THE INFLUENCE OF FEATURE-RICH COMPUTERIZED GLOSSES ON READING COMPREHENSION AND VOCABULARY ACQUISITION

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ABSTRACT

To investigate the influence of media-rich computerized glosses on reading comprehension and vocabulary acquisition, we assigned second language Spanish learners to five conditions: 1) no gloss, 2) gloss with text (English translation), 3) text and audio (spoken in Spanish and English), 4) text, audio and picture, 5) text, audio, picture and writing. Participants read a 608 word Spanish story with 25 glossed words, and completed comprehension and vocabulary tests.

Gloss users had significantly higher reading comprehension and vocabulary acquisition scores than non-gloss users. The quantity of gloss accesses was positively correlated to comprehension and vocabulary scores, especially when learners use glosses that include text, audio and picture. Results also found that reading time was positively correlated to comprehension.

The more frequently second language learners consult computerized glosses the better they comprehend and acquire new words. Glosses with text, audio and carefully selected pictures are particularly beneficial in advancing the ability to produce new words.

KEY WORDS: Web-based Education, User Interfaces, Electronic Glosses, Computer-Based Learning.

1. Introduction

Many scholars consider vocabulary acquisition to be the single most important aspect of second language learning [1]. In order to develop linguistic abilities second language (L2) learners need to reach a certain level of vocabulary threshold [1, 2, 3, 4, 5, 6]. Research has shown that reading comprehension is closely connected to vocabulary knowledge [7, 8] and fundamental to reading comprehension. Readers cannot understand text without knowing what most words mean [9].

With advances in computer networking and media technologies, computerized glosses have emerged over the past 15 years as efficient resources for improving vocabulary acquisitions and reading comprehension [10]. Researchers are now investigating how different media features incorporating text, still pictures and video influence incidental vocabulary acquisition [11, 12, 13, 14, 15] and reading comprehension [15, 16, 17, 18, 19]. This area of research, especially with foreign language learners, is at the beginning stage [20]. In fact, there is a need to investigate incidental vocabulary learning from reading tasks involving multimedia [21, 16, 22, 11, 23]. This research has been productive, yet it is not conclusive in terms of which media features and gloss designs are most effective in advancing reading comprehension and word retention. This study investigated the influence of glosses with different features (text, audio, and pictures) on word retention and reading comprehension among second language (L2) Spanish learners.

2. Review of Research on Electronic Glosses

The Impact of Glosses on Reading Comprehension

Davis [24] found the value of conventional paper glosses on reading comprehension in a study with 71 French language learners in an American university. He used a 936 word story with 38 glosses in the text margin. Students were in one of three conditions: condition 1 (no gloss) read the story, wrote what they remembered and re-read story; condition 2 (prior gloss) studied vocabulary, read story, wrote what they remembered and reread the text; gloss condition 3 (embedded gloss) read the story with vocabulary definitions embedded as glosses, wrote what they remembered and reread the story. All three groups wrote what they remembered for 15 minutes. Results found that students in condition 2 (prior gloss) and condition 3 (embedded gloss) recalled significantly more information than students in condition 1 (no gloss).

The value of hypertext glosses was established in an early study by Aust, Kelley, and Roby [10] that compared the use of conventional paper and hypertext dictionaries on reading comprehension. Participants were 80 undergraduate Spanish learners who were assigned to four conditions: condition 1 (English translation paper dictionary), condition 2 (simplified Spanish paper dictionary), condition 3, English hypertext dictionary), condition 4 (simplified Spanish hypertext dictionary). All words in the 420-word reading passage were glossed with pop-up definitions in hypertext. The frequency of consulting glosses, study time, efficiency (consultations per minute) and reading comprehension were considered using tracking software to monitor students' use of glosses and a recall protocol to measure reading comprehension. Results revealed higher efficiency of hypertext glosses as students in the hypertext conditions (3&4) consulted more than twice as many definitions and read the passage in less time with no comprehension loss.

Lomicka [6] looked at the effectiveness of glossing for reading comprehension. She investigated whether glosses

facilitated or hindered reading comprehension among second-semester French language learners. Students studied the text under three conditions: condition 1 (no gloss); condition 2 (text gloss) with English translation and French definitions; condition 3 (media gloss) with English translation, French definitions, audio pronunciations, images, references, and questions. Results indicated that full media glossing produce more causal inferences and higher comprehension.

