The Effect of Using Artificial Intelligence on Learning Vocabulary among Jordanian EFL University Students

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Abstract

This study examines the role of Artificial Intelligence (AI) in enhancing English vocabulary acquisition among university students at Al-Hussein Bin Talal University in Jordan. A quasi-experimental design was employed, involving 40 EFL students, evenly split by gender (20 males and 20 females), all of whom were enrolled in the Basic English Language Course. The students were randomly assigned to either an experimental group, which utilized the Duolingo app for vocabulary learning, or a control group, which followed traditional methods of vocabulary instruction. The intervention was conducted during the first semester of the 2023/2024 academic year, and the results were analyzed using SPSS. Analytical methods included (MANOVA), T-tests, and (ANCOVA), which helped assess the impact of AI-driven tools compared to conventional approaches. The findings revealed that students using Duolingo showed significant improvement in vocabulary acquisition compared to the control group. Furthermore, no significant differences in learning outcomes were observed between male and female participants, suggesting that AI-driven tools are equally effective for all learners. The study concludes by recommending the integration of AI-based platforms like Duolingo into EFL curricula and calls for further research to explore their long-term effects on various aspects of language learning.

Keywords: Artificial Intelligence, Jordan, English Language Vocabulary, Higher education. Technology integration.

1. Introduction

The education system in Jordan has long been recognized as a key driver of socio-economic development, with English language proficiency playing an increasingly pivotal role in equipping citizens for the global economy. Since the early 1990s, English has been systematically integrated into the national curriculum, beginning in primary schools and continuing through to higher education. This comprehensive approach develops students' verbal communication, thus preparing them for diverse communication needs in both academic and professional contexts. However, despite these efforts, the traditional pedagogical methods employed in many classrooms have faced significant criticism. They often emphasize rote memorization and the mastery of grammatical rules at the expense of fostering practical language skills and fluency. As a result, students frequently struggle with applying their knowledge in

real-life situations, which hinders their ability to communicate effectively in English (Alhabahba, Pandian, & Mahfoodh, 2016).

Vocabulary, which is central to language learning, has also been a challenging area for learners. Schmitt (2000) noted that understanding a word requires not only knowledge of its form and meaning but also an understanding of its use within a specific context. This comprehensive view of vocabulary acquisition underscores the complexity of the learning process, where students must grasp pronunciation, spelling, and grammatical structures, as well as semantic nuances. Moreover, as Hiebert, Scott, Castaneda, and Spichtig (2019) highlighted, the challenges of learning vocabulary often stem from the intrinsic difficulty of the words themselves, further complicating the acquisition process for learners. Without sufficient opportunities to engage with new vocabulary in meaningful contexts, students may fail to achieve the level of mastery necessary for fluent communication (Crossley, Subtirelu, & Salsbury, 2013).

To address these limitations, there is a growing interest in leveraging technology, particularly Artificial Intelligence (AI), to enhance language learning outcomes. AI-based tools, such as Duolingo, have introduced a dynamic, personalized approach to vocabulary acquisition, offering learners a more interactive and adaptive learning experience. These tools are in line with the principles of deeper cognitive processing, which emphasize the importance of engaging students in tasks that require critical thinking, categorization, and the establishment of semantic connections between words (Tomlinson, 2013). By incorporating AI into language learning, educators have the potential to move beyond traditional rote memorization techniques, allowing students to engage more deeply with the language and improve their overall proficiency.

Thus, the current study seeks to investigate the impact of the Duolingo AI application on vocabulary acquisition among Jordanian EFL university students. Specifically, this research aims to explore whether AI-driven learning can offer measurable advantages over traditional methods of vocabulary instruction, and whether gender differences influence learning outcomes. By examining these factors, this study intends to contribute valuable insights into how AI tools can be integrated into English language curricula in Jordan, helping to modernize teaching practices and improve students' language skills in an increasingly globalized world.

Statement of the Problem

Within the field of ELT, a persistent and formidable challenge revolves around the effective learning of vocabulary among EFL students in the educational landscape of Jordan. Historically, traditional pedagogical methods rooted in rote memorization and stringent grammar instruction have hindered the development of a comprehensive and versatile English vocabulary. This challenge is multifaceted, encompassing the complexities of vocabulary acquisition, which extends beyond mere memorization to include nuanced aspects such as pronunciation, spelling, morphology, semantics, and cultural nuances. Consequently, EFL students in Jordan often face limitations in their ability to communicate confidently and proficiently in English, which is a vital skill for their academic and socio-economic advancement.

