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TOPIC:

Systematic review of digital technologies and artificial intelligence for teaching university-level English vocabulary

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RESUMEN

El estudio tuvo como finalidad analizar de manera sistemática la producción científica publicada entre 2020 y 2025 sobre el uso de tecnologías digitales y la inteligencia artificial en la enseñanza del vocabulario del idioma inglés en el nivel universitario. En este sentido, se consideró el enfoque cualitativo, revisión sistemática y se empleó la metodología PRISMA para la selección de 40 artículos científicos de fuentes confiables. En cuanto a los hallazgos sé detalló que el mayor número de estudios se centra en las tarjetas digitales y el aprendizaje de idiomas asistido por dispositivos móviles (MALL), que suelen hacer hincapié en la repetición espaciada y la práctica autónoma. Esta categoría está representada por múltiples estudios empíricos que se centran en el aprendizaje de vocabulario académico, técnico y general con tarjetas móviles y herramientas de repetición espaciada. Además, una parte importante de los artículos encaja en la categoría de plataformas gamificadas, y estos estudios se centran principalmente en el vocabulario general y académico a través de actividades interactivas en el aula y ejercicios basados en tareas para casa. Asimismo, el aprendizaje de vocabulario se produce a través de indicaciones del profesor, debates entre compañeros, intercambios multimodales (texto/audio/imágenes) y una participación sostenida más allá del horario lectivo. En esa misma línea, la aparición de chatbots con IA y herramientas generativas de IA, en particular ChatGPT, está documentada en estudios analizados, lo que indica un cambio hacia el aprendizaje adaptativo y dialógico del vocabulario.

Palabras clave: digital, vocabulario, inglés, universidad

ABSTRACT

The study aimed to systematically analyze scientific publications between 2020 and 2025 on the use of digital technologies and artificial intelligence in teaching English vocabulary at the university level. In this regard, a qualitative approach and systematic review were considered, and the PRISMA methodology was used to select 40 scientific articles from reliable sources. The findings revealed that the largest number of studies focused on digital flashcards and mobile-assisted language learning (MALL), which tend to emphasize spaced repetition and autonomous practice. This category is represented by multiple empirical studies that focus on academic, technical, and general vocabulary learning with mobile flashcards and spaced repetition tools. In addition, a significant portion of the articles fall into the category of gamified platforms, and these studies focus primarily on general and academic vocabulary through interactive classroom activities and homework-based exercises. Vocabulary learning also takes place through teacher guidance, peer discussions, multimodal exchanges (text/audio/images), and sustained participation beyond class hours. Along the same lines, the emergence of AI chatbots and generative AI tools, particularly ChatGPT, is documented in the studies analyzed, indicating a shift toward adaptive and dialogic vocabulary learning.

Keywords: digital, vocabulary, English, university

1. Introduction

English has become the dominant language of academic communication, so university students are expected to handle texts in English, participate in international academic spaces, and produce academic writing. An essential factor in achieving these goals is accurate knowledge of vocabulary, because lexical competence is a key element and objective of reading comprehension and overall educational performance in English-language contexts. In other words, learners with a limited educational vocabulary often have difficulty understanding advanced texts and expressing ideas in detail, both orally and in writing. For this reason, vocabulary acquisition remains a significant and persistent challenge in the teaching of English at the university level (Pir et al., 2023). Despite its importance, English language teaching in higher education has often been based on traditional tools such as keyword lists, memorization of information, and decontextualized activities. In this sense, it should be noted that these methods are effective in the short term, but they do not have positive long-term effects and, therefore, are not significant for students in real-life tasks. Furthermore, university classes often have to deal with large numbers of students, as well as heterogeneous educational levels and minimal teaching time, which reduces opportunities for personalized learning and practice of English vocabulary (Arslan, 2022). As a result, students end up engaging in unsystematic self-learning, which leads to uneven vocabulary acquisition.

Along the same lines, the expansion of technology in universities has significantly changed vocabulary teaching, because it generates constant practice outside of university hours. In other words, learning vocabulary through the use of tools such as flashcards and academic activities in learning management systems (LMS), among others, provides frequent exposure to learning and repetition under optimal conditions, which, if used effectively, leads to vocabulary retention. Based on the above, a review of English language teaching contexts shows that digital flashcards and mobile tools are among the main technologies used by teachers in the university setting, because they capture students' attention and encourage their participation in the learning process (Teymouri, 2024). In this regard, it is important to thoroughly review how technologies such as AI have been implemented in the field of education.

To analyze the literature review, the studies are grouped into thematic blocks that reflect the advancement of digital technologies and artificial intelligence in English vocabulary teaching in higher education between 2020 and 2025. The first block focuses on the accelerated introduction of digital technologies in the context of the COVID-19 pandemic, when universities switched to fully virtual educational formats. The second block is based on the expansion and diversity of vocabulary learning strategies using mobile technologies and gamification in the university environment. The third section examines the emergence and subsequent consolidation of artificial intelligence-based tools, such as chatbots and adaptive systems, used for vocabulary learning. These organized sections are connected and provide a detailed understanding of how digital and intelligent technologies have shaped vocabulary learning in the university setting.

2. Theoretical Framework

Background

COVID-19 pandemic (2020)

It is important to note that 2020 marked an accelerated shift to digital teaching in every university in every country around the world. This was due to the emergence of COVID-19, which weakened all the barriers to traditional, face-to-face teaching (Okumuş, 2023). In other words, English language teachers largely turned to mobile-assisted vocabulary learning (MAVL) and online platforms, especially digital flashcards and spaced repetition tools (Zhou and Zhou, 2025).

In this context, since 2020, artificial intelligence, known by its acronym AI, has become automatically integrated into language teaching through the use of adaptive platforms, conversation agents, and detailed, automated feedback. In other words, AI tools can personalize vocabulary conversation according to students' levels, as well as their immediate conditions and difficulties. In this sequence, research data details that learning through AI support systems such as chatbots strengthens both productive and receptive language knowledge, especially when communication is based on the structure and meaning of the language. This highlights ethical and educational issues such as the effectiveness of feedback, the privacy of the information provided, and the preparation of university professors for the responsible and effective use of these tools (Wilboolyasarin et al., 2025).

The studies focused on this period detail that tools such as digital cards were the most studied in English vocabulary learning. This is evident in the voluntary and

interactive participation of each of the students. Therefore, it can be said that, starting in 2020, a reference base was established that digital tools are not only a complement but also a fundamental support for the continuous learning of students in a university setting. However, it should be noted that, while teachers can make appropriate use of information, students have the power to make appropriate use of each of the tools provided in class (Okumuş, 2023). Nevertheless, the process that took place during the two years following the pandemic is detailed below.

Diversification (2021-2022)

Following the establishment of distance learning in 2021-2022, studies in the field of vocabulary teaching at universities began to reflect a constant transformation in the emergency use of virtual tools aimed at pedagogical change and specific grouping. Over the course of these years, authors focused on learning through the use of mobile devices, gamified platforms, and self-teaching resources aimed at increasing student engagement and deepening lexical knowledge. It should be noted that the aforementioned tools began to be used not only to repeat each of the words learned in class, but also to generate different types of learning in aspects of lexical competence, such as usage, form, and meaning. Therefore, this period is based on the expansion of strategies and methodologies for teaching English (Muhammad et al., 2021; Aynur, 2021).

In 2021, vocabulary studies expanded beyond the basic use of digital flashcards to include multiple resources such as audio glossaries, images, and interactive videos tailored to university interests. In addition, there is a strong increase in experimental studies that analyze whether interaction designs strengthen learning and lexical knowledge (Muhammad et al., 2021).

Intelligence as a fundamental element in language teaching, involving intelligence systems, educational feedback engines, and vocabulary tools focused on recommendations, should be used by teachers according to each of the realities reflected in the classroom. It should be noted that AI studies have shown that algorithm-centered feedback and personalization have become a topic of conversation and research, with the aim of improving vocabulary acquisition in real time and constant repetition by learners. However, the studies highlighted that the findings depended largely on the limited knowledge of students' digital use, as well as the pedagogical grouping of tools in course development (Jiang, 2022).

AI and adaptive systems (2023-2025)

Starting in 2023, research on English vocabulary teaching in higher education will increasingly focus on the use of artificial intelligence-based tools and adaptive

systems. The focus will be on chatbots, generative models, and intelligent learning platforms that enable personalized and contextualized vocabulary practice.

Between 2023 and 2025, these technologies are seen as tools to support productive vocabulary use, reflection, and self-directed learning. This stage reflects the maturity of digital solutions and the transition to integrated educational models in which technology is combined with pedagogical guidance and institutional support (Klímova, 2023; Mohamed, 2023; Wilboolyasarin et al., 2025).

In 2023, empirical studies on university vocabulary began to increasingly use generative AI tools, such as ChatGPT-type systems, which were used to clarify meaning, expand synonym vocabulary, create contextual sentences, and provide instant lexical feedback. The findings indicated the considerable impact of these technologies on vocabulary use in written and oral expression, but research authors also pointed out the risks associated with the detail of the responses and the possible constant and frequent dependence of students on these resources (Mohamed, 2023). In the same vein, conversational AI and chatbots became a central factor in university work related to English as a foreign language (EFL), because they enabled students to practice vocabulary in dialogues and real communicative environments. As a result, it reinforced both receptive and productive lexical knowledge, and the research findings highlighted an increase in vocabulary, along with increased interaction, motivation, and autonomy among young university students (Klímova, 2023). Thus, 2023 confirmed that AI supports vocabulary development in detail when activities require active language production and directed interaction, rather than passive lexical learning.

In 2024, with the rapid expansion of AI tools in universities, reviews of English as a foreign language (EFL) teaching paid particular attention to the fact that the effectiveness of these technologies depends on their consistency with the curriculum, pedagogical support from the teacher, and the ethical treatment of student data, including issues of privacy, bias, and transparency (Macinska and Vinkler, 2024) . At the same time, research has increasingly focused on integrated learning models that combine mobile applications, AI chatbots, and “andémis” (step-by-step support and accompaniment) in the classroom. Mini-reviews on MAVL emphasized that flashcards remained a highly effective medium, but were increasingly being compared toenhanced AI solutions capable of adapting to student needs and providing interactive feedback (Teymouri, 2024).

Furthermore, empirical university studies have shown that mobile-compatible flashcards contribute significantly to the development of academic vocabulary,

including its retention in memory and controlled use in context (Mohammadi et al., 2024).

Thus, the year 2024 has provided more accurate and balanced evidence that technology is most effective not as a substitute for teaching, but as part of an educational ecosystem with clear learning objectives.

Studies conducted in early 2025 increasingly emphasize the issue of sustainability in technology implementation: teacher training, institutional policies, and equal access are considered key conditions for long-term impact on vocabulary development, and reviews of adaptive platforms particularly highlight the importance of confidentiality guarantees and ongoing pedagogical support (Tan et al., 2025).

At the same time, systematic reviews summarizing evidence from 2020-2024 show that, in general, AI tools improve lexical outcomes through personalized learning trajectories, adaptive repetition, and instant feedback, although effectiveness varies significantly depending on task design and educational context (Yang, 2025).

Furthermore, the latest systematic reviews on AI chatbots across all language skills, including lexicon, confirm their consistent benefit for vocabulary practice, especially when students engage in meaning-oriented interactions and perform reflective tasks (Wilboolyasarin et al., 2025). Thus, the year 2025 consolidates a more mature understanding: digital technologies and artificial intelligence are most effective in teaching university vocabulary when they are pedagogically organized, ethically managed, and continuously maintained.

Definition

Regarding the theoretical framework, Haleem et al. (2022) specify that digital technologies are broadly defined as digital (computer-based) tools, platforms, and networked systems used to create, store, process, and communicate information and, in the field of education, this includes the use of educational technologies to support teaching, learning, and related school tasks (e.g., learning platforms, multimedia resources, connected devices, and software applications) (Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura [UNESCO], 2023).

In this context, Zambrano and Chancay (2024) mention that digital technologies came to be understood as catalysts for digital change, which involves not only modifying tools, but also the way in which teaching, learning, and communication take place in the field of education. In other words, they are conceptualized as integrated systems that connect teachers, information, and learners in order to support learning outcomes, the development of digital skills, and innovation in university education (Araujo et al., 2024; Wang et al., 2024).

Based on the above, AI is framed within its functional capabilities in learning environments, for example, intelligent tutoring, adaptive learning, analysis-based personalization, automated feedback, and other systems that simulate or enhance instruction and assessment processes (Crompton & Burker, 2023). In the field of education, AI is understood as a group of computational methods such as automated learning sequences and predictive analysis that enable educational technologies to increase, simulate, and expand people's intelligence in the fields of teaching and learning (Demera et al., 2023; Ayuso & Gutierrez, 2022).

Based on the above, teaching English vocabulary refers to the positive development of learners' knowledge and use of expressions and words composed of different terms, involving their form, meaning, and compound use in different environments, paying close attention to the repeated manifestation of terms (Zeng et al., 2025; Sun et al., 2023). Likewise, vocabulary teaching is considered essential for learners to move beyond literacy, because it allows them to learn meanings, interact with texts, generate language formulation, and interact with confidence in a communicative and written English environment (Cardozo & Gonzales, 2023).

Finally, the purpose of the study was to systematically analyze the scientific output published between 2020 and 2025 regarding the use of digital technologies and artificial intelligence in teaching English vocabulary at the university level.

3. Methodology

The qualitative approach focused on understanding the meaning, experiences, and perceptions in educational environments, providing a more accurate understanding of detailed phenomena beyond the numerical data (Piña, 2023). In this context, the descriptive level led researchers to describe and characterize educational environments as they are generated, detailing trends and relationships without altering the categories (Arias et al., 2020).

Complementarily, the systematic review ensured methodological rigor by analyzing the empirical findings through detailed processing such as the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines, in order to provide general and reproducible conclusions (Page et al., 2021). As a group, a detailed and evidence-based understanding of the use of technology for teaching English can be expressed.

Likewise, the search sequence was generated between September and October 2025, using different academic databases from journals such as ERIC, Scopus, Web

of Science, etc. This information was found in a group of high-quality journals, and the following keywords were considered: (digital flashcards or WhatsApp vocabulary learning or mobile-assisted language learning) and (English vocabulary learning or English vocabulary learning) and (vocabulary gain or vocabulary retention).

Taking into account the search results obtained, each abstract, title, and keyword was reviewed to verify that they focused on each of the inclusion and exclusion criteria. Each selected article was read in its entirety to confirm its relevance to the research objectives. A flowchart inspired by PRISMA was used to document the identification, selection, eligibility, and inclusion phases, ensuring transparency in the selection process.

A total of 40 studies met all criteria and were included in the final analysis. Each document was coded according to author(s), year, country, research design, sample size, digital technologies and artificial intelligence, and university English vocabulary teaching. This systematic coding process allowed for the extraction of comparable data between studies and facilitated thematic synthesis.

4. Results and discussion Table 1

Digital technologies and artificial intelligence used for teaching university-level English vocabulary

Type of technology	Common examples (2020–2025)	Type of vocabulary used	How it is used in higher education
Digital flashcards / mobile learning (MALL)	Flashcard applications with spaced repetition (Anki, NGSL Builder, mobile apps)	Academic, technical, and general vocabulary	Independent practice outside the classroom, blended learning, progress tracking
Gamified Platforms	Kahoot, Quizlet, Duolingo, Memrise	General and academic vocabulary	Classroom activities and assignments, interactive quizzes, repeated practice with immediate feedback
Messaging and social media applications	WhatsApp, messaging groups, educational bots	General and academic vocabulary	Collaborative learning, assignment submission, asynchronous and multimodal interaction
Chatbots and generative artificial intelligence	ChatGPT, educational chatbots	Contextualized vocabulary and productive use of lexicon	Guided practice, example generation, personalized feedback
Immersive technologies (AR/VR)	Augmented reality and virtual reality	Contextual and situational vocabulary	Scenario-based learning, immersive games, simulations
Multimodal resources	Videos, audio files, images, multimedia glossaries	Vocabulary associated with reading and listening	Support for comprehension, form–meaning association

Note: Information obtained from the analysis of the data

Table 1 shows that the distribution of evidence indicates that research on English vocabulary teaching at university mainly focuses on mobile-assisted learning and gamified platforms, while other types of technology appear less frequently.

Overall, the corpus reflects a clear trend toward student-centered, out-of-classroom, or blended practice, in which vocabulary building is supported by repeated exposure, retrieval practice, and digital engagement features (e.g., progress tracking, instant feedback, and interactive tasks).

First, the largest number of studies focus on digital flashcards and mobile-assisted language learning (MALL), which typically emphasize spaced repetition and autonomous practice. This category is represented by multiple empirical studies focusing on academic, technical, and general vocabulary learning with mobile flashcards and spaced repetition tools (e.g., Boroughani et al., 2023; Xodabande et al., 2022; Zakian et al., 2022; Zarrati et al., 2024; Koleini et al., 2024), as well as syntheses of evidence reinforcing the importance of MALL in recent vocabulary research (e.g., Dagdeler, 2023; Zhou & Zhou, 2025). In Table 1, these studies closely follow the described mode of use—blended learning and independent learning outside the classroom—and tend to focus on vocabulary necessary for university studies (academic and technical lexicon).