In another study, Sakar and Ercetin [25] examined the effect of mediated glosses on reading comprehension among Turkish ESL learners. Participants read the text using the glosses and then completed a recall protocol task reading comprehension test. The participants reported that they preferred the video glosses more than textual and audio glosses. Although participants had positive attitudes toward video glosses, results found that video glosses had a negative impact on comprehension. The authors explain that the video glosses were created with available resources and that may have been too complex or less than ideal conceptual representations.

Glosses and Second Language Vocabulary Acquisition

Chun and Plass [16] studied 160 second-semester German language learners in three American universities. They investigated the effect of media annotations on incidental vocabulary learning. The researchers designed a program called CyberBuch, where students read a 762-word story with 82 glossed words under three conditions: 1st condition (text definition); 2nd condition (picture gloss); 3rd condition (video gloss). Results showed that students in picture gloss condition recalled the most vocabulary.

In a similar study, Al-Seghayer [23] examined the effects of still picture and video glosses among ESL students at an American university. Students were in one of three conditions: 1st condition (text definitions + audio pronunciation), 2nd condition (text definition + picture) 3rd (text definition + video). Results showed that students in condition 2 (text + picture) and condition 3 (text + video) remembered more words on a delayed post-test.

Yoshii, M. & Flaitz, J. [15] investigated incidental vocabulary learning using text and picture glosses with 151 beginning and intermediate ESL adult learners. Students read a story with 14 glossed words presented in three conditions: condition 1 (text definition only); condition 2 (picture only); condition 3 (text definition + picture). Results showed that students in condition 3 (text + picture) understood more vocabulary than students in the text or picture only conditions.

Yeh and Wang [14] investigated the effect of three gloss types on vocabulary learning with 82 ESL learners at a Taiwanese university. Students were in one of three conditions: condition 1 (text translation + definition) Chinese translation and English explanations; condition 2 (translation + definition + pictures); condition 3 (translation + definition + picture + audio). Results found

that gloss condition 2 (text translation + definition + picture) was most effective for vocabulary acquisition.

The previously discussed studies have shown that conventional glosses are effective in promoting vocabulary acquisition and reading comprehension in language learning. When computerized glosses are available as hypertext L2 translations or simple definitions in the reader's native Language (L1), they are accessed more frequently and promote greater comprehension than paper glosses.

Findings concerning the value of media enhancements to computerized glosses are less conclusive. While learners report that they like mediated glosses, the evidence for the value of different media features in promoting vocabulary acquisition is still in question. Studies have indicated that the addition of pictures to glosses may improve vocabulary acquisitions. Research showing the benefits of gloss media enhancements on reading comprehension is less conclusive.

Research on computerized glosses is advancing. Yet, there is little empirical evidence to guide the design of mediated glosses features [20]. This study addresses questions on how gloss features can benefit learning new vocabulary and improve reading comprehension. Two learning theories guide this design: generative theory and dual coding theory. Generative theory [26] states that learning is better when information is presented in multiple forms so that the learner can select relevant information to construct meaning [27]. Similarly, Paivio's Dual-Coding Theory [28] claims that learning improves when the information is received through two channels (verbal and visual) to construct meaning [27, 28, 29, 30]. Clark & Paivio [29] explain that words associated with actual objects or images are acquired and retained better.

3. Method

Research Questions
1. Will learners who have access to glosses have significantly higher reading comprehension and vocabulary test scores than learners who do not have access glosses.
2. Will reading comprehension and vocabulary test scores differ as gloss media features (text, audio, graphics) differ?
3. Will learners who access glosses more frequently and spend more time reading have higher reading comprehension and vocabulary test scores?

Participants

Participants were 93 (61 females and 32 males) intermediate level Spanish students ranging in age from 18-23. They all completed a multiple-choice reading comprehension test and an immediate vocabulary test. Many students (63) also completed a post vocabulary test. All were native English speakers except for one native Korean speaker.

Reading Passage and Gloss Selection

Studies of electronic glosses typically select a reading passage of appropriate difficulty level and then design the text, pictures and audio for the glossed words. We designed an original method to avoid the problem that faced Kost et.al (1999) and others who had words in the reading passage that could not be glossed well with pictures. Instead of beginning with the selection of an appropriate passage, we began by selecting 25 challenging words from a list of word/picture developed by Szekely and colleagues [31]. These word/picture pairs have been designed and validated so that most people will draw the same, precise meaning from the word. For example, when to describe the picture in figure 1 most people will say jump or jumping. This careful selection of pictures is critical to the value of glosses because readily understood pictures are more likely to serve, in Pavio's [28] terms, as the conceptual peg for establishing robust and sustainable mental representation that learners can draw on as they encounter and produce the word.

