Vocabulary Learning Research in ESL/EFL: A Bibliometric Review of Trends, Innovations, and Gaps

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Abstract: Vocabulary acquisition is fundamental to language learning and overall proficiency in English as a Second Language (ESL) and English as a Foreign Language (EFL) context. In line with the United Nations' Sustainable Development Goal (SDG) 4: Quality Education, understanding trends in vocabulary research is essential for advancing inclusive and equitable education. This bibliometric analysis examines the evolution of vocabulary learning research from 2010 to 2024, based on 338 articles indexed in the Web of Science database. The study identifies key publication patterns, leading authors, influential institutions, and emerging themes. Findings show a notable increase in research after 2016, mainly driven by technological advancements such as mobile-assisted and computer-assisted language learning, as well as pedagogical innovations like flipped classrooms and task-based learning. However, critical gaps remain, especially in long-term vocabulary retention and the integration of emerging technologies like artificial intelligence (AI), augmented reality (AR), and virtual reality (VR). While previous studies have explored traditional instructional methods, few have examined the transformative role of these technologies in vocabulary acquisition. By mapping the current research landscape and highlighting underexplored areas, this study offers strategic insights to guide future research. The findings support efforts to improve vocabulary instruction and promote lifelong learning, in line with SDG 4.

Keywords: bibliometric analysis, emerging technology, technology-assisted learning, vocabulary acquisition, vocabulary learning

INTRODUCTION

Vocabulary acquisition plays a pivotal role in language learning, significantly contributing to literacy, comprehension, and overall proficiency, particularly for EFL (English as a Foreign Language) and ESL (English as a Second Language) learners. Over the last 30 years, research has shown a positive correlation between vocabulary knowledge and language proficiency, indicating that as learners' vocabulary expands, their language skills improve (Qian & Lin, 2020). This underscores the importance for educators to stay informed about the latest research developments in vocabulary teaching to adopt more effective strategies (Heidari, 2023). Recently, the integration of digital tools and active learning strategies has transformed vocabulary learning. Research has focused on methods such as flipped classrooms (Akbarian & Elyasi, 2023; Al-Amri, 2022), mobile-assisted learning (Alhebshi & Gamlo, 2022; Alqarni, 2024), and emerging technologies like artificial Intelligence (AI), augmented reality (AR), and virtual reality (VR) (Lin et al., 2022; Chen et al., 2021; Khodabandeh & Mombini, 2024), making vocabulary instruction more interactive and engaging for students.

Despite these advancements, vocabulary learning research remains fragmented across themes and methodologies. A comprehensive review is essential to map these developments and highlight under-researched areas. Bibliometric analysis offers a systematic approach to track the evolution of research by analyzing trends in publications, citations, and emerging topics over time (Darel, Chris, Daudet & Mavoungou, 2023). Additionally, it provides insights into key authors and influential studies that have shaped the field (Güler, 2023). By evaluating the impact of research through citation metrics and identifying collaboration patterns, bibliometric analysis can guide future studies and practices (Mahendro, Prasetyo & Kusumo, 2023).

This study focuses on research conducted between 2010 and 2024, a period marked by significant technological advancements that have reshaped vocabulary learning. Technologies such as mobile-assisted learning, AI, AR, and VR have opened new avenues for vocabulary instruction, creating immersive and interactive environments (Zhang & Huang, 2024; Chen et al., 2021). However, gaps remain, particularly in long-term vocabulary retention (Çelik & Baran, 2022) and understanding cognitive factors like working memory and motivation, especially for younger learners (Lee et al., 2022). Additionally, while emerging technologies have shown promise, their scalability across diverse contexts is under-researched (Fuhrman et al., 2021; Hung & Yeh, 2023; Khodabandeh & Mombini, 2024). This study seeks to identify these gaps and explore future research directions. The six research questions guiding this analysis are:

1. What are the annual publication trends in vocabulary learning research from 2010 to 2024, and how do they reflect shifts in academic interest?
2. Who are the most influential authors and institutions in vocabulary learning research from 2010 to 2024, and how have they shaped the field?
3. Which articles and citation patterns have had the greatest impact on vocabulary learning research from 2010 to 2024, and what emerging trends do they reveal?
4. What are the key thematic clusters in vocabulary learning research from 2010 to 2024?
5. How has the focus of vocabulary learning research evolved from 2010 to 2024?
6. What are the gaps and under-researched areas in vocabulary learning studies conducted between 2010 and 2024, and how can these gaps inform future research directions?

These questions aim to provide a comprehensive overview of the research landscape and uncover opportunities for further investigation.

This bibliometric analysis provides a clear overview of the evolving research landscape in vocabulary learning from 2010 to 2024, highlighting key trends and under-researched areas,

such as long-term retention and the integration of emerging technologies. The study offers valuable insights that can shape future research by guiding scholars to focus on critical gaps that could enhance vocabulary learning practices. The findings also have practical implications for educators, policymakers, and curriculum developers, emphasizing the need for more longitudinal studies on vocabulary retention and a deeper understanding of cognitive factors in digital learning environments. By identifying these areas, this study supports the development of more effective teaching strategies and policies that integrate new technologies to improve outcomes for diverse learners.