Secondly, a significant portion of the articles fall into the category of gamified platforms, such as Quizlet, Kahoot, Duolingo, and Memrise, and these studies focus primarily on general and academic vocabulary through interactive classroom activities and homework-based exercises. Research on Quizlet (Aynur, 2021; Chaikovska and Zharavska, 2020; Lukox, 2022; Montaner, 2020; Mykytka, 2023) and Kahoot (Ayub et al., 2022; Ridho et al., 2022) illustrate how gamified quiz formats are frequently used to increase engagement, repetition, and test-related performance. Similarly, studies focusing on Duolingo and Memrise (Irzawati, 2023; Ouyang et al., 2024; Alim et al., 2025; Gonzales and Dario, 2020; Lynn and Bongiwe, 2024) show a growing interest in app-based vocabulary learning linked to learner motivation and online engagement. In terms of Table 1, these platforms typically operate through interactive quizzes, repeated practice, and immediate feedback, often combining classroom use with independent study.

Thirdly, a smaller but clearly identifiable group of studies corresponds to messaging applications and social media-like environments, especially WhatsApp, including WhatsApp-mediated teaching and WhatsApp bots (Muhammad et al., 2021; Kamrul et al., 2022; Hakeen and Rashid, 2024; Boufhja et al., 2025; Ghaithi et al., 2024). These studies align directly with the description of collaborative and asynchronous interaction in Table 1, in which vocabulary learning occurs through teacher prompts, peer discussions, multimodal exchanges (text/audio/images), and sustained engagement beyond class time.

It is worth noting that Khoshsima and Khosravi (2022) connect WhatsApp with ANKI and traditional approaches, suggesting that social platforms can function as a bridge between structured spaced practice and peer-supported learning routines.

Fourth, evidence related to immersive technologies (AR/VR) is relatively limited in the corpus provided, but appears to be an emerging area with a strong emphasis on contextual and situational vocabulary through simulations and scenario-based learning. This is represented by an empirical study based on VR games (Seunghee, 2021) and two systematic reviews that map AR/VR applications for vocabulary learning, including in higher education (Haoming and Wei, 2024; Alhawsawi and Alzaid, 2025). In terms of Table 1, these studies align with immersive and experiential learning, in which vocabulary is learned through interaction in simulated environments, rather than through the study of decontextualized words.

Fifth, multimodal resources (videos, audio, images, and multimedia glosses) appear as another specialized trend, mainly linked to vocabulary development through reading and listening support and the correspondence between form and meaning. This area is represented by work on multimodal input and glosses (Boers, 2021; Feng, 2023; Li et al., 2022; Wang and Lee, 2021) and by a meta-analytic synthesis of the effects of multimedia glosses (Saleh et al., 2024). Compared to gamified applications and MALL flashcards, these studies emphasize vocabulary learning as part of comprehension-based tasks, in which technology enhances perception, processing depth, and memory through dual coding and richer input formats.

Finally, the emergence of AI chatbots and generative AI tools, particularly ChatGPT, is documented in recent studies and systematic reviews (2023-2025), indicating a shift toward adaptive and dialogic vocabulary learning. Finally, AR/VR technologies, examined in systematic reviews and empirical studies between 2021 and 2025, remain less prevalent but show promising potential for contextualized and immersive vocabulary learning at the university level.

Table 2

Teaching strategies used for teaching university-level English vocabulary

Teaching strategy	Support technology	Description of implementation	Main benefits
Spaced repetition and retrieval practice	Digital flashcards, mobile apps	Scheduled vocabulary review in short, frequent sessions	Improved long-term retention and learning efficiency
Gamification	Kahoot, Quizlet, Duolingo, Memrise	Use of games, points, rankings, and immediate feedback	Increased motivation and participation
Combined use of multiple applications	Kahoot + Quizlet + WhatsApp	Integration of assessment, practice, and collaboration over several weeks	Greater exposure to vocabulary and sustained learning
Collaborative learning mediated by messaging	WhatsApp, educational bots	Group discussion, shared tasks, sending multimedia resources	Social reinforcement and shared responsibility
Multimodal input and digital annotations	Videos, audio, images, interactive annotations	Presentation of vocabulary in multiple sensory formats	Better form-meaning association and comprehension
Guided practice with artificial intelligence	ChatGPT, chatbots	Dialogues, example generation, correction, and reformulation	Productive use of vocabulary and personalized learning

Note: Information obtained from analysis of the data.