The instructors of the target participants rated the selected words to be at the appropriate difficult level. This was meant to increase the probability of students consulting the glosses provided in the text. The reading passage has 602 words with 25 glosses. The glosses are composed of 8 verbs and 17 nouns.

The Online Reading Passage and Gloss

We created a web site that hosted four versions of the reading text: 1) no gloss, 2) gloss with text (English translation), 3) text and audio (spoken in Spanish and English), 4) text, audio and picture. In a fifth gloss condition learners used the gloss type 4 (text, audio and picture) but they also wrote down the word. Participants access the gloss by clicking the highlighted word. In the version with audio, the voice says the word immediately.

Users log on, read the passage and use the gloss, and then log off. The time between log on and off is considered the reading time. The program also records the number of times the users access the gloss. The total number of time that the learner consults the gloss is considered gloss access frequency.

Figure 1: An Electronic Gloss with Picture
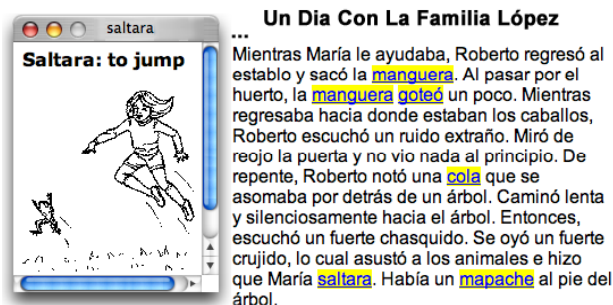
Note: The gloss window does not cover story text. In audio conditions the word is spoken after the user clicks the word.

Comprehension Test

The comprehension test was administered immediately after the completion of the reading task. The test included 25 items with four alternatives and a coefficient alpha of .78. Each item asked the reader about one particular idea in the text. To be able to answer each question correctly students needed to know the meaning of one gloss that was associated with the idea. None of the four alternatives featured the gloss verbatim. Instead, a synonym was provided. This was meant to avoid turning the reading comprehension test into a memorization exercise.

Vocabulary Test

The vocabulary test was designed to measure the effect of each type of gloss on word retention and find out whether students who had access to gloss outperformed students of the control group who only had a reading passage alone. Students were given the test after the completion of the reading task and logging off the computer. This vocabulary test was administered immediately after the reading comprehension test and again two weeks after to measure word retention. The test included 13 recognition items and 12 production items. The coefficient alpha is 0.8. The recognition section of the test required students to answer multiple-choice items with four alternatives to reduce the probability of correctly guessing the answers. The production section required students to write the meaning of 12 glosses in English. The total number of test items was 25. Students received one point for each correct answer and no points for a wrong answer.

Table 1: Sample Vocabulary Recognition Items

1. tiburón	2. resbalar	3. granero	4. arrastrar
a. seahawk	a. jump	a. barn	a. arrest
b. shark	b. bounce	b. hut	b.drag
c. seal	c. slip	c. pen	c. chase
d. seagull	d. fall	d. shed	d. push

Vocabulary Posttest

The vocabulary posttest was identical to the immediate vocabulary test that was administered to students after treatment. The posttest allowed the researcher to determine the amount of vocabulary that students were able to retain two weeks after the treatment. Students' performances in the posttest were compared to their scores in the first vocabulary test.

Procedures

Participants were randomly assigned to one of the five conditions: 1) no glossing (control group), 2) text and audio 3) picture and audio, 4) text, audio and picture or 5) text, audio, picture and writing. Those in condition 1 had to read the text with no access to glosses. Participants in condition 2 had to read the text with access to audio pronunciation of the target word in both Spanish and

English, as well as its English translation. Those in condition 3 had to read the text with access to audio pronunciation of the target word and a picture. Those in condition 4 had to read the text with access to English translation and audio pronunciation of the target word and a picture. Those in condition 5 read the text with access to English translation and audio pronunciation of the target word and picture. They were also required to write on a piece of paper the glosses they had consulted.