METHOD

This study employed a bibliometric analysis to systematically explore research trends, gaps, and under-explored areas in vocabulary learning from 2010 to 2024. Bibliometric analysis offers a quantitative approach to assessing the structure and development of scientific research within this period.

Data Collection

The data for this study were sourced from the Web of Science (WoS) Core Collection database, known for its comprehensive coverage of high-quality academic publications. According to Jia and Harji (2022), and supported by Tan, Harji & Hu (2023), the WoSCC includes high-quality journal literature that is widely recognized and influential worldwide, making it suitable for extensive bibliometric analysis on a large scale. This aligns with Rifa'i et al. (2023), who emphasize that the database contains high-quality, peer-reviewed journals, ensuring that the publications analyzed are of a high academic standard. This improves the reliability of the bibliometric findings.

The data for this analysis were collected using a structured keyword search. The following search terms were applied: ("Vocabulary learning" OR "Vocabulary acquisition" OR "Vocabulary instruction" OR "Vocabulary retention" OR "Vocabulary teaching" OR "Vocabulary knowledge") AND ("ESL" OR "English as a Second Language" OR "EFL" OR "English as a Foreign Language" OR "L2" OR "Second Language" OR "Foreign Language") AND ("teaching methods" OR "learning strategies" OR "teaching techniques" OR "technology integration" OR "blended learning" OR "mobile-assisted learning" OR "computer-assisted learning" OR "flipped classroom" OR "task-based learning" OR "project-based learning"). The search criteria included studies published between 2010 and 2024, restricted to peer-reviewed journal articles. Conference papers, book chapters, and non-peer-reviewed literature were excluded to maintain high-quality standards. The search was limited to English-language publications to ensure consistency in data interpretation. Boolean operators (AND, OR) were used to refine the search, resulting in an initial dataset of 469 articles.

Data Processing

The initial dataset consisted of 469 articles identified from the Web of Science database, with search parameters designed to capture relevant studies on vocabulary learning in ESL and EFL contexts from 2010 to 2024. To ensure the accuracy and relevance of the data, a thorough processing procedure was undertaken, as illustrated in Figure 1.

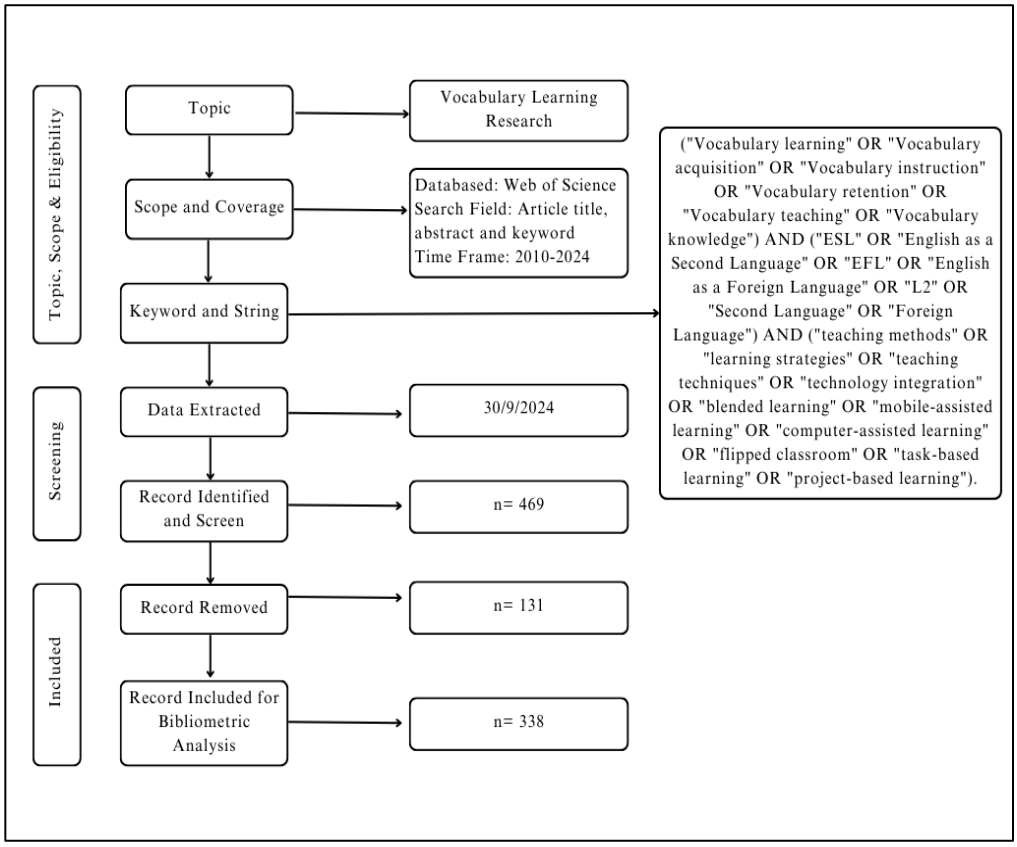

Figure 1: *PRISMA flow diagram for vocabulary learning research (2010–2024)*

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria were carefully applied to ensure a relevant and reliable dataset for this bibliometric analysis, focusing on vocabulary learning in ESL/EFL contexts. Only peer-reviewed journal articles in English, published between 2010 and 2024, were included to capture recent trends and advancements, aligning with studies like those by Lucena et al. (2019), Liu et al. (2022), