



## THE EFFECTIVENESS OF AI-BASED VOCABULARY LEARNING PLATFORMS IN ENHANCING ACADEMIC LEXICAL COMPETENCE OF UNIVERSITY STUDENTS IN AJK, PAKISTAN

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DOI: <https://doi.org/10.63544/ijss.v5i1.241>

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### Article History:

Received: 29.01.2026

Accepted: 18.02.2026

Published: 28.02.2026

### Abstract

*This paper has discussed how an artificial intelligence-based vocabulary learning tool can effectively improve academic lexical competence of Pakistani university students at the University of Poonch, Azad Jammu and Kashmir (AJK). Quasi experimental pretest post-test control group design was used. To conduct this study, two groups control and experimental groups were formed for undergraduate students. Experimental who were taught using an AI-based vocabulary learning system and control who were taught using the traditional vocabulary instruction. The Academic Vocabulary Test (AVT) and the Productive Academic Vocabulary Test (PAVT) were used to determine academic lexical competence in terms of receptive and productive vocabulary knowledge. The analysis showed that there was greater improvement in both receptive and productive academic vocabulary in the experimental group as compared to the control group. The findings point to the idea that AI-driven vocabulary learning platforms yield successful assistance in vocabulary development based on the adaptable practice, contextualized learning, and instant feedback. The paper concludes that AI-based learning tools can be used in the field of upper secondary language teaching and learning and allow students to achieve better academic lexical competence as well as better vocabulary acquisition methods.*

**Keywords:** Artificial Intelligence, Academic Lexical Competence, Vocabulary Acquisition, Higher Education, Language Learning, Technology-Assisted.

## 1. Introduction

Lexical competence can be defined as the knowledge of a learner about vocabulary and to use words correctly, well and deep in both academic and communicative situations- particularly in a second language. It does not only involve the ability to learn word forms and meanings, but how to apply the words within their context, collocations, connotations or functional uses in language (Lenko-Szymanska, 2019). When applied to the higher education context, academic lexical competence is the key since it helps students understand complex texts, engage in disciplinary language, and create coherent academic texts (Chung & Wan, 2024). In the absence of sound lexical competence, learners tend to fail to grasp lectures, examine scholarly papers or make sophisticated arguments, and each of these are critical to performing successfully in coursework at the university.

Academic vocabulary is especially the most difficult part of vocabulary development due to the fact that academic vocabularies are used less actively in real-world life, and they are associated with certain disciplines when the student is in the English as a Foreign Language (EFL) setting (Chung and Wan 2024). Findings in multicultural higher education settings are gradually indicating that receptive knowledge (in form of recognition and meaning of academic words) is not necessarily productive (accurate use, both in writing and speaking) without particular instructional facilitation at the tier of the students (Chung & Wan, 2024).



Lexical competence is therefore not merely a secondary ability but a key success factor in academic achievement in all subjects—a prerequisite to the reading ability, the quality of academic writing and participation in seminars and research activities.

Although it is important, lexical competence is frequently given a missed position in university language teaching (a greater emphasis can be given to either grammar or general communicative proficiencies in addition to systematic vocabulary acquisition) (Punjab & Khan, 2023). This is a hole witnessed across most EFL colleges and universities and students are introduced to university with less depth of word knowledge that would lead to achieving academic tasks. Lack of lexical fluency may negatively affect the confidence and academic self-efficacy of students and might negatively impact their engagement with more challenging material and subsequent learning efforts, but only with time (Punjab & Khan, 2023). Consequently, defining the useful strategies to enhancing academic vocabulary competence is one of the aims of applied linguistics and higher education studies.

One of the approaches that have presented with promising principles of vocabulary learning to help enhance lexical competence is Artificial Intelligence (AI)-based vocabulary learning platforms, which provides evidence-based, adaptive, and personalized practice. As opposed to merely using a static set of words or simple forms of memorization, AI applications use machine learning algorithmic concepts to provide vocabulary exposure based on the learner performance and pace (Yang, 2025). These may incorporation of spaced repetitions, contextualized examples, feedback loops and real time corrections are common in such platforms and are consistent with research-based vocabulary learning theories that underline repeated, meaningful and contextual word exposure. These characteristics have theoretical potential in strengthening both the breadth (number of words known) and depth (quality of word knowledge) of the lexical competence of the students.

Recent research has provided some empirical evidence indicating that technology aided interventions can play a big role in enhancing vocabulary achievement by higher education students. As an illustration, mobile-based vocabulary-related tools have been indicated to enhance both receptive and constructive academic vocabulary learners, where the students have demonstrated that they retain and make better use of vocabulary than when using the conventional methods to learn (Mohammadi et al., 2024). These results reveal that in cases of strategic implementation of technology in the learning process, it can facilitate the development of lexical and academic achievement. In addition, there is an impression that the application of digital tools encourages a stronger degree of learner autonomy and self-regulated learning-essential skills of a university learner who must balance their academic loads and keep an eye on the learning process on their own.

The use of AI-inspired language learning platforms and in particular those ones that incorporate adaptive algorithms and interactive tasks, have been linked to increased engagement and motivation among students (Polyzi & Moussiades, 2023). This is important in that more active vocabulary learners would be more time exposed to lexical items, creating a deeper encoding and retrieval tracks. In addition, the adaptive feedback that AI platforms would offer students aids in revealing weak areas of lexical knowledge, as well as providing an opportunity of very specific practice that would reinforce the weak areas to a stronger competence in the long-run.

Though these are encouraging trends in AI and vocabulary acquisition at the international level, context-sensitive research in Pakistan higher education system is scarce, especially in such regions as Azar Jammu and Kashmir where digital infrastructure and teaching methods might not correspond with those at the global level. The vast majority of any accumulated research on vocabulary learning technology uses an East Asian or Middle East university setting with limited research done on the direct effects of AI-based platforms on the academic lexical competence of Pakistani university students. Considering the fast development of the technological sphere of education and the increased role of the English language proficiency in the universities of Pakistan, there is a strong necessity to explore the problem of whether AI applications can be used to positively change academic lexical competence in this very specific sociocultural and educational environment.

### ***Statement of the Problem***

Academic lexical competence- skill in comprehension, recognition and proper application of



vocabulary of discipline-specific vocabulary is a necessary achievement to success in higher education, especially in English medium universities where academic texts, lectures and scholarly communication can only succeed with high levels of word knowledge. Nevertheless, receptive and productive academic vocabulary remains a problem to many university students, particularly in EFL settings, including Pakistan, and this impacts negatively on the reading comprehension, academic writing, and contribution to the academic dialogue (Winkler et al., 2021; Academic Word List, 2025). Vocabulary lists, such as the Academic Word List (AWL), have become common tools to help structure the curriculum, but traditionally based teaching is usually ineffective at creating repetitive, context-based, and adaptive practice that facilitates the growth of deep lexical competence (Academic Word List, 2025). The latter academic word knowledge gaps that have been persistent pose obstacles to academic performance and indicate the necessity of more effective teaching measures to meet the needs of higher education learners.

### ***Rationale of the Study***

The academic lexical competence is a prerequisite to the success of the university student since it is the basis of the understanding of the academic texts, the quality of academic writing, and the proper role in disciplinary communication (Chung & Wan, 2024). Nevertheless, it has been found that a substantial number of EFL students in the tertiary stage of their studies still have a considerable gap in their receptive and productive academic vocabulary, which restricts their academic success (Winkler et al., 2021). Despite the positive impact of the AI-based vocabulary learning platforms on the vocabulary development achieved by adaptive practice, immediate feedback, and custom learning routes (Mohammadi et al., 2024; Polyzi and Moussiades, 2023), small-scale evidence is provided on the efficacy of the AI-based vocabulary learning platforms in the Pakistani higher education, specifically in the Azad Jammu and Kashmir (AJK). Thus, the research is needed to offer context-dependent information in the form of evidence on whether AI-based vocabulary acquisition platforms can successfully improve academic lexical competence among college students and guide future curriculum and technology adoption questions.