Considering these challenges, there emerges a growing recognition of the potential of AI as a transformative tool within the field of ELT. AI-driven solutions offer a personalized and

interactive approach to vocabulary learning, providing real-time feedback and tailored activities that cater to individual student needs. By facilitating the exploration of words within diverse contexts and fostering a deeper understanding of vocabulary elements, AI holds promise to address the persistent vocabulary learning challenges faced by EFL students in Jordan. However, despite the growing enthusiasm for AI's potential, there remains a need for empirical research to comprehensively assess its effectiveness and practical implementation within the specific educational context of Jordan and its implications for enhancing language proficiency and communication skills among EFL learners.

Purpose of the Study

This study aims at investigating the efficacy of integrating Artificial Intelligence (AI) into ELT to address the enduring challenge of vocabulary learning among EFL students in Jordan's education setting. This study assesses the practical implementation and impact of AI-driven solutions on enhancing vocabulary learning. Through this investigation, the study aspires to inform pedagogical practices and educational policies, fostering more effective strategies for vocabulary learning within the specific context of Jordanian EFL education.

Significance of the Study

The research holds importance in the context of EFL pedagogy in Jordan and offers broader implications for the adoption of educational technology. First, it makes a valuable contribution to addressing the ongoing challenge of vocabulary acquisition in Jordanian EFL classrooms. By empirically examining the effectiveness of incorporating AI into vocabulary learning, the study has the potential to transform traditional pedagogical strategies. It emphasizes the importance of creating adaptable learning experiences, which can help bridge achievement gaps and enhance overall learning outcomes for diverse groups of learners.

Additionally, this research carries notable implications for educational technology adoption in Jordan. It provides a practical example for educational institutions to integrate AI-based tools into their curricula. By showcasing the benefits of AI integration, including improved learning outcomes and cost-effectiveness, this study offers valuable insights for institutions considering the adoption of similar technologies. Furthermore, it positions Jordan as an active participant in the international trend toward technological innovation in education, demonstrating the country's commitment to staying at the forefront of advancements in teaching and learning. In doing so, the study aligns Jordan with international developments in language education, ensuring that the nation remains competitive in providing high-quality, technology-enhanced educational experiences.

Research Questions

In ELT in Jordan, the integration of AI has emerged as a topic of increasing significance. This research seeks to explore these questions:

- Are there any statistically significant differences ($\alpha \leq 0.05$) between the means score results of the students in the control group and the experimental group in learning vocabulary

among Jordanian EFL university students due to the teaching method (using artificial intelligence method and the conventional method)?

- Are there any statistically significant differences in vocabulary learning when using AI due to gender?

2. Literature Review

Vocabulary acquisition is widely recognized as a critical component in mastering a second language, as it forms the foundation for effective communication in both spoken and written contexts. Schmitt (2000) and Nation (2001) argue that vocabulary knowledge is integral to language use, with a reciprocal relationship between vocabulary proficiency and broader language skills. However, traditional approaches to vocabulary learning, such as rote memorization, have been criticized for their limitations in fostering deeper engagement with the language. Alqahtani (2015) highlights that many learners struggle to retain and apply new vocabulary effectively, largely due to the complexity of vocabulary, which includes understanding a word's form, meaning, and usage in various contexts.

Artificial intelligence (AI) has emerged as a promising solution to many of these challenges in language learning, offering personalized and adaptive learning experiences that cater to individual student needs. According to Ng, Leung, Su, Ng, and Chu (2023), AI-driven educational applications, such as intelligent tutoring systems and automated assessments, can provide immediate feedback and tailored instruction, thereby enhancing student engagement and learning outcomes. These technologies starkly contrast conventional teaching methods, offering a more flexible and responsive learning experience. However, the increasing prevalence of AI in education raises significant concerns, particularly regarding data privacy, algorithmic biases, and the evolving role of educators. These challenges necessitate a careful examination of how AI technologies are implemented to ensure they enhance, rather than hinder, the educational process.

The introduction of smart educational applications such as Duolingo reflects the integration of several key learning theories into the design of these AI-driven tools. Constructivist learning theory (Piaget, 1954; Vygotsky, 1978), which emphasizes active learning and knowledge construction through experience, is evident in the interactive and adaptive features of these applications. Duolingo, for example, allows learners to engage with content at their own pace, fostering vocabulary acquisition in a flexible, personalized environment. Additionally, behaviorist learning theory (Skinner, 1953), particularly the principles of operant conditioning, underpins many of these tools. Gamification elements, such as rewards, points, and badges, serve as reinforcement mechanisms that motivate students to continue learning by providing immediate feedback and recognition for their efforts.