Students were given 20 minutes to read the text and understand it for comprehension questions that were given once they logged off the computer. Two weeks after the treatment, students were given an unannounced vocabulary posttest in their individual classes to determine to what extent they retained the target words.

4. Results

To explore the impact of different types of glosses on L2 reading comprehension and word retention, a 5 x 2 analysis of variance (ANOVA) with treatments (treatments vs. control) as a between groups factor and time (pretest vs. posttest) as a within groups factor was conducted to determine the effectiveness of each one of the four treatments on the students' reading comprehension and word retention. Bivariate Correlation analyses were conducted to explore the relationship between frequency of gloss use and students' performance in vocabulary and reading comprehension tests and the correlation between reading time and vocabulary and reading comprehension test scores.

Question 1: Will learners who have access to glosses have significantly higher reading comprehension and vocabulary scores than learners with no gloss access.

A One-Way analysis of variance (ANOVA) revealed that participants in all electronic gloss conditions (aggregate score), had higher reading comprehension scores (M=17.2) than those who did not use a gloss (M=9.2), (F=82.81, p>.000). The control group (no gloss) had an average of 9 correct answers out of 25 (36%) while the experimental groups who had access to gloss had an average of 17 correct answers out of 25 (68%).

On the combined recognition and production vocabulary test conducted immediately after treatment, gloss users (students of the four experimental groups) performed significantly better (M=13.9) than non-gloss users (M=7.2), (F=23.4, p>.000). They correctly produced the correct English word for about 2 out of the 12 target words provided (17%). The gloss users selected the corresponding English word in a multiple-choice task for about 11 out of 13 words (85%). When the production and recognition scores on the two tests were combined, the gloss users responded correctly to about 14 of the 25 questions (56%). On the combined recognition and production delayed vocabulary test, gloss users outperformed (M=11.5) non-gloss users (M=5.4), (F=12.4, p>.000). They retained a total of 11 out of 25

words (44%) compared to a total number of 5 out of 25 words (20%) retained by non-gloss users who got 5 words on the recognition section and zero words on the production section of the vocabulary test.

Question 2: Will comprehension and vocabulary test scores increase as gloss media features (text, audio, graphics) increase?

A one-way analysis of variance (ANOVA) was conducted to evaluate the relationship between the access to more gloss features and the reading comprehension scores. Results found no significant difference between the four experimental groups F (3, 71) = 1.75, p>.05. The one way ANOVA detected no significant difference between the four experimental groups in terms of their performance in immediate vocabulary test.

Question 3: Will learners who access glosses more frequently and spend more time reading have higher reading comprehension and vocabulary test scores?

Bivariate correlation analyses revealed a moderate positive relationship between frequency of gloss access for all conditions (M=48) and reading comprehension (M=17.8), (r=.4, p>.002). Frequency of access to glosses and comprehension test scores was significant only for group 3 (text + audio).

The study found a positive correlation in gloss access conditions between minutes of reading time (M=9.2) and comprehension (M=17.9), (r=.29, p>001). Correlation coefficients revealed that there was a significant positive relationship between the time each group spent reading the text and comprehension scores. There was a significant correlation between reading time and comprehension scores for group 3 (text + audio) (r=.50) and group 4 (text + audio + picture) (r=.63).

The investigation of vocabulary acquisition conducted immediately after treatment found a positive correlation between frequency of gloss access (M=48.8), and the vocabulary recognition (M=11.2) and vocabulary production (M=1.9), (combined M=13.9), (r=.42, p>.000). There was also a positive correlation between frequency of gloss access and the delayed vocabulary scores (M=11.4), (r=.48, p>.000). This correlation is strongest for group 3 (text, audio) (r=.63, p>.02) and group 5 (text, audio, picture, and writing) (r.69, p>.03).