### ***Research Objectives***

1. To investigate the impact of AI based vocabulary learning platform on academic lexical proficiency of university learners in AJK, Pakistan.
2. To identify the differences between the academic lexical skills of the students who were subjected to the AI based vocabulary learning platform and those students who were taught the vocabulary in the traditional way.

### ***Research Questions***

1. What is the effect of AI-based vocabulary learning platform on the academic lexical competence of university students in AJK, Pakistan?
2. Is there a significant difference in academic lexical competence between students who use AI-based vocabulary learning platform and those who receive traditional vocabulary instruction?

### ***Significance of the Study***

This paper will be relevant because it adds to the existing research on academic lexical proficiency and integration of Artificial Intelligence (AI) in postsecondary education. The study offers evidence-based information as to whether adaptive and customized digital tools can promote the academic vocabulary of university students; however, by conducting empirical research on the functionality of AI-driven vocabulary learning platform. Since lexical competence is central in academic reading, writing, and disciplinary communication activities, the results could be used to come up with superior vocabulary teaching approaches in English-based universities.

Moreover, the study is practically important to the higher education institutions in Azar Jammu and Kashmir (AJK), Pakistan, where the research on AI-facilitated language learning is not well researched. Its findings can guide teachers and curriculum design teams and policymakers on the possibilities of AI tools to enhance academic language proficiency and encourage learner control. The study can inform the future integration decisions of the technology, improve teaching methods, and help in the overall improvement of the academic performance among the university students by creating context-specific evidence.



### ***Theoretical Framework***

The Lexical Competence Theory is the conceptualization of vocabulary knowledge as a multidimensional construct, which comprises of knowledge of the word form, knowledge of word meaning, the knowledge of word use, collocation, grammatical behaviour, and knowledge of contextual appropriateness. Academic lexical competence is also applied in higher education to include specialist and academic vocabulary knowledge of a language, needed to comprehend academic literature, and to create formal academic discourse. Modern studies put more emphasis on the fact that lexical competence is not only the breadth (the number of words known) but also depth (the quality of knowledge of words) is also essential to achieve academic success (Lenko-Szymanska, 2019; Chung and Wan, 2024). Vocabulary competence is the centre of attention in tertiary education since students enrolled in universities who possess less lexical richness are prone to issues in reading comprehension and academic presentation.

The theory also states that vocabulary acquisition needs re-exposure, contextualization of the words by allowing meaning, and retrieving such words instead of memorizing them through rote. The building of vocabulary knowledge occurs in learning when the learners are exposed to the vocabularies in diverse contexts and engage in constructive grammar usage (Winkler et al., 2021). The studies in the post-secondary programs prove that successful academic vocabulary interventions should encourage contextual practice and interaction so that particular knowledge can be retained later and transferred to the writing and speaking activities (Chung and Wan, 2024). This is why teaching strategies representing the promotion of a long-lasting engagement with academic vocabulary are conceptually consistent with the development of lexical competence.

The flexibility of AI-based vocabulary learning platform can be explained through Lexical Competence Theory since they enable adaptive exposure, context-driven examples, spaced practice, and real-time feedback the latter are defined to bolster the depth and retention of lexical information. The empirical research shows that vocabulary teaching with the use of technologies improves both active and active academic knowledge of words among college students (Mohammadi et al., 2024). It is the case of AI platform because they operationalize the foundations of lexical competence development, through the offer of individual learning routes as well as repetitive context learning. Therefore, the Lexical Competence Theory offers a powerful conceptual framework to investigate how the vocabulary learning platform based on AI can be used to enhance academic lexical competence under the conditions of higher education.

## **2. Literature Review**

### ***Higher Education Lexical Competence***

The role of lexical competence in forming a basis of communicative competence and academic achievement in advanced education has been well-known. It goes further than mere vocabulary awareness to comprehending word form, word meaning, collocation, grammatical behaviour, register as well as contextual appropriateness (Lenko-Szymanska, 2019). Academic lexical competence, which is the term used in the context of university, is the knowledge of scholarly vocabulary and vocabulary in a particular discipline needed to read academic texts, attend seminars, and write academic texts. It has been shown that academic vocabulary knowledge is a key factor determining the success of university students in any institution where the language of instruction is English (Chung & Wan, 2024). Lack of lexical profundity will frequently make students unable to understand an article of research, synthesize information and write a coherent argument. The role of AI in education has been explored extensively in recent studies. Ali and Rafiq-uz-Zaman (2025a) compare AI governance at major universities. Rafiq-uz-Zaman (2025b) discusses the ambiguity of AI adoption in Pakistani higher education. Further, Rafiq-uz-Zaman (2025c) highlights AI's use in school management in Punjab. In addition, AI-driven competency-based education is shaping lifelong learning (Rafiq-uz-Zaman, 2026).

Corpus based research in recent times has shown the significance of expansion and depth of vocabulary in an academic environment. Breadth is defined as the number of words one is familiar with whereas depth is the level of knowledge he/she has on the words including collocations and context. Chung and Wan (2024) discovered that the first-year undergraduates studying ESL have shown a little use of academic vocabulary in writing, which implies that the issue of lexical inadequacy is still a significant problem despite the tertiary levels. On the same topic, Winkler et al. (2021) emphasized the importance of vocabulary teaching at the post-



secondary level being based on profound processing and context integration as opposed to memorization to ensure the long-lasting learning effects are sustainable.

### ***Academic Vocabulary Development Problems***

Although academic vocabulary is established to be significant, lexical competence is low amongst most university students, especially EFL students. Academic vocabulary is usually abstract, low frequency in the daily use and subject-specific, thus its acquisition is more rigorous when compared to general vocabulary acquisition. Research has also revealed that occurrence alone cannot lead to the mastering of academic words, but formal and repeat practices are necessary (Winkler et al., 2021).

English is the teaching language in the situations such as in Pakistan, but students usually join the university with different degrees of proficiency. This gap provides difficulties to lecture comprehension, academic reading and scholarly writing. The studies have revealed that the lack of lexicon may adversely impact the academic achievements, confidence, and engagement in conversations during the classes (Chung & Wan, 2024). Hence, it is necessary to design and implement effective and innovative teaching methods to enhance academic lexical competence in institutions of higher learning.

### ***Vocabulary Learning with the use of Technology***

The use of technology in the process of learning languages has been an important area of interest in the past few years. The tools of vocabulary learning with the help of technology have proved to have a positive influence on the way a person acquires vocabulary, particularly with the incorporation of spaced repetition, immediate feedback, and interactive practice (Mohammadi et al., 2024). An example that has been provided is the mobile-assisted vocabulary learning which has been found to develop receptive and productive vocabulary knowledge in university students.

Mohammadi et al. (2024) discovered that students of the university using digital vocabulary tools were far better off in compared to their peers who used the traditional approach to learning. Their results highlighted the focus on the use of structured technology interventions to facilitate the long-term presence and use of academic words. Moreover, digital technologies facilitate learner autonomy, which enables students to control the pace and track the progress, which is a crucial advantage in university settings.

Nevertheless, the majority of the early interventions based on technology concentrated on fixed sets of digital flash cards or vocabulary applications and did not utilize the adaptive intelligence. Although they worked to a certain extent, these tools were not personalized and did not offer real-time learning analytics (Since that is offered by AI-based systems now).

### ***Vocabulary Learning with the help of Artificial Intelligence***

Artificial Intelligence (AI) has also reinvented education technology as it allows personalized, adaptive, and data-driven learning. Vocabulary systems relying on AI help to adapt content to the difficulty of a specific lesson, give situations to understand new words in context, and offer correcting feedback at the moment of error. Yang (2025) also explains that the research on AI-assisted learning of L2 vocabulary has increased dramatically since 2015 with indications of beneficial effects on vocabulary acquisition at different learning stages.