Cognitive load theory (Sweller, 1988) is another key framework influencing the design of smart educational applications. This theory suggests that learning environments should be structured to minimize unnecessary cognitive effort, allowing learners to focus on the most relevant

information. Duolingo and similar platforms address this by breaking down complex language tasks into manageable chunks and presenting information using multimodal approaches—such as text, images, and audio—that engage learners through multiple sensory channels. This approach aligns with dual-coding theory (Paivio, 1986), which posits that learning is more effective when both verbal and non-verbal information is processed simultaneously. Furthermore, self-determination theory (Ryan & Deci, 2000) is reflected in the motivational strategies employed by these applications. By offering learners autonomy over their learning paths and providing feedback that fosters a sense of competence, these tools enhance intrinsic motivation, which is crucial for sustained engagement in language learning.

It has been demonstrated that AI applications can positively impact various language skills, including vocabulary and listening comprehension. For instance, Al-mawaly and AL-Jamal (2022) found that AI applications significantly improved the listening comprehension skills of Jordanian EFL students. This aligns with findings from other studies which emphasize the potential of AI-driven learning platforms to create personalized and adaptive learning experiences, thus addressing the individual needs of students more effectively than traditional methods (Aljohani, 2021). By providing continuous feedback and structured practice, AI tools like Duolingo have the potential to enhance language fluency and support students in acquiring complex language skills (Putri & Islamiati, 2018).

Duolingo, in particular, has garnered significant attention for its role in vocabulary acquisition. Istiqamah, Latifa, and Larekeng (2023) found that second-grade students who used Duolingo demonstrated significantly greater vocabulary mastery compared to those who relied on traditional teaching methods. This was attributed not only to the gamification elements of Duolingo but also to its ability to adapt to individual learning needs, providing personalized instruction that keeps learners engaged.

However, while the benefits of Duolingo are well-documented, there are critical issues regarding its long-term efficacy. Some scholars have expressed concerns that the over-reliance on gamification might reduce intrinsic motivation over time (Ryan & Deci, 2000). Ajisoko (2020) reported that while students initially displayed high levels of motivation when using Duolingo, this engagement appeared to wane after the novelty of the app diminished. Moreover, although Duolingo provides immediate feedback, Cunningham (2015) suggests that it lacks comprehensive explanations of complex grammatical rules, which are essential for achieving higher levels of language proficiency. Therefore, while Duolingo is effective for vocabulary acquisition, it may not fully support more advanced language learning outcomes that require a deeper understanding of grammar and syntax.

Moreover, Duolingo aligns with self-determination theory (Ryan & Deci, 2000), as it fosters autonomy, competence, and relatedness—three core factors that enhance learner motivation. Users can control their pace of learning, engage in self-directed study, and receive feedback that bolsters their sense of competence. However, limitations remain, particularly in providing rich contextual experiences necessary for advanced conversational practice. Portnoff, Gustafson, Bicknell, and Rollinson (2021) argue that while Duolingo offers conversation exercises, these are largely automated and lack the authenticity of real-life language interactions. This limitation

highlights the need for further enhancement to provide a more holistic language learning experience.

In an experimental study by Alsadoon (2021), AI-driven Chabot was used alongside Duolingo to enhance vocabulary acquisition. The findings revealed that combining multiple AI tools—such as Duolingo for vocabulary retention and Chabot for conversational practice—offered a more comprehensive language learning experience. This integration of multiple AI platforms addresses some of Duolingo's limitations, suggesting that a combination of tools may be necessary to fully support diverse language learning needs.

Overall, while Duolingo and other AI-powered platforms hold significant promise for improving vocabulary acquisition, their long-term impact on language learning requires further exploration. Current research suggests that while these tools are highly effective for beginner and intermediate learners, they may need to be supplemented with additional instructional support and resources to fully address the complexities of language acquisition. Lei (2022) emphasizes the importance of continuously improving AI technologies to overcome their current limitations, particularly the lack of deeper grammatical explanations and the need for more authentic conversational practice.

In sum, the integration of AI in language education, particularly through smart applications like Duolingo, offers considerable opportunities for enhancing vocabulary acquisition and overall language proficiency. However, these technologies must be carefully implemented, with attention to issues such as teacher training, data privacy, and access disparities. Al Amri and Almaiah (2021) highlight that the effectiveness of AI tools is contingent on equitable access to technology, and without addressing these challenges, the potential of AI to transform education may remain unrealized.

