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Effects of Computer-assisted Language Learning (CALL) and Different Interaction Patterns on Vocabulary Development of EFL Learners

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ABSTRACT

Background: Research on the integration of Computer-assisted language learning (CALL) in EFL contexts has witnessed a significant advance due to the modern changes in language education and technology over the last decades. However, the effects of CALL on vocabulary development through different interaction patterns have not been investigated by researchers.

Purpose: Attempts have been made to assess the effects of CALL and Memrise software on the vocabulary development of intermediate EFL learners through the three interaction patterns: 1) pair-work interaction, 2) small-group-work interaction, and 3) individual content.

Method: A total of 100 male and female Iranian EFL learners were selected through convenience sampling and assigned into three experimental and one control groups, each consisting of 25 learners. The Oxford Quick Placement Test was taken to assure the homogeneity of the participants. Then, a multiple-choice vocabulary test was taken as a pretest. The three experimental groups learned vocabulary through Memrise desktop software with three different interaction patterns, while the control group learned the same through the conventional pattern. A reshuffled version of the pretest constitutes the subsequent posttest.

Result: The results of the comparison between all pretests and posttests indicated that there was a significant difference between the vocabulary scores of the pretest and the posttest of the experimental groups, indicating the efficiency of these treatments. It was revealed that the pair work was slightly more effective than small-group work and that these two types of intervention were more effective than individual-content interaction, where the latter was more effective than conventional instruction.

Conclusion: According to the findings, students are advised to take advantage of CALL-based facilities and participate in interactive activities.

KEYWORDS

Computer-assisted Language Learning (CALL), Individual-Content Interaction, Pair work, Small-group work, Vocabulary Development

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INTRODUCTION

A foreign language process of learning is subject to vocabulary learning. Vocabulary comprises the words of a native language expressed through a single item or phrase reflecting a specific meaning. In learning a foreign language, vocabulary is the primary tool for acquiring all languages. Learning vocabulary is viewed as a fundamental stage of language learning (Alhamani, 2014; Nation, 2001). An extensive vocabulary span in the target language would support reading, writing, listening, and speaking skills (Schmitt & Schmitt, 2020). According to Nation (2015), vocabulary is not an end in itself. A rich vocabulary makes the skills of listening, speaking, reading, and writing easier to perform. Lack of vocabulary knowledge as a tool was the critical reason for not exposing learners to the skills of reading and listening. The word frequency, saliency, learning burden, and learners' particular vocabulary needs and wants were the new elements acknowledged by Grabe & Stoller (2018), who insisted on vocabulary development

as a multi-faceted phenomenon, which includes the knowledge of the word meanings, pronunciation, spelling, parts of speech, grammar, connotations, morphology, and the word semantics. Vocabulary development must be directed and appropriately guided to optimize learning inside and outside the classroom (Rogers, 2018). He also stated that vocabulary acquisition was essential to building students' other basic skills in L2. The prevailing two critical reasons are (1) the availability of many specific words, and (2) the learners' focus on this issue is low in this context and must be of primary concern for the teachers because learning vocabulary is complex (Ko & Goranson, 2014). When learners lack sufficient vocabulary, communication becomes weak, leading to a negative aspect of L2 vocabulary acquisition. There are many studies on practical techniques for promoting EFL vocabulary learning. Adopting an appropriate method for teaching and learning vocabulary is highly recommended. One of the approaches to overcoming vocabulary learning constraints is applying computer technology, which has influenced human exercise and training in recent years. The electrical technology application has recently encouraged researchers to examine the effect of computer technologies on EFL learners' vocabulary acquisition (Tabatabaei, 2012; 2021). Computers, combined with other educational methods, are linked to people's lives and jobs and highly contribute to our contemporary lives. Computer-assisted language learning (CALL) is searching for and studying computer applications in language teaching and learning. CALL includes different applications and procedures to teach and learn foreign languages, from the traditional method to more recent CALL applications.(Shield, 2008; Schmid, 2009).

To explore CALL research on vocabulary acquisition, Talarposhti and Pourgharib (2014) conducted a study that examined the use of computers for lexical skill development in terms of linking CALL with vocabulary acquisition and searching for effective ways to use CALL in vocabulary instruction. The results showed that the experimental group performed significantly better than the other group in a retention test. This suggests that the presentation of vocabulary in visual, aural, and sentence contexts in computer-assisted learning environments would enhance vocabulary learning and teaching (Talarposhti & Pourgharib, 2014). CALL provides a new outlook for teaching language, learning, and vocabulary acquisition; incorporating technology in education might assist learners in improving their language learning by significantly enhancing their vocabulary development (Mousavi & Nemati, 2017).

Applying computer-assisted language learning (CALL) to vocabulary learning rather than listening or reading was discussed by Vasilevski & Birt (2020). The effect of CALL on Iranian intermediate EFL learners' vocabulary learning was assessed with more versatility in many areas by domestic researchers. In the same vein, Ellis (2000) stated that applying computers has demonstrated significant effects on the achievement levels of language learners in recent years (Ellis, 2000).

Applying computers as an instrument in education makes it unique in student interaction. Through this interaction, learners can develop their language proficiency. CALL consists of substantial interactive elements that contribute to the presentation, reinforcement, and assessment of the material to be learned (Davis & Lyman-Hager, 2002). Because computers are considered the ideal medium for online interaction, students can reconsider their communication patterns. CALL's effectiveness relies on its application in meeting the language learning objectives for individualized learners in specific educational settings.

