a major oil and natural gas company in Dammam for three years. Last year, he started a two-year college program in oil and natural gas pipeline maintenance. It is a busy time for Khalid because he continues to work part-time while attending his school. He also knows that if he does not score well in his school, he will have less of a chance to become a pipeline maintenance manager or to someday advance into other areas in petroleum engineering. Fortunately, Khalid's wife is a high school science teacher and she helps him study. Every night after dinner, you can see the light turned on in their kitchen as Khalid and Salma talk about their day and Khalid's studies.

Khalid: "Salma, where is Ahmed?"

Salma: "He is looking at his **distorted** reflection in front of his new **concave** mirror."

Khalid: "Okay, we will let him play for a while."

Salma: "Thanks for fixing Ahmed's sink. I am glad to see that the flow of the water is **steady** now. I also saw that there is a problem with Ahmed's bike tire."

Khalid: "Yes, the gas station filled Ahmed's bike tire with **excessive** air, and the tire **ruptured**."

Salma: "That is not fair to Ahmed. The gas station should fix his bike tire for free. Okay, Khalid, let's talk about your work today."

Khalid: "Well, I had a real surprise at work today, Salma. Early this morning I was watching

Faisal, one of the new workers, repairing the pipeline. Faisal was joining two pipes together near a new **flange** using a **weld**. Faisal did not apply the **flux** properly, and I saw a **globule** on the pipeline. After Faisal worked on the pipeline, it looked **defective**."

Salma: "Oh, what did you do, Khalid?"

Khalid: "As you know, my job is to inspect oil and natural gas pipelines, so the workers and I opened the pipeline's **valve**. We left the pipe exposed to the sun for a while to increase the temperature and decrease the **viscosity** of the oil. As the **velocity** of the oil increased, the **surge** caused the oil to **seep** from the joint."

Salma: "That seems **hazardous**. Is it?"

Khalid: "I understand why you might say that, but I made sure that we did not go near things that were **combustible**, and the fluids were contained and did not flow over the **crest** of the **berm**."

Salma: "Was the pipeline area **contaminated** with any **toxic** materials?"

Khalid: "It wasn't. I **lubricated** the valve and then used a **wrench** to completely close the valve. We **purged** the oil from the pipeline using a **scraper** before repairing it."

Salma: "Do you think that the pipeline became **fatigued**?"

Khalid: "I am not sure. The pipeline seemed **rigid** enough everywhere except near the new weld. **Ambient** temperature changes could have caused the pipe to **elongate** or to show **shrinkage** and perhaps stressed the joints, exceeding their **tensile** strength."

Salma: "What kind of clothing were you wearing?"

Khalid: "We were wearing **retardant** clothing."

Salma: "That was a good choice. Oh, just a minute, Khalid. The soup is nearly ready. I see a **ripple** in the soup and it is about to boil. I think that the oven's gas bottle in the **rack** is nearly **depleted**, though. Will you go check it while I get the soup ready for our lunch tomorrow?"

Khalid: "Okay, I will."

Salma: "Let's talk more about your work."

Khalid: "Okay, Salma. Later in the afternoon, I received a call from my boss, Ali, who told me that a **destructive** object had fallen on one of the three main pipelines near its **terminus**."

Salma: "What did you do to solve this problem?"

Khalid: "We decided to stop the flow of the oil at the main **hub** and remove all the **debris** near the pipelines. We repaired the pipes and wrote a report suggesting that these pipes should be buried in a **trench** to keep them from being **vulnerable**."

Salma: "Do you think the trenches could hurt the pipelines?"

Khalid: "Yes, but we want to prevent those problems. We will be careful not to **flex** the pipes when we are laying them. We will make sure that there are no **sharp** objects in the trenches. We will also label where the pipelines are buried to reduce the chance that someone might **compress** them."

Salma: "Is it possible that some chemicals in the ground could be **absorbed** through the pipelines?"

Khalid: "Well, the ground in this area is **permeable** allowing fluids to come in contact with the pipelines. However, the pipes are made with **alloys** that make them **impervious** to water containing corrosive **ions**. If water did leak into the pipes, it would most likely happen at the joints. Water and oil are **immiscible**, so we should know this quickly."

Salma: "This sounds like a good idea."

Khalid: "My goal is to extend the life of our pipelines. This should be good for the company and my career in the pipeline industry. Who knows? Maybe I will get a raise."

Salma: "I like the part about the raise, especially because we will soon have another mouth to feed."

APPENDIX P

Characteristics of the Glossed Words in the Separate List

Glossed Words	Parts of Speech
rupture seep lubricate purge elongate flex compress deposit	Verbs
Ion Alloy trench debris hub terminus rack ripple shrinkage scraper	Nouns

wrench berm crest surge velocity viscosity valve globule flux weld flange equilibrium flare fusion oscillation swab	
immiscible impervious permeable absorbed vulnerable destructive depleted	Adjectives

retardant	
tensile	
ambient	
rigid	
fatigued	
sharp	
contaminated	
hazardous	
toxic	
defective	
excessive	
steady	
concave	
distorted	
combustible	
intermittent	
linear	
transverse	

APPENDIX Q

Characteristics of the Glossed Words in the Story

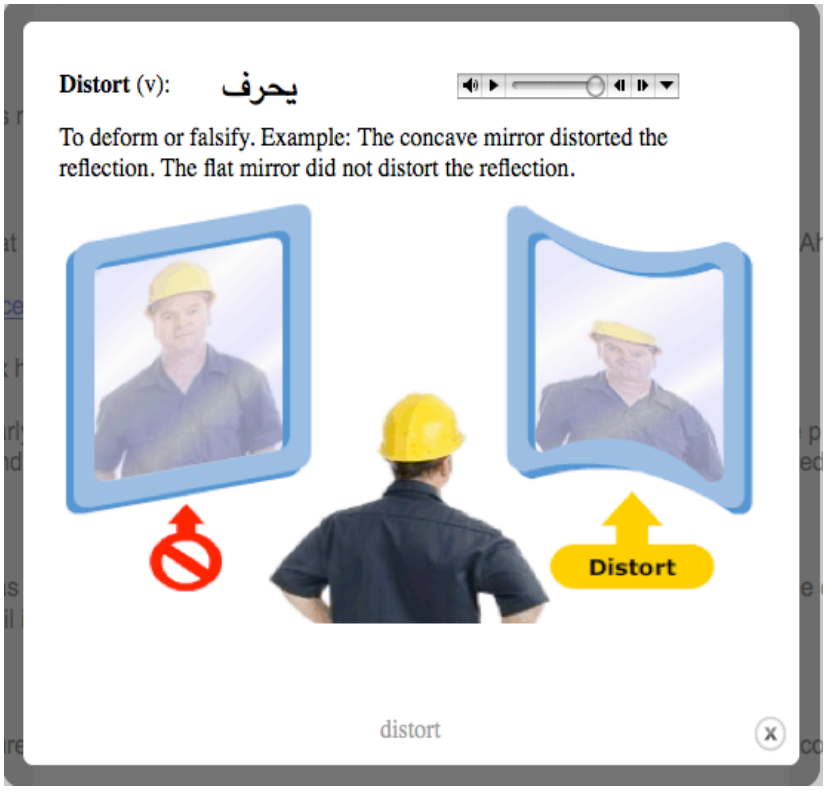
Glossed Words	Parts of Speech
rupture seep lubricate purge elongate flex compress	Verbs
Ion Alloy trench debris hub terminus rack ripple shrinkage scraper wrench	Nouns

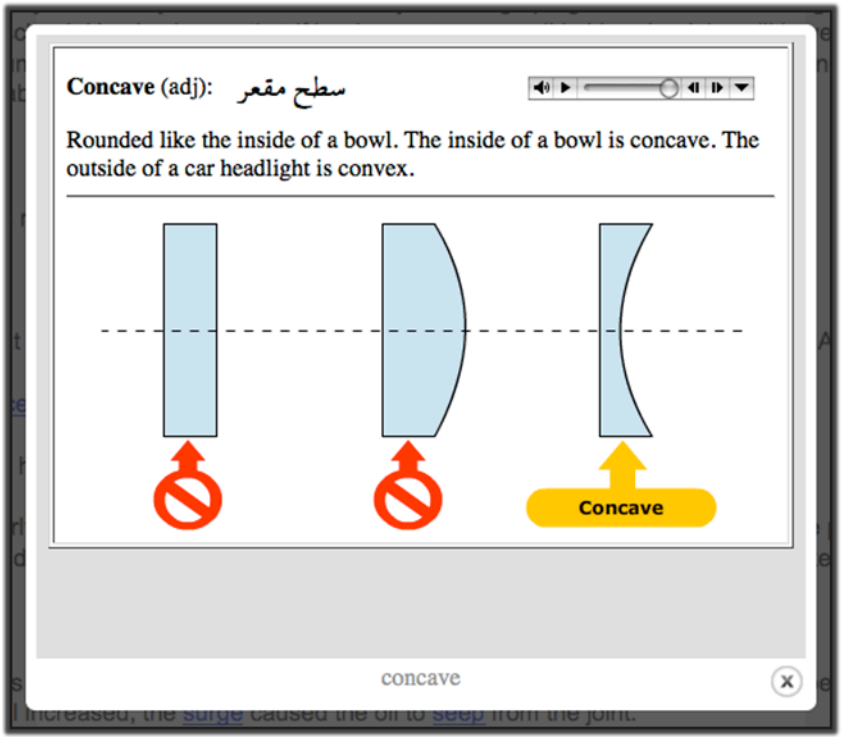
berm crest surge velocity viscosity valve globule flux weld flange	
immiscible impervious permeable absorbed vulnerable destructive depleted retardant tensile ambient rigid fatigued sharp	Adjectives

contaminated	
hazardous	
toxic	
defective	
excessive	
steady	
concave	
distorted	
combustible	

APPENDIX R

Screen Shots for All Three Conditions (Pictures, Animations, and Texts)





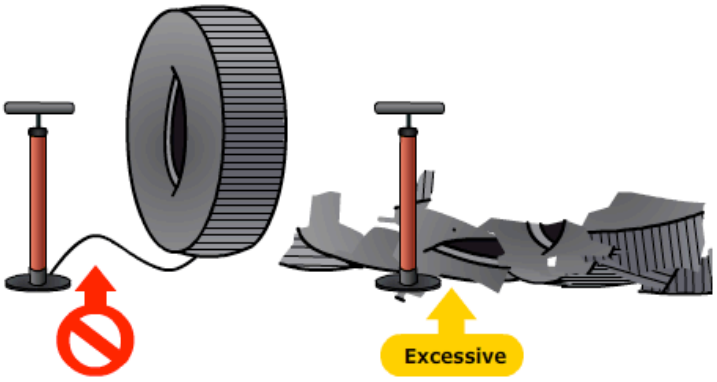
Steady (adj): مستمربشکل ثابت

Continuous; a state that is consistent over time. Example: There is a steady flow of oil in the pipe. The flow of oil is not steady; it changes every minute.

steady

Excessive (adj): مفرط

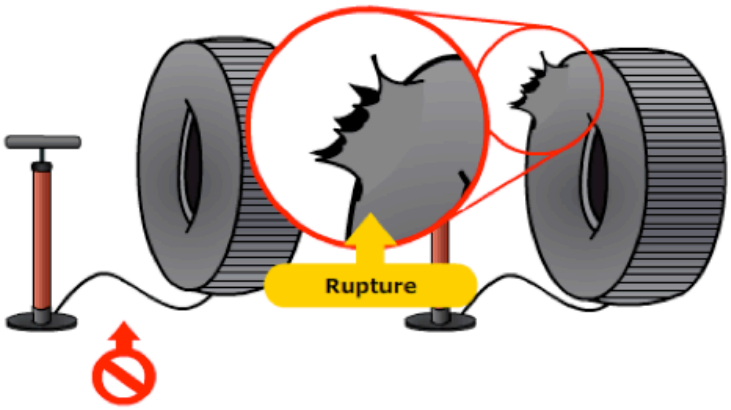
Going beyond what is necessary; too much. Example: The tire ruptured when it was filled with an excessive amount of air.



excessive

Rupture (v): ينفجر

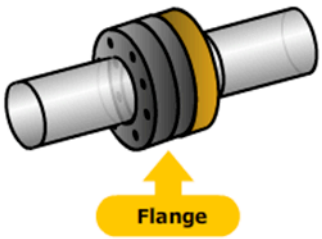
To burst or break. Example: The high pressure ruptured the tire.



rupture

Flange (n): الحافة

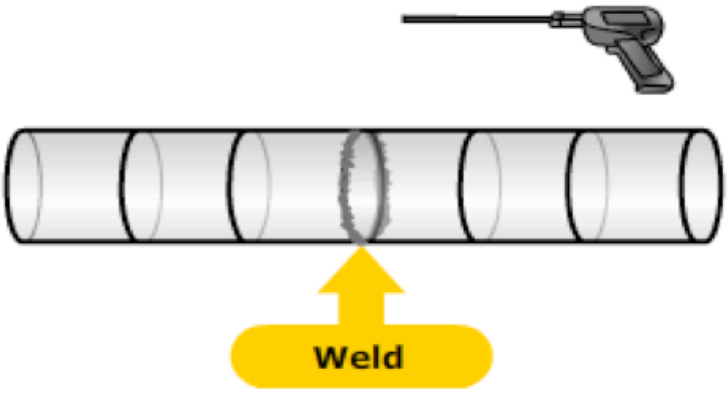
A collar or rim on a wheel or pipe that is used to keep an object in place.
Example: The pipe has a flange.The pipe has no flange.



flange

Weld (v): يلحم أجزاء معدنية

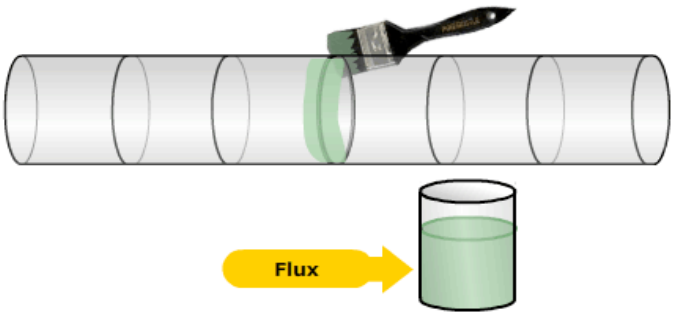
To join pieces of metal by heating. Example: Two pipes can be joined by welding two ends together to form a single pipe.



weld

Flux (n): مادة تساعد علي لحام المعادن

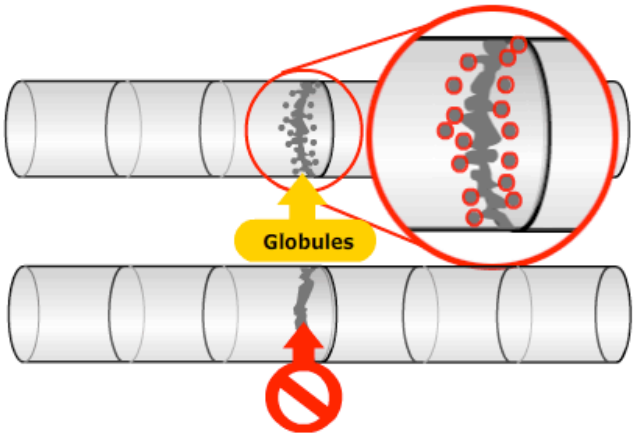
A substance used to help when joining metals. Example: We added flux to the pipes before joining them together with a weld to clean and free them from oxide and promote their union.



flux

Globule (n): كريات صغيرة

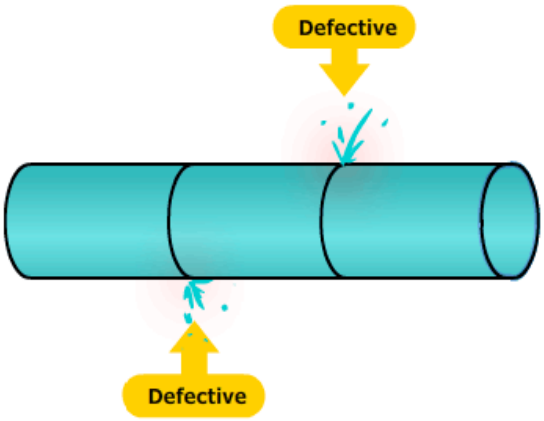
A small drop of liquid in the shape of a ball. The weld included small globules of metal. The weld produced no globules of metal.



globule

Defective (adj): يحتوي علي عيب

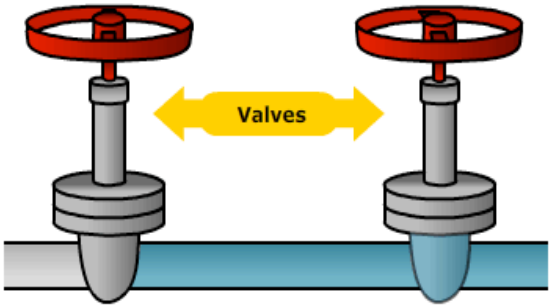
Not perfect in form or function. Example: The defective pipe weld caused a leak.



defective

Valve (n): صمام

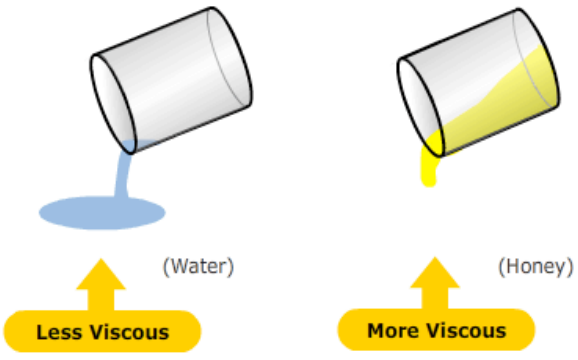
A movable part that controls the flow of a liquid or gas. Example: This valve is open and the oil is flowing.



valve

Viscosity (n): لزوجة

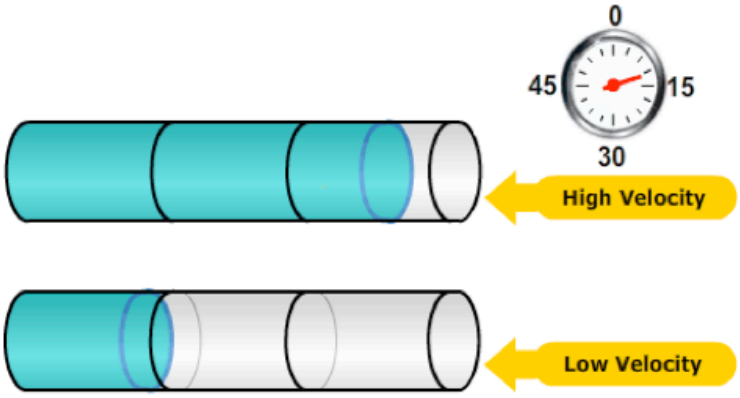
Viscosity is a measure of the resistance of a fluid to flow. A fluid with high flow resistance is called thick, while a fluid with low flow resistance is called thin. Example: Water is thin while honey is thick.



Viscosity

velocity (v): سرعة

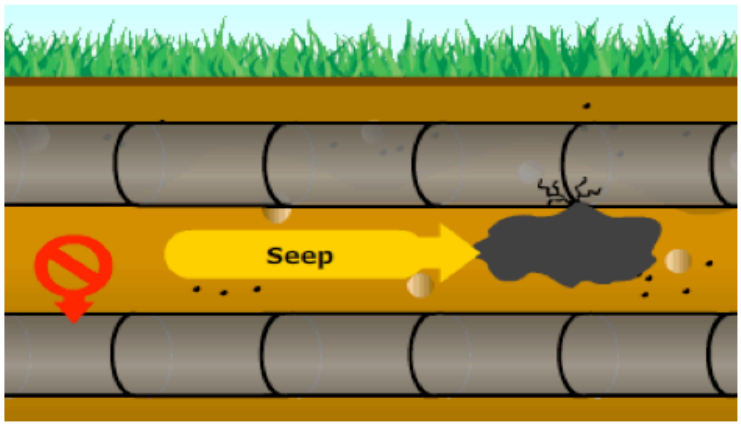
The speed of motion or action. Example: The velocity of oil flowing in a pipeline is a measure of how fast the oil is moving past a fixed point.



