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Revolutionizing Vocabulary Acquisition through AI Chatbots

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Abstract. The present research aimed to investigate the impact of using an interactive chatbot on learning receptive and productive vocabulary. Sixty Omani learners with intermediate English proficiency levels were randomly divided into experimental and control groups, with 30 students in each group. Initially, a pretest was conducted to ensure the homogeneity of learners in terms of their vocabulary knowledge. Then, both groups of students followed their normal face-to-face classes, but the experimental group received extra practice through an interactive chatbot using the WhatsApp platform. The study lasted four weeks, and after the treatment, posttests and delayed posttests were also conducted. The study's results showed that both groups progressed in receptive and productive vocabulary knowledge, but the experimental group performed significantly better. In addition, the findings showed that the control group performed better in productive tasks, while the experimental group performed better in the receptive section of the exams. The study's findings are helpful for teachers, curriculum developers, students, and institutions.

Keywords: Artificial Intelligence; Chatbots; Vocabulary; Receptive Productive

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1. Introduction

Recently, technology has been employed to enhance and promote language learning (Radhakrishnan, 2017). Tseng (2019) has highlighted various areas of language acquisition where technology can be beneficial, including grammar rules, vocabulary, and assessment. According to Groot (2000), Technology-Enhanced Language Learning (TELL) instruments can help students learn large amounts of vocabulary more efficiently. TELL also offers learners regular repetition of vocabulary to memorise and utilise, constituting an effective perceptual practice tactic in vocabulary acquisition (Tran, 2020; Tran & Vo, 2019).

Furthermore, TELL may aid the development of learner autonomy in students (Tran & Duong, 2020). One of the recent advances in utilising technology in education is Artificial Intelligence (AI), which has been increasingly applied in education (Roos, 2018). Chatbot technology is one of the most common forms of artificial intelligence used to enhance learning processes (Okonkwo & Ade-Ibijola, 2020; Mendoza et al., 2020). Chatbots and virtual assistants have recently been increasingly employed in education (Clarizia et al., 2018).

The goal of educational chatbots has expanded significantly to focus on preparing materials in a manner similar to that of a teacher (Han & Lee, 2022; Pérez et al., 2020). The rise in chatbot usage can be attributed to the development of natural language processing (Adamopoulou & Moussiades, 2020). The creation and application of chatbots in education have accelerated owing to the wide availability of processing power and communication technology (Maroengsit et al., 2019).

Chatbots may present student information such as syllabi and materials (Cunningham-Nelson et al., 2019), ask and answer questions (Ranoliya et al., 2017; Sinha et al., 2020), assessment standards (Benotti et al., 2017; Durall & Kapros, 2020), dates of assignments (Ismail & Ade-Ibijola, 2019), and route information (Mabunda & Ade-Ibijola, 2019). Such technologies may increase learners' participation and support while significantly reducing instructors' administrative efforts, allowing them to focus on developing curricula and conducting research (Cunningham-Nelson et al., 2019).

Kim (2018) investigated how Korean institutions can utilize chatbots to motivate students to acquire new words. Learners in the experiential group engaged in 10-minute weekly conversations with a messenger chatbot on various subjects, demonstrating a substantial increase in vocabulary knowledge, particularly in their understanding of adjectives and verbs. Additionally, Al Ghaithi et al. (2024) created an interactive chatbot that could be implemented in vocabulary learning. The findings indicated that the chatbot functioned well and effectively at all three levels. The experimental group successfully increased their word competencies more than their counterparts in the face-to-face instruction control group.

The limitations of earlier machine learning methods, which struggled with personalisation and language proficiency levels, can be attributed to the limitations of chatbots in the language learning process (Zhang & Huang, 2024).

There is currently little practical research on AI chatbots in EFL disciplines (Kim et al., 2020), and many concerns remain unsolved regarding the functional use of chatbots in the language learning process (Yanguas, 2010). Furthermore, the efficiency of these strategies varies depending on the proficiency level. For instance, chatbots are best suited for advanced foreign language learners and are not appropriate for beginner pupils who need to grasp their fundamentals (Fryer & Carpenter, 2006).

Maraoengsit et al. (2019), Liu et al. (2020), and Yin et al. (2021) stated that to gain a deeper understanding of the functions and importance of chatbots in academic environments, it is essential to conduct further studies in various settings to measure their impact on the learning process. In addition, education in Oman, especially in the early stages, focuses on learning general skills and sub-skills, particularly vocabulary development. This study focused on developing interactive chatbots in the context of Omani English as a Foreign Language (EFL) learners' receptive and productive vocabulary knowledge.

The research question investigated in the current study was as follows:

(1) Does teaching and practising vocabulary using an interactive chatbot assist Omani EFL learners in improving their receptive and productive vocabulary knowledge?