The current research addressing the effectiveness of AI applications in vocabulary learning provides valuable insights, yet it reveals several critical research gaps. One prominent gap is the predominant focus on elementary and primary school students, which underscores the need for a more comprehensive exploration of university-level EFL students in Jordan. Understanding how AI applications impact vocabulary acquisition among university students is essential, as they possess distinct learning needs and capabilities that differ from those of young learners.

Furthermore, while conducted in various countries and contexts, these studies often overlook the critical cultural and contextual factors that could influence the implementation and effectiveness of AI applications in vocabulary learning, especially among Jordanian EFL university students. Factors such as cultural factors, language proficiency levels, and educational backgrounds may shape the outcomes of AI-driven interventions. Consequently, future research must place a strong emphasis on considering these contextual factors when examining the impact of AI on vocabulary learning. This approach will develop more effective strategies for integrating AI technology into language learning programs, particularly in the unique context of Jordanian EFL university students.

The imperative to conduct an in-depth investigation into the influence of AI applications on vocabulary acquisition among university-level Jordanian EFL students is pronounced. Although

extant literature has provided valuable insights into the efficacy of AI in enhancing vocabulary learning, a substantial knowledge gap persists concerning its precise effects on university students in Jordan. This demographic is characterized by distinct learning prerequisites, motivational factors, and varying levels of language proficiency, diverging from the younger cohorts often studied. Additionally, the intricate interplay of cultural and contextual variables unique to Jordanian EFL university students may substantially influence the outcomes of AI-based interventions. The pursuit of this inquiry holds significant implications for educational practices. It offers the opportunity to tailor AI-infused language learning methodologies to the particular requisites of this demographic, thus elevating the overall caliber of English language education in Jordan.

3. Methodology

Research Design

This study used a quasi-experimental research design to examine the effect of the Duolingo AI application on vocabulary acquisition among university-level Jordanian EFL students. A quasi-experimental approach was selected for its ability to facilitate comparative analysis between groups while considering the limitations of real-world educational settings. The research involved two distinct groups: the experimental group, which utilized the Duolingo application in vocabulary learning, and the control group, which used traditional vocabulary learning techniques without the usage of the app. Both groups were evaluated using pre-tests and post-tests to measure any significant differences in vocabulary acquisition. Pre-tests were conducted to determine the initial proficiency of each group, followed by post-tests to assess the level of improvement after the study period. The aim was to identify any measurable advantages in vocabulary learning attributed to the use of AI-driven technology.

Participants

The research was conducted at Al-Hussein Bin Talal University, specifically within the Faculty of Arts, Department of English Language and Literature. A total of 40 university students participated, equally divided between male (20) and female (20) students. The experimental group comprised 10 males and 10 females, while the control group followed the same gender distribution. Participants, aged between 18 and 22 years, were enrolled in a Basic English Language Course, which aligned with the researcher's focus on vocabulary acquisition as part of English language development. Students were randomly assigned to the experimental group, which engaged with Duolingo for vocabulary learning, or the control group, which continued with conventional vocabulary teaching methods.

Data Collection

Instruments of the Study

The Duolingo Application

Portnoff, et al. (2021) stated that Duolingo, established in 2012, is an online language-learning platform that offers courses in 27 different languages and provides a mobile application compatible with Android, IOS, and Windows devices. It serves as a private language tutor, delivering individualized instruction through gamified activities. Duolingo caters to a diverse user base, including non-native speakers pursuing language learning for various purposes, such as business, work, or educational needs. While users can access Duolingo without creating an account, registering allows them to save their progress. The platform offers users the flexibility to choose their language and learning level, adjusting the learning experience to their abilities. Duolingo offers a dynamic and gamified approach to language learning, combining vocabulary and grammar acquisition with interactive exercises and elements of gaming, making it engaging and enjoyable for learners.

This study specifically employs the Duolingo application as a key tool in its research design. Duolingo's innovative approach to language learning is evident in its structured lessons, divided into levels or "trees" focusing on specific language aspects. These include vocabulary, grammar, idioms, and cultural references, providing comprehensive language instruction. Additionally, the study acknowledges the introduction of Duolingo for Schools, a feature designed for educators to create classrooms, assign homework, and monitor student progress. This development enhances teacher effectiveness and offers a personalized learning experience for students, with the ability to track their progress and receive feedback. Duolingo's manage classroom, create assignments, and view student activity features further facilitate teacher-student interactions and learning management (Portnoff, et al., 2021).