Table 2 shows that university English vocabulary teaching between 2020 and 2025 is dominated by strategies that implement well-established learning principles, especially distributed practice (spaced repetition), retrieval practice, and repeated exposure, implemented through accessible digital tools. In the corpus provided, the strongest line is spaced repetition and retrieval practice, consistently implemented through digital flashcards and mobile apps. Studies using mobile flashcards and spaced repetition systems indicate that vocabulary practice is typically structured into short, frequent sessions that allow learners to review lexical items over time, a format consistent with long-term retention and learning efficiency (Hanson and Brown, 2020;

Xodabande et al., 2022; Zakian et al., 2022; Boroughani et al., 2023; Mohammadi et al., 2024; Zarrati et al., 2024; Koleini et al., 2024; Dalu and Mihali, 2025). Furthermore, the reviewed evidence confirms that MALL vocabulary research during this period emphasizes these mechanisms as fundamental to vocabulary acquisition (Dagdeler, 2023; Zhou and Zhou, 2025; Teymouri, 2024; Nguyen, 2021).

A second important group in Table 2 is gamification, represented by Kahoot, Quizlet, Duolingo, and Memrise. Across all sources, gamification is systematically implemented through points, quizzes, competitive rankings, and immediate feedback, whether in class, online, or in blended formats. Kahoot tests highlight how game-like assessment and repetition can boost engagement and promote memorization and retention in exam-oriented conditions (Ayub et al., 2022; Ridho et al., 2022). Quizlet studies also emphasize interactive exercise sets and repeated exposure, often linked to positive learner experiences in higher education settings (Aynur, 2021; Chaikovska & Zharavska, 2020; Montaner, 2020; Lukox, 2022; Mykytka, 2023). Studies on Duolingo from your list frame the platform as a technology-enhanced system that can increase engagement and willingness to communicate in online learning contexts (Irzawati, 2023; Ouyang et al., 2024; Alim et al., 2025), while research on Memrise supports its use for vocabulary enrichment and action research in the classroom in tertiary contexts (Gonzales and Dario, 2020; Lynn and Bongiwe, 2024).

In addition, two strategies are proposed that reflect a shift from vocabulary learning with a single tool to digital practice ecosystems: (a) the combined use of multiple applications and (b) collaborative learning mediated by messages. Their dataset contains direct support for both. The multiple-app strategy is explicitly represented by Bakhit et al. (2025), who examine the integrated use of MALL across all tools (e.g., assessment + practice + communication over weeks), aligning directly with the idea of sustained exposure and long-term engagement. In parallel, WhatsApp-based studies demonstrate how messaging apps enable collaborative vocabulary learning through group discussions, teacher-led tasks, asynchronous interaction, and multimodal resource sharing, as described in the table (Muhammad et al., 2021; Kamrul et al., 2022; Hakeen and Rashid, 2024; Boufhja et al., 2025). The inclusion of WhatsApp bots extends this collaborative approach to semi-automated delivery and practice formats (Ghaithi et al., 2024), while Khoshsima and Khosravi (2022) show how WhatsApp can complement structured practice such as ANKI, connecting social accountability with deliberate practice.

The multimodal input and digital glossing strategy in the table is also well supported in its corpus, but represents a different pedagogical approach: vocabulary learning as a function of comprehension and meaning-making, rather than just exercise and practice. Research on multimodal input indicates that presenting vocabulary through multiple sensory formats (e.g., visual and verbal information) can facilitate stronger links between form and meaning and improve retention (Li et al., 2022; Feng, 2023). Work focused on glossing further supports the role of digital annotations and glossing formats in strengthening vocabulary learning and reading comprehension by making lexical meaning more accessible during input processing (Boers, 2021; Wang & Lee, 2021). At the synthesis level, Saleh et al. (2024) reinforce this line of thinking by adding evidence on multimedia glossaries and vocabulary learning. Therefore, Table 2 correctly frames multimodal strategies as supporting form-meaning correspondence and comprehension, especially when vocabulary is encountered through reading/listening tasks.