Velocity

Seep (v): يتسرب

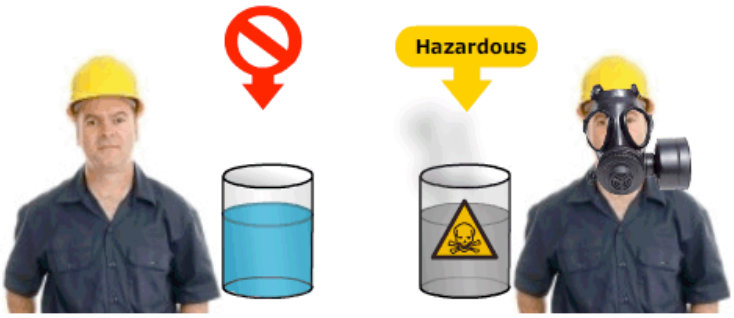
To leak slowly. Example: Oil seeps slowly into the sand from the small leak in the pipe.The pipe does not have a leak. Oil does not seep into the sand.



seep

Hazardous (adj): خطر

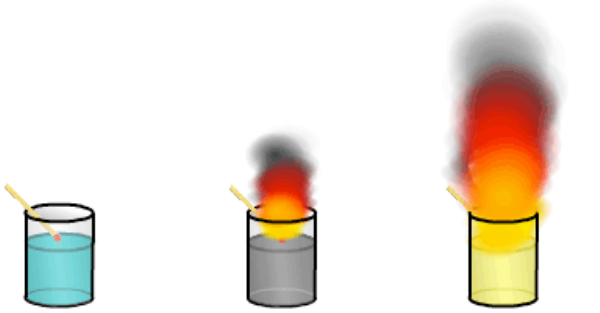
Breathing toxic fumes can be hazardous to your health. Example: Toxic fumes can be hazardous if you are not wearing a protective mask.



hazardous

Combustible (adj): قابل للاشتعال

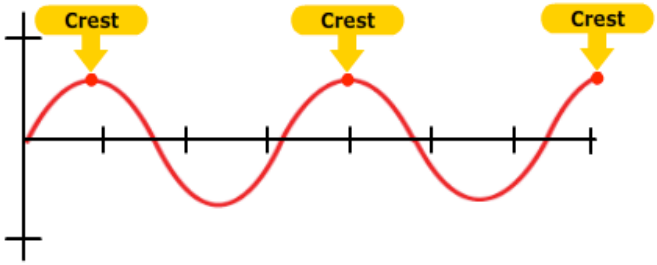
Burns easily; highly flammable. Example: Gas is combustible while water is not.



combustible

Crest (n): قمة

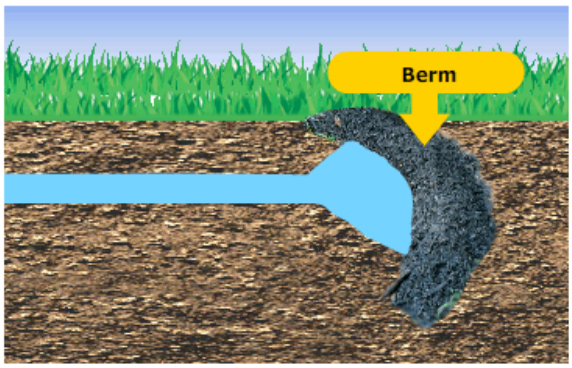
The top, high point or peak. Example: The crest of the wave is at the top.



crest

Berm (n): مرتفع من الرمل

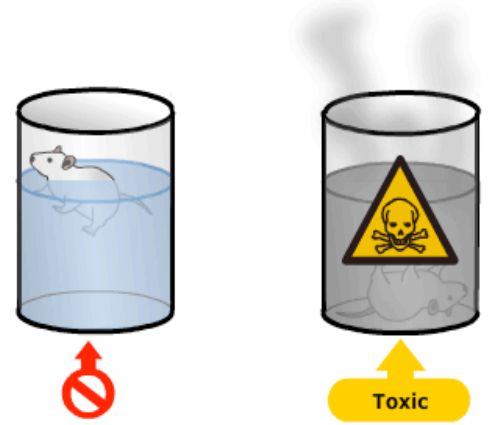
A ridge of soil. Example: A berm is placed over the pipeline then sprayed with asphalt to protect the pipeline from wind and rain.



berm

Toxic (adj): سام

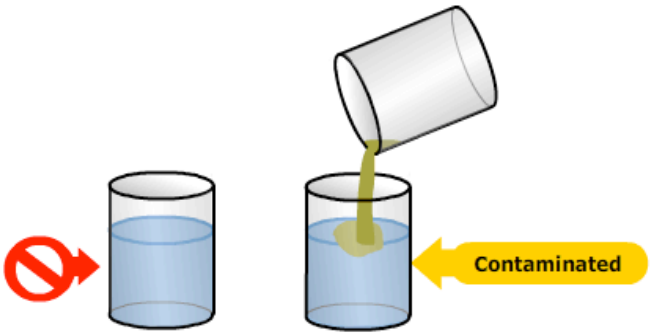
Containing poisonous materials capable of causing death to humans, animals or plants. Example: The fumes from a barrel of sulfuric acid are toxic. The fumes from a barrel of water are not toxic.



toxic

Contaminated (adj): ملوث

Containing undesired components Example: The oil was contaminated with the desert sand. Bottled water is not contaminated. Seawater was contaminated with oil.



contaminated

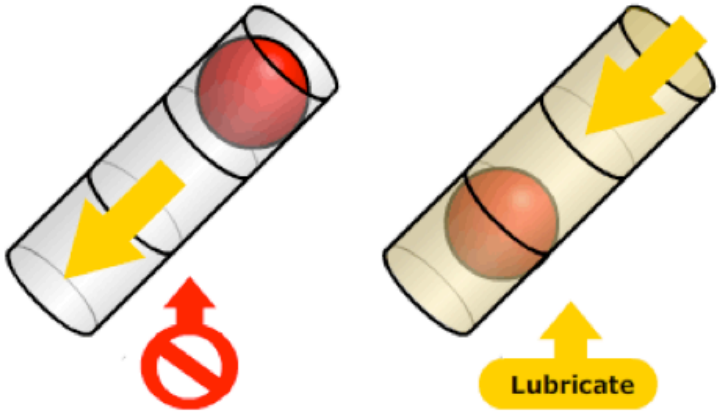
Wrench (n): مفتاح ربط

A tool used to adjust nuts, bolts, or pipes fitting. Example: A correct wrench was used to loosen the pipefitting.A wrench was not available to loosen the pipefitting.

wrench

Lubricate (v): يدهن بمادة ملينة

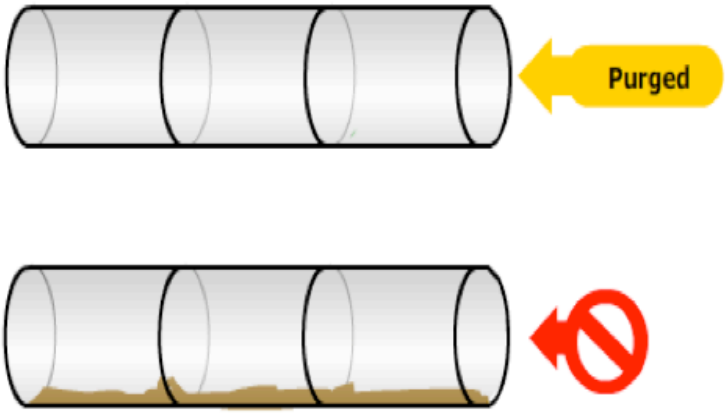
To make slippery or smooth. Example: The ball moved easily through the lubricated pipe.



lubricate

Purge (v): ينظف

To remove something unwanted. Example: The pipe was purged of dirt before it was used to transport oil. The pipe was not purged of dirt and the dirt mixed with the oil.



purge

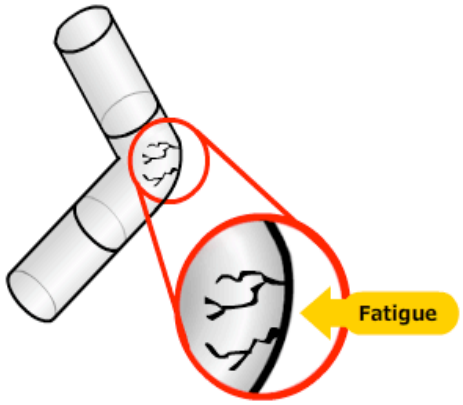
Scraper (n): مكشطة

A tool used to remove waste materials. Example: A scraper is passed inside the pipeline to remove unwanted water and waste materials from the pipe.

scraper

Fatigue (n): ضعيف

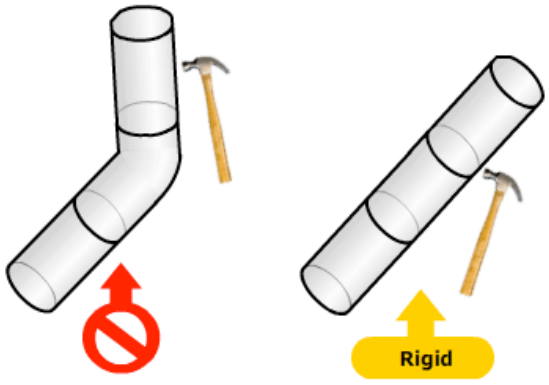
A weakening of a substance caused by continued bending or deformation. Example: When a steel wire is bent back and forth many times, it becomes fatigued and may break.



fatigue

Rigid (adj): صلب

Does not bend easily. Example: The pipe made of rigid steal cannot be easily bent. The pipe made of soft plastic is not rigid and it can be easily bent.