Cunningham (2015) stated that despite its advantages, Duolingo has limitations. While it offers a game-based approach to language learning and tracks learners' progress, it lacks the ability to provide learners with exposure to natural language spoken by native speakers. The automated sound system used in listening exercises falls short of replicating the nuances of spoken language. Furthermore, Duolingo does not offer comprehensive explanations of grammar structures, which is a critical component of language learning. These limitations can hinder learners' ability to fully grasp the intricacies of a language and may impact their performance on assignments.

The Pre/Posttest

The study commenced with the pre-test conducted by the researcher to assess the initial competency of both the experimental and control groups in vocabulary learning. After completing 36 lectures, the posttest was administered to evaluate the effect of Duolingo Application usage on participants' vocabulary learning. This test covered spelling, connotation, collocation, denotation, and derivation. The test scored on a scale of 25, comprised of multiple-choice questions, with each of the aspects being tested by five items (see Appendix 1 for details).

Validity and Reliability of the Instruments

The evaluation of the research instruments involved the expertise of professors specializing in TEFL, CALL, and linguistics. These experts were invited to assess the correctness, clarity, validity, and appropriateness of the instruments used in the study. Their valuable insights,

observations, and suggestions were carefully considered during this evaluation. Various aspects of the instruments, including the test score distribution, question composition, format, and grammatical accuracy, were scrutinized. Additionally, the time required for completing the questions was considered. Their feedback encompassed recommendations such as including additional questions, rectifying typographical errors, and incorporating objective question types.

To ensure the reliability of the instruments, a test-retest method was employed, known for its robustness in yielding clear and accurate results in the context of this recent study. This phase involved conducting a pilot research initiative in which a test was administered to a group of 30 students for the first time. Their initial responses served as a baseline for further evaluation and refinement of the instruments. Two weeks later, the same group of students participated in a re-test, aiming to assess the test's reliability. The application of Person's formula led to determining of a reliability coefficient of 85%. This high level of reliability substantiates the instruments' consistency and dependability, establishing them as reliable tools for assessing the research objectives.

Procedures of the Study

The research was conducted in the first semester of the 2023/2024 academic year at Al-Hussein Bin Talal University. The participants in this study were already divided into two groups randomly designated as experimental and control groups. The investigation utilized a pre/post-test in vocabulary learning to determine if there were notable statistical differences in vocabulary learning and its related components between the control and experimental groups.

In the initial session, the researcher administered a 40-minute pre-test to 40 students. Following the test, the responses were collected and evaluated.

During the second session, the students, in the experimental group, were instructed to use Duolingo to improve various aspects of their vocabulary. This method was implemented over a period of six weeks, with five 50-minute lessons each week.

Both the experimental and control groups underwent a post-test. Subsequently, the tests were collected and assessed.

To address the research questions, statistical analysis was conducted. The data from the tests was systematically analyzed.

4. Results

The study implemented various statistical analyses such as means, standard deviations, MANOVA, and T-tests for all the variables under investigation. This included comparing the instructional methods (using Duolingo versus conventional teaching) across both experimental and control groups in terms of vocabulary and its various aspects, such as spelling, denotation, connotation, collocation, and derivation.

Before commencing the experiment, a pre-vocabulary test was given to both groups to assess their initial proficiency levels. To identify any significant differences between the two groups, statistical analysis was conducted using means, standard deviations, and a t-test. The results are presented in the table below.

Table 1: Means, Standard Deviation and t-test results of the Experimental and Control Groups on Pre vocabulary test.

	GROUP	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Spelling pre	Experimental	20	3.20	1.105	.473	38	.639
	Control	20	3.05	.887			
Denotation pre	Experimental	20	2.95	1.099	1.476	38	.148
	Control	20	2.55	.510			
Connotation pre	Experimental	20	2.55	.887	-.386	38	.702
	Control	20	2.65	.745			
Collocation pre	Experimental	20	2.70	.979	-.447	38	.657
	Control	20	2.85	1.137			
Derivation pre	Experimental	20	2.15	1.226	.459	38	.649
	Control	20	2.00	.795			
Pre total	Experimental	20	13.55	3.220	.501	38	.619
	Control	20	13.10	2.404			

Table 1 demonstrates that the pre-test scores for both groups were comparable prior to the experiment. This confirms that the two groups were initially at an equivalent level before the intervention. Additionally, the analysis indicates that the difference in scores between the two groups on the pre-vocabulary test was statistically insignificant.

1. Are there any statistically significant differences ($\alpha \leq 0.05$) between the means score results of the students in the control group and the experimental group in learning vocabulary among Jordanian EFL university students due to the teaching method (using the artificial intelligence method and the conventional method)?