Over the years, besides teacher-learner interactions, the focus has shifted to examining interactions between learners who exhibit negotiation of meaning (NoM) and focus on form (FoF) (Foster & Ohta, 2005). The advantages of these interactions in L2 are highlighted in research done by Varonis & Gass (1985); Gass & Mackey (2007); Mackey et al. (2012), who are in agreement on this issue. As Furnborough (2012) stated, "language learning is a social activity that requires interaction with others" (p. 99). Bernard et al. (2009) and Borokhovski et al. (2012) described the interaction as an active exchange of actions and information among teachers and students and the student interactions with the curriculum content. Lewis (1997) and Hill (1997) pointed out that pair work establishes an environment where learners can practice the language by communicating, reducing anxiety, and increasing classroom participation. Kuo et al. (2014) found that learner-content interaction was the most robust interaction where the students 'requirements were met.

The input, output, and interaction hypotheses constitute the axioms of collaborative learning. Interaction, the most fundamental theme in sociocultural theory (SCT), highlights the supportive nature of instructors or more knowledgeable peers in providing scaffolding to the less competent learners on the path to the Zone of Proximal Development (ZPD) introduced by Vygotsky (1978) as the gap between learners' independent performance and when guided by more capable peers. A significant educational consequence of ZPD is its focus on interaction in learning and teaching contexts, which is the focus of this study. The teachers and students realize that vocabulary acquisition is impossible without interaction. Researchers (Oga-Baldwin & Nakata, 2017; Mourão & Nordi, 2018; Namaziandost & Nasri, 2019) have long advocated ESL/EFL learners' active participation in their interactions with peers. Teaching vocabulary allows students to understand and communicate with others in the given language, in this case, English. Shabaneh & Farrah (2018) believed that it was important to emerge with a new teaching style and to focus on student-centered teaching methods, which would result in graduating students who could comprehend the language and communicate efficiently. Because there isn't much research in Iranian

schools about how to use CALL to help students learn vocabulary through three different types of interactions: pair work group (PWG), small work group (SWG), and individual work (IW), this study aims to find out how CALL affects students' vocabulary growth through these three types of interactions.

LITERATURE REVIEW

Social Constructivism

Social constructivism is a learning theory proposed by Lev Vygotsky in 1968. The theory states that language and culture are the frameworks through which humans experience, communicate, and understand reality. According to Vygotsky (1978), language and culture play essential roles both in human intellectual development and in how humans perceive the world. In social constructivism, social interaction and collaboration are essential for learning. Individual cognitive development cannot be achieved in isolation, and social enterprise is a need for learning (Nassaji & Tian, 2010).

Computer-Assisted Language Learning (CALL) in Language Education

Following the current learning theories as a field that arose towards the end of the 1970s, computer-assisted language learning (CALL) has been interesting for the researchers who are studying language learning and technology. Computer-Assisted Language Learning (CALL) applications transform students' learning attitudes and heighten their self-confidence (Lee, 2001). CALL is a product of the advances made in computer technology with substantial potential for English language teaching. Many studies on vocabulary learning support the CALL application and indicate its positive effect. The contribution of computers in and out of the classroom is inevitable for language teachers and learners (Ahmadi, 2017).

Interaction in L2 Acquisition and Vocabulary Development

The role of input and interaction in L2 acquisition is also an important issue. Allright (1984, p. 156) points out that interaction is an essential fact in classroom pedagogy because everything that occurs in the classroom happens through a process of person-to-person interaction. When the nature of classroom interaction is considered, the socio-cultural theory's significance becomes apparent as peer and teacher's assistance repeatedly takes place in student-student and student-teacher interactions. In ESL and EFL classrooms, vocabulary resources are available to assist students in engaging in meaningful interactions. In these interactions, learning moves from other-regulated to self-regulated; students consider themselves both novices and experts (Mirzaei et al., 2017).

Related Studies

There are many studies on practical techniques for promoting EFL vocabulary learning. The pretest and posttest are the main components of measuring the learners' progress in learning vocabulary. Adopting an appropriate method for teaching and learning vocabulary is highly recommended. Technology application has recently encouraged some researchers to assess the impact of applying computer technologies on EFL learners' vocabulary acquisition. Emami & Amirghasemi (2022) assessed the effect of computer-assisted language learning on improving learners' vocabulary learning. Regina and Devi (2022) assessed the efficiency of computer-based vocabulary instruction in English language classrooms and evaluated research on the usefulness of computer-based vocabulary acquisition, particularly in English language classes. The findings of these studies indicated that computer-based vocabulary learning is a frequent and effective approach to developing and learning new words. Wiharja & Cahyadi (2022), using Vocabulary.com as Computer Assisted Language Learning (CALL) to assess the vocabulary acquisition of the learners. Results showed that utilizing Vocabulary.com was effective in vocabulary acquisition for first-year undergraduate students.

Regarding the role of interaction in vocabulary development, Ariffin (2021) investigated the effectiveness of student collaboration as a technique for improving vocabulary development among a group of ESL learners. Two types of data—qualitative from the teacher's observation and the students' interviews—and quantitative data from the pretest and posttest were collected. The result of the t-test indicated that students outperformed vocabulary knowledge after studying collaboratively, and they had a positive attitude toward collaborative learning. Huong (2006) and Mirzaian (2020) assessed learning vocabulary in collaborative groups at the university level, compared the results with the conventional method, and found that group work affected learning vocabulary. The analysis of covariance reveals that the experimental group outperforms the control group in learning and retaining vocabulary. The advantages of collaborative learning vs. individual learning for L2 vocabulary learners were assessed by Nassaji and Tian (2010).