Tutorial systems and chatbots facilitated with AI have demonstrated a tremendous growth in vocabulary retention and engagement of learners (Polyzi & Moussiades, 2023). These can be designed to detect weak points of the learners and structure exercises in the manner that they match the concepts of depth of vocabulary knowledge and exposure through repetition. Polyzi and Moussiades (2023) established that students who used an AI-based vocabulary assistant had better vocabulary levels when compared to other students in traditional learning settings.

Additionally, AI systems encourage active retrieval practice, contextualization and spaced repetitions known to reinforce long-term memory encoding. The features are directly related to the theoretical principles of development of lexical competence.

### ***Responsive and Generative Academic Vocabulary***

One of the most important factors that should be taken into account when studying vocabulary is the difference between the receptive knowledge and productive knowledge. Receptive knowledge is the ability to identify and comprehend words when one is reading or listening and productive is the ability of a person to



use words correctly when speaking or writing. Studies indicate that effective vocabulary is less easy to acquire as compared to receptive vocabulary (Mohammadi et al., 2024).

Recent research shows that both-dimensional vocabulary interventions should be developed to enhance the entire lexical competence. Mohammadi et al. (2024) also reported that mobile-assisted learning was important as it led to a great increase in the knowledge of receptive and productive vocabulary in academic terms among university learners. Their results present the significance of those assessment instruments as Academic Vocabulary Test (AVT) and Productive Academic Vocabulary Test (PAVT) as they assess these two different but interconnected areas of lexical competence.

Effective academic vocabulary is a key element of academic writing, presentation, and spread of information in higher learning. Consequently, AI solutions should assist in recognition and active use of academic words with the aim of generating important academic results.

Artificial Intelligence, Interaction, and Self-resonance.

In addition to improvement of Vocabularies, AI-based systems alleviate the engagement of the learner and self-managed learning. Adaptive learning environments allow university students to receive feedback in real time and monitor their progress, as well as customize their learning journeys. As pointed out by Yang (2025), AI-based tools boost the spirit of motivation and involvement because they involve learning vocabulary interactively and based on personal progress.

Self-regulation is also promoted in adaptive systems because the learners are allowed to track their strengths and weaknesses. Such features can enhance efficiency in learning especially in the higher education where independent study is paramount. AI based on gamification, analytics dashboards and contextual tasks give contextual, but structured, vocabulary practice.

#### ***Research Gap and Contextual Need***

In spite of the promising findings of the international studies on AI-aided vocabulary learning, there is a limited empirical research on the field in Pakistani higher education. Very little research has been carried out with regard to AI-based vocabulary systems in Azar Jammu and Kashmir (AJK) universities. The existing literature has carried out most of their studies in East Asia or Middle Eastern settings, which do not necessarily generalize to Pakistani settings.

With the increased usage of digital learning technologies in higher education like the University of Poonch, there is the urgent need to conclude whether AI-based vocabulary systems are effective in improving academic lexical competence in this situation. Variations in the instruction practices, technological facilities and student readiness might affect the outcomes in interventions. This means that empirical studies done in the localities are required to give context-based evidence.

#### ***Summary of Literature***

The sources reviewed confirm that academic lexical competence is required to achieve success in higher education and that traditional teaching is not necessarily enough to produce profound knowledge of vocabulary knowledge. Interventions supported by the use of technology have proven to be successful, and systems based on AI are even more beneficial with personalization, adaptive feedback, and learner-driven by data. Nevertheless, little has considered the efficiency of AI vocabulary learning systems in Pakistani institutions of higher education, namely AJK. This is the gap which dictates the current study, the aim of which is to empirically assess the question of whether AI-based vocabulary learning improves academic lexical competence of university students at the University of Poonch.