rigid

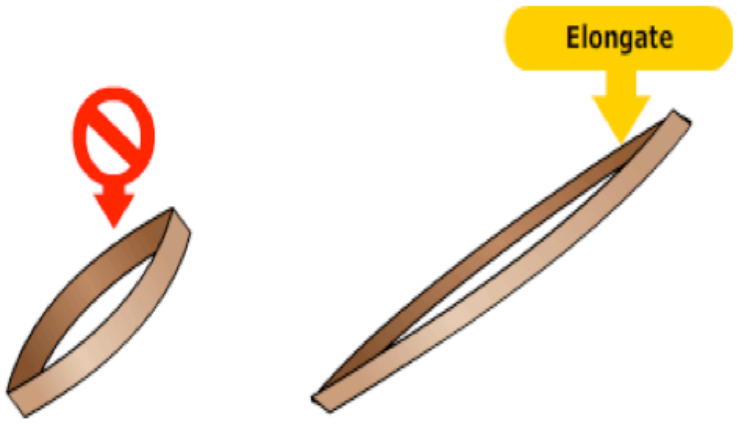
Ambient (adj): محيط

Surrounding; on all sides. Example: The ambient area around the house is lighted.The lights in the sky are not in the house's ambient area.

ambient

Elongate (v): يمتد

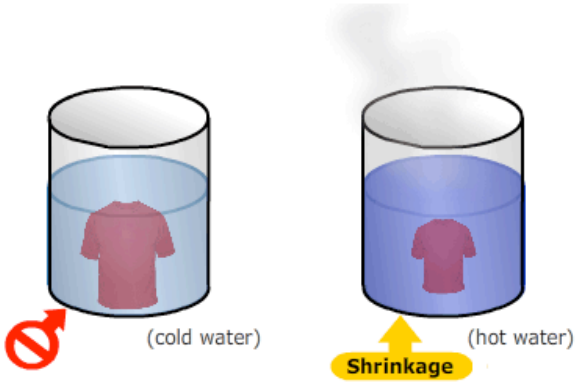
To extend the length by stretching. Example: A rubber band is easily elongated.



elongate

Shrinkage (n): انكماش

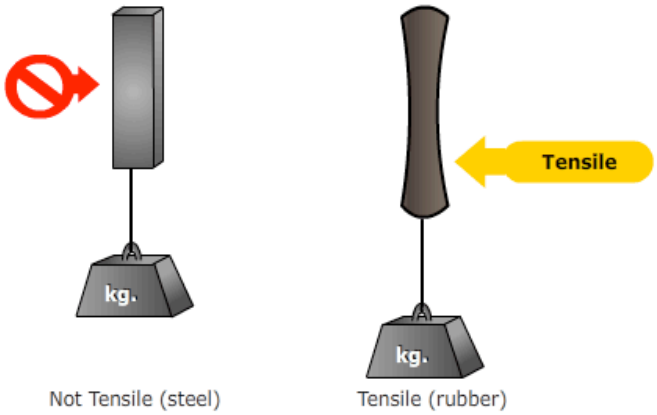
A process or result of becoming less or smaller. Example: There was much shrinkage when the shirt was in hot water. The shirt did not shrink in cold water. Crude oil shrinks under pressure.



shrinkage

Tensile (adj): قابلللامتداد

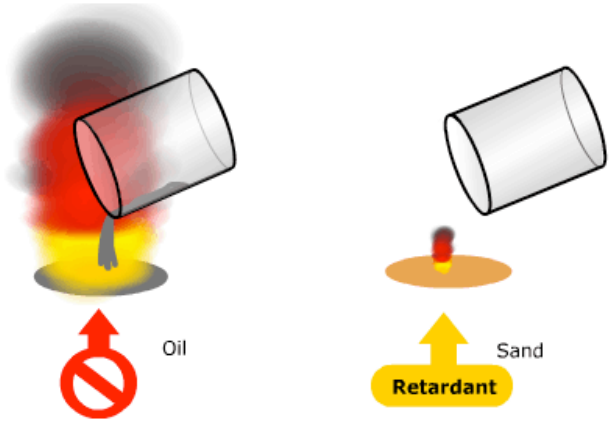
Can be stretched or extended. Example: Rubber is tensile. It is easy to stretch or bend. Steel is not tensile. It is difficult to stretch or bend.



tensile

Retardant (adj): عائق

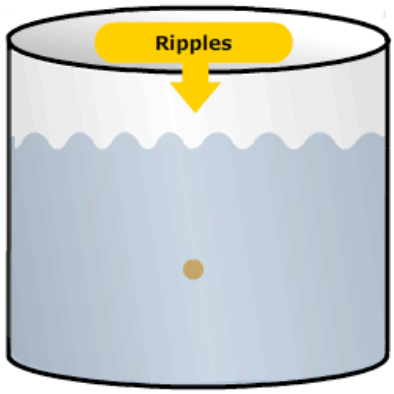
Something that delays or reduces the effect. Example: Chemicals are sprayed on an oil fire to retard the spread of the flames



retardant

Ripple (n): موجة صغيرة

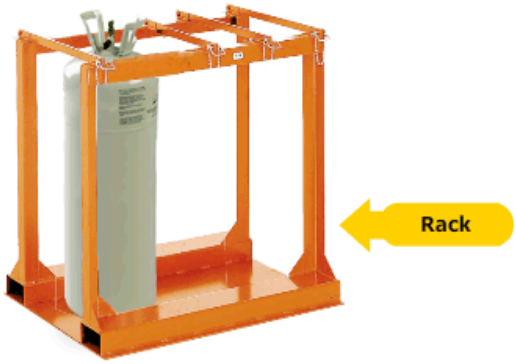
A small wave on the surface of a liquid. Example: If you drop a rock on the surface of water, you can see the ripples.



ripple

Rack (n): رف أوحامل

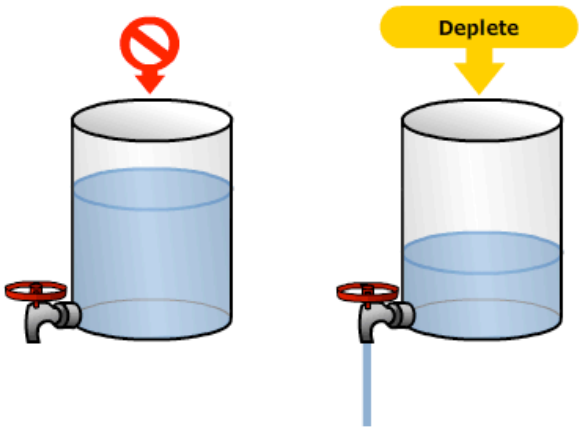
A frame for holding or hanging objects. Example: The rack was used to safely store the cylinders.No rack was found to store the cylinders safely.



rack

Deplete (v): يفرغ

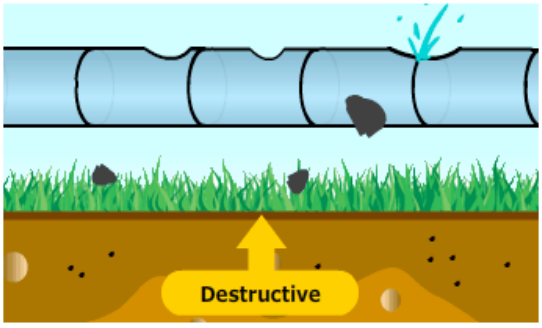
To empty wholly or partly. Example: Some oil reservoirs are depleted after 60 years of production.



deplete

Destructive (adj): محطم

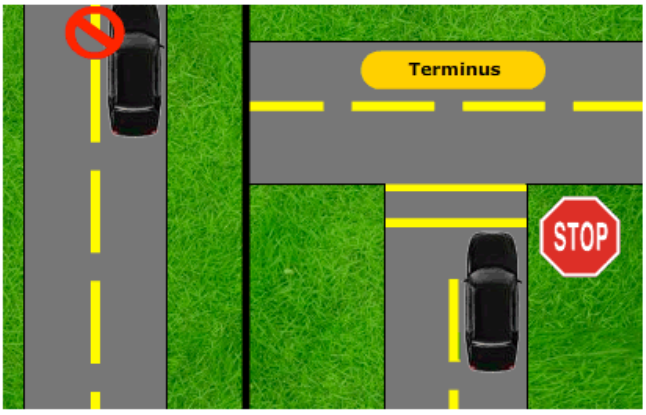
To damage or destroy. Example: Large falling objects can be destructive to a pipe laying above the ground.



destructive

Terminus (n): حد أونهاية

End point; a place where something ends or is complete. Example: There is a stop sign at the terminus of this road. The road continues with no terminus in sight.



terminus

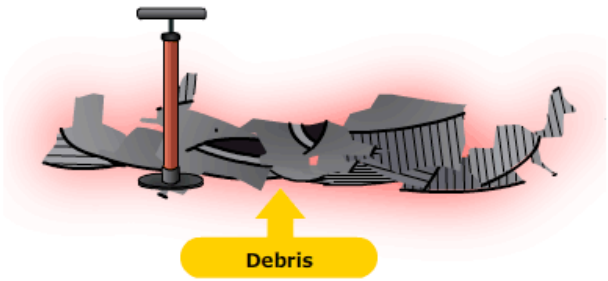
Hub (n): محور

The shaft or central point around which things revolve. Example: The wheel rotates on the hub of the bicycle wheel.

hub

Debris (n): حطام

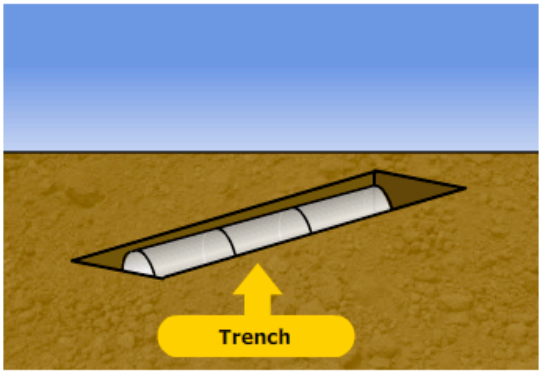
Rubble or wreckage that remains when something is broken or destroyed. Example: The debris in the pipe clogged the valve.