2. Literature Review

2.1. Receptive and Productive Vocabulary Knowledge

In contrast to productive vocabulary, which is the capacity to generate words during spoken and written communication, receptive vocabulary is the capacity to comprehend terms while reading and listening. This definition defines productive vocabulary as an active skill, whereas receptive vocabulary is considered a passive skill. However, this assertion is inaccurate, as learners must engage in the learning process to acquire receptive and productive lexical knowledge. Additionally, all memory, recognition, remembering, and information-gathering processes are often perceived as active processes that require learners to be cognitively engaged and participate in relevant processes to learn effectively. Receptive and productive understanding, as well as linguistic aptitude, are interconnected (Nation, 1990).

In addition, Waring (1997a, b) asserted that receptive vocabulary relates to identifying and retaining the meaning of a term or expression in the first language. However, productive vocabulary focuses on recalling and evocating vocabulary terms in the target language. The term was attempted to be modified by Laufer et al. (2004), who defined receptive vocabulary knowledge as the ability to recall the form of lexical terms, whereas productive vocabulary knowledge is the ability to recall the meaning of terms. Receptive vocabulary knowledge refers to the ability to identify a word's form and provide synonyms, while productive vocabulary is the ability to recall the form and meaning of a term, according to Webb (2008). It is possible to argue that these explanations are inadequate for everyday life because they only partially assess receptive and productive knowledge (Heidari, 2019).

A comprehensive description, as accurately indicated by Nation (2001), is not limited to any ability or feature of language and includes all dimensions of word knowledge in various contexts. It was also found that students' receptive knowledge cannot be easily and quickly converted into productive vocabulary. The nature of this shift remains uncertain, as previously stated. Additionally, it is important to be aware of this distinction due to its significance in the fields of foreign and second-language education and acquisition (Heidari, 2019).

Ryle (1949) stated that production vocabulary is linked to cognitive processes associated with procedures, while reception vocabulary is involved in declarative cognitive processes. However, despite this distinction being discussed and understood in various ways, no agreement has been reached (Paradis, 2009). Melka (1997) suggested that there is a connection between a similar mental process linked to these two types of vocabulary knowledge. According to Laufer (1998), learners progress from receptive to productive vocabulary in their lexicon learning. Furthermore, Melka (1997) found that students are more likely to learn receptive vocabulary before productive language. This suggests that vocabulary learning progresses in a single direction, from receptive to productive.

Contrary to popular belief, Zhong and Hirsh (2009) discovered that productive knowledge increases more rapidly than receptive knowledge. Similarly, the more frequently a vocabulary item is used, the more effectively it will likely be utilized. Lehmann (2007) asserts that the difference between learners' receptive and productive knowledge is more pronounced in English as a Foreign Language (EFL) contexts. In EFL contexts, most words remain in the receptive mode and rarely transition to productive vocabulary. Furthermore, learners' comprehension and pragmatic word usage are enhanced when they effectively employ a word they have learned in a real-life situation. The differences in productive and receptive vocabulary knowledge studies highlighted above underscore the gap between the two (Clark, 1993), and it is crucial to identify strategies to bridge this gap and help students utilise language more effectively.

One way to achieve this goal and move students towards a more productive role is by allowing them to generate words that they have predominantly acquired through receptive learning (Heidari, 2019). Yamamoto (2011) employed output-oriented tasks in instruction, particularly in vocabulary, to help learners learn receptive and productive terms more effectively over an extended period. This approach encourages learners to connect the linguistic structure, meaning, and application of words, thereby enhancing their ability to internalise them. This highlights the crucial role of language production in facilitating receptive and productive vocabulary acquisition.

Zhong and Hirsh (2009) observed that productive knowledge even develops faster than receptive knowledge. Hagtvet (1982) also suggested that children must learn a term positively before they can be passive towards it. The frequency of words has been further associated with transitioning from a receptive to a productive mode in other studies (Laufer & Paribakht, 1998).

2.2. Vocabulary Acquisition via WhatsApp

Mortazavi et al. (2021) suggest that mobile-assisted language learning (MALL) can enhance learners' receptive and productive language abilities. WhatsApp can be a functional platform for facilitating brainstorming and understanding (Hwang et al., 2011). Such an immediate messaging system will intensify the level of active learning, with the potential to provide immediate feedback, reduce task time, and increase accessibility to learning materials (Desai & Graves, 2006; Farmer, 2003). Additionally, mobile app implementation combines official and informal educational settings (Cook et al., 2009). Rambe and Bere (2013) stated that using WhatsApp in a learning environment provides opportunities for students with a lack of confidence and a high level of shyness to feel comfortable engaging in learning situations with less stress.

