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Electronic L1 and L2 glosses' impact on vocabulary acquisition of Moroccan English as a foreign language learners

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Abstract

With the growing interest in integrating information and communication technology in the EFL classroom, the present study investigated the impact of electronic first language (L1) translations and second language (L2) definition glosses on incidental vocabulary learning and retention among Moroccan EFL learners. In total, 172 first-year university students participated in this study. The participants were divided into three groups: a comparison group with no glosses (NGG) and two experimental groups, namely the L1 electronic gloss group (EL1GG) and the L2 electronic gloss group (EL2GG). During the eight-week treatment, participants had to read texts without glosses or glossed with target vocabulary items, as well as complete reading comprehension questions and vocabulary tests. The results of one-way analysis of variance revealed that those with glosses significantly outperformed those without. Qualitative data from semistructured interviews revealed that participants perceived both L1 and L2 glosses as beneficial tools for vocabulary learning and comprehension, though L2 glosses posed challenges at times, which highlighted the need for individualized glossing strategies. Implications for researchers and EFL teachers are provided.

Keywords: Electronic glosses; individual differences; incidental vocabulary; L1 and L2

Introduction

It is widely acknowledged among language learners, practitioners, and researchers that vocabulary is the hub of language (Ramezanali et al., 2021). Many researchers have shown a direct link between students' vocabulary knowledge and their ability to read and write (Alharthi, 2018; Laufer & Aviad-Levitzky, 2017). Actually, not being able to use a vocabulary item appropriately may lead to partial or total breakdowns in communication, because vocabulary is the carrier

of the message (Llach, 2011; Nation, 2013; Thornbury, 2006). Some text coverage research has suggested that learners should know about 9000 words to understand 98% of most texts (Nation, 2013). Given this large figure, it makes sense to claim that learning all these words through explicit instruction alone is impossible for most learners. To deal with this issue, the literature suggests learning vocabulary incidentally through reading (Choi, 2016; Mao & Zhang, 2017; Yanguas, 2009).

Students can learn vocabulary incidentally through reading or listening activities when the focus is not on vocabulary (Boers, 2022; Krashen, 1989; Nation, 2013). It is considered a significant means of language acquisition for both first-language (L1) and second-language (L2) learners (Choi et al., 2014; Coady & Huckin, 1997; Hulstijn et al., 1996; Nagy et al., 1987; Schmitt, 2010). Despite the innate process of unintentional acquisition of new words, L2 learners face many challenges when it comes to incidental vocabulary learning. These stem from inadequate L2 exposure, lower English reading competency, and the ineffectiveness and accessibility of contextual hints (Choi, 2016; Hu et al., 2014).

To narrow the shortcomings of learning vocabulary incidentally through reading, L2 research has identified glossing as a beneficial tool for incidental vocabulary learning (Choi, 2016; He, 2019; Kim et al., 2024; Nation, 2013; Ramezanali & Faez, 2019; Teng, 2020). Glossing means providing translations or explanations of target vocabulary items that are believed to be unfamiliar or challenging in a written text, either through interlinear or marginal notes (Boers, 2022; Nation, 2013; Richards & Schmidt, 2013). Nation (2013) argued that glosses are useful with regard to improving reading comprehension. According to Nation (2013), glosses make challenging texts easier to understand and provide helpful clarifications of unfamiliar vocabulary. Additionally, glosses minimize interruptions to the reading process and facilitate learning new knowledge (Ko, 2017; Laufer, 1992; Rott, 2007; Rott et al., 2002). In computer-assisted language learning and mobile-assisted language learning settings, a "gloss is often a translation in the margin or in a pop-up window of a word that has been clicked on with a computer or electronic device" (Taylor, 2021, p. 2).

Given the acknowledged benefits of glosses and the increasing interest in integrating technology in the Moroccan English as a foreign language (EFL) classroom (Razkane et al., 2021; Yeou, 2016; Zyad, 2016), the present study aimed to investigate the potential impact of electronic glosses on incidental vocabulary acquisition among Moroccan EFL learners. Whereas Kim et al. (2024) highlighted the need for more studies comparing L1 and L2 glosses, Al-Hoorie et al. (2022) underscored the importance of using qualitative data to give more meaning to quantitative data. Following this recommendation, the present study incorporated qualitative data to provide a richer context for the quantitative data. Thus, this study addresses the following questions:

(1) To what extent does supporting computer-based texts with L1 and L2 glosses affect Moroccan EFL learners' incidental vocabulary learning?
(2) Which condition (no gloss, L1, or L2) is more conducive to incidental vocabulary learning among Moroccan EFL learners?

Literature Review

Vocabulary learning is a vital component for developing reading comprehension, writing proficiency, and overall communicative competence (Alharthi, 2018; Laufer & Aviad-Levitzky, 2017; Nation, 2013; Schmitt, 2010; Webb & Nation, 2017). Many researchers have highlighted the essential role of extensive exposure to L2 input in fostering vocabulary growth, especially through reading (Krashen, 1989; Laufer & Hulstijn, 2001; Taylor, 2021). However, the fact that

reading texts may be full of unfamiliar vocabulary may impede vocabulary learning (Nassaji, 2003; Webb & Nation, 2017). To overcome this obstacle, researchers and educators have explored various strategies to enhance L2 reading experiences, amongst which is glossing.