Means and standard deviations and estimated marginal means of participants' vocabulary test scores, due to the teaching method (using the artificial intelligence method and the conventional method) are shown in the table below.

Table 2: Means, standard deviations, and estimated marginal means of participants' vocabulary test scores due to the teaching method.

		Pre		Post		Estimated Marginal Means	Std. Error
teaching method	N	Mean	Std. Deviation	Mean	Std. Deviation		
using artificial intelligence	20	13.55	3.220	20.60	2.371	20.454	.463
conventional	20	13.10	2.404	17.05	3.086	17.196	.463

Table 2 shows a slight variance in the means of the pre, and post participants' vocabulary test score attributed to the teaching method (using artificial intelligence method and the conventional method), to find out whether there are statistical significant differences in these means, one way

ANCOVA was conducted and the results are shown in tables 3.

Table 3: One-way ANOCVA results of participants' vocabulary test scores related to the teaching method.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Group	129.488	1	129.488	30.273	.000	.450
Pretest (covariate)	105.425	1	105.425	24.647	.000	.400
Error	158.262	37	4.277			
Corrected Total	413.775	39				

Table 3 reveal that there are statistically significant differences at (α= 0.05) in participants' vocabulary test scores due to the teaching method in favor of using artificial intelligence method.

Means and standard deviations and estimated marginal means of domains of the vocabulary test, due to the teaching method are shown in table below.

Table 4: Means, standard deviations and estimated marginal means of domains of vocabulary due to the teaching method.

			Pre		Post		Estimated Marginal Means	Std. Error
	Group	N	Mean	Std. Deviation	Mean	Std. Deviation		
Spelling pre	Experimental	20	3.20	1.105	4.55	.605	4.521	.127
	Control	20	3.05	.887	4.00	.795	4.029	.127
Denotation pre	Experimental	20	2.95	1.099	4.15	.933	4.059	.186
	Control	20	2.55	.510	3.40	.754	3.491	.186
Connotation pre	Experimental	20	2.55	.887	3.95	.826	3.917	.165
	Control	20	2.65	.745	3.35	.813	3.383	.165
Collocation pre	Experimental	20	2.70	.979	4.10	.641	4.136	.145
	Control	20	2.85	1.137	3.20	.894	3.164	.145
Derivation pre	Experimental	20	2.15	1.226	3.85	.813	3.825	.221
	Control	20	2.00	.795	3.10	1.210	3.125	.221

Table 4 shows a slight variance in the means of the pre and post domains of vocabulary test score attributed to the teaching method (using artificial intelligence method and the conventional method), to determine whether there were statistically significant differences between these means, a one-way MANCOVA was performed. The results of this analysis are presented in Table 5.

Table 5: One-way MANOCVA results of the domains of vocabulary attributed to the teaching method.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
GROUP Hotelling's Trace= 1.062 P=.001	Spelling post	2.158	1	2.158	7.127	.012	.178
	Denotation post	2.891	1	2.891	4.417	.043	.118
	Connotation post	2.544	1	2.544	4.970	.033	.131
	Collocation post	8.440	1	8.440	21.114	.000	.390

	Derivation post	4.388	1	4.388	4.742	.037	.126
Pre-Spelling (Covariate)	Post	5.136	1	5.136	16.962	.000	.339
Pre-Denotation (Covariate)	Denotation post	2.505	1	2.505	3.828	.059	.104
Pre-Connotation (Covariate)	Connotation post	3.028	1	3.028	5.916	.021	.152
Pre-Collocation (Covariate)	Collocation post	7.500	1	7.500	18.761	.000	.362
Pre-Derivation (Covariate)	Derivation post	1.242	1	1.242	1.342	.255	.039
Error	Spelling post	9.992	33	.303			
	Denotation post	21.594	33	.654			
	Connotation post	16.889	33	.512			
	Collocation post	13.192	33	.400			
	Derivation post	30.538	33	.925			
Corrected Total	Spelling post	21.975	39				
	Denotation post	32.975	39				
	Connotation post	29.100	39				
	Collocation post	31.100	39				
	Derivation post	45.975	39				

Table 5 shows significant differences at (α= 0.05) in all domains (Spelling, Denotation, Connotation, Collocation, Derivation) due to the teaching method, which favors using artificial intelligence.

2. Are there any statistically significant differences in vocabulary learning when using AI due to gender?

To answer the second question of the study, mean ranks and Mann-Whitney U of vocabulary learning total score and its domains when using AI due to gender were calculated, the findings are displayed in Table 6

Table 6: Whitney U results of vocabulary learning total score and its domains when using AI due to gender.