WhatsApp can motivate and encourage learners (Fageeh, 2013); ultimately, WhatsApp may benefit independent learners or those with hectic schedules, as it provides access to resources without time or location restrictions (So, 2016). Despite these acknowledged benefits, contemporary research often fails to investigate the impact of customised bot-mediated interactions on WhatsApp on the vocabulary breadth and depth of English as a Foreign Language (EFL) learners over time.

Sivabalan and Ali (2022) investigated how students in higher education utilise WhatsApp to enhance their language skills. The teacher and students addressed all the words by providing definitions, discussing pronunciation, sharing expressions, and completing WhatsApp lexical exercises. Everybody took a turn in the performance and gave another comment. The results revealed that WhatsApp had a significant impact on acquiring new words and improved student learning achievement. WhatsApp has several potential uses that warrant further examination. This research builds upon earlier studies by utilizing a bot-driven environment within WhatsApp to investigate both word retention and learners' engagement patterns with automated feedback.

Hashemifardnia et al. (2018) investigated the impact of WhatsApp on the vocabulary growth of Iranian EFL learners. The experimental group used WhatsApp to practice the selected English keywords outside the L2 classroom after receiving them via the messaging app. In contrast, the control group used a conventional approach to study vocabulary in the classroom. The study concluded that the experimental group fared better than the control group. However, their research did not encompass automated chatbot interaction or evaluate delayed retention—two critical components of the present study.

Bensalem (2018) used WhatsApp to study the expansion of academic English vocabulary. Forty elementary EFL students from the Arabian Gulf State University participated in this study. The experimental group completed and activated their vocabulary assignments, which included looking up new words in a dictionary, creating a sentence for each word, and sending the phrases they had produced via WhatsApp. The control group used paper and pencil, as well as the conventional method, to complete the same work as the experimental group. The

results indicated that the experimental group showed greater improvement. Unlike Bensalem's method, this study utilises a customised WhatsApp bot to automate feedback, track user engagement, and assess learners' perceptions of vocabulary learning, thereby expanding its scope and methodology.

2.3. Using Chatbot in Vocabulary Acquisition

During the COVID-19 pandemic, Qasem et al. (2023) investigated the impact of chatbot use on online courses for English for Specific Purposes (ESP) learning. They found that DialogFlow Chabot might be a fun Internet resource for ESP students learning a language. Two classrooms at the University of Bisha were selected for this investigation. The participants were taking a Business English course. The control group received instruction using a conventional approach without the assistance of Dialogflow Chabot, whereas the experimental group used the chatbot to supplement their instruction over a 12-week period. The results revealed that students in the experimental group who used DialogFlow Chabot made greater advancements in acquiring ESP vocabulary. This study, while significant, did not assess vocabulary depth or the retention of learning post-intervention, both of which are essential to the current research.

Chen et al. (2020) examined the impact of using a chatbot for learning Chinese in different educational settings. For the study, 58 students were divided into two groups: an experimental group and a control group. The control group used ChatBot in a one-on-one classroom to help them retain their language. By contrast, the experimental group employed a chatbot as a learning aid in a one-on-one learning setting. The results demonstrated that ChatBot substantially enhanced students' academic performance, with superior outcomes in one-on-one settings. It was discovered that behavioral intention could be predicted by how helpful people felt ChatBot was, and it was found to be a determinant of behavioral intent.

Chen et al. investigated the overall usefulness of chatbots; however, this study focuses on pre-intermediate English as a foreign language (EFL) learners using a domain-specific bot on WhatsApp, providing contextual and platform-specific insights. Chen et al. (2020) investigated the overall usefulness of chatbots; however, this study focuses on pre-intermediate English as a foreign language (EFL) learners using a domain-specific bot on WhatsApp, providing contextual and platform-specific insights.

Conversation scripts were developed by Jia et al. (2012) using the course curriculum as a guide. While the participants in the control group completed the same tasks using the conventional method and did not use the CSIEC chatbot, the experimental group was required to use the chatbot to fulfil one vocabulary assignment weekly, testing their vocabulary knowledge using two distinct types of questions: multiple-choice and closed-ended. According to the pretest and posttest data, the experimental group's vocabulary acquisition progressed more quickly than that of the control group. Still, the evaluation focused primarily on learning new words immediately. This study introduces a dual-measurement approach that assesses both immediate and delayed language recall, offering a more holistic perspective.

Kim (2018) investigated the impacts of chatbots on Korean EFL students' vocabulary development. This study included 47 Korean college students. While the students in the experimental group conversed with a chatbot, those in the control group acquired vocabulary via conventional in-person instruction. According to the findings, the experimental group's interactions with the chatbot resulted in a greater increase in vocabulary compared to the control group. This study broadens the investigation to a specific learner demographic (Omani EFL students), integrates both quantitative and qualitative vocabulary evaluations, and employs a WhatsApp-based bot, therefore addressing hitherto unexplored dimensions in existing research.