Glossing

Glosses are short explanations or definitions teachers add to target vocabulary items in a text to make them clearer for students (Boers, 2022; Choi, 2016; Khezrlou et al., 2017). One of the main objectives of using glosses in the EFL classroom is to contribute to learners' reading comprehension and vocabulary learning (Melhi, 2014; Vela, 2015). Previous research about the effect of different types of glosses has provided evidence for the effectiveness of glossed reading on vocabulary learning when compared with non-glossed reading (Boers, 2022; Hulstijn et al., 1996; Jacobs et al., 1994; Ko, 2012; Watanabe, 1997). This technique is found to provide immediate access to word meanings, reduce students' over-reliance on dictionaries, and enhance the noticing of unknown words (Ko, 2012; Nation, 2013; Yanguas, 2009).

The Language of Glosses

A central question in glossing research is whether to provide glosses in the learners' L1 or L2. According to Nation (2013), L1 glosses are found to offer the advantage of providing clear and concise meanings of the target vocabulary item regardless of learners' proficiency levels. Glosses can also facilitate making connections between the words the learners know in their L1 and those they do not know in the L2, which leads to better comprehension as well as vocabulary development (Ko, 2017). On the other hand, L2 glosses are found to increase exposure to the target language and are more suitable for multilingual classrooms (Nation, 2013). Previous studies that compared the effectiveness of L1 and L2 glosses found that L1 glosses are more favorable (Laufer & Shmueli, 1997; Miyasako, 2002), although others found no significant difference (Al-Jabri, 2009; Jacobs et al., 1994; Ko, 2012; Yoshii, 2006).

Utilizing Different Gloss Types

Glosses can generally be classified into traditional and interactive glosses (Yanagisawa et al., 2020). The first category is mainly applied in paper-based texts and includes marginal glosses, which are provided in the margin of the text; interlinear glosses, which are inserted between lines of a text; in-text glosses, which are given adjacent to the target word; and glossaries, which are provided at the end of the text (Yanagisawa et al., 2020). However, the advent of computer-assisted language learning has provided EFL teachers with many possibilities for glossing (Boers, 2022). These include marginal glosses, in-text glosses, pop-up glosses, hyperlinked glosses, and multimedia glosses incorporating images, videos, or audio pronunciations (AbuSeileek, 2011; Chun & Plass, 1996; Kost et al., 1999; Lee & Lee, 2015; Yanagisawa et al., 2020; Yoshii & Flaitz, 2002). Research on the use of different types of glosses has shown that many factors, such as the learners' proficiency level, learning styles, and the specific task or context, may affect the effectiveness of different gloss types (Abraham, 2008; Chen & Yen, 2013; Taylor, 2009). For instance, greater vocabulary gains come from using multiple-choice questions, mainly because they promote deeper processing (Hulstijn, 1992; Rott, 2005). Other studies, however, have reported no significant difference between multiple-choice and single-translation glosses (Nagata, 1999; Watanabe, 1997).

Previous Studies

One of the main questions regarding the use of glosses for vocabulary learning is whether to provide glosses in the learners' L1 or L2. In this regard, previous research has found that

both L1 and L2 glosses have a positive impact on incidental vocabulary learning (Jacobs et al., 1994; Ko, 2017). Although Jacobs et al. (1994) did not report any effect size, Ko (2017) found that language proficiency accounted for 52.70% of the variance, and gloss type accounted for 16.30% of the variance in the immediate post-test. For the delayed post-test, Ko (2017) found that language proficiency accounted for 55.70% of the variance, whereas gloss type accounted for 5.60%. Another study by Hu et al. (2014) found significant differences between L1 and L2 glosses in their study with Taiwanese high school students with different proficiency levels. Moreover, Choi (2016) found that both L1 and L2 marginal glosses were more effective than no glosses for 180 tenth-graders, but they found no significant differences between the two gloss types except when the words were encountered four times in the reading text. Choi (2016) found the significant main effects of the group on immediate and delayed vocabulary tests, with large effect sizes (d = 1.96 and 1.86 for the immediate test; d = 1.08 and 0.84 for the delayed test), indicating that both the L1 and L2 gloss groups outperformed the comparison group.

On the other hand, other studies have shown that L1 and L2 glosses do not always have the same results. According to Mao and Zhang (2017), L1 glosses were more effective for learning and memorizing new vocabulary among 117 non-English majors. Similarly, Ko (2017) found that learners with lower proficiency benefited more from L1 and a combination of L1 + L2 glosses. Moreover, L2 glosses and L1 + L2 glosses were found to be more effective for higher-proficiency learners (Ko, 2017). In the same vein, Zhu (2023) investigated the effect of L1 glosses, L2 glosses, multiple L1 glosses, and multiple L2 glosses on 175 senior high school students. Zhu found that those who had L1 glosses scored significantly higher on both immediate and delayed recall tests ($p < 0.001$) and immediate and delayed recognition tests ($p < 0.001$). Another study by Hung and Hoang (2023) examined the effect of L1 and L2 glosses on 180 eleventh-grade Vietnamese EFL learners. The study reported that L1 glosses were more beneficial for intermediate active recall ($p < 0.0001$) and passive recall ($p < 0.0001$). The researchers found a significant effect of glossing language on passive recall in intermediate learners' ($\eta^2 = 220$) and advanced learners ($\eta^2 = 263$). They also found that the effectiveness of L1 and L2 revealed large effect sizes (d = 2.85 and d = 2.32, respectively). In contrast, Kang et al. (2022) reported a significant difference between L1 and L2 glosses in their study with 77 advanced Korean university students.