Considering the role of CALL in vocabulary, Delavari Khalifehkari and Pourhosein Gilakjani (2022) investigated the effect of CALL on intermediate EFL learners' vocabulary learning and compared it with traditional teaching methods. A quasi-experimental design was used, and 80 students were chosen based on their performance in an Oxford Placement Test (OPT) and were randomly assigned to the experimental and control groups. Six reading comprehension passages consisting of 72 new words were selected from the book "504 Essential Words" and used as the pretest for the study. Then, the experimental group received twelve sessions of treatment, which consisted of teaching vocabulary through different tools on the computer, such as related pictures,

videos, textual highlights, PowerPoint slides, or Narsis software, while the control group received the traditional way of teaching, such as providing oral pronunciation of words, explaining their parts of speech, and offering a direct translation of words in Persian. Afterward, both groups attended the post-test of vocabulary at the end of the study. The result of the independence *t*-test revealed that the experimental group outperformed the control group. Kouhsarian et al. (2023) investigated the effect of collaborative learning on the motivation of EFL learners and their vocabulary learning. The findings indicated that engaging them in collaborative learning significantly improved their vocabulary learning.

The effects of applying vocabulary software on Iranian EFL learners' vocabulary learning were assessed in a quasi-experimental method by Mousavi and Nemati (2017). They used an English Language Test as a proficiency test to choose 54 intermediate-level students. The experimental group received instruction from the software version of the same book while the control group received instruction from the printed textbook in the conventional manner. The independent sample t-test and two paired sample tests were run to examine the results of this study. The results revealed that although both methods had a positive effect on learners' vocabulary learning, vocabulary learning programs done via CALL were more effective.

The impacts of web-based language (WBL) learning on learners' vocabulary enhancement were experimentally assessed by Hajebi et al. (2018), where all participants were IELTS students. The findings revealed a considerable difference between the experimental and control groups concerning vocabulary knowledge. WBL instruction improved EFL learners' vocabulary knowledge.

To assess the impact of Memrise on vocabulary learning, Fathi et al. (2018) conducted a study with 59 EFL learners. The learners were divided into two groups: 33 experimental and 26 control. The experimental group was exposed to vocabulary learning through the Memrise app, and the control group applied the conventional method. After 13 weeks, the results indicated that the students who applied Memrise strengthened their vocabulary more significantly than those who applied the conventional method.

The effects of CALL on the vocabulary learning of Iranian EFL learners were assessed by Johan and Wiharja (2022), who investigated whether using vocabulary.com as computer-assisted language learning (CALL) was proven to be effective in terms of vocabulary acquisition. Seventy-eight first-year undergraduate students in three different majors participated during a six-week period. The results of the pre- and post-tests showed that utilizing Vocabulary.com was effective in vocabulary acquisition for first-year undergraduate students.

The influence of CALL on Iranian intermediate learners' vocabulary learning was experimentally assessed by Enayati and Pourhosein Gilakjani (2020) in the Tell Me More (TEM) software environment. They applied the Preliminary English Test (PET) to measure the level of language proficiency, and the learners were placed into two control (30 EFL learners) and experimental groups (31 EFL learners) groups. All participants were given a pretest containing 80 choice items to assess their vocabulary knowledge before the treatment. Vocabulary teaching took 12 sessions with the same volumes in both groups. The experimental group was assigned to the TEM software, while the control group was assigned to the conventional method. After the sessions ended, a posttest of 65 multiple choice items was given to both the groups of learners to evaluate their vocabulary knowledge and the effectiveness of applying CALL. The data were analyzed by an independent sample *t*-test, where the scores from the pretest and posttest were involved. The results indicated that the experimental group outperformed the control group.

The effect of the practice model focus on form (FonF) on the vocabulary learning of L2 learners through CALL was examined by Soltani and Mohseni (2021). The study was run on 23 male and 39 female medical students by applying the English for Specific Purposes (ESP). Quizzes, podcasts, games, and videos were applied based on the FonF practice model for vocabulary learning. Participants were asked to select, practice, and memorize 12 (four nouns, four verbs, and four adjectives) from the audiovisual contents. The procedure of running one pretest and one posttest was similar to the available studies. According to the results, it could be concluded that practitioners of computer-assisted language learning can apply the FonF practice model as a technology-oriented pedagogical model to facilitate the L2 learners' intentional and incidental vocabulary learning abilities and enhance the integration of the emerging educational technologies in L2.

Research Questions and Hypotheses

The following four questions are formulated based on the advantages and disadvantages of the available approaches in this context:

(1) Does pair work interaction through CALL significantly improve Iranian EFL learners' vocabulary knowledge?
(2) Does small group work interaction through CALL significantly improve Iranian EFL learners' vocabulary knowledge?
(3) Does learning vocabulary through CALL improve students' vocabulary knowledge through individual-content interaction?

(4) Do different interaction patterns affect the vocabulary knowledge of students learning vocabulary through CALL?

Following the research questions, four hypotheses corresponding to the research questions were formulated:

$H_0$1: Pair work interaction through CALL did not lead to significant improvement of Iranian EFL learners' vocabulary knowledge.
$H_0$2: Small work interaction through CALL did not lead to significant improvement of Iranian EFL learners' vocabulary knowledge.
$H_0$3: Individual-content interaction through CALL did not lead to significant improvement of Iranian EFL Learner's vocabulary knowledge.
$H_0$4: Different interaction patterns did not affect the vocabulary knowledge of students learning vocabulary through CALL.