Zhang and Huang (2024) conducted a study with 52 learners to measure the effectiveness of using chatbots in word acquisition. Based on Large Language Models (LLMs), participants were divided into two groups: a control group without additional learning facilitators and an experimental group that received learning and instruction support from a chatbot. For eight weeks, both groups studied the same set of target words. Both immediately following the treatment and again two weeks later, post-treatment assessments were performed. These included systematic observations and quantitative evaluations of productive and receptive vocabulary knowledge. The findings showed that using an AI on LLMs greatly aids students in gaining productive and receptive vocabulary while pursuing a second language. Specifically, chatbots aid the persistent retention of functional language and accidental vocabulary development.

3. Method

The present study was designed as a quantitative investigation focusing on the development and implementation of a chatbot in an educational context. Therefore, this study employed an experimental design. This section analysed the study population, the helpful instruments, and the data analysis.

3.1. Participants

This study selected 60 Omani English as a Foreign Language (EFL) learners from the Foundation Department using a random sampling method. Based on the national curriculum in Oman, participants are required to spend one to two academic years in the General Foundation Program (GFP). The GFP program is mandatory and considered a prerequisite for higher education in Oman. Therefore, to join the specialisation departments, the GFP program prepares students in various subjects, such as English, Mathematics, and IT, with English as the medium of instruction.

The selected participants were divided into two different classes, each with 30 students. One of the classes was selected as the control group, and the other as the experimental group. The treatment was thoroughly implemented in both groups. These students were native Arabic speakers with an age range of 18–19 years. Based on the institution's placement test, the study population had intermediate English language proficiency. As these students were spending their regular training sessions in addition to this study, there was no control over factors such as age and gender.

3.2. Research Instruments

The following tools were used in the data-collection process:

3.2.1. Vocabulary Knowledge Tests

To assess the influence of the WhatsApp bot on receptive and productive vocabulary knowledge, the researchers developed and implemented one set of assessments, including a pretest, posttest, and delayed posttest, to track participants' progress during the study. The evaluations were created using the vocabulary items that the bot taught and were reviewed by experts to ensure they had content validity. The exam was challenging enough for the participants, who were placed at an intermediate level according to the institution's placement norms.

Each exam consisted of two tasks, each containing 40 questions. The choice of 40 items for each exam was made to ensure that the vocabulary spectrum was well-represented and that both receptive and productive knowledge could be accurately measured, in line with accepted criteria for vocabulary testing. The first task focused on students' receptive vocabulary. It consisted of 20 multiple-choice questions. The second task focused on productive vocabulary knowledge, including fill-in-the-blank and translation activities.

The reliability of these tests was measured through a pilot study conducted with 20 Omani EFL learners at an intermediate level within the institution where the research was carried out. The following scores were obtained, which demonstrated the high reliability of the researcher-made tests (Table 1). Two PhD holders in Applied Linguistics verified the exam questions before administration. SPSS software (version 27.0) was used to analyse the test results.

Table 1: The results of the reliability analysis for all the tests

Cronbach's Alpha	Participants (total)	N of Items
.889	20	40
.767	20	40
.850	20	40

3.2.2. NorthStar GCC 2 Edition

The researcher obtained 40 words from credible sources. The researcher chose terms from the NorthStar GCC. The words were among those to be covered during the academic semester as part of the college's course delivery plan. There are two books: one focuses on reading and writing, whereas the other focuses on listening and communication. These two books are in the second edition, and universities use them as primary textbooks at an intermediate level. Each volume contained various units, and each unit comprised ten lessons. This study was centred on unit three from both books. This study covered 40 words to be taught to students over four weeks, with 10 new words introduced and covered each week.

3.2.3. WhatsApp Bot

An interactive WhatsApp bot for word practice was created in Python. The program was linked to a local phone number. Students started the experiment by typing "Hello" to the bot throughout treatment. The pupils were immediately involved in the treatment by the bot. Three categories of questions for every word were loaded into the bots' database before the start of the treatment. These exercises included fill-in-the-blank, multiple-choice, and translation questions. These types of questions were practised, providing similar situations to those in the pretest, posttest, and delayed posttest.

The researchers created 40 interactive, 20 multiple-choice, and 20 fill-in-the-blank questions. Students were given three options for the multiple-choice questions and a phrase with missing words. To finish the phrase, the students must choose the appropriate word. Students were given sentences with missing words in the fill-in-the-blank interactive quizzes. They chose the correct word from the learning context to complete the blank. In each attempt via the interactive WhatsApp bot, students received feedback automatically on the correctness or incorrectness of their answers. The students were given an unlimited number of attempts to try the questions as often as they wanted.