Previous studies regarding the impact of L1 and L2 glosses on vocabulary learning and retention are inconclusive (Outamgharte et al., 2024). To explain, some research found that L1 glosses were more beneficial for beginners because of their clarity and ease of understanding, but L2 glosses were also found to be valuable for increasing exposure to the target language as well as for promoting deeper processing for more proficient learners. The effectiveness of each gloss type may also depend on individual learners' characteristics, such as learning style and prior vocabulary knowledge. This means that further research is needed in order to see which type is the most effective in different learning contexts and learners with varying proficiency levels and backgrounds. This study, therefore, sought to explore the impact of electronic L1 and L2 glosses on Moroccan learners, especially that there are no empirical studies regarding the use of glosses among Moroccan learners.

Method

Participants

The study reports the findings of a mixed-methods approach. Convenience sampling was used for collecting quantitative data, whereas purposive sampling was used for collecting qualitative data. The data were initially collected from 179 participants who were first-year university students. Six of these were excluded because SPSS identified them as outliers, given their high receptive vocabulary knowledge. Additionally, one more participant was excluded because they

did not take the delayed post-test. We calculated the sample size of this study using G*Power version 3.1.9.7 (Faul et al., 2009). On the basis of a small effect size of $f = 0.25$, a significance level of $\alpha = 0.05$, and a power of 0.80, G*Power revealed that we needed a sample of 160 participants (Figure 1). The participants' native language was Arabic, and they had all studied English for 3 years in Moroccan public high schools. The participants were randomly assigned to a comparison group, known as the no-gloss group (NGG), and two experimental groups: the experimental L1 gloss group (EL1GG) and the experimental L2 gloss group (EL2GG) using a random group generator, which is accessible at https://www.randomlists.com/team-generator. The demographics of the participants are shown in Table 1. Levene's test of homogeneity of variance revealed a nonsignificant difference in variance among the three groups regarding their initial vocabulary size before the treatment (F (2, 169) = 1.075, p = 0.344).

Table 1 *Participants' demographics*

		NGG	EL1GG	EL2GG
AGE	18–20	(58) 98.31 %	(54) 100%	(58) 98.33 %
	20–22	(1) 1.69 %		(1) 0.67 %
Gender	Female	(38) 64.4%	(39) 72.73 %	(41) 70 %
	Male	(21) 35.6%	(15) 27.27 %	(18) 30 %

NGG, no-gloss group; EL1GG, experimental L1 gloss group; EL2GG, experimental L2 gloss group.

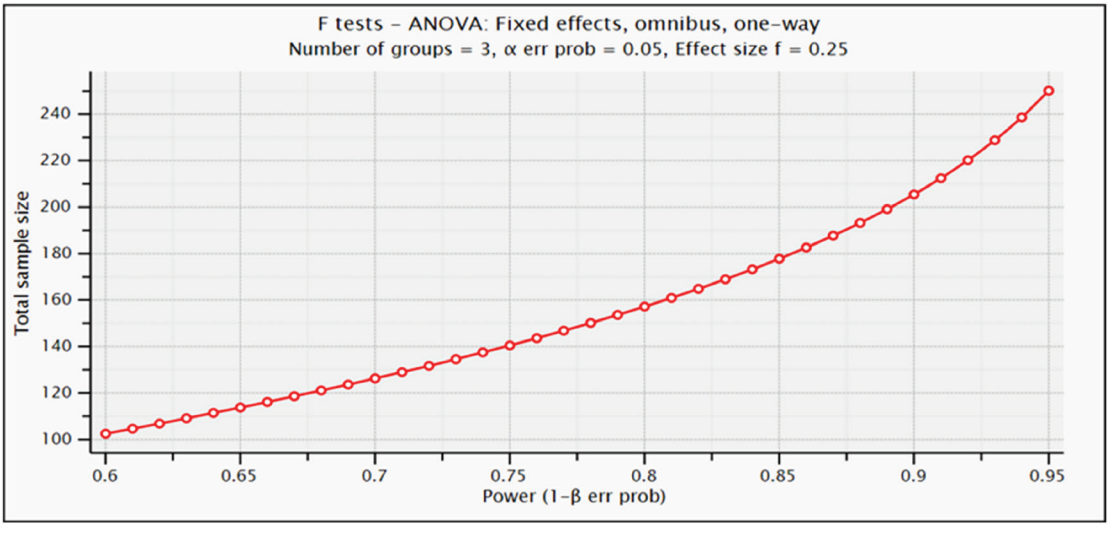


Figure 1 *Determining sample size for one-way analysis of variance*

Materials

Vocabulary Size Test

This study used the Vocabulary Size Test (VST) (Nation & Beglar, 2007) to measure the participants' receptive vocabulary size. The test format measures word recognition and

meaning by requiring the participants to choose the correct definition from multiple choices. Permission for using the test was not required according to the guidelines outlined by Beglar (2010). Although the test is offered in two versions (20,000 and 14,000 words), the present study utilized the 14,000-word version according to the results of a piloting study. The test itself has a multiple-choice format, with each stem (target word) followed by a nondefining sentence. This sentence serves a dual purpose: indicating the stem's part of speech and limiting its meaning, especially when dealing with polysemous words like "bank" (Nation & Beglar, 2007). The VST uses easier distractor options whenever possible (Nation & Beglar, 2007).

Reading Texts

Although EFL teachers may not always select reading materials carefully, this study prioritized a careful selection process to maximize engagement with the reading texts and minimize dropouts. Three key criteria guided text selection in this study, namely length (Alderson, 2000), difficulty (Krashen, 1989), and topic familiarity (Horiba & Fukaya, 2015; Zainal, 2003). To consider the potential difficulty of longer texts (Alderson, 2000), passages limited to 300 words were selected. Regarding difficulty, Krashen's (1989) i+1 input theory informed the selection of texts slightly above the participants' vocabulary level in accordance with the participants' VST results (Nation & Beglar, 2007). Finally, topic familiarity was addressed by selecting texts deemed to be interesting and familiar to the students according to a pilot study. This approach helped the researchers ensure a balance between comprehensibility and engagement. The Corpus of Contemporary American English was used to verify the frequency range of the chosen texts (Figure 2), and volunteers from a sample similar to the participants helped select interesting titles and identify possible unfamiliar vocabulary in the reading texts.