Research Gap and Rationale for the Current Study

As the literature review indicated, CALL and all its subsidiary tools have contributed to L2, in our case, vocabulary knowledge. Despite all the studies conducted so far, not many studies to date have conducted a comparative study measuring the effectiveness of CALL in vocabulary learning through three interaction patterns. This study seeks to investigate the effectiveness of three interaction patterns, i.e., pair work group (PWG), small workgroup (SWG), and individual work (IW) interactions, through Memrise and indicate how collaborative activity promotes learning vocabulary in this case, intermediate EFL learners.

METHOD

Participants

A total of 100 male and female intermediate-level Iranian EFL learners of English within the 15-20 age group from a private language institute in Isfahan were selected through convenience sampling. All participants are Farsi-speaking English learners who have been exposed to the English language for about three years. To assess their general proficiency level and to make them homogeneous, they took the Oxford Quick Placement Test (OQPT); participants with scores between 30 and 47 were selected as the intermediate level and assigned into four groups of three experimental and one control group in a random manner: pair-work interaction group (PWG), small interaction group (SG), individual content interaction group (IG), and control group (CG).

Materials and Instruments

The data-gathering tools applied here consist of the Oxford Quick Placement Test (OQPT), the Multiple-Choice Recognition Test of Vocabulary (MCRT) (a 40-item multiple-choice test), and Memrise (flashcards, multiple-choice tests, and typing quizzes).

English Proficiency Test

The Oxford Quick Placement Test (OQPT), consisting of 60 multiple-choice questions(36 testing structure and 24 testing vocabulary), was administered to ensure that the learners were truly homogeneous regarding their English proficiency level. The learners with scores ranging from 40 to 74 are considered intermediate. The reliability of this test was .85 in the present study.

The Multiple-Choice Recognition Test of Vocabulary

A 40-item multiple-choice vocabulary test (Appendix A) was developed to measure the participants' vocabulary knowledge before and after the treatment. The 40 items measure the vocabulary knowledge randomly selected from the book the four groups were to cover. The test contained the textbook's new words that the students would study during the upcoming semester; this test assures the researchers that the participants were not exposed to the terms before the treatment. This test was administered to both the experimental and control groups. The score of each learner in the test ranged from 0 to 40, with each correct answer receiving one mark for 45 minutes. The KR-21 reliability index of the pretest is (r = 0.73). Three experts in the field of SLA and language testing checked the test, made some suggestions regarding the wording of the items and the options, and confirmed its validity after the changes were made. The posttest resembled the pretest in its reshuffled form to eradicate the possibility of a test effect. The posttest reliability was reviewed through KR-21 (r = 0.77), and the experts reexamined its validity.

Memrise

Memrise Desktop software contains flashcards, multiple-choice tests, and typing quizzes applied with spaced repetition to help remember new words efficiently. This software is available at www.memrise.com and works through a simple sign-up process in an email. This software was first released in 2010 and has gained wide application (40 million people in 189 countries learn languages with it). The teacher (the first researcher in this study) worked on five lessons (each containing 12 words) of the *504 Essential Words in English,* which served as the supplementary materi-

al for the course, next to the regular English classroom materials. In each session, students practiced new vocabulary and reviewed the previous ones to enhance their vocabulary knowledge. Reviewed words in Memrise saved the words in long-term memory. This term relates to the count of the words reviewed according to the spaced repetition schedule. As students begin to practice the words, each word appears with its own pronunciation and definition. Suppose the students cram some words or have problems therein. In that case, some exercises appear again on the screen to be practiced. The environment of the application and a few of the exercises used therein are shown in Figure 1:

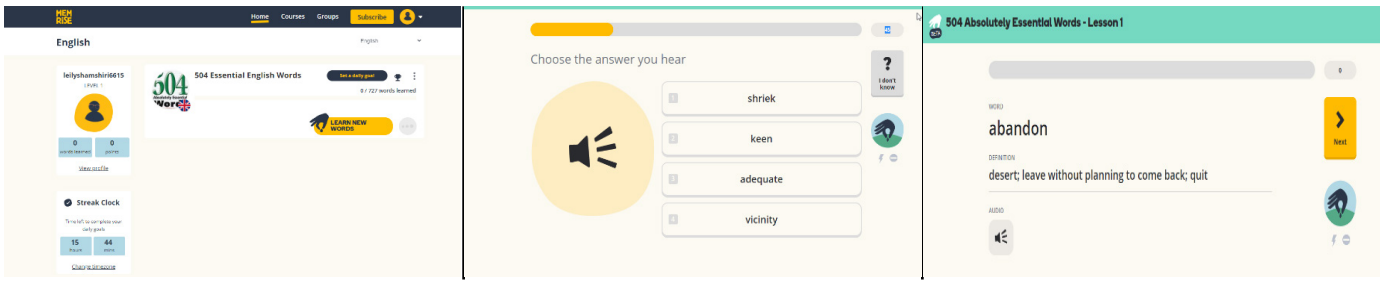
Procedure

The participants went through all the data-gathering steps: proficiency test, vocabulary knowledge pretest, and posttest. Once homogeneous learners were chosen based on the OQPT, they were randomly divided into three experimental groups and one control group. Before the study, these groups were informed about the purpose and the study procedure. They were assured of the confidentiality of the collected data. During the first session, the vocabulary pretest derived from the 504 Essential Words book was administered to measure their vocabulary knowledge before treatment. The vocabulary pretest administration and assessment of the students' vocabulary knowledge come next. The experimental groups used Memrise, a vocabulary learning program, in various ways to interact with one another. The experimental group of students downloaded the Memrise software program on their laptops and applied it for 20 minutes in each session. The remaining time was spent on their regular language learning activities. The treatment lasted 15 weeks. The control group learned vocabulary conventionally, with teachers' explanations and by memorizing vocabulary. The class met three times a week, each for 90 minutes. During each session, the researcher selected the target vocabulary items from the *504 Essential Words* book, explained them to the control learners, and then monitored the learners in the other three experimental groups. The procedure will be explained in detail as follows:

The three experimental groups each undertook the required vocabulary exercise, such as group pair-work interaction, small-group interaction, and individual work. In each session, four new vocabulary items with their definitions, antonyms, and synonyms were practiced in pairs, small groups, and individually in Memrise. Before the vocabulary instruction, the students in the experimental groups were provided with a 30-minute technical training session to learn how to use Memrise with its different functions in three classes with different interaction patterns. In this setup, in each session, students practice new vocabulary and review all previous words in Memrise to enhance their vocabulary knowledge. In all group work conditions, the learners were expected to correct one another, retrieve the word knowledge, and reconsider the meaning of the target word. After making sure they had access to the internet, the students in the experimental groups started working on the 504 essential words on Memrise and studying the level one words. The words appeared with their definition, synonym, and pronunciation. The correct pronunciation and definition were immediately presented for practice if they selected the wrong answer. In the pair group, the students shared one computer to learn new vocabulary by applying Memrise software. They were instructed to complete the exercises by sharing information through collaboration to choose the correct answer. The teacher evaluated the task at the end of each 20-minute session assigned to vocabulary learning. In the small group condition, all four members had to participate to practice vocabulary on the Memrise application on one computer, and no one was allowed to remain inactive. Finally, in the individual work conditions, each student encountered the Memrise content under the teacher's supervision. Regarding vocabulary instruction, the control group was directed through the conventional method (i.e., through the regular curriculum, which is lecturer-based, face-to-face training, and the teacher's explanation of the word's definition). Each session began with the introduction of four words and ended with an explanation of their synonyms and antonyms. The students were required to recite the vocabulary and focus on their meanings and spelling within the context. Finally, the students were supposed to rewrite the words and their meanings at home as homework. After the treatments, the researcher administered the vocabulary posttest to all experimental groups with different interaction patterns—pair work interaction, small group work interaction, and individual-content interaction—and one control group to

Figure 1

An illustration of the Memrise software



check whether the three types of interaction patterns with vocabulary learning software Memrise had a considerable effect on learners' vocabulary knowledge.

Data Analysis

A paired-samples t-test was used to look at the data and answer the first, second, and third research questions. It also looked at how the CALL program affected the students ' vocabulary learning through the three types of interactions. These tests compare the performances of a single group of learners on two occasions (i.e., the pretest and posttest). For the analysis of the fourth research question in relation to the differences among the different interaction patterns regarding their effects on the vocabulary knowledge of students learning vocabulary through CALL, a one-way ANCOVA was run to capture any potential differences among the four groups of participants.

RESULTS

Three separate paired-samples *t*-tests were run to answer the first three research questions. A paired-sample *t*-test was run to determine whether the pair-work group (PWG) learners improved when exposed to their treatment. The results for this *t*-test analysis are tabulated below.

As shown in Table 1, the mean scores and standard deviations of the pretest (*M* = 7.48, *SD* = 2.16) and posttest (*M* = 31.44, *SD* = 2.48) belong to the pair-work group learners. The learners in this group improved noticeably from pretest to posttest. To check whether this improvement is big enough to have statistical significance, the results of the paired-samples *t*-test are tabulated below and should be evaluated:

In reference to Table 2, the difference between the pretest and posttest scores of the learners in the pair-work group is statistically significant, *t* (24) = -91.70, *p* < .05 (2-tailed). The effect size for this difference, calculated through the *eta squared*equation is 0.997, indicating a considerable effect size based on Cohen (1988, as cited in Pallant, 2010), who believes that for this effect size, the values: 01 = small, .06 = moderate, and .14 = large must be reserved. The results for the comparison of the small-group-work (SWG) learners' pretest and posttest are tabulated below, respectively:

Does Small Group Work Interaction through CALL Significantly Improve Iranian EFL Learners' Vocabulary Knowledge?

As evident in Table 3 for SGW learners, the posttest mean score (*M* = 30.20, *SD* = 3.24) is of higher significance than the pretest mean score (*M* = 7.08, *SD* = 2.32), indicating that the learners gained proper improvement from the pretest to the posttest of vocabulary. Whether this difference between the pretest and posttest scores has statistical significance can be determined according to the content of Table 4.

In Table 4, there exists a statistically significant difference between the pretest and posttest scores of the learners in the SGW condition, t(24) = -69.37, *p* <0.05 (2-tailed). The magnitude of the effect, calculated through the *eta squared* equation, is 0.995, indicating a considerable effect of the treatment applied to the SGW condition. The comparison of the pretest and posttest scores in the individual-work group (IWG) is observed in Table 4.

Table 1

Results of Descriptive Statistics for the Pretest and Posttest of the PWG

Tests	Mean	*N*	Std. Deviation	Std. Error Mean
PWG Pretest	7.48	25	2.16	0.43
PWG Posttest	31.44	25	2.48	0.49

Note. PWG=pair-work group

Table 2

Results of Paired-Samples t-Test for the Pretest and Posttest of the PWG

	Paired Differences					*t*	*df*	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PWG Pretest PWGposttes	-23.96	1.30	0.26	-24.49	-23.42	-91.70	24	0.000

Table 3

Results of Descriptive Statistics for the Pretest and Posttest of the SGW

Tests	Mean	*N*	Std. Deviation	Std. Error Mean
SGW Pretest	7.08	25	2.32	.46
SGW Posttest	30.20	25	3.24	.64