The command through which Python language programming functioned in the present study was as follows:

1. Initiation:
    - Configure the WhatsApp bot to respond to new messages.
    - To store responses and queries, link the bot to a database.
2. Monitoring:
    - Keep an eye out for new messages from users.
    - Process the message that arrives (e.g., start quiz, answer question) to determine what the user is requesting.
3. Interactive Quizzes:
    - Select one question at random from the database when the user requests to begin the quiz.
    - Provide the user with a multiple-choice question or fill-in-the-blank query with options.
4. Collecting Responses
    - Verify the user's response using accurate responses found in the database.
    - Provide user feedback indicating whether their responses are correct.
    - If the answer is incorrect, allow the user to try again or proceed to the next one.
5. Feedback:
    - Give a synopsis of their performance (e.g., % of accurate answers and number of correct responses).
    - Offer to start a new quiz or offer further details or resources relevant to the quiz topic if desired.

3.3. Procedures

In the Autumn Semester of 2023, this research was conducted in regular classrooms at one of the Omani institutions in Sohar, Oman. Participants were

informed that their performance would not affect their academic standing and that their participation in the study was entirely voluntary. The experimental group utilised an interactive WhatsApp bot to practice vocabulary outside the classroom and accelerate their English learning. Under the teacher's guidance, the control group used conventional in-person language learning methods to acquire the vocabulary. The researchers held a session where the experimental group was instructed to use WhatsApp Bot to learn English words and solve technical issues. The researcher conducted a pilot session using five words from each set to ensure that all students understood the procedure.

The investigation was conducted within a four-week period. Before implementing the treatment, the researcher administered the same pretest to both groups. Subsequently, both groups learned and studied vocabulary according to the teachers' instructions. The experimental group utilised the WhatsApp bot as an aid to understand and practice vocabulary outside the classroom. The experimental groups interacted with the WhatsApp bot during the treatment for extra practice. The algorithm informed the students whether their responses were correct or incorrect and provided the correct response. Additionally, the researcher observed the students to identify potential issues.

During the inaugural week of school, pupils in the experimental group attended two sessions in the computer lab focused on vocabulary enhancement through the integration of artificial intelligence. The instructor initially delivered the lecture on the unit topic in a traditional classroom setting, adhering to the curriculum. The instructional approach altered throughout the vocabulary segment, specifically with a list of 10 target terms from the coursebook. Students in the experimental group engaged with an interactive chatbot to enhance their vocabulary. During the researcher's active participation in the session, students were allotted 15 minutes to complete the AI-focused exercises.

The researcher's responsibility was to ensure that students remained on track and to address technology challenges that enhanced AI outputs. They may repeat these tasks as frequently as desired, facilitating self-paced, mastery-oriented instruction. This system aimed to employ artificial intelligence for adaptive learning, enabling students to practice the same vocabulary set across several modalities while receiving quick, personalized feedback. In contrast, the control group acquired vocabulary through conventional classroom instruction. The teacher employed traditional presenting approaches to lecture the students on the exact 10 target vocabulary phrases. Each word was taught deductively, accompanied by its meaning, part of speech, and an example of usage.

The researcher employed elicitation procedures to ensure understanding during the presentation. Concise, targeted inquiries assess student comprehension of the significance and proper usage of the stress words without direct questioning. Students in the control group completed a comparable series of in-class vocabulary exercises, which were designed and overseen by the researcher, to replicate the conditions of the experimental group without utilizing artificial intelligence. Students collaboratively crafted brief narratives including all 10

target words to stimulate creative and contextual vocabulary use. After four weeks, the researcher administered the identical posttest to both groups. In the fifth week, the same delayed posttests were administered to assess students' overall receptive and productive vocabulary knowledge in both sets.

3.4. Data Analysis

First, it was essential to determine whether the data distribution of all tests was normal before evaluating the linked study hypothesis. To achieve this, a Kolmogorov-Smirnov test was run, and the results are shown in Table 2.

Table 2: The results of the normality test

		Kolmogorov-Smirnova		
	Groups	Statistic	df	Sig.
pretest	experimental	.137	30	.157
	control	.143	30	.119
posttest	experimental	.208	30	.002
	control	.131	30	.197
delayed posttest	experimental	.171	30	.025
	control	.128	30	.200

Table 2 confirms that the experimental group (Sig. = 0.157) and the control group (Sig. = 0.119) had p-values larger than 0.05 in the pretest, indicating that the data in both groups followed a normal distribution. In the posttest, the experimental group (Sig. = 0.002) had a significant value below 0.05, suggesting that the data was not normally distributed. On the other hand, the control group (Sig. = 0.197) exhibited normal distribution. In the delayed posttest, the experimental group (p = 0.025) continued to exhibit a distribution that was not normal, with a significance value below 0.05, while the control group (p = 0.200) maintained a normal distribution. Therefore, the parametric test could be suitable for the comparison. A repeated-measures ANCOVA was conducted to measure the changes in scores within the control group, and the results are presented in Table 3.