In more recent studies, AI-driven strategies, particularly chatbot-guided practice using ChatGPT, shift the instructional focus toward contextualized lexical use, feedback, and productive vocabulary development, as highlighted in studies published between 2023 and 2025. Overall, analysis of the strategy indicates that effective university vocabulary teaching depends less on the novelty of technology and more on how tools implement established learning principles, such as repetition, feedback, interaction, and contextualization.

Table 3

Reported effects and results of the use of digital technologies and AI in teaching university-level English vocabulary

Dimension evaluated	Most commonly used indicators	Frequent comparisons	Reported results
Vocabulary gain (receptive and productive)	Pre-test–post-test, academic vocabulary tests	Technology vs. traditional method	Significant increase in vocabulary learned
Vocabulary retention	Deferred tests (weeks later)	Spaced repetition vs. non-spaced practice	Better long-term retention
Motivation and commitment	Quizzes, motivation scales, usage logs	Gamification vs. traditional teaching	Increased motivation and participation
Self-regulation and autonomy	Self-regulated learning scales, study habits	Mobile learning vs. guided instruction	Greater autonomy and control over learning
Student perception and acceptance	Interviews, satisfaction surveys, TAM/UTAUT models	Evaluation of digital tools	Positive attitudes toward the use of technologies

Note: Information obtained from the analysis of the data.

Table 3 accurately reflects the predominant pattern of results in the 2020-2025 literature you have selected: most studies operationalize effectiveness through measurable learning gains (increased vocabulary between pre- and post-tests), then extend to retention, and more recently include learner-centered dimensions such as motivation, engagement, self-regulation, and acceptance. Across the dataset, evidence suggests that digital technologies function primarily as amplifiers of exposure (more encounters with words) and optimizers of practice (better timing, feedback, and learner control), which is consistent with the results reported across the five dimensions.

In terms of content, vocabulary acquisition is the most stable and frequently reported effect, commonly measured through pretest-posttest designs or specific instruments (academic/technical vocabulary tests). Strong support comes from studies with

mobile-assisted flashcards and broader MALL interventions, which repeatedly report statistically significant improvements in vocabulary knowledge when learners use digital flashcards or mobile practices compared to baseline or comparison conditions (Xodabande et al., 2022; Zakian et al., 2022; Xodabande et al., 2022 [paper flashcards vs. mobile flashcards]; Boroughani et al., 2023; Mohammadi et al., 2024; Zarrati et al., 2024; Koleini et al., 2024). The same pattern of results appears in platform-based learning (especially Quizlet), where students' vocabulary performance improves thanks to repeated digital practice aligned with course requirements (Aynur, 2021; Chaikovska & Zharavska, 2020; Montaner, 2020; Lukox, 2022; Mykytka, 2023). Although the magnitude may vary depending on the duration of the intervention and the type of assessment, the cross-cutting message from the studies are consistent: technology-mediated repetition, coupled with structured practice, is associated with significant vocabulary growth in university contexts.

Table 3 emphasis on delayed retrieval closely aligns with its dataset, where retention is most convincingly supported by research on spaced repetition and flashcard-based systems. Studies using spaced repetition tools show that distributed review schedules promote long-term memory consolidation and reduce forgetting compared to less structured practice (Hanson and Brown, 2020; Xodabande et al., 2022; Zakian et al., 2022; Dalu and Mihali, 2025). Retention is also central to research on gamified quizzes that measure recall ability and delayed performance following repeated exposure to games (Ayub et al., 2022; Ridho et al., 2022). In multimodal branches, retention is interpreted through the durability of connections between form and meaning, supported by multimedia input and annotation formats (Feng, 2023; Li et al., 2022), while meta-analytic evidence further reinforces the claim that multimedia glossaries can support vocabulary learning effects beyond immediate comprehension outcomes (Saleh et al., 2024). Overall, their corpus makes it clear that retention improves more reliably when technology enables systematic spacing, repeated retrieval, or sustained encounters, rather than a single exposure.