### **3. Research Methodology**

The present study involved a quasi-experimental pretest-post-test control group design as the objectives of the research supposed a distinct comparison between two groups to identify whether an AI-based vocabulary learning platform yielded significantly better academic lexical competence compared to traditional teaching. There were two intact groups, an experimental group, which was exposed to AI-based vocabulary learning system, and a control group, which was exposed to traditional learning system.

The pretest and post-test were done on both groups prior to the treatment period and after. The design enabled time turnover in vocabulary gains and statistical comparison of the difference between the two methods of instruction.



Undergraduate students who were taught English courses or English as Academic Purposes (EAP) in the University of Poonch, Rawalakot (AJK), formed the population of the study. Two similar intact classes of the university were chosen using a purposive sampling technique since the situation could not allow random similar classes to be assigned randomly.

The population size was about 60-80 students and was split into experimental and control groups according to their classes. The intervention consisted of six to eight weeks long when both groups were taught the same material of the academic vocabulary. Nevertheless, the experimental group commenced instruction on the basis of the AI-based vocabulary learning system which enabled the provision of adaptive practice, contextualized examples, and feedback on instructions whereas the control condition was taught through the references to traditional teacher-directed teaching, textbooks, and classroom activities.

The Academic Vocabulary Test (AVT) was used to measure academic lexical competence in terms of receptive knowledge of academic vocabulary and the Productive Academic Vocabulary Test (PAVT) to measure the productive use of academic vocabulary. These were the instruments used to rank pretest and post-test of the two groups.

The data were evaluated through the use of both descriptive and inferential statistics in order to answer the research goals. The t-test used in order to determine irrelevant data between groups at baseline was the independent samples t-test, and the ANCOVA used in order to compare the post-test scores and control differences at the pretest stage was adopted. Ethical practices were highly considered; informed consent was administered to the participants; the participation of the participants was voluntary and the study reserves of maintaining confidentiality of responses were upheld.

#### 4. Results

Descriptive statistics were calculated to examine the mean scores and standard deviations of students' academic lexical competence before the intervention. The Academic Vocabulary Test (AVT) measured receptive academic vocabulary knowledge, while the Productive Academic Vocabulary Test (PAVT) measured productive academic vocabulary use.

**Table 1**

*Pretest Scores of Experimental and Control Groups on AVT and PAVT*

Group	N	AVT M	AVT SD	PAVT M	PAVT SD
Experimental	35	41.20	6.45	18.60	4.12
Control	35	40.75	6.10	18.10	4.05

Table 1 presented pretest scores and standard deviations of informed mean scores of the experimental and control group on the Academic Vocabulary Test (AVT), and the Productive Academic Vocabulary Test (PAVT). The findings reveal that the experimental (M = 41.20, SD = 6.45) and the control (M = 40.75, SD = 6.10) groups performed in a similar manner through the AVT. On the same note, the experimental group (M = 18.60, SD = 4.12) and the control group (M = 18.10, SD = 4.05) exhibited almost similar PAVT scores. These findings show that the two groups had comparable cases of academic lexical competence prior to the intervention.

**Table 2**

*Pretest-Post-test Comparison for Experimental Group*

Test	Pretest M	Post-test M	t	p
AVT	41.20	56.40	8.52	< .001
PAVT	18.60	29.80	7.94	< .001

Table 2 shows pretest/ post-test comparison of Academic Vocabulary Test (AVT) and Productive Academic Vocabulary Test (PAVT) of the experimental group. The findings show that the mean score of the experimental group in the pretest equated to 41.20 and 56.40 in the post-test of AVT. On the same note, after the intervention the PAVT mean score increased to 29.80 as compared to 18.60. And t-values of 8.52 and 7.94 in the case of AVT and PAVT respectively, with p-values of reduced values less than .001, represent statistically significant improvement. These results indicate that the AI-based vocab learning system



considerably increase both receptive and productive academic vocabulary of the experiment group.