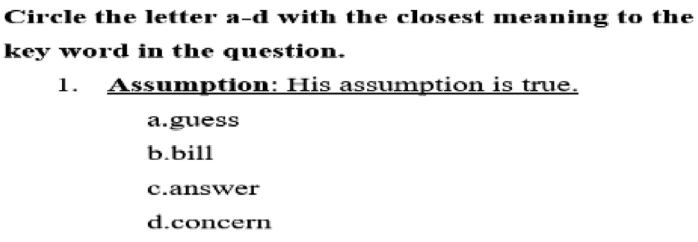
Figure 2 *Frequency range of a sample text*

Target Vocabulary Item Pretest and Post-Tests

In order to identify target vocabulary items (TVIs) that needed to be glossed, a pilot study was conducted with 15 students similar to the participants in the present study. The participants

in the pilot study had to read the selected eight texts and highlight all the words they did not know. The researchers analysed their responses to select the initial glossing list and design the TVI pretest. The pretest applied Meara's (2010) yes/no format. In other words, it tested form recognition. The test initially contained 84 target words, amongst which 17 were non-words generated using the Australian Research Council (ARC) nonword database (accessible at http://www.cogsci.mq.edu.au/research/resources/nwdb/nwdb.html) to control for guessing and providing false information, and 67 TVIs. After piloting the TVI pretest with another 10 students and analysing the data, 55 target vocabulary items were included in the TVI pretest.

To assess vocabulary retention, we used an immediate and delayed post-test. The researchers designed a 55-item multiple choice test, which included vocabulary items from the pretest in simple sentences to help the participants recognize the part of speech of the target words, echoing the VST (Nation & Beglar, 2007). Distractors were chosen from Corpus of Contemporary American English's most frequent words and were of the same part of speech as the target vocabulary items. The immediate post-test (Figure 3) presented vocabulary items following their order in the reading texts. The participants were given 40 minutes to finish the test. Scoring was straight, with one point per correct answer.


Circle the letter a-d with the closest meaning to the key word in the question.

1. **Assumption**: His assumption is true.
   a.guess
   b.bill
   c.answer
   d.concern

Figure 3 *A snip of the post-test*

Questionnaire

In addition to the vocabulary tests, we administered a questionnaire in the first session to gather demographic data and information on technology access and reading preferences within the three groups. All participants across the groups were between 18 and 20 years old. In terms of technology access, the NGG had the lowest percentages, with 50.8% having laptops and 67.8% having regular internet access. In the EL1GG, 57.4% reported having laptops and 75.9% had regular internet access, whereas the EL2GG had the highest percentages, with 64.4% and 86.4%, respectively. Notably, there were significant differences in the preference for online reading among the groups. For the NGG, only 13.6% of the participants preferred this mode of reading compared with 27.8% of the EL1GG and 20.3% of the EL2GG. Overall, these results suggest that the majority of participants across all groups were equipped to utilize the Canvas platform for the study, though preferences for online reading varied considerably.

Interviews

In order to have a deeper understanding of the participants' vocabulary acquisition experience from reading texts, 26 participants from the three groups (Figure 4) with varying scores in the delayed post-test were purposively selected for interviews. The semistructured interviews focused on vocabulary learning strategies, perceptions of glosses, and challenges encountered while also allowing for the exploration of emerging themes. Following Cohen et al. (2018), the participants were provided with interview questions beforehand, and the order of questioning was generally maintained, with the flexibility to adapt them according to the participants' responses.

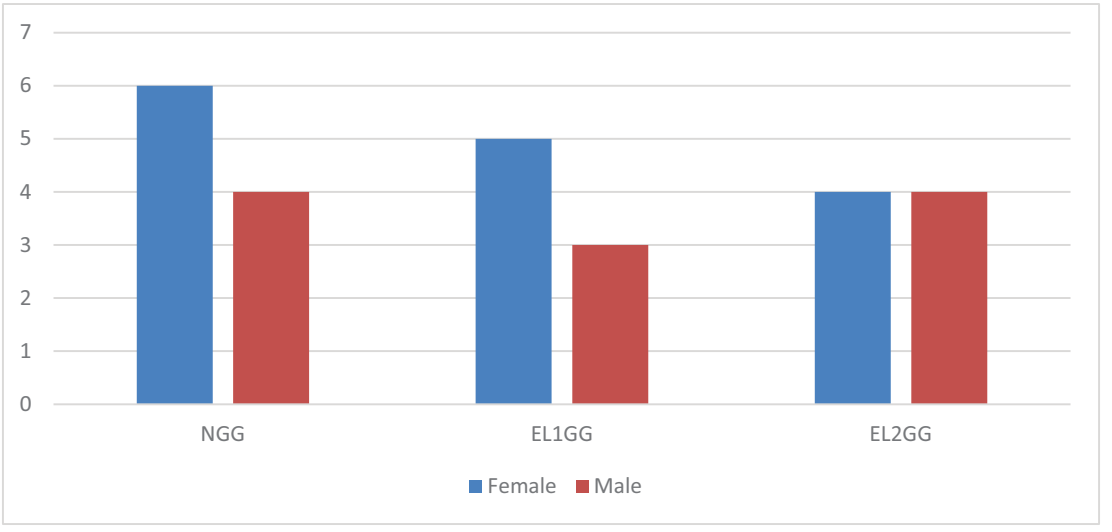


Figure 4 *Number of interviewees from each treatment group*

Canvas Platform

The integration of information and communication technology into Moroccan EFL classrooms has gained significant attention (Yeou, 2016; Zyad, 2016). These technologies include a learning management system like the Canvas platform which has been shown to enhance teaching and learning through features such as online interaction, resource sharing, and flexible access (Fathema et al., 2015). This study utilized Canvas to deliver glossed e-texts to the experimental groups. The first author conducted a pretreatment workshop with the experimental groups to introduce the platform and address potential usage issues. The course materials comprised eight texts distributed weekly over eight weeks (Figure 5). The participants maintained continual access to each text from its publication until the end of the study.