Table 3: Repeated measures of ANCOVA within the control group

					95% Confidence Interval for Difference	
group	group	Mean Difference	Std. Error	Sig.	Lower Bound	Upper Bound
pretest	posttest	-17.300	.460	.000	-18.469	-16.131
	delayed	-13.333	.483	.000	-14.560	-12.107
posttest	pretest	17.300	.460	.000	16.131	18.469
	delayed	3.967	.269	.000	3.283	4.650
delayed	pretest	13.333	.483	.000	12.107	14.560
	posttest	-3.967	.269	.000	-4.650	-3.283

Based on Table 3, the comparison of pretest and posttest scores revealed a significant mean difference of -17.300. The observed difference was statistically

significant (p = 0.000), indicating the enhancement from the initial to the final assessment. Similarly, when comparing the pretest to the delayed posttest, the average difference was -13.333, and the result remained highly significant, with a p-value of 0.000. The comparison between the posttest and delayed posttest revealed a mean difference of 3.967, which was statistically significant (p = 0.000). To determine which type of test, receptive or productive, students performed better in, a comparison test was conducted, and the results are presented in Table 4.

Table 4: The results of Paired-Sample effect sizes within the control group

		Standardizer	Point Estimate	95% Confidence Interval	
				Low	Upp.
Rec.posttest – prod. posttest	Cohen's d	.80230	-5.401	-6.825	-3.969
	Hedges' correction	.81286	-5.331	-6.736	-3.918
Rec. delayed posttest – prod.delayed posttest	Cohen's d	.96431	-3.491	-4.449	-2.524
	Hedges' correction	.97700	-3.446	-4.391	-2.491

Table 4 indicates statistically significant disparities between the scores of the posttests for receptive and productive skills. The effect size (Cohen's d), which compared the receptive posttest to the productive posttest, was 0.80230, indicating that learners performed better in the productive section of the test. When comparing the receptive delayed posttest to the productive delayed posttest, the effect size, as measured by Cohen's d, was 0.96431, indicating a larger effect size, which suggests better performance by students in the productive section of the delayed posttest. The findings indicated that students achieved higher scores on tests that required them to produce answers compared to assessments that required them to comprehend information. This effect was particularly noticeable in the delayed posttest.

To monitor the score changes among the experimental group participants, the nonparametric Wilcoxon Signed-Rank Test was conducted, and the results are presented in Table 5 below.

Table 5: The Wilcoxon-Signed Rank Test within the experimental group

	post- pre	Delayed post- pre	Delayed post-post
Z	-5.477	-5.477	.000
Asymp. Sig. (2-tailed)	.000	.000	1.000

Table 5 revealed a p-value (Asymp. Sig. 2-tailed) smaller than 0.001, comparing the pretest and posttest, which implies a statistically significant difference between the two sets. Specifically, the posttest scores were much higher. The delayed posttest and pretest were compared using a p-value of less than 0.001. This outcome indicated a statistically significant disparity between the scores,

implying that the improvements exhibited in the posttest are sustained to a large degree in the delayed posttest. The p-value for the delayed posttest and posttest comparison was 1.000, suggesting no statistically significant disparity between the scores. These findings indicated that the scores were consistent between the immediate and delayed posttests, showing no significant decrease or increase. A comparison test was conducted to evaluate the performance of students in the experimental group in both receptive and productive sections of vocabulary tests, as measured by posttest and delayed posttest results. Table 6 below shows the results.

Table 6: The results of the Paired Samples T Test within the experimental group

		Standardizer	Point Estimate	95% Confidence Interval	
				Lower	Upper
Rec. post – prod.post	Cohen's d	1.11211	1.738	1.161	2.304
	Hedges' correction	1.12675	1.716	1.146	2.274
Rec. delayed post – prod.delayed post	Cohen's d	.80301	2.615	1.851	3.369
	Hedges' correction	.81359	2.581	1.826	3.325

Table 6 reveals statistically significant disparities between the scores of the experimental group regarding receptivity and productivity. The receptive and productive posttest comparison showed a Cohen's d value of 1.11211, indicating a statistically significant difference, with higher receptive scores. The comparison of receptive and productive delayed posttests revealed a substantial effect size, with a Cohen's d of 0.80301 and an estimated value of 2.615, indicating a statistically significant difference in favor of receptive scores. The results suggested that students in the experimental group substantially improved their ability to understand vocabulary compared to their ability to use vocabulary, as seen by the posttests and delayed posttests.

Another parametric test was conducted to measure the differences between the groups. The results can be seen in Table 7.