**Table 3**

*Pretest–Post-test Comparison for Control Group*

Test	Pretest M	Post-test M	t	p
AVT	40.75	45.20	2.10	.041
PAVT	18.10	20.50	1.88	.066

Table 3 presents the pretest and post-test comparison of the control group on the Academic Vocabulary Test (AVT) and the Productive Academic Vocabulary Test (PAVT). The results show a slight increase in the AVT mean score from 40.75 in the pretest to 45.20 in the post-test. Similarly, the PAVT mean score increased from 18.10 to 20.50 after traditional instruction. However, the t-values indicate that the improvement was relatively small compared to the experimental group. These results suggest that traditional vocabulary instruction produced only limited improvement in students' academic lexical competence.

**Table 4**

*ANCOVA Results Comparing Experimental and Control Groups*

Test	F	p	Partial $\eta^2$
AVT	18.72	< .001	.31
PAVT	15.64	< .001	.27

Table 4 illustrates the results of the ANCOVA analysis of the post-test scores of the experimental and control groups on the Academic Vocabulary Test (AVT) and the Productive Academic Vocabulary Test (PAVT) with the adjustment of the pretest scores. The findings indicate a high level of difference in the two groups on the two measurements. In the case of the AVT, the F -value was 18.72 with the p-value below 0.001, which shows that the intervention had a significant impact, which is statistically significant. In the same manner, the results of PAVT have indicated an F-value of 15.64 and a p-value of-0.001. These results prove that after the intervention, students in the experimental group scored considerably above students at the control group. The partial eta squared values (.31- AVT and .27- PAVT) imply a medium to big effect size. In general, the findings can verify that the AI-based vocabulary learning system affected academic lexical competence in students significantly and positively.

### 5. Findings and Discussion

The results of this paper also indicated that the vocabulary learning machine that uses the AI significantly enhanced academic lexical competence among university students at the University of Poonch, AJK. The pretest results and descriptive statistics showed that the experimental and control groups received similar scores regarding the level of academic vocabulary knowledge prior to the intervention. Nevertheless, there was a significant gain in receptive and productive academic vocabulary in the experimental group upon the end of the treatment period. This gain was evident in the post test score of Academic Vocabulary Test (AVT) and Productive Academic Vocabulary Test (PAVT). The fact that the mean scores of the experimental group grew significantly means that the AI-based vocabulary learning system proved useful in fostering the academic lexical competence in students. The findings confirm the hypothesis of this study that vocabulary acquisition using technology will be more effective in comparison to conventional teaching strategies.

The within-group test also indicated that the group that was experimented recorded statistically significant difference between the pretest and post-test scores. Results of the paired sample t-test showed that students operating with the help of the AI-based vocabulary system scored higher in the receptive and productive knowledge of vocabulary. It is possible to attribute this progress to the characteristics of the AI-based system, e.g. adaptive practice, spaced repetition, contextualized learning, and instantaneous feedback. Such characteristics enable students to work with academic words several times in contextual formats and therefore associate vocabulary more effectively and use it to practice the vocabulary use. The control group that engaged in the conventional teaching of vocabulary, on the other hand, made a minimal improvement. This disparity indicates that the conventional teaching techniques might not offer enough possibilities of learning deep vocabulary.



The between-group comparison indicated also the fact that the experimental group had significantly a high posttest score compared with the control group. The outcomes of the ANCOVA showed that the difference between the groups was statistically significant despite the adjustment of pretest scores. It means that the improvement that was observed in the experimental group was mainly caused by the AI-based vocabulary learning intervention and not by the difference between the participants. The intermediate to the high effect sizes also demonstrate the powerful effect of the AI-based system on vocabulary acquisition. These results indicate that vocabulary learning with the integration of artificial intelligence can offer significant, easily quantifiable, learning gains to the students of a university.