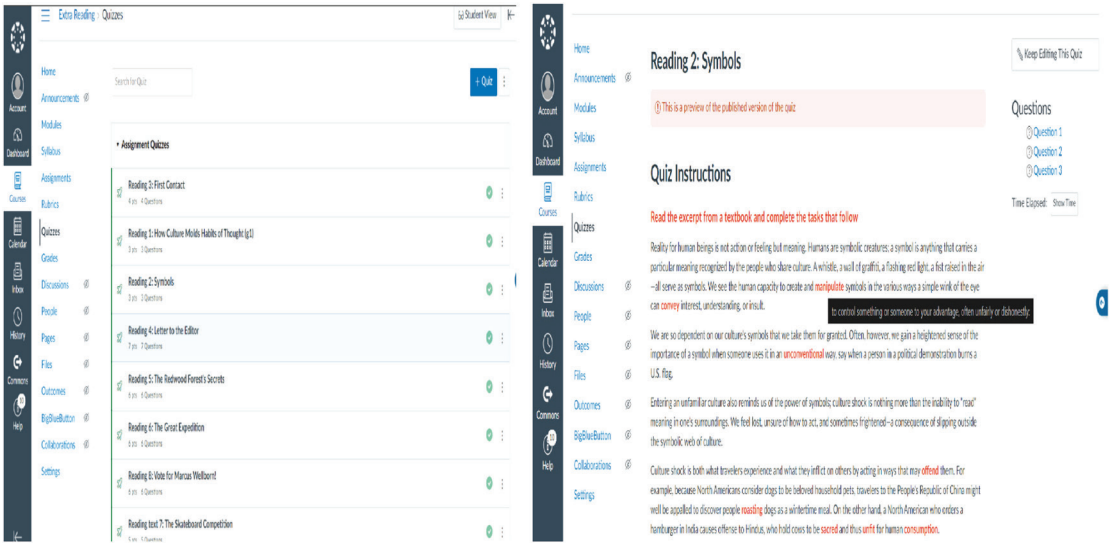


Figure 5 *Canvas published e-texts with sample gloss*

The Treatment

This study compared a comparison group (the NGG) with two experimental groups, namely the EL1GG and the EL2GG, on their incidental vocabulary acquisition from the reading comprehension texts. The participants in the three groups read eight texts and answered comprehension questions, but the primary focus was on vocabulary retention rather than reading comprehension. The research design involved a pretest, eight weeks of text-based activities, an immediate post-test, a delayed post-test six weeks later, and follow-up semistructured interviews. The study's procedure is detailed in Table 2.

Table 2 *A detailed description of the treatment*

	NGG	**EL1GG**	**EL2GG**
Week 1	Pretest1 (VST)	Canvas workshop Pretest (VST)	Canvas workshop Pretest (VST)
Week 2	Pretest2 (TVIs)	Pretest2 (TVIs)	Pretest2 (TVIs)
Week 3 ↓ Week 9	Reading text 1→7	Reading text 1→7	Reading text 1→7
Week 10	Reading text 8 Immediate Post-test	Reading text 8 Immediate Post-test	Reading text 8 Immediate Post-test
Week 16	Delayed post-test	Delayed post-test	Delayed post-test
Week 18	Interview	Interview	Interview

Ratings

The rating of all three vocabulary tests was straightforward. The participants received 1 point for correct answers and 0 points for incorrect answers. The pretest and the post-tests were scored by the first author, an EFL teacher with a PhD in Applied Linguistics, and a university teacher. The average inter-rater reliability between the three raters was a perfect agreement, indicated by a coefficient of 1.00.

Results

Quantitative Results

To establish the participants' receptive vocabulary levels for the study, the VST (Nation & Beglar, 2007) was administered as a pretest to all three groups. The VST results (Table 3) showed a score range of approximately 1400 points for all the groups, with moderate score dispersion around the mean. The NGG obtained a mean of 2548, the EL1GG had a mean of 2599, and the EL2GG achieved the highest mean of 2666. Although there seems to be some variability within the groups, particularly in the EL2GG, statistical tests confirmed group homogeneity (F (2, 169) = 1.075, p = 0.344). In brief, the participants showed a comparable level of vocabulary knowledge, centering around the first 2000 most frequent words, thus providing a solid foundation for the study.

Building on the VST results, a TVI pre-test focusing on the 3000–4000-word frequency band was administered to all participants. As shown in Table 4, the NGG scored the highest average (7.49) with a moderate spread. The EL1GG showed a similar performance, with a slightly wider

score range. Finally, the EL2GG had the lowest average score and the widest score distribution. The average scores and standard deviations show that the performance was consistent across the groups, but there were some differences in how well individuals performed in each group.