debris

Trench (n): خندق

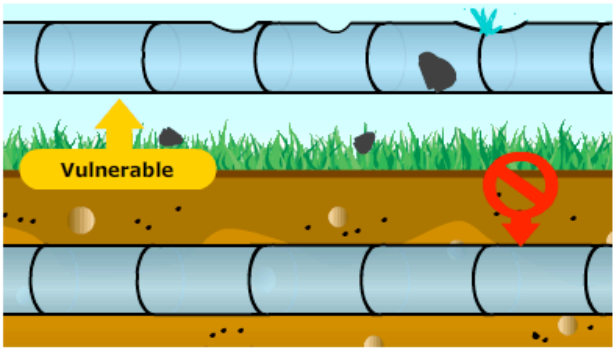
A long, narrow ditch dug in the earth. Example: A trench is dug to lay the pipe underground. Without a trench, the pipe remains above the ground.



trench

Vulnerable (adj): عرضة للضرر

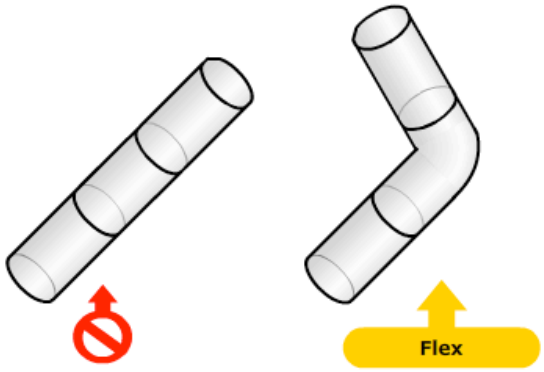
Open to damage. Example: The pipe above the ground is vulnerable to damage from falling objects. The pipe buried deeply in the ground is less vulnerable to falling objects.



vulnerable

Flex (v): يلوي

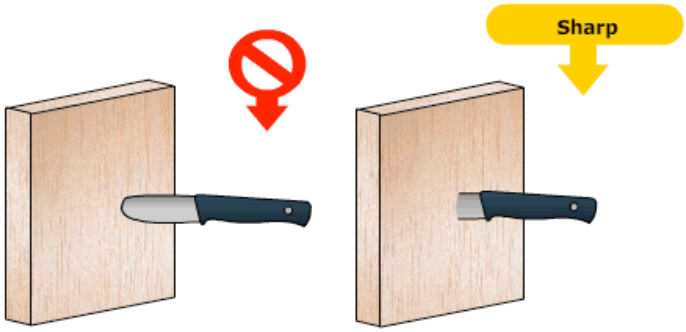
To bend; to enlarge and contract. Example: The pipe flexed as the weight of the truck passed over it.



flex

Sharp (adj): حاد

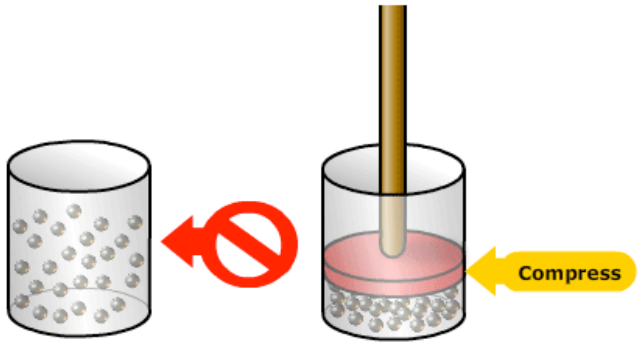
Not rounded. Example: This knife has a sharp point at the tip.



sharp

Compress (v): يضغط

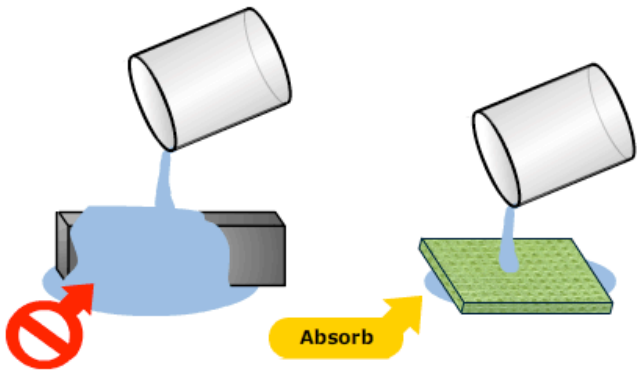
To press or squeeze together; to force into less space.



compress

Absorb (v): يمتص

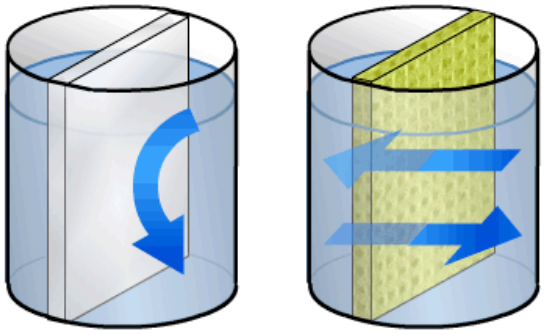
To take in or suck up. Example: The sponge absorbs water well. The steel does not absorb water well.



absorb

Permeable (adj): قابل للنفاذ

Having pores or openings that permit liquids or gases to pass through. Example: Cheesecloth is permeable by water. Glass is not permeable by water.

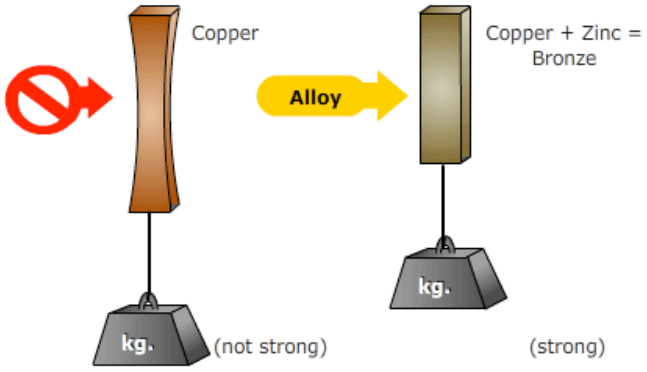


Not Permeable (glass) Permeable (spongecloth)

permeable

Alloy (n): معدن مخلوط

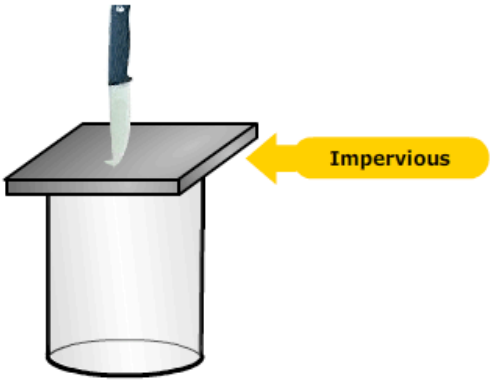
Mixing of metals, or a metal and a nonmetal, to reach a desired quality. Example: Copper is a soft element. When copper is mixed with zinc, it forms a strong alloy called bronze.



alloy

Impervious (adj): غير قابل للنفاذ

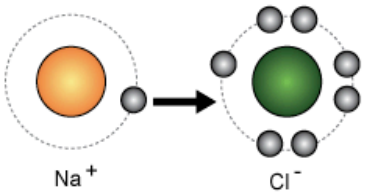
Not allowing penetration; allowing no passage. Example: Metal is more impervious to a knife cut than paper.



impervious

Ion (n): جسيم أو ذرة

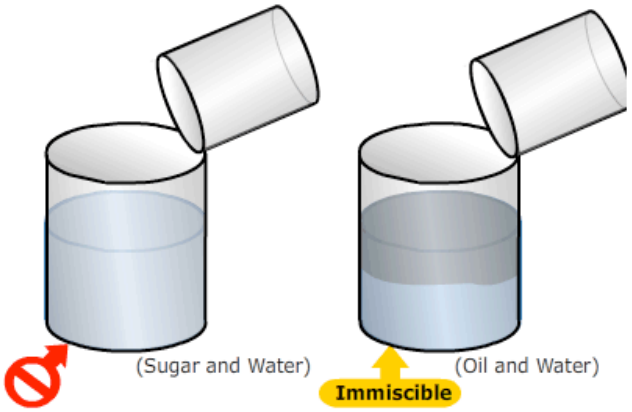
An atom or molecule which has an electronic charge as a result of losing or gaining one or more electrons. Example: When sulfuric acid dissolves in water, the molecule ionizes forming two positive hydrogen ions and a negative sulfate ions.



Ion

Immiscible (adj): غير قابل للامتزاج

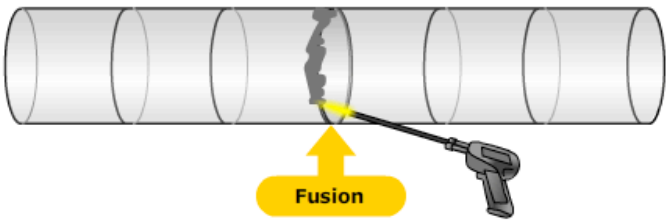
Cannot be mixed or blended together. Example: Water and oil are immiscible. Ethyl alcohol and water are miscible.