Note. SGW= small-group-work

Table 4

Results of Paired-Samples t-Test for the Pretest and Posttest of the SWG

	Paired Differences					*t*	*df*	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
SGW Pretest – SGW Posttest	-23.12	1.66	.33	-23.80	-22.43	-69.37	24	0.000

Table 5

Results of Descriptive Statistics for the Pretest and Posttest of the IWG

Tests	Mean	*N*	Std. Deviation	Std. Error Mean
IWG Pretest	6.52	25	2.29	.45
IWG Posttest	24.88	25	3.04	.60

Note. IWG= individual work group

Table 6

Results of the Paired-Samples t-Test for the Pretest and Posttest of the IWG

	Paired Differences					*t*	*df*	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
IWG Pretest IWG Posttest	-18.36	1.72	.34	-19.07	-17.64	-53.08	24	.000

Does Learning Vocabulary through CALL Improve Students' Vocabulary Knowledge through Individual-Content Interaction?

Learners' vocabulary knowledge in the IWG improved considerably, and it was determined whether the difference between the pretest and posttest scores in the IWG condition had statistical significance.

As shown in Table 6, the difference between the pretest and posttest scores of the learners in the IWG condition is of statistical significance, t (24) = -53.08, p < .05 (2-tailed). The effect size for this condition is 0.991, indicating a significant effect.

After observing that the three experimental groups' mean scores improved significantly from pretest to posttest, it is worth answering the question: Which group benefited more from the instructions provided, and whether there exists a difference among the four groups?

A one-way ANCOVA was run to answer the fourth research question, the results of which are tabulated below:

Do Different Interaction Patterns Affect the Vocabulary Knowledge of Students Learning Vocabulary through CALL?

In this table, the posttest mean scores of the PWG (M = 31.4), SWG (M = 30.20), IWG (M = 24.88), and control group (M = 20.76) indicate that the PWG and SWG learners gained higher mean scores than the other two groups. Whether the

differences among these four groups have statistical significance is determined in Table 8.

In the Sig. column, the *p*-value in the row labeled Groups is lower than the alpha level of significance (p <.05), indicating that the differences among the four groups on the posttest have statistical significance. The partial *eta squared* value (0.87) indicates that the magnitude of the difference is large. The Scheffe post-hoc test in Table 9 should be checked to determine the exact differences among these groups.

As shown in Table 9, the difference between the learners in the PWG and SGW conditions is not statistically significant, although the PWG learners outperformed the SGW learners. Statistically, significant differences were found between the mean scores of the learners in the PWG and IWG; PWG and control group; SGW and IWG group; SGW and control group; and IWG and control group (p<.05). These differences indicate the effectiveness and superiority of CALL-based interactive activities over conventional instruction. It was revealed that pair work was (although not significantly) more influential among the three interaction patterns than small group work. It suggests that these two types of interventions are significantly more effective than individual interaction, which, in turn, is significantly more effective than conventional instruction.

DISCUSSION

Three types of interaction were used to look at and compare the effects of CALL-based instruction on the vocabulary learning of intermediate Iranian English as a foreign language (EFL) student: pair work, small groups, and individual content interaction. The results revealed that the experimental groups outperformed the control group. The success of the experimental groups in terms of vocabulary knowledge achievement was explained by answering the following questions:

The first research question was formulated to determine whether pair-work interaction through CALL would be effective in L2 vocabulary learning. The results indicate that pair-work interaction through CALL significantly improved the learner's vocabulary knowledge, suggesting that computer software can be applied together with conventional techniques to foster intermediate EFL learners' vocabulary competence. These results reveal the advantages of collaborative activities in this study for the L2 learners' development of vocabulary knowledge. Students interacted with their peers to practice the CALL software program and learn new vocabulary.

Table 7

Descriptive Statistics for the Posttest Scores of the Four Groups

Groups	Mean	Std. Deviation	*N*
PWG	31.44	2.484	25
SGW	30.20	3.240	25
IWG	24.88	3.045	25
CG	20.76	2.817	25
Total	26.82	5.168	100

Table 8

Results of One-way ANCOVA for Comparing the Posttest Scores of the EG and CG

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	2422.15	4	605.53	258.42	.000	.91
Intercept	3614.82	1	3614.82	1542.68	.000	.94
Pretest	590.75	1	590.75	252.11	.000	.72
Groups	1623.63	3	541.21	230.97	.000	.87
Error	222.60	95	2.34	_	_	_
Total	74576.0	100	_	_	_	_
Corrected Total	2644.76	99	_	_	_	_

Note. EG=experimental group; CG=control group

Table 9

Scheffe Post Hoc Test Results for Comparing the Learners' Posttest Scores

Groups	Groups	Mean Difference	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
PWG	SG	.81	.43	.38	-.35	1.98
PWG	IWG	5.53	.43	.00	4.35	6.71
PWG	CG	10.08	.43	.00	8.91	11.25
SG	IWG	4.72	.43	.00	3.55	5.89
SG	CG	9.27	.43	.00	8.10	10.43
IWG	CG	4.54	.43	.00	3.37	5.71

Borokhovski et al. (2012) found that peer-to-peer interaction has the most significant effect on achievement. Zarei and Sahami Gilani (2013) examined the effects of selected collaborative techniques on second language (L2) vocabulary. The findings revealed that collaborative learning improved vocabulary learning. The same holds for the findings by Bernard et al. (2009, p. 315), who assessed the effectiveness of student-student interaction treatments through a meta-analysis of the specific literature. The post hoc analysis revealed that student-student interaction has the highest effect on achievement outcomes, especially compared to student-teacher interaction. The findings are also compatible with those of Johan and Wiharja (2022), who investigated Vocabulary.com, as Computer-Assisted Language Learning (CALL) is effective in terms of vocabulary acquisition.