The immediate post-test (Table 5) revealed some variations in performance and score distribution among the three groups. The NGG obtained a mean score of 20.18 (standard deviation (SD) = 6.08), ranging from 7.00 to 33.00. The EL1GG obtained the highest mean score of 31.74 (SD = 7.43), with scores ranging from 18.00 to 50.00. Finally, the EL2GG had a mean score of 28.61 (SD = 8.79), with scores ranging from 14.00 to 50.00.

One-way analysis of variance (ANOVA) confirmed a statistically significant difference among the three groups (F (2, 169) = 36.143, $p < 0.001$). To determine which groups significantly differed, Tukey's honest significant difference (HSD) post hoc test was conducted (Table 6). The analysis revealed that both the EL1GG (M = 31.74, SD = 7.43) and EL2GG (mean = 28.61, SD = 8.79) significantly outperformed the NGG (mean = 20.18, SD = 6.0) with p-values of $p < 0.001$ and $p < 0.001$, respectively. However, there was no significant difference between the EL1GG and EL2GG (p = 0.072). According to Cohen's (1988) thresholds, the difference between the EL1GG and the NGG represents a large effect size (d = 1.71). Moreover, the difference between the EL2GG and the NGG demonstrated a large effect size (d = 1.13). However, the difference

Table 3 *VST results*

Group	Mean	N	SD	Range	Minimum	Maximum
NGG	2548.47	59	286.891	1400	1960	3360
EL1GG	2599.63	54	266.592	1360	1960	3320
EL2GG	2666.10	59	330.522	1440	1920	3360
Total	2604.88	172	298.995	1440	1920	3360

Table 4 *TVI pretest*

Group	N	Mean	SD	Minimum	Maximum	Range
NGG	59	7.49	1.569	4	11	7
EL1GG	54	7.35	1.580	3	11	8
EL2GG	59	7.32	1.591	5	14	9
Total	172	7.39	1.573	3	14	11

Table 5 *Immediate post-test scores*

	N	Mean	SD	Minimum	Maximum
NGG	59	20.1864	6.08127	7.00	33.00
EL1GG	54	31.7407	7.43319	18.00	50.00
EL2GG	59	28.6102	8.79854	14.00	50.00

between the EL1GG and EL2GG was not statistically significant, with a small effect size (d = −0.39) indicating that the EL2GG had a slightly lower mean score, though this difference was negligible.

Similar to the immediate post-test, the delayed post-test (Table 7) also revealed variations in performance and score distribution. The NGG had a mean score of 19.62 (SD = 7.01), ranging from 10.00 to 38.00. The EL1GG displayed the highest mean score of 26.39 (SD = 11.19), with scores ranging from 7.00 to 50.00. The EL2GG had a mean score of 23.64 (SD = 7.96), with scores ranging from 11.00 to 44.00. These findings indicate that the EL1GG performed the best on average on the delayed post-test, followed by the EL2GG and NGG.

To determine if there are any significant differences in the delayed post-test scores among the groups, a one-way ANOVA is conducted. The one-way ANOVA (Table 9) revealed a significant main effect of reading condition on the delayed post-test scores (F (2, 169) = 8.421, p < 0.001), which suggests that at least two groups significantly differed in their mean performance.

Table 6 *Tukey's HSD post hoc test for the immediate post-test*

Group1	Group 2	Mean Difference (1 −2)	Std. Error	Sig.	95% confidence interval	Cohen's *d*
EL1GG	NGG	−11.55430*	1.4167	< 0.001	−14.9042, −8.2044	1.71
EL2GG	NGG	−8.42373*	1.385	< 0.001	−11.6986, −5.1488	1.13
EL1GG	EL2GG	3.13057	1.4167	0.072	−0.2193, 6.4804	−0.39

* The mean difference is significant at the 0.05 level.

Table 7 *Delayed post-test results*

	N	Mean	SD	Minimum	Maximum
NGG	59	19.6271	7.01943	10.00	38.00
EL1GG	54	26.3889	11.19538	7.00	50.00
EL2GG	59	23.6441	7.96060	11.00	44.00

Table 8 *Descriptive statistics for the pretest, immediate post-test, and delayed post-test scores*

	Pretest		Immediate post-test		Delayed post-test	
	M	SD	M	SD	M	SD
NGG	7.49	1.569	20.1864	6.08127	19.6271	7.01943
EL1GG	7.35	1.580	31.7407	7.43319	26.3889	11.19538
EL2GG	7.32	1.591	28.6102	8.79854	23.6441	7.96060

Table 9 *ANOVA results for the delayed post-test scores*

	Sum of squares	df	Mean square	F	Sig.
Between groups	1313.031	2	656.515	8.421	< 0.001
Within groups	13176.155	169	77.965		
Total	14489.186	171			

Table 10 *Tukey's HSD post hoc test for the delayed post-test scores*

Group 1	Group 2	Mean difference (1 – 2)	Std. error	Sig.	95% confidence interval	Cohen's *d*
EL1GG	NGG	6.76177*	1.6629	< .001	2.8298, 10.6938	0.74
EL2GG	NGG	4.01695*	1.6257	0.038	.1729, 7.8610	0.5
EL1GG	EL2GG	2.74482	1.6629	0.227	-1.1872, 6.6768	-0.3

* The mean difference is significant at the 0.05 level.

To determine which groups differed, the Tukey's HSD post hoc test (Table 10) was conducted. We chose this test because it is one of the most common post hoc tests used in psychological research. The test allows researchers to compare pairs of groups to determine which groups differ when the results of ANOVA are significant (Gravetter et al., 2021). The test's results indicated that the EL1GG (mean = 26.38, SD = 11.19) significantly outperformed the NGG (mean = 19.62, SD = 7.01, p = 0.001). Similarly, the EL2GG (mean = 23.64, SD = 11.10) significantly outperformed the NGG (mean = 19.62, SD = 7.01, p = 0.038). The results also indicated that there were no significant differences between the EL1GG and the EL2GG (p = 0.227). The difference between the EL1GG and the NGG represents a medium effect size (d = 0.74), whereas the difference between the EL2GG and the NGG was also significant, with a medium effect size (d = 0.5). However, the difference between the EL1GG and the EL2GG was not statistically significant, with a small effect size (d = –0.3).