The motivation/engagement row is strongly supported, especially in studies of Kahoot, Quizlet, Duolingo, and Memrise, where technology is designed to increase engagement through immediacy and game-like elements. Kahoot studies explicitly highlight engagement, enjoyment, and motivation alongside learning outcomes (Ridho et al., 2022; Ayub et al., 2022). Research on Quizlet also tends to report positive engagement by learners and a preference for digital practice formats, especially when learning is aligned with exam preparation and course outcomes

(Aynur, 2021; Chaikovska & Zharavska, 2020; Montaner, 2020; Mykytka, 2023). Similarly, studies of Duolingo in its corpus emphasize online participation variables such as engagement and willingness to communicate, reflecting the motivational possibilities of the platform and its feedback-based design (Ouyang et al., 2024; Irzawati, 2023; Alim et al., 2025). Studies of Memrise add evidence that motivation and intensity of vocabulary practice can increase when learning is app-based and progress is visible (Gonzales and Dario, 2020; Lynn and Bongiwe, 2024). The overall conclusion is clear: motivational benefits are observed more consistently in gamified or app-based environments that provide immediate feedback and progress cues.

Furthermore, the information is particularly consistent with one of the most notable contributions of their corpus: the relationship between MALL vocabulary learning and self-regulation skills. Boroughani et al. (2023) explicitly frame the use of mobile flashcards in relation to college students' self-regulation, while several flashcard-based studies emphasize autonomy outside the classroom, student control of pace, and habit formation through structured practice (Xodabande et al., 2022; Zakian et al., 2022; Zarrati et al., 2024). Review articles also place mobile vocabulary learning as a context in which autonomy is necessary and reinforced, as students manage when and how they practice and monitor their progress (Nguyen, 2021; Dagdeler, 2023; Zhou & Zhou, 2025; Teymouri, 2024). In comparative terms, the corpus supports the assertion in Table 3 that mobile learning environments tend to increase autonomy relative to more teacher-controlled instruction, especially when tools are intentionally used as self-learning systems rather than occasional classroom supplements.

Along the same lines, the dataset also supports the bottom row of the table, where many studies include surveys, interviews, or perception measures that indicate generally favorable attitudes toward digital tools for vocabulary learning, especially when the tools are easy to use and clearly linked to performance or engagement outcomes. This is evident in studies focusing on Quizlet (Aynur, 2021; Chaikovska & Zharavska, 2020; Lukox, 2022; Montaner, 2020; Mykytka, 2023), studies on gamification (Ridho et al., 2022; Ayub et al., 2022), work on the perception of Duolingo (Alim et al., 2025), and classroom-based research on Memrise (Gonzales and Dario, 2020; Lynn and Bongiwe, 2024). Research on WhatsApp similarly suggests acceptance, as the platform is already familiar to students and supports flexible, social learning (Muhammad et al., 2021; Hakeen and Rashid, 2024; Boufhja et al., 2025). However, a critical point is that acceptance measures in many studies are less standardized than vocabulary tests; therefore, the direction of the results is

consistent (positive), but comparability across studies may be weaker than in the dimensions of gain/retention.

5. Conclusion

The systematic review shows that research between 2020 and 2025 has focused primarily on mobile-assisted language learning tools and gamified digital platforms for teaching university-level English vocabulary. Digital spaced repetition flashcards, mobile apps, and gamified platforms such as Quizlet, Kahoot, Duolingo, and Memrise have become the most widely used technologies, while messaging apps (e.g., WhatsApp) and immersive technologies (AR/VR) are less common but growing in popularity. Although there are increasing conceptual references to artificial intelligence, the studies reviewed provide limited direct empirical evidence on vocabulary teaching based on generative AI or chatbots, indicating that current practice relies heavily on digital technologies, rather than entirely on AI.

The results indicate that effective vocabulary teaching at the university level is consistently based on pedagogical strategies grounded in repeated exposure, retrieval practice, and student engagement, supported by digital tools. Spaced repetition using digital flashcards, gamified practice, and the combined use of multiple applications were the best-documented strategies. In addition, collaborative learning mediated by messaging applications and multimodal input with digital glossaries improved sustained engagement and comprehension. Overall, the reviewed evidence suggests that technology is most effective when strategically integrated into sound pedagogical practices, rather than used as an isolated educational supplement.

In all of the studies reviewed, the use of digital technologies in teaching English vocabulary at university was consistently associated with a significant increase in vocabulary, better long-term retention, greater student motivation, improved self-regulation, and positive perceptions by students. Mobile and gamified learning environments were particularly effective in promoting autonomous learning and sustained engagement, while spaced repetition strategies showed the greatest impact on vocabulary retention. However, despite growing interest in artificial intelligence, the lack of direct evidence on AI-based vocabulary teaching highlights a significant research gap, underscoring the need for future empirical studies that explicitly examine the role of generative AI tools in vocabulary learning outcomes.

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