Table 7: The results of the Kruskal Wallis Test between the groups

	pretest	posttest	Delayed posttest
Kruskal-Wallis H	44.885	44.348	44.909
df	1	1	1
Asymp. Sig.	.000	.000	.000

Table 7 shows that the p-value was less than 0.001, showing significant variations in the pretest results among the groups. The p-value of less than 0.001 indicates substantial variations in the posttest results among the groups. The delayed posttest scores among the groups showed significant differences with a p-value of less than 0.001. To measure the exact size of the difference between the groups, a post-hoc test is conducted, and the results are observable in Table 8.

Table 8: The results of the effect size of posttests and delayed posttests between the groups

			95% Confidence Interval	
		Point Estimate	Lower	Upper
postteat	Eta-squared	.756	.636	.819
	Epsilon-squared	.751	.630	.816
	Omega-squared Fixed-effect	.748	.626	.814
	Omega-squared Random-effect	.748	.626	.814
delayed posttest	Eta-squared	.923	.881	.943
	Epsilon-squared	.921	.879	.942
	Omega-squared Fixed-effect	.920	.877	.941
	Omega-squared Random-effect	.920	.877	.941

Table 8 shows that the effect sizes in the posttest are substantial, with Eta-squared measuring 0.756, Epsilon-squared measuring 0.751, and Omega-squared measuring 0.748. These values indicated a considerable impact. Similarly, the delayed posttest showed significant effect sizes, with Eta-squared at 0.923, Epsilon-squared at 0.921, and Omega-squared at 0.920. The consistently high effect sizes observed in all phases indicate a considerable influence of the independent variable on the dependent variable, suggesting that the interventions or circumstances being tested have effective and enduring consequences.

4. Discussion

The main objective of this study was to develop an educational chatbot using Python to teach receptive and productive vocabulary. Although learners in the control and experimental groups received similar face-to-face instruction to develop vocabulary knowledge, the WhatsApp bot facilitated vocabulary learning within the experimental group. The study results showed smooth progress of students in vocabulary learning for both groups. This could result from the general instructions that students received during their classes.

However, after comparing both groups, it was observed that learners in the experimental group made significant progress in vocabulary learning; therefore, it can be concluded that using technological devices, such as interactive chatbots, is a functional tool in language learning environments. This finding is consistent with a previous study conducted by Alemi et al. (2015), which demonstrated that chatbots can enhance language memory by promoting increased student engagement and motivation.

Moreover, comparing the receptive and productive sections in both groups, as well as the posttest and delayed posttest, revealed that the control group performed better in the productive vocabulary test. In contrast, the experimental group demonstrated higher receptive knowledge of vocabulary. This aligns with Nation's (2001) theoretical paradigm, which distinguishes between receptive and

productive vocabulary knowledge, suggesting that distinct types of input and output exposure influence these types of knowledge.

There are several reasons to justify the findings of this study. First, in contrast to conventional classroom training, chatbots offer a dynamic environment that allows students to connect in a personalised manner due to their interactive nature, which encourages active engagement. Due to WhatsApp's simplicity and widespread availability, learning is more easily accessible beyond traditional educational settings. With the flexibility to interact with the chatbot at their preferred rates and comfort, students can enhance their study habits with adaptable learning possibilities.

Additionally, the chatbot's interactive features create a welcoming learning environment in which students can experiment with language without worrying about being judged. When social pressure is absent, people are more willing to take opportunities and explore, which boosts their confidence and drives them to participate actively in vocabulary acquisition activities. These findings are consistent with Vygotsky's (1978) sociocultural theory, which emphasizes the importance of mediated interaction in language learning. The chatbot serves as a bridge, helping learners in their Zone of Proximal Development (ZPD), encouraging them to take charge of their learning, and enhancing their thinking skills.

Incorporating an interactive WhatsApp bot into language learning offers a comprehensive strategy for acquiring vocabulary by leveraging technology to enhance accessibility, engagement, personalisation, and learner autonomy. The chatbot successfully stimulates students' vocabulary expansion by accommodating various learning preferences and demands, ultimately contributing to more robust linguistic competency. This result supports Kukulska-Hulme and Shield's (2008) study on mobile-assisted language learning (MALL), indicating that mobile technologies enhance learner independence and facilitate the acquisition of new words in a relaxed setting.

In addition, considering the contrasting emphasis on teaching approaches between the control and experimental groups, the former probably employed conventional teaching methods focused on developing productive vocabulary through speaking and writing activities. These exercises involved actively recalling and using vocabulary, resulting in improved performance in productive vocabulary. On the other hand, the experimental group may have participated in activities that focused on receptive abilities, including reading and listening.

This would have given them a wider range of vocabulary in real-life situations and reduced the mental effort required for active usage. Focusing on receptive learning methods would naturally result in improved performance in receptive vocabulary exams, as pupils become more skilled at passively recognizing and comprehending words. The control group's better performance in productive vocabulary and the experimental group's higher scores in receptive vocabulary are consistent with the different instructional focusses and cognitive processes

used in each group's learning activities. This classification of learning outcomes aligns with Laufer and Goldstein's (2004) assertion that different activities enhance specific vocabulary dimensions, whereas form-focused output tasks strengthen productive knowledge, and input-oriented tasks promote receptive vocabulary growth.