		N	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Spelling post	Male	10	10.30	103.00	48.000	103.000	-.175	.861
	Female	10	10.70	107.00				
Denotation post	Male	10	10.00	100.00	45.000	100.000	-.404	.686
	Female	10	11.00	110.00				
Connotation post	Male	10	10.80	108.00	47.000	102.000	-.240	.810
	Female	10	10.20	102.00				
Collocation post	Male	10	8.10	81.00	26.000	81.000	-2.072	.038
	Female	10	12.90	129.00				
Derivation post	Male	10	10.20	102.00	47.000	102.000	-.242	.809
	Female	10	10.80	108.00				

Post total	Male	10	10.25	102.50	47.500	102.500	-.192	.848
	Female	10	10.75	107.50				

Table 6 shows there are no statistically significant differences at (α= 0.05) due to gender variable in all domains and total scores.

5. Discussion of Results

This study explored the impact of the Duolingo AI application on vocabulary acquisition among university-level EFL students in Jordan. The results reveal several important insights into the effectiveness of AI-driven language learning tools like Duolingo, particularly within the context of Jordan's evolving educational landscape.

First and foremost, the findings demonstrate that Duolingo has a significant positive effect on vocabulary acquisition for university students, which is consistent with prior research. The app's gamified and interactive features play a pivotal role in enhancing student engagement and motivation. Duolingo's ability to utilize a multisensory learning environment, incorporating visual aids, sound feedback, and stimulating activities, has been shown to aid memory retention. This is supported by the dual-coding theory, which posits that learning is more effective when auditory and visual information are presented simultaneously. Thus, the combination of visual and auditory elements in Duolingo makes the process of learning new vocabulary more dynamic and memorable, a finding in line with studies by (Ajisoko, 2020).

What is newly revealed by this study is the degree to which personalization through AI algorithms contributes to vocabulary learning. Duolingo's advanced learning algorithms offer customized learning pathways, adjusting to the proficiency level and pace of each individual learner. This study underscores how tailored learning experiences, as highlighted by Portnoff et al. (2021), ensure that learners remain consistently challenged without becoming overwhelmed. This adaptability leads to enhanced engagement, a key factor that keeps students invested in their language learning journey over time. While previous research has alluded to this adaptability, this study further highlights its importance in maintaining a balance between challenge and accessibility, especially for university students who may juggle various academic and personal commitments.

Another important aspect of this study is Duolingo's ability to provide immediate feedback, which facilitates an iterative learning process. The results showed that prompt correction of errors was crucial for reinforcing the accurate use of vocabulary. This is consistent with language acquisition theories, which highlight the important role of practice and correction. Students who received instant feedback were able to self-correct more efficiently, leading to better retention and application of newly acquired vocabulary. This finding suggests that AI-powered applications like Duolingo can potentially fill the gap in traditional classroom environments, where immediate, personalized feedback is often limited due to time constraints or large class sizes.

The study also examined the flexibility that Duolingo offers, allowing students to engage in learning activities at their convenience. This flexibility was particularly valued by participants, as it enabled them to integrate language learning into their daily routines without disrupting other academic responsibilities. The ability to engage with learning materials at any time, as described by Portnoff et al. (2021), contributed to a more sustained and consistent engagement in vocabulary acquisition, further enhancing the students' overall educational outcomes.

One particularly noteworthy and novel finding was that there were no statistically significant differences in vocabulary learning outcomes between male and female students. Both genders demonstrated equal benefits from the use of the Duolingo app, suggesting that AI-enhanced vocabulary tools are universally effective, regardless of gender. This is an important finding, as it supports the idea that AI-based educational platforms can provide equitable learning experiences, thus fostering inclusive education. The gender-neutral effectiveness of Duolingo highlights the potential of AI applications to bridge gaps in traditional education, where learning experiences may sometimes be unintentionally biased or unequal.

This study's findings contribute new insights into the role of AI in promoting personalized learning experiences that transcend gender differences. By providing personalized learning experiences that are tailored to meet the unique needs and preferences of each individual learner, regardless of gender, Duolingo demonstrates its ability to create inclusive educational environments. This reinforces the argument for a broader implementation of AI tools in language learning curricula, especially in educational systems like Jordan's, where traditional methods have often prioritized memorization over interactive and tailored learning experiences.