The current study results are incompatible with Kuo et al. (2014), who found that learner-content interaction was the most robust interaction where the students were satisfied. However, most studies reviewed here revealed that interaction patterns improved vocabulary development, but not in a CALL context. Vygotsky's Socio-Cultural Theory (1978, 1986) theorized that social and collaborative interaction contribute highly to language learning. Pair work allows learners to interact with their peers, which improves their learning abilities. Lewis (1997) and Hill (1997) pointed out that pair work establishes an environment where learners can practice the language by communicating, reducing anxiety, and increasing classroom participation.

The second research question was formulated to determine whether small group interaction through CALL-based instruction would be effective in L2 vocabulary learning for EFL learners. The findings indicate that small group interaction through CALL-based activities significantly improved their L2 vocabulary knowledge, given that the participants had little knowledge of the target words before the treatment. These results indicate the benefits of collaborative activities in this study for the L2 learners' development of vocabulary knowledge. Students interacted with other group members to read a text and encounter new vocabulary.

The findings of the present research correspond with those of Kouhsarian et al. (2023) and Mirzaian (2020), who assessed learning vocabulary in EFL vocabulary learning collaborative groups, compared the results with the conventional method, and found that group work significantly outperformed individual work in vocabulary learning. Laufer and Hulstijin (2001) indicated that learning the different aspects of vocabulary knowledge through error correction, explanation, suggestion, and resource sharing would be more effective in pairs than in group work. Students in the short term attained higher scores through collaborative learning, pair work, and group work than individual learning. To them, learners in group work are more interactive in what they do than in individual setups. The same holds for Tamjid and Moghadam (2012), who ran an experimental study to assess the Narsis software's effects on Iranian intermediate EFL learners' vocabulary acquisition. Their results indicate that the experimental group outperforms the control group, and through interviews, it was found that the participants in the experimental group had positive attitudes towards Narsis software.

The influence of CALL on Iranian intermediate learners' vocabulary learning was experimentally assessed by Enayati and Gilakjani (2020) in the Tell Me More (TEM) software environment. In line with the findings of the current study, these studies indicated that applying the Tell Me More (TEM) software highly contributes to vocabulary learning in L2. Khalifehkari and Gilakjani (2022) investigated the effect of CALL on intermediate EFL learners' vocabulary learning. The result of the independence *t*-test revealed that the experimental group outperformed the control group.

The results do not correspond with the results obtained by Aist's (2002) study, where learners used both computer-assisted and human-assisted oral reading to learn vocabulary. The learners' performance was not significantly different when they used the computer program and conventional method to assist in learning word meanings in reading. Most studies in his article indicate that CALL users outperformed those who did not use it. CALL technology allows

students to access a virtual learning environment where they can use several English software programs to learn different languages and provide immediate feedback for learners. According to Lan et al. (2009), CALL was applied as an alternative to examining students' learning progress.

The third research question was addressed to determine whether the individual work through CALL would be practical for vocabulary learning. The results indicate that the individual interaction group, who learned English vocabulary through CALL-based instruction, outperformed the control group in the vocabulary posttest. These findings agree with those of Mousavi and Nemati (2017), who assessed the effects of CALL on Iranian EFL learners' vocabulary learning. The control group was taught the vocabulary in the conventional way through the printed textbook, while the experimental group was instructed by the software version of the same book. The results of an independent sample t-test revealed that electronic vocabulary learning programs were more effective.

The results obtained in the current research do not correspond with those of Huong (2006), Mirzaian (2020), and Ariffin (2021), who found the advantages of collaborative learning vs. individual learning for L2 vocabulary learners. The experimental and control groups exhibited lower performance on the vocabulary test in the delayed posttest than in the immediate posttest, indicating that the effect of instructions was not retained over time; thus, another topic of concern in this context.

The fourth research question was addressed to determine whether different interaction patterns affect students' vocabulary acquisition differently through CALL. The findings indicate the effectiveness of CALL-based interventions over conventional instruction. The control group followed the usual pattern of student-instructor interaction. Among the three interaction patterns, pair work was superior to group work interaction, which was, in turn, more effective than individual-content interaction. The results obtained here correspond with those of Laufer and Hulstijin (2001), in which students in the short term attained higher scores through collaborative learning, pair work, and group work, respectively. Vygotsky (1978), who contends that collaborative learning is more effective when learners are in their proximal development zone, may support the findings of this study. Interaction is crucial in collaborative learning between the learners and the learning group to promote mutual progress (Hu, 2001; Schunk, 1996).

CONCLUSION

Technological applications, particularly CALL, have recently encouraged some researchers to examine their effects on the vocabulary acquisition of EFL learners. This study is concerned with CALL's integration into vocabulary learning and the effects of interaction patterns examining and determing whether they influence the vocabulary knowledge of EFL learners. The results confirmed that call-based instruction integrated with pair work and group work interactions could significantly enhance EFL learners' English vocabulary knowledge. Collaborative learning is a more effective pattern to be applied by second-language learners. It makes vocabulary learning enjoyable, promotes students' motivation and attitude toward attending the classes, and makes the learning process more meaningful and intriguing.

Significant differences exist between this study and the mentioned studies in the literature review, applying the three interaction patterns (pair-work interaction, small-group-work interaction, and individual-content interaction) and CALL intervention for vocabulary learning. Many studies are focused on assessing the effects of interaction patterns and/or CALL on different language skills, especially vocabulary development, but not with the patterns of interaction applied in this study. Call-based software in this study allows students to learn new words and expand their vocabulary knowledge. Students develop their cognition by interacting with each other in the class and participating in collaborative tasks, like co-constructing knowledge. The findings indicate that, to date, the contribution of CALL has been high in this context.