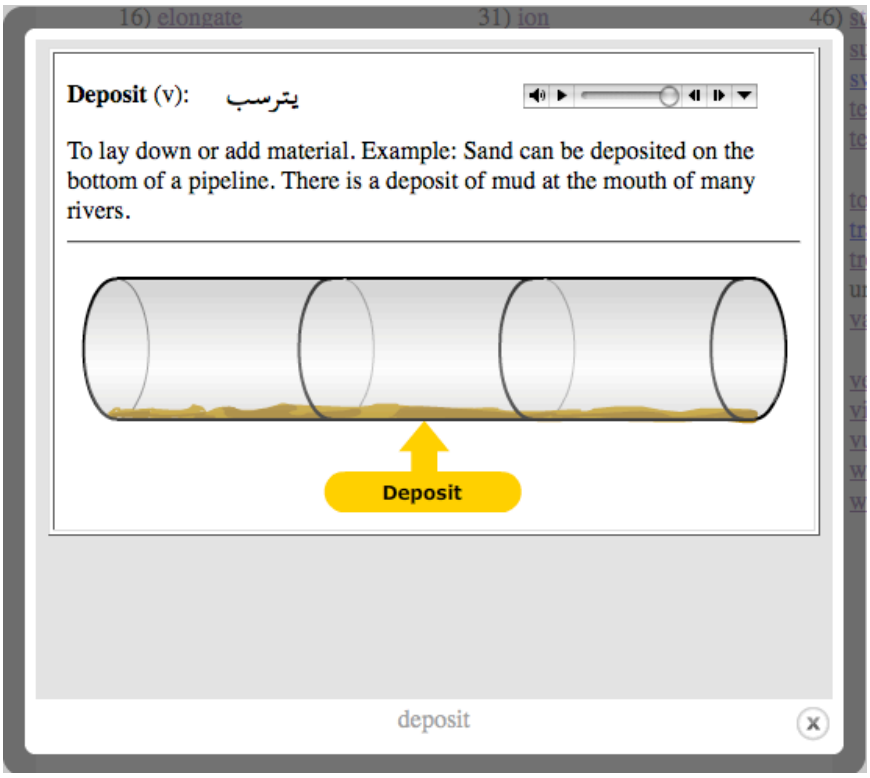
immiscible

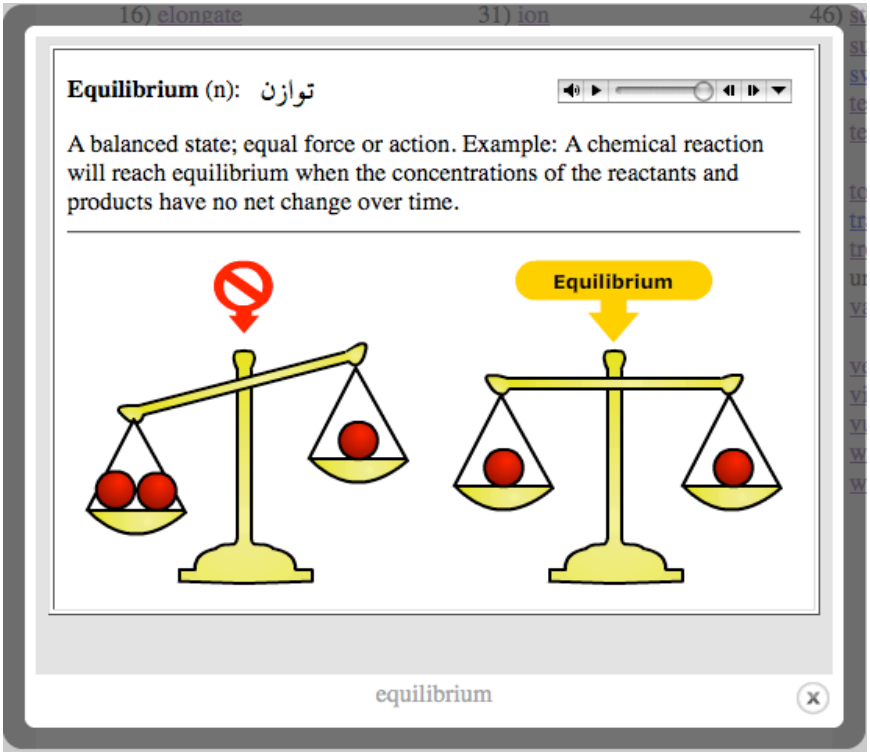
Fusion (n): توصيل شيئين

Melting or blending together. Example: The welder fused the two pipes together to form a solid pipe without leaks.



fusion

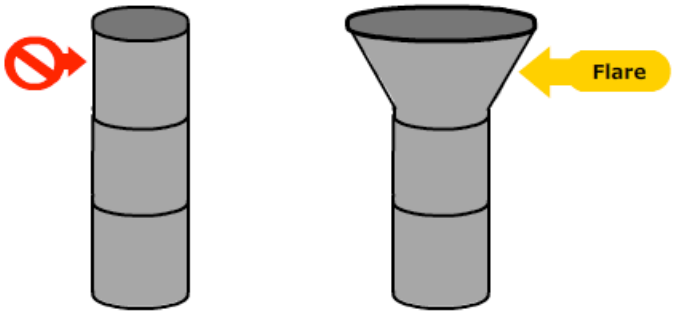

16) elongate
31) ion
46)
Deposit (v): يترسب
To lay down or add material. Example: Sand can be deposited on the bottom of a pipeline. There is a deposit of mud at the mouth of many rivers.
Deposit
deposit


16) elongate
31) ion
46)
Equilibrium (n): توازن
A balanced state; equal force or action. Example: A chemical reaction will reach equilibrium when the concentrations of the reactants and products have no net change over time.
Equilibrium
equilibrium

16) elongate 31) ion 46)

Flare (n): شعلة ضوء

A shape that spreads outward. Example: The pipe has a flare that is wider at the end.

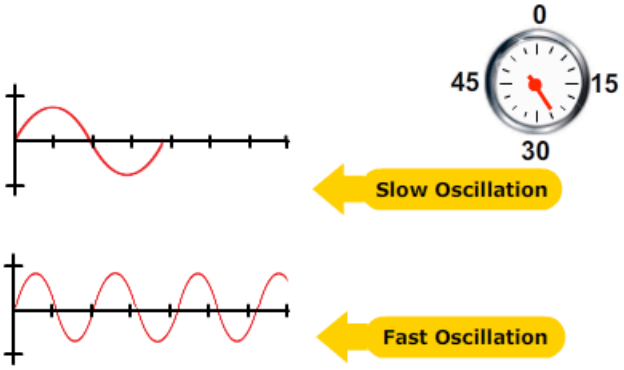


flare

16) elongate 31) ion 46)

Oscillation (n): تذبذب منتظم

Periodic movement between two positions. Example: A pumping unit on an oil well operating continuously oscillates between the bottom and the top of the stroke.

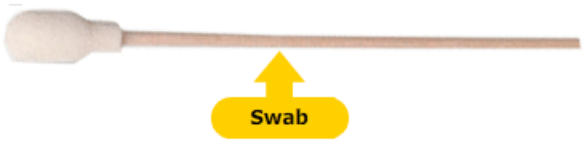


Oscillation

16) elongate 31) ion 46) s

Swab (n): مسحة للتنظيف

A sponge or cloth used to absorb liquids. Example: A swab was used to clean water from the pipe.



swab

16) elongate 31) ion 46) s

Intermittent (adj): متقطع

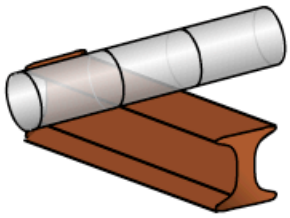
Stopping for a time and beginning again. Example: The flow of oil from a well operated on a time clock is intermittent.

intermittent

16) elongate 31) ion 46)

Transverse (adj): مستعرض

Lying across; crosswise. Example: The support beams are lying transverseunder the pipe.The horizontal support beams were not transverse to pipe.



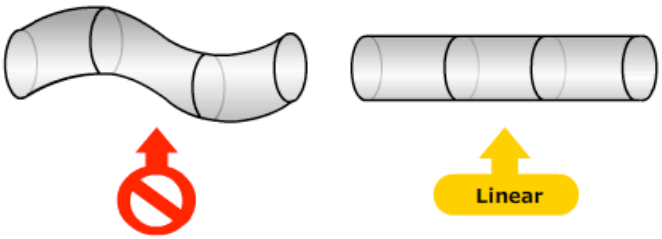
Transverse

transverse

16) elongate 31) ion 46)

Linear (adj): خطي

Resembling or following a straight line or path. Example: These pipes are laid in a linear pattern. These pipes are laid in a non-linear crosswise pattern.