6. Recommendations

The study recommends that educational institutions should incorporate AI-based learning tools, such as the Duolingo app, into their English language teaching curricula to capitalize on the personalized and efficient learning experiences these technologies offer. Further empirical research is advocated to extend beyond vocabulary to include grammar, reading comprehension, and spoken language proficiency, thereby broadening the understanding of AI's educational benefits. It also suggests that educators receive professional development and training to effectively utilize AI technologies in their instructional strategies, creating more engaging and learner-centered environments. Acknowledging the equal effectiveness of AI tools across genders, the study underscores the importance of designing gender-neutral educational strategies with AI technologies, ensuring inclusivity and equal opportunities for all students. Additionally, it emphasizes the need for AI learning tools to be sensitive to Jordanian students' cultural and educational contexts, advocating for the adaptation and development of content that aligns with local preferences and needs. This holistic approach aims to leverage the transformative potential of AI in revolutionizing English language learning, promoting a shift towards more interactive, personalized, and contextually relevant educational experiences.

7. Conclusion

This study examined the effectiveness of the Duolingo AI application in enhancing vocabulary acquisition among university-level EFL students in Jordan. The findings confirmed that Duolingo's interactive and personalized approach significantly improved vocabulary retention and learning outcomes, providing a more engaging alternative to traditional vocabulary instruction methods. The app's use of gamification, multisensory input, and immediate feedback facilitated a more dynamic learning process, fostering both higher motivation and deeper retention of vocabulary. Importantly, the results revealed no significant gender differences in learning outcomes, suggesting that AI-enhanced vocabulary tools can be universally effective across diverse learner populations. These findings contribute to the growing body of literature supporting the integration of AI-driven educational tools in language learning curricula.

8. Implications

The study carries many implications for educators, policymakers, and curriculum designers in EFL education. First, the successful use of Duolingo to enhance vocabulary acquisition indicates that AI-powered educational tools can play a critical role in modernizing language instruction. Integrating such tools into the curriculum could provide learners with more tailored, flexible, and engaging learning experiences, complementing traditional classroom methods. Additionally, the gender-neutral impact of Duolingo suggests that AI tools can promote inclusive learning environments, making them particularly useful in diverse educational settings where equitable learning opportunities are a priority.

The findings also suggest that educators and institutions should be more open to adopting AI-driven applications to support vocabulary learning, especially given the flexibility these tools offer to accommodate varying schedules and learning styles. Furthermore, the ability of AI applications to provide immediate and personalized feedback offers a solution to the limited teacher-to-student interaction that is common in larger classrooms. Policymakers should consider these factors when designing national language education strategies, especially in countries like Jordan, where traditional teaching methods have been the norm.

9. Limitations

The current study had some limitations. One limitation of this study is the relatively small sample size of 40 university students, which restricts the ability to generalize the results to a wider population. To gain a more comprehensive understanding of the effects of AI-driven tools, future research should include larger, more varied samples across different educational contexts and student groups. Moreover, the six-week duration of the study may not have been enough to fully assess the long-term benefits of using Duolingo for vocabulary acquesition. Extended studies that track learners over longer periods could provide more comprehensive insights into how AI tools affect vocabulary retention and language development over time.

Another limitation is that the study focused solely on vocabulary acquisition. While this is an important aspect of language learning, it does not encompass other critical components such as grammar, reading comprehension, and speaking skills. Future research should investigate how AI-powered applications like Duolingo can influence these broader language skills, as well as their potential for integration into holistic language learning programs. Finally, while Duolingo's features proved effective for the experimental group, the study did not explore student perceptions of the app's limitations, such as potential dependency on gamification or reduced opportunities for deeper linguistic analysis. This is an area that could benefit from further exploration.

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This research is built upon a broad spectrum of scholarly work that has explored the intersection of technology and language learning, the specific application of AI in enhancing language acquisition, and the unique educational landscape of Jordan. The contributions from studies examining the use of digital platforms to improve language skills, the exploration of AI's contribution to listening comprehension, and the analysis of AI bots as educational tools have been instrumental in shaping our investigation. These foundational works have provided critical insights into the engaging, personalized learning experiences afforded by AI technologies, underpinning our study's exploration of Duolingo's impact on vocabulary learning.

Moreover, the context provided by analyses of Jordan's higher education landscape offers a nuanced backdrop for our study, allowing for a deeper understanding of AI's integration into language learning within a specific cultural and educational framework. This broader perspective has been crucial in highlighting both the opportunities and challenges associated with technological advancements in education in Jordan.

In summary, this study owes its depth and breadth to the collective knowledge and efforts of many, whose contributions have paved the way for a richer understanding of AI's transformative potential in language education. Our gratitude extends to all those whose work has informed and inspired this research, contributing to a comprehensive examination of how AI tools can enhance language proficiency and educational experiences in diverse learning environments."

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