Qualitative Results

With the aim of establishing a deeper understanding of the quantitative results, we conducted interviews with 26 participants from all three groups (see the supplementary material). Thematic analysis was used to analyse the interviews (Phakiti, 2014). This approach is believed to allow researchers to organize qualitative data systematically, thus allowing them to uncover recurrent ideas, concepts, or experiences that emerge during the interviews. To this end, the researchers transcribed the interviews and analysed the data to identify recurring patterns, issues, and topics. These included participants' perceptions of the reading texts as well as the glosses used, the challenges they encountered, and the vocabulary learning strategies employed. Once this was complete, the researchers coded segments of the texts according to the identified themes (i.e., perceptions, challenges). After this, the data were analysed in light of the existing literature and the context within which it was collected. The interviews provided important

information regarding the vocabulary strategies the participants used, their experiences with the glosses, and their perceptions of the learning process (Table 11).

Participants in the NGG reported that they employed a variety of vocabulary learning strategies, such as using contextual clues to figure out the meaning of unfamiliar words from the surrounding text because of the absence of any type of aid. For instance, Participant 1 stated, "Usually, when I find a word I don't know while reading, I'll try to understand it from the context first" but if they cannot figure out the meaning of the word using this strategy, the participant explained that they would look up the words in a dictionary. In the same vein, Participant 10 in this group added, "First, I try to use context clues from the rest of the sentence… For example, if the sentence is describing something scary, the word is probably scary too". The participants also used other vocabulary learning strategies, such as writing sentences using the new vocabulary. In this regard, Participant 1 stated, "I practice using them in sentences". In addition, some others created word lists, like Participant 6, who stated that they "create[d] lists of the words I want to learn". Moreover, some participants tended to ignore difficult words. In this respect, Participant 2 in this group stated, "For the really difficult ones, I just pass them". Furthermore, Participant 4 explained that they "write the definition of the words in the text in Arabic or the synonym in English". Looking at the results of the NGG, it is clear that the strategies used can be effective for immediate learning of the target vocabulary items but may not always lead to long-term retention of new vocabulary.

As for participants in the EL1GG, they expressed a high level of satisfaction with the glosses because they were "like little helpers" (Participant 1) and "very helpful" (Participant 6). The same participant noted, "When I see words in Arabic, I can understand the text very well". The availability of L1 glosses allowed them to quickly acquire the meaning of unfamiliar words, which led to better reading and comprehension. In this regard, Participant 3 stated that the glosses helped them "understand the main ideas of the texts without checking every new word". This means that L1 glosses may aid in immediate comprehension as well as contributing to a deeper understanding of the text. Moreover, it may lead to better retention of new vocabulary, as this group's performance in the delayed post-test showed. However, some participants felt that providing different types of glosses, such as sentences or pictures, would lead to a better learning experience. In addition, the interviews showed that some participants preferred not to use glosses before trying to infer the meaning of words they know. For instance, Participant 6 emphasized that "I didn't use the L1 glosses all the time while reading. I use the context first". Moreover, they would use flashcards and strategies such as "writ[ing] the word on one side and the definition on the other" to remember the meaning of the TVIs.

Similar to participants in the EL1GG, the EL2GG found that the glosses were of great help, especially in improving their understanding of complex or technical terms. Moreover, they appreciated the convenience of having instant definitions available while reading. Participant 1, for example, asserted that glosses "were helpful because it allowed me to learn the meaning of the word in the context of the language I'm trying to improve". Similarly, Participant 2 likened them to a "teacher who is there to help" with unknown words. Participant 4 added that it is important to "check if the meaning I know is correct" especially if the glosses are from a trusted source. Some of the participants, however, reported that the L2 glosses are sometimes challenging to understand because the definitions themselves contain unfamiliar vocabulary. In this regard, Participant 1 stated that "some of the definitions were a bit complex", which made them read the glosses multiple times to understand their meaning. In addition to this, the interviews revealed that this group adopted different vocabulary learning strategies, such as guessing from context, using dictionaries, and writing down the TVIs' definitions. For instance, Participant 2 in this group stated "I use dictionaries or electronic glosses to gain the

Table 11 *Learners' perceptions, vocabulary strategies, and challenges*

	Perceptions	Vocabulary strategies	Challenges
NGG	• NA	• Guessing from context • Using dictionaries • Using TVIs in sentences • Using word lists • Ignoring unfamiliar words	• NA
EL1GG	• Very helpful but insufficient for learning vocabulary	• Using contextual clues • Writing TVIs' definitions • Writing translations and synonyms • Flashcards	• Do not cater to different learning styles
EL2GG	• Very helpful. • Providing instant access to L2 meanings	• Guessing from context • Using dictionaries • Writing TVIs	• May sometimes be complex

NA = not applicable.

meaning." Another participant added that "I always use my dictionary to look up new words," whereas Participant 3 pointed out that "Sometimes I even write [it down] to remember it." In conclusion, it can be said that the effectiveness of L2 glosses may be affected by the learners' existing vocabulary knowledge and their ability to process complex definitions in the target language as well as the vocabulary learning strategies used.