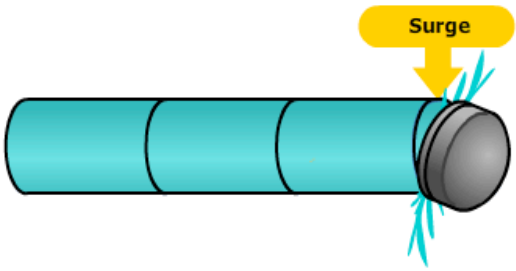


Linear

linear

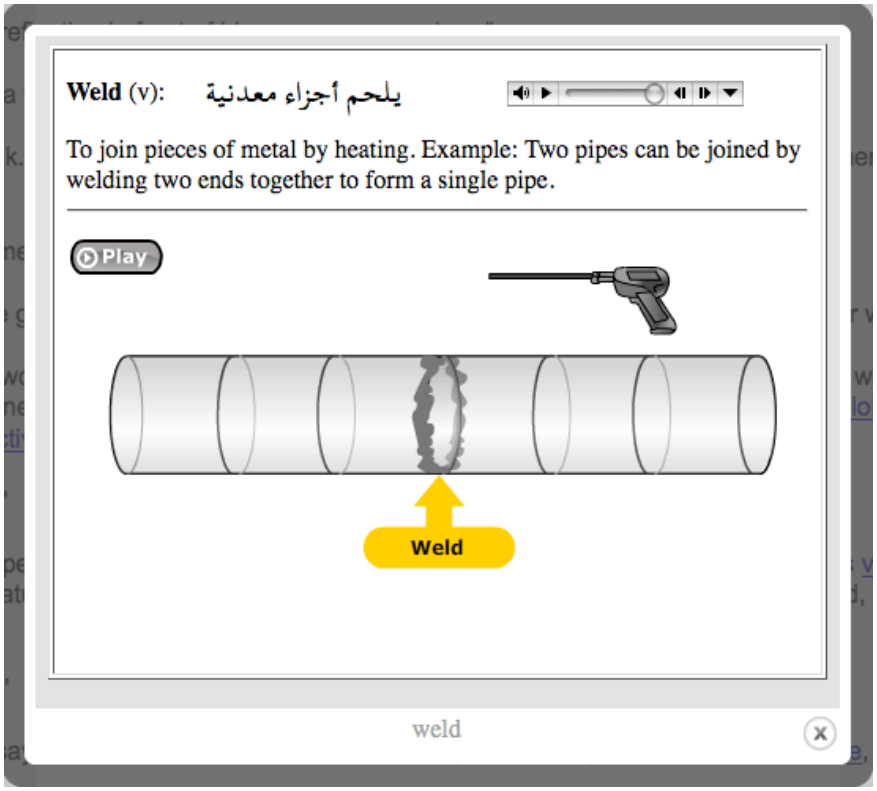
Surge (n): اندفاع

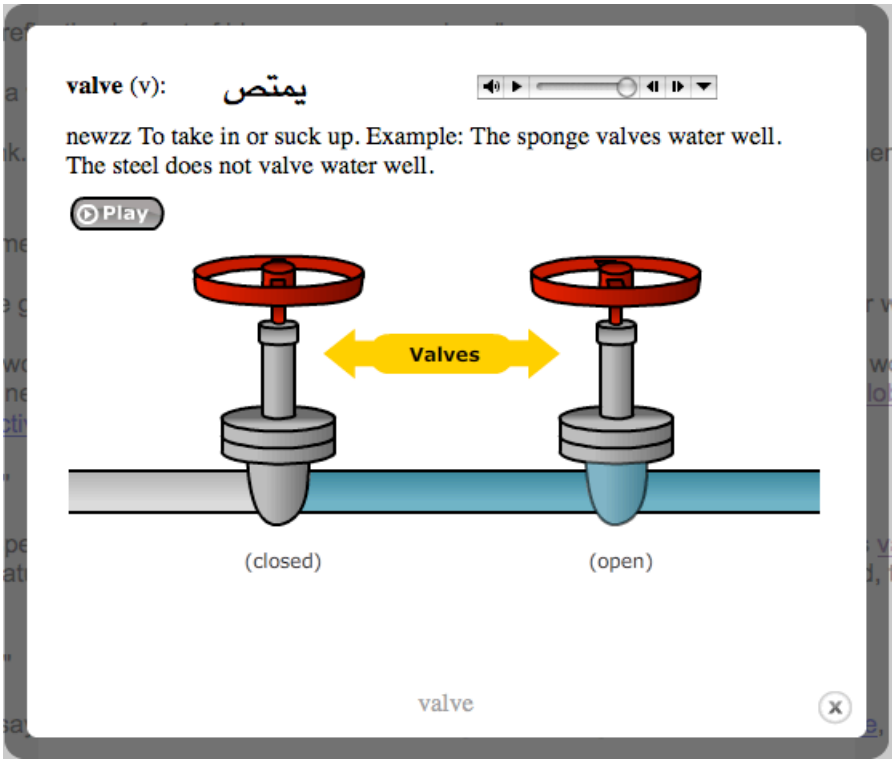
A sudden increase in pressure of movement. Example: The steady flow with no surge does not rupture the seal.The surge in oil pressure ruptures the seal.



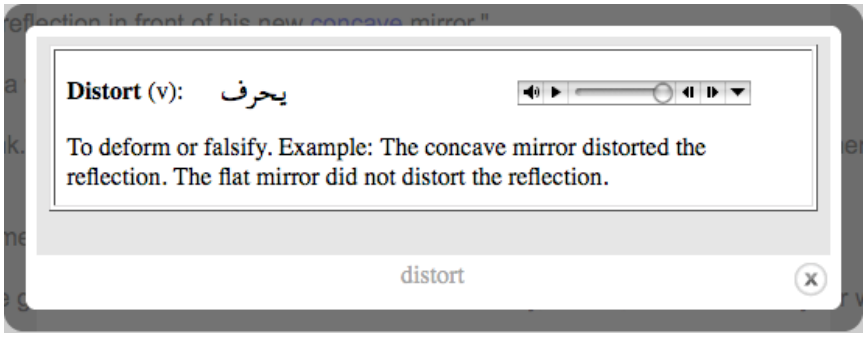
surge

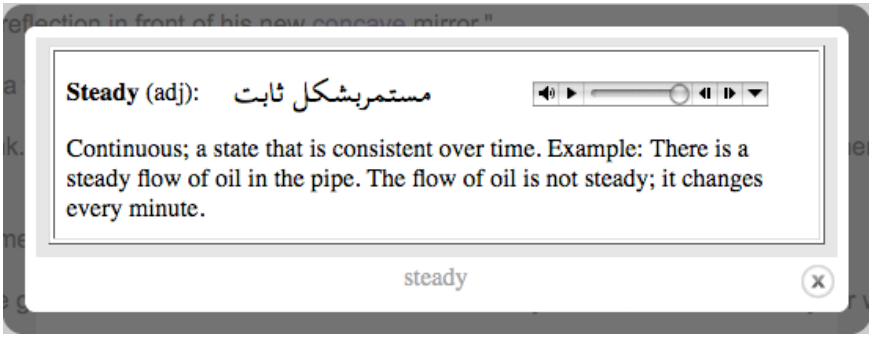
Animation Gloss Conditions (Two Examples)

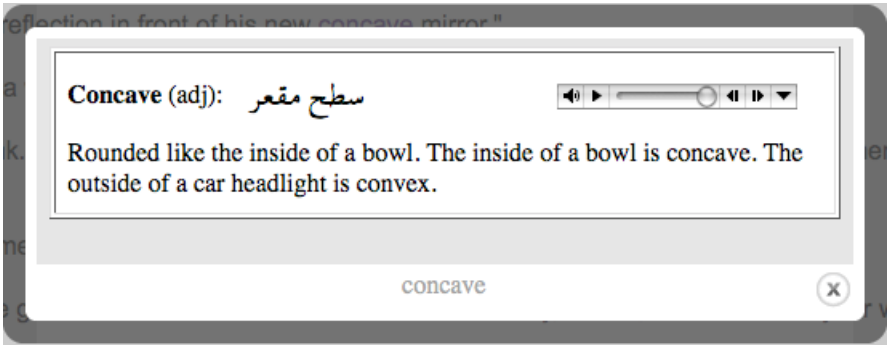




Text Gloss Conditions (Three Examples)







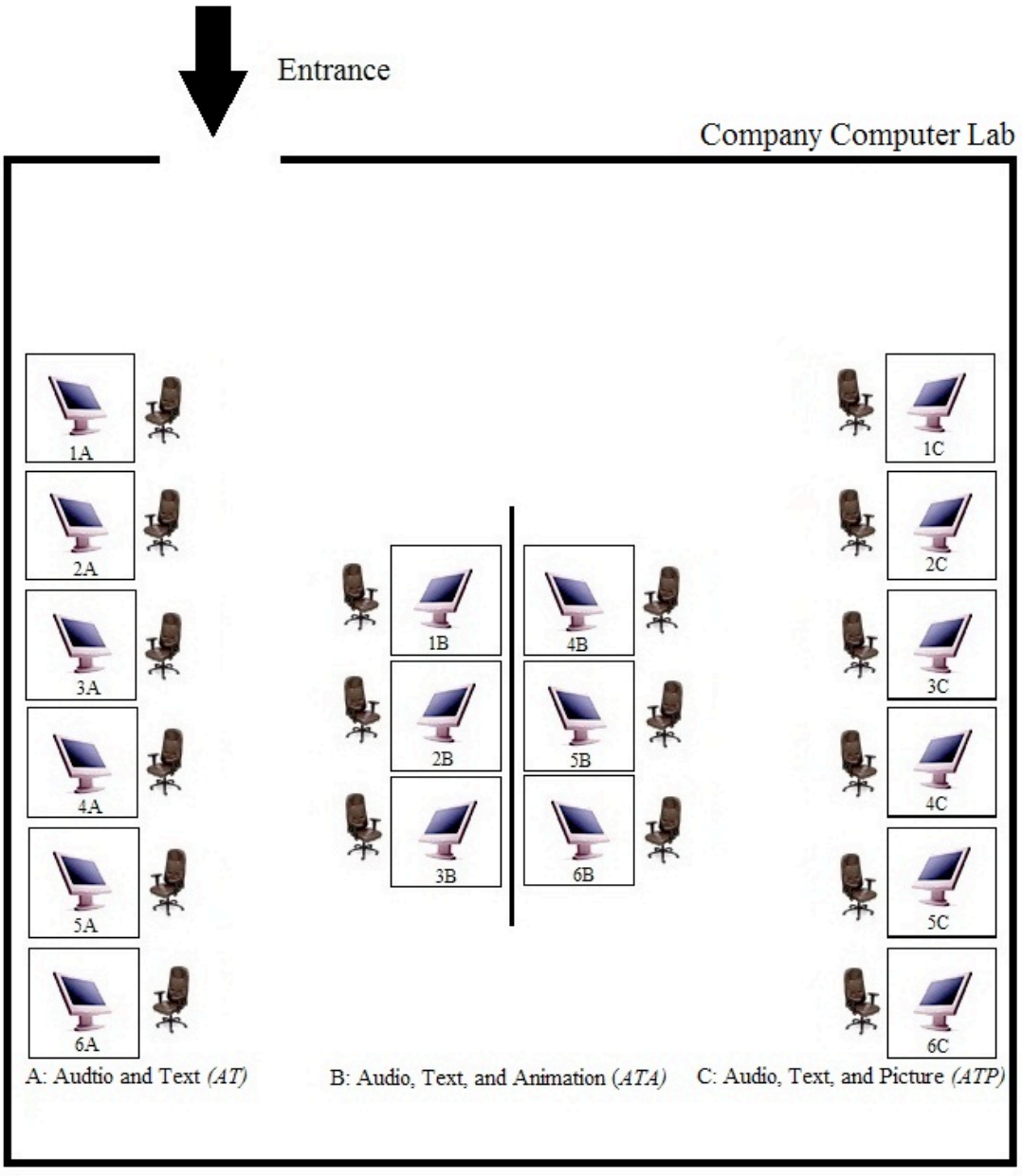
APPENDIX S

Synopsis of the Materials and Procedures

Materials	Time (Minutes)
Part 1:	
Informed Consent Statement	5
Explaining the task of the three gloss type groups	5
Reading the online story and clicking on the glossed words	40
Immediate Multiple-Choice Reading Comprehension Test	20
Demographic and Background Questionnaire	5
Immediate Multiple-Choice Recognition Vocabulary Test	20
Attitude Questionnaire Towards Online Glosses	5
Part 2:	
Delayed Multiple-Choice Vocabulary Test	20
Total	120