The study's conclusions align with those of Al Ghaithi et al. (2024), who developed a WhatsApp bot to teach vocabulary to EFL students at various levels of English proficiency. Compared with traditional in-person lectures, experimental groups employing basic- and intermediate-level WhatsApp bots showed notable differences. The results of this research are consistent with those of Rashtchi and Yazdani (2020), who employed two distinct modalities, including voice messages and written texts, to assess EFL students' deliberate word acquisition and retention using the WhatsApp application. The pretest and posttest scores of the students differed significantly after the 12 therapy sessions. These findings support the idea that deliberate vocabulary acquisition and retention might benefit from WhatsApp.

Thus, social media may be a significant factor in language acquisition. In light of the EFL scenario, it is worth noting that this function may be transferred to social media in the capacity of the facilitator, as there is no access to the target language in the shared living space. One of the tremendous benefits of using apps like WhatsApp is the individualisation of learning, where students can participate in the learning process at any time and from any location using their smartphones (Rashtchi & Tollabi Mazraehno, 2019).

In a related study, Jafari and Chalak (2016) assessed the impact of WhatsApp on vocabulary acquisition. Students in the experimental group were given word directives and activities via WhatsApp, whereas students in the control group were instructed in conventional in-class scenarios. The study results showed that the experimental group, which utilized WhatsApp for vocabulary acquisition, outperformed the control group in the same vocabulary and tasks.

However, the current study's findings contradict those of Dehghan et al. (2017), who investigated the effects of teaching new terms to Iranian English as a foreign language (EFL) students using WhatsApp. The control group attended regular in-person lessons, whereas the experimental group received a list of new terms via WhatsApp. The results of this investigation did not show any appreciable variation between the two groups in the given test. The study's authors speculated that student use of WhatsApp may have caused distractions that impacted the study's findings.

5. Conclusion

With an emphasis on receptive and productive vocabulary learning, this study aimed to develop an interactive WhatsApp bot for vocabulary instruction. Following the intervention, which involved using an interactive WhatsApp bot in a classroom setting, the experimental group significantly outperformed the control group in both the posttest and the delayed posttest.

The results of this study are significant for teachers, curriculum developers, students, and institutions. Teachers are encouraged to promote the use of mobile applications and social media to enhance students' access to learning resources. WhatsApp could be valuable for teachers to teach students many words when class time is limited. However, it is recommended that teachers employ monitoring strategies via WhatsApp to ensure that their students are focused on learning. Curriculum developers can utilise the findings of this study to select the most suitable technology to support vocabulary learning in a language learning environment. Students can use mobile phones and applications to facilitate vocabulary learning during their education. This enables them to access materials outside the classroom, resulting in smooth learning progress.

The chatbot's demonstrated effectiveness in enhancing receptive vocabulary knowledge underscores the potential of interactive digital technology to supplement traditional classroom learning. Schools may utilise these tools to encourage students to take the initiative in their learning, engage them more deeply in their education, and offer them additional options for learning beyond the classroom. The differing outcomes of receptive and productive vocabulary acquisition underscore the need to align digital treatments with specific linguistic goals. These insights can help institutions plan their curriculum, share resources, and educate their teachers. As technology improves language instruction, schools that use these improvements may be able to create more dynamic and effective learning environments.

This study had certain limitations that need to be acknowledged. The small sample size, limited to one school in Oman, makes it challenging to generalize the results to all Omani EFL learners. Secondly, the study focused solely on intermediate-level students, so omitting learners of varying proficiency levels whose responses to the intervention would differ. Thirdly, gender was not considered in the participant selection process, which restricted the ability to identify any gender-related differences in performance or technological engagement. Ultimately, while the study focused on learners' results, it failed to investigate the opinions and attitudes of EFL teachers, which might have yielded greater insight into the effectiveness and acceptance of chatbot-based vocabulary instruction.

This study's findings and limitations provide several avenues for further investigation. As educational technology continues to progress rapidly, subsequent studies should examine the application of developing digital platforms beyond WhatsApp, particularly those focusing on various aspects of language learning, including grammar, reading, and speaking. Additionally, expanding the sample to include various institutions across Oman would provide a more comprehensive understanding of the readiness of both students and teachers for technology-enhanced language education. Further research should investigate the effectiveness of these tools across a broader range of language proficiency levels, encompassing both beginner and advanced learners. Furthermore, future studies might be designed to incorporate gender as a variable to investigate any differences in learning outcomes. Ultimately, analyzing

educators' perspectives and attitudes toward the integration of interactive technology in language instruction may yield valuable insights for institutional implementation and pedagogical approaches.

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