Discussion

This study adds to the ongoing discussion about the effectiveness of L1 and L2 glosses on incidental vocabulary learning in different contexts. The results of the EL1GG in the immediate and delayed post-test give more credit to the use of L1 glosses for vocabulary learning in the EFL classroom. Actually, the effectiveness of L1 glosses in this study can be attributed to different factors. First, L1 glosses provide learners with immediate and unambiguous access to word meanings in their mother tongue, which is likely to bridge the gap between the known (L1) and unknown (L2). In this regard, the participants described the glosses as "little helpers" and "very helpful". Moreover, enhancing texts with the L1 equivalents seems to foster a sense of familiarity with TVIs, which probably reduced the participants' anxiety and led to a positive learning environment. In this respect, Jiang (2004) explained that providing learners with L1 equivalents gives "the learner a sense of certainty about the meaning of a word, a certainty that is a vital first step for reinforcing the form-meaning connection and retaining the new word in long-term memory" (p. 426).

Similarly, the results of the EL2GG in the delayed post-test show that this type of gloss can help learners enhance their vocabulary gains. Glossing texts with L2 definitions seems to encourage learners to engage deeply in processing word meanings, which is likely to foster a more contextualized understanding of the TVIs. One possible reason for this may be the L2 glosses' capacity to provide learners with constant exposure to the target language, which is likely to give them more familiarity with the TVIs and the sentence structure. L2 glosses also allow learners to experiment with different vocabulary learning strategies, such as learning from context and making inferences. Another explanatory reason for the superiority of EL2GG

in this study may be the learners' positive attitudes toward monolingual glosses to teach vocabulary. Bearing in mind the variability in the scores, it is possible that for some learners, encountering glosses in the L2 is as efficient as encountering L1 glosses.

The results of the EL1GG and EL2GG support previous research, which found that L1 and L2 glosses are more conducive to vocabulary learning when compared with no gloss (Ko, 2012; Meihami & Meihami, 2014; Taheri & Zade, 2014; Yoshii, 2006). This is proven by the superior performance of the EL1GG and EL2GG in the delayed post-test, which means that glosses can facilitate better processing and retention of the target words in comparison with no gloss (Boers, 2022). This conclusion is further supported by qualitative data, as some participants considered glosses to be "little helpers" that facilitated the understanding of main ideas without having to "check every new word". The results, however, contradict the findings from Choi (2016) and Faghfouri et al. (2022), who found that L1 glosses were more effective than those in the L2.

However, the study also shows that the learners' proficiency level and the complexity of the glossed definition may affect the effectiveness of L2 glosses. This finding supports the findings from Ko (2017), who argued that the L2 may be more beneficial for learners with high proficiency because they have the necessary linguistic resources to process complex definitions in the target language. Moreover, the findings of the study resonate with Taylor's (2009) findings regarding the counter-effect of glosses. In this regard, some of the participants in the L2 group reported clicking on every unfamiliar glossed word, which might have actually hindered their independent vocabulary learning. For example, Participant 3 stated that they "clicked on all the words you glossed in the texts".

Furthermore, the qualitative data provide further insight into the participants' experiences and perceptions regarding the use of glosses. The EL1GG provided positive feedback regarding the ease and helpfulness of the L1 glosses. The glosses were found to increase comprehension and lead to better vocabulary learning and retention. However, some participants wished for a variety of glosses, such as example sentences and visuals. This highlights that considering he homogeneity of the groups and the different learning preferences might have led to better results. As for the EL2GG, most of the feedback stressed the importance of considering the learners' proficiency level as well as providing concise and clear definitions that do not include complex vocabulary. Some participants in this group found that the provided definitions "were a bit complex" while some others stated that the L2 glosses do not always clear confusion, especially with regard to words with more than one meaning.

In a nutshell, this study provides more evidence for the effectiveness of glosses in incidental vocabulary instruction among Moroccan university students. The findings showed that although L1 glosses can be effective for vocabulary learning and retention for learners with lower proficiency levels, taking individual differences into account may increase their effectiveness. Moreover, although L2 glosses have proven their efficacy, they may hinder vocabulary learning and retention because of their complexities. Future research, in this regard, could investigate the effects of different types of glosses, considering individual differences and learners' interactions with the glosses.

Conclusion

This study looked at how using electronic L1 and L2 glosses affects Moroccan university students' incidental vocabulary learning and retention from reading. It was found that both types are effective in incidental vocabulary learning. The findings stress the importance of considering individual differences when designing and implementing glosses because some learners prefer to use other vocabulary strategies before engaging with glosses. Thus, providing

learners with different types of electronic glosses and allowing them to choose may be more effective than using single glosses (i.e., textual glosses). Furthermore, the study has implications for EFL teachers and material developers in Morocco. Enhancing electronic texts with L1 and L2 glosses can serve as a valuable scaffolding tool to support vocabulary learning and retention. However, it is crucial to consider the type of gloss, the proficiency level, and the complexity of the texts. To maximize the effectiveness of L1 and L2 glosses, EFL teachers may benefit from asking learners to reflect on how they used glosses.

Limitations

This study has some limitations. First, although we used G*power to estimate the sample size (Faul et al., 2009), a larger sample is believed to provide more generalizable results. Moreover, the participants were all first-year university students from one university, which provides insights only about this category of students. Future research could replicate this study with a larger and more diverse sample to confirm the generalizability of the findings. Additionally, future studies could investigate the relationship between individual differences and glosses' efficacy, how students interact with glosses, and the effects of different types of glosses (such as multimedia or multimodal glosses) on incidental vocabulary learning and retention. Moreover, it would be interesting to investigate the effect of glosses on teaching technical terms and polysemous words.

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