Teachers and students can adopt other software programs for improving vocabulary learning. Applying newly developed devices (software) for different English skills and subskills would enhance L2 learning and, consequently, have a broader scope in this field. For this purpose, selecting more English learning institutions, schools, and universities with a broader study scope is essential to obtaining better results. By resorting to the findings here, students are advised to take advantage of CALL-based facilities and participate in interactive activities.

The limitation of this study is due to the time constraints, where the participants received treatments for only one term, and the number of participants was limited to 100 EFL learners, making it difficult to generalize the theme in other contexts. It may be argued that some of these treatments may require a longer time to take effect or might have long-term effects. Their effects may not be evident immediately after instruction. In this study, other mediating variables like gender and attitude, the age of the participants, individual differences, and the different context of the study, which can affect the learners' perception of Memrise and technology in the four groups, are of no concern. These shortcomings can be the subject of future research, and where possible, new software may be provided. Remember that all these effects lead to innovation in teaching and learning.

DECLARATION OF COMPETITING INTEREST

None declared.

AUTHORS' CONTRIBUTION

Fatemeh Shamshiri: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Supervision; Writing – original draft; Writing – review & editing.

Sajad Shafiee: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Supervision; Writing – original draft; Writing – review & editing.

Fariba Rahimi: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Supervision; Writing – original draft; Writing – review & editing.

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APPENDIX A

A. Choose the best answer.

1. This advertisement is a.....example of their marketing strategy.
   a. typical b. scared c. annual d. jealous

2. She finally managed to .....him to go out for dinner with her.
   a. play b. persuade c. persist d. blend

3. A careful ..... of fine products will result in delicious food.
   a. blend b. burn c. fire d. work

4. It is difficult to ..... what the long-term effects of the accident will be.
   a. forbid b. buy c. predict d. make

5. The ..... number of students we need to run the course is fifteen.
   a. minimum b. annual c. keen d. hard

6. The .....materials for baking cake are flour and sugar.
   a. visible b. essential c. expensive d. humid

7. Sara showed a ..... for acting at an early age.
   a. tradition b. tact c. talent d. bachelor

8. The .....was found by children playing in the woods.
   a. corpse b. employee c. topic d. debate

9. The path was .....by long grass.
   a. reclined b. explored c. tempted d. concealed

10. Many wild animals .....in the woods.
    a. predict b. blend c. inhabit d. persuade

11. It did not matter that her .....was only five dollars.
    a. hardship b. burden c. wage d. campus

12. There was something .....about Mr scott's death.
    a. sinister b. popular c. thorough d. jealous

13. When the weather is so ....., she sometimes stays in bed all day.
    a. keen b. dismal c. rural d. unusual

14. Her mother puts her own life in .....to rescue her daughter.
a. burden b. wholesale c. oath d. peril

15. In winter my fingers become so ..... that I can hardly write.
    a. numb b. enormous c. popular d. moist

16. The game had to be ..... due to rainy weather.
    a. keen b. abandoned c. expensive d. essential

17. At the age of 16, Ali bore the .....of providing of his family.
    a. beret b. burden c. border d. band

18. My father never hurts anyone's feeling because he always uses .....
a. wager b. campus c. tact d. client

19. Servicemen have to swear an .....of loyalty to their country.
a. oath b. data c. approach d. theory

20. Jack is so .....that he always gives up his subway seat to a woman.
a. jealous b. gallant c. minimum d. humid

21. Sara was completely exhausted by the ..... heat.
a. unaccustomed b. visible c. gallant d. keen

22. She .....her employers of thousands of pounds.
a. defrauded b. reformed c. assembled d. explored

23. "Keep away from me" she .....
a. shrieked b. probed c. evaded d. neglected

24. The doctor gave him a ..... check-up.
a. enormous b. thorough c. popular d. comprehensive

25. The .... price of juice is six cents a quart lower than retail.
a. wholesale b. vapor c. burden d. topic

26. He was ..... on the lounge chair which had been his cradle during his trip through space.
a. descending b. reclining c. vanishing d. persuading

27. The ..... of his breath feathered in a trail behind him as he moved through the cold bushes towards the stream.
a. vapor b. majority c. client d. data

28. When the ..... fell down the wall, everyone lived happily ever after.
a. wager b. annual c. villain d. talent

29. Swimming helps to get the blood .....through the muscles.
a. utilizing b. circulating c. producing d. insisting

30. My ring was here a minute ago but now it's .....
a. vanished b. reclined c. works out d. permitted

31. In some languages you may be able to ..... material from grammar books for these lists.
a. qualify b. circulate c. utilize d. plan for

B. chose the correct word for each definition.

32. ....., Tell beforehand
a) utilize b) vanish c) predict d) probe

33. ..... once a year; something that appears yearly or lasts for a year.
a) sinister b) numb c) vacant d) annual

34. ....., able to be seen
a) wager b) eliminate c) visible d) jealous

35. ..... search in to, examine thoroughly, investigate
a) probe b) reform c) neglect d) decieve

36..... think out; plan; invent
a) devise b) defraud c) detect d) deceive

37....., Liked by most people
a) popular b) enormous c) humid d) keen

38. .....closely packed together, thick
a) dense b) rural c) expensive d) frigid

39.....try to get someone to do something; invite
a) tempt b) utilize c) inhabit d) conceal

40..... make someone believed as true something that is false; mislead
a) Deceive b) Encourage c) Persuade d) pretend