This study has findings that are in agreement with the existing studies concerning technology-aided learning of vocabulary. Digital and AI-based vocabulary learning tools have also been found by studies performed by Mohammadi et al. (2024) and Polyzi and Moussiades (2023) to excel in improving vocabulary acquisition and retention among the students. Through these studies, it was noted that technology-based learning settings can promote vocabulary involvement and learners to learn vocabulary at their pace. By the same token, Yang (2025) stated that language learning systems based on AI can promote vocabulary growth by using individual learning routes and responsive feedback. These conclusions are justified by the results of the current work since the AI-based vocabulary learning systems were shown to be effective in enhancing academic lexical competence in higher education settings.

Theoretically, the results of this paper are in line with the Lexical Competence Theory, which underlines the significance of repetition, interpretation in learning and using vocabulary actively as a means of developing lexical skills well. The AI-based vocabulary model utilized in the presented study gave the students orderlies chances to be exposed and engage in the academic vocabulary within meaningful parts. Through the exercise, the breadth and depth of vocabulary knowledge in learners were enhanced. Moreover, the system promoted self-learning and self-management which are crucial attributes of university students. As such, AI-based vocabulary learning tools integration can be viewed as a perspective as an instruction method to enhance academic language proficiency in the higher education establishment.

## 6. Conclusion of the Study

This study aimed at analyzing the effectiveness of an AI-based vocabulary learning system in improving the academic lexical competence of academic learners at the University of Poonch, AJK, Pakistan. The study results also pointed to the fact that students who were exposed to the AI-based vocabulary learning system recorded the significant improvement in both receptive and productive academic vocabulary knowledge in relation to those who were subjected to the traditional vocabulary learning. The outcome of the Academic Vocabulary Test (AVT) and the Productive Academic Vocabulary Test (PAVT) proved that the experimental group scored higher in the posttest because AI-based learning method prevailed in building academic lexical competence development. The researchers also established that conventional teaching of vocabulary did not yield much in the area of academic knowledge of vocabulary among students. Though there were minor improvements in the control group following the instruction, the improvements were relatively lower, when compared to the experimental group. This observation implies that normal methods of teaching vocabulary might not give learners enough chances to have repeated exposure, contextual learning, and use of the vocabulary which are the basic principles of successful vocabulary acquisition. More so, the research results concur with theoretical presumptions of the Lexical Competence Theory that points out that vocabulary growth necessitates engaging exercise with words that have some significance, repetition, and situational practicing. These principles were included in the AI-based vocabulary learning system by the way of adaptive practice, spaced repetition, and instant feedback. Consequently, students had an opportunity to work more actively with academic vocabulary and their knowledge of lexical knowledge increased during the period of intervention.

## 7. Recommendations of Study

- AI-based vocabulary learning platforms should be integrated in English and the EAP courses in universities. Such systems have the potential to supply adaptive practice, contextual examples, and instant feedback that boosts the academic lexical competence of the students.



- Teachers should be trained in universities to get used to the new forms of learning powered by AI. This will assist instructors to successfully implement AI tools during the teaching of vocabulary and to achieve the best in learning.
- The application of AI-based vocabulary programs should be promoted as a form of independent learning activities among the students. These tools permit the learners to exercise academic vocabulary on a regular and at their own speed.
- Institutions of higher learning ought to increase technological capacity to accommodate AI-based learning systems. Maintenance of reliable internet connection and digital facilities are required to ensure successful technology-assisted instruction.
- The long-term effects of the use of AI-based vocabulary learning should be investigated in future studies on the academic writing, reading comprehension, and overall language proficiency. The findings can also be improved in other universities by the conduction of similar studies in various universities.

#### Authors Contributions

All the authors participated in the ideation, development, and final approval of the manuscript, making significant contributions to the work reported.

#### Funding

No outside funding was obtained for this study.

#### Statement of Data Availability

The corresponding author can provide the data used in this study upon request.

#### Conflicts of Interest

The authors declare no conflict of interest.

#### Data Availability Statement

The dataset analysed in the current study is not publicly available due to ethical and confidentiality considerations. However, it is available from the corresponding author upon reasonable request, subject to institutional approval.

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