Table 2: Gloss Access and Vocabulary Scores

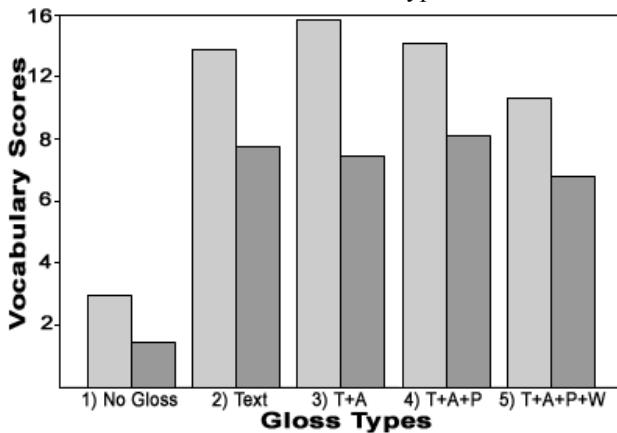| Gloss Types*	Gloss Access		Recognition		Production		Vocabulary Overall	
	M	*SD*	M	*SD*	M	*SD*	**M**	*SD*
1. None	**0**	*0*	6.7	*1.8*	.50	*.71*	**7.2**	*1.7*
2. Text	**53.6**	*11.7*	11.5	*1.4*	2.5	*1.7*	**14.1**	*2.1*
3. TA	**54.8**	*19.1*	11.5	*1.7*	3.2	*2.5*	**14.7**	*3.5*
4. TAP	**48.9**	*22.5*	11.0	*2.4*	2.4	*1.3*	**13.5**	*2.9*
5. TAPW	**38.1**	*11.3*	10.8	*1.8*	2.4	*2.3*	**13.5**	*2.7*

* 1) No Gloss; 2) Text only; 3) Text, Audio (TA);
4) Text, Audio, Picture (TAP);
5) Text, Audio, Picture, Writing (TAPW)

There was also a positive correlation between minutes reading time (M=9.2) and comprehension (M=17.9), (r=.292 p>001). In a closer analysis of gloss features, in the text + audio condition frequency of gloss access (M=54.8) was correlated positively to the immediate overall vocabulary score (M=14.7), (r=.69, p>.002.). In the text + audio + picture condition frequency of gloss access (M=48.9) was correlated positively to immediate vocabulary production (M=2.4), (r=.51, p>.026).

Bivariate Correlation analyses revealed that there was a significant positive relationship between the amount of glosses students consulted and the level of word retention (combined M=11.42), (r=.48 p>.000). The correlation is significantly strong (r=.63, p>.02) for group 3 (text, audio) and group 5 (text, audio, picture, and writing) (r.70, p>.03). The more glosses students consulted the higher their vocabulary test scores.

Figure 2: Immediate and Delayed Vocabulary Scores for Different Gloss Types

1) No Gloss; 2) Text only; 3) Text & Audio (T+A);
4) Text, Audio & Picture (T+A+P);
5) Text, Audio, Picture & Writing (T+A+P+W)

5. Conclusion and Recommendations

When feature-rich electronic glosses are carefully designed to promote robust and meaningful mental representations, they clearly benefit comprehension and word retention in second language learning. This study found that learners who use electronic glosses comprehend second language Spanish stories better and retain more new words than those who did not use glosses. Moreover, the more often learners consult electronic glosses the better comprehension they achieve. These results corroborate Knight's (1994) findings of a high correlation between the number of words students looked up and their vocabulary test scores.

Feature rich glosses that incorporate text, audio and pictures are particularly beneficial in advancing word retention. The strongest correlation between gloss access and word retention was with the glosses that contained text, audio and pictures. These findings were supported even under the more difficult task of producing, as opposed to recognizing, a translation. Feature rich glosses with well-designed pictures may assist learners in establishing robust multi-sensory mental representations that Pavio [28, 29] and others have described as being easier to access and retain in long-term memory.

Learners who spend more time consulting electronic glosses comprehend second language Spanish stories better. This may be attributed to the additional time spent in internalizing the multi-sensory features of the gloss.

Implications

This study indicates that electronic glosses should be readily available to foreign language learners. Students should be encouraged to consult available glosses frequently. Since vocabulary learning is incremental and ongoing, the benefits of mediated glosses may not be fully realized in a single exposure [35, 36].

Outcomes of this study support the need to include well-designed feature-rich glosses in online language learning resources. The positive benefits of glosses also call for comprehensive software systems that automate the process of including feature-rich glosses in online language learning materials.

Future studies are needed to replicate this study with larger sample sizes, more reading passages and longer periods of time. Studies should also be designed to identify which gloss features are most beneficial to learners with a different level of proficiency, different languages, different linguistic abilities and learning styles (verbal / visual). The scope of glosses should go beyond nouns and verbs to include other parts of speech. Studies using different languages will help to clarify generalizability and implementations across cultures.

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