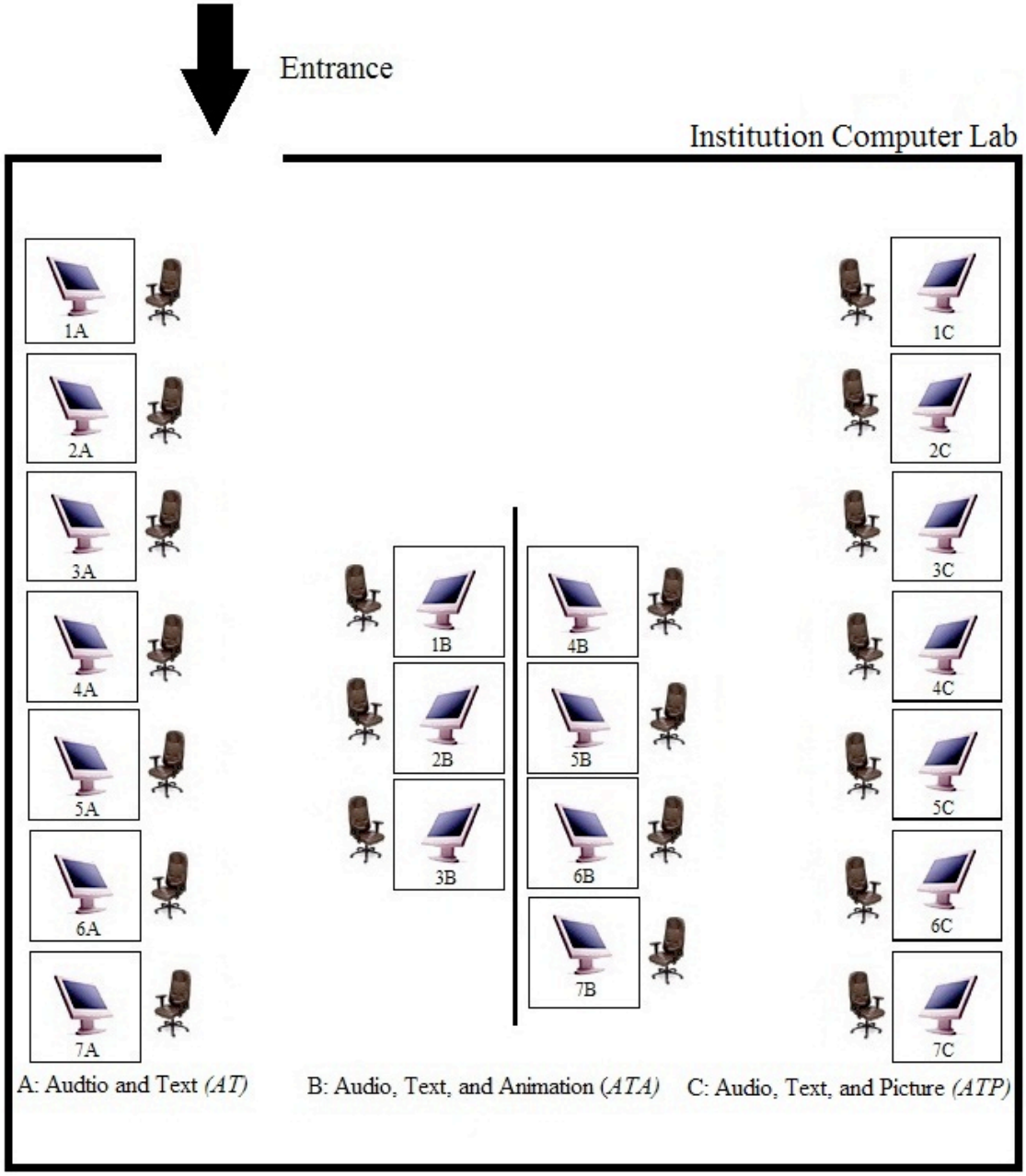
APPENDIX T

Students Seating Chart in the Company Computer Lab



APPENDIX U

Students Seating Chart in the Institution Computer Lab



APPENDIX V

Terms Ranking for Immediate and Delayed Vocabulary Scores

Immediate Vocabulary Scores

Terms	Immediate Vocabulary Results	
	#	%
Hazardous	175	79%
Weld	162	73%
Flux	154	69%
Seep	149	67%
Valve	146	66%
Combustible	137	62%
Wrench	137	62%
Swab	130	59%
Crest	127	57%
Purge	124	56%
Scraper	124	56%
Toxic	123	55%
Flare	118	53%
Concave	116	52%
Velocity	115	52%
Ion	113	51%
Rigid	112	50%
Alloy	110	50%
Destructive	107	48%
Hub	106	48%
Equilibrium	106	48%
Steady	104	47%
Distort	103	46%
Excessive	102	46%
Lubricate	101	45%
Flex	101	45%
Defective	100	45%
Terminus	99	45%
Absorb	99	45%
Immiscible	99	45%

Retardant	98	44%
Globule	97	44%
Ambient	97	44%
Ripple	97	44%
Shrinkage	95	43%
Rack	94	42%
Oscillation	93	42%
Linear	93	42%
Intermittent	92	41%
Compress	90	41%
Rupture	88	40%
Surge	87	39%
Contaminated	86	39%
Trench	85	38%
Fusion	85	38%
Viscosity	84	38%
Fatigue	83	37%
Tensile	83	37%
Posit	81	36%
Berm	78	35%
Deplete	78	35%
Permeable	76	34%
Transverse	71	32%
Debris	67	30%
Elongate	66	30%
Flange	65	29%
Sharp	65	29%
Impervious	58	26%
Vulnerable	54	24%

Delayed Vocabulary Scores

Terms	Delayed Vocabulary Results	
	#	%
Hazardous	155	70%
Seep	153	69%
Swab	144	65%
Flare	142	64%
Wrench	142	64%
Toxic	138	62%
Shrinkage	131	59%
Valve	129	58%
Ambient	128	58%
Weld	127	57%
Linear	119	54%
Alloy	117	53%
Scraper	116	52%
Lubricate	112	50%
Rigid	107	48%
Ion	106	48%
Flange	105	47%
Destructive	103	46%
Equilibrium	102	46%
Contaminated	99	45%
Compress	98	44%
Concave	98	44%
Excessive	98	44%
Velocity	96	43%
Oscillation	95	43%
Distort	95	43%
Fatigue	95	43%
Berm	94	42%
Immiscible	93	42%
Purge	93	42%
Defective	89	40%
Rack	87	39%
Crest	87	39%
Hub	86	39%
Flux	86	39%
Retardant	81	36%

Intermittent	78	35%
Rupture	78	35%
Absorb	77	35%
Surge	76	34%
Flex	74	33%
Trench	73	33%
Permeable	73	33%
Ripple	72	32%
Deplete	72	32%
Transverse	71	32%
Viscosity	70	32%
Sharp	68	31%
Debris	64	29%
Tensile	60	27%
Terminus	60	27%
Globule	59	27%
Fusion	56	25%
Posit	50	23%
Impervious	49	22%
Elongate	38	17%
Vulnerable	34	15%
Steady	28	13%
Combustible	12	5%

Immediate and Delayed Vocabulary Scores

Terms	Immediate Vocabulary Results		Delayed Vocabulary Results	
	#	%	#	%
Hazardous	175	79%	155	70%
Weld	162	73%	127	57%
Flux	154	69%	86	39%
Seep	149	67%	153	69%
Valve	146	66%	129	58%
Combustible	137	62%	12	5%
Wrench	137	62%	142	64%
Swab	130	59%	144	65%
Crest	127	57%	87	39%
Purge	124	56%	93	42%
Scraper	124	56%	116	52%
Toxic	123	55%	138	62%
Flare	118	53%	142	64%
Concave	116	52%	98	44%
Velocity	115	52%	96	43%
Ion	113	51%	106	48%
Rigid	112	50%	107	48%
Alloy	110	50%	117	53%
Destructive	107	48%	103	46%
Equilibrium	106	48%	102	46%
Hub	106	48%	86	39%
Steady	104	47%	28	13%
Distort	103	46%	95	43%
Excessive	102	46%	98	44%
Flex	101	45%	74	33%
Lubricate	101	45%	112	50%
Defective	100	45%	89	40%
Absorb	99	45%	77	35%
Immiscible	99	45%	93	42%
Terminus	99	45%	60	27%
Retardant	98	44%	81	36%
Ambient	97	44%	128	58%
Globule	97	44%	59	27%
Ripple	97	44%	72	32%
Shrinkage	95	43%	131	59%
Rack	94	42%	87	39%

Linear	93	42%	119	54%
Oscillation	93	42%	95	43%
Intermittent	92	41%	78	35%
Compress	90	41%	98	44%
Rupture	88	40%	78	35%
Surge	87	39%	76	34%
Contaminated	86	39%	99	45%
Fusion	85	38%	56	25%
Trench	85	38%	73	33%
Viscosity	84	38%	70	32%
Fatigue	83	37%	95	43%
Tensile	83	37%	60	27%
Posit	81	36%	50	23%
Berm	78	35%	94	42%
Deplete	78	35%	72	32%
Permeable	76	34%	73	33%
Transverse	71	32%	71	32%
Debris	67	30%	64	29%
Elongate	66	30%	38	17%
Flange	65	29%	105	47%
Sharp	65	29%	68	31%
Impervious	58	26%	49	22%
Vulnerable	54	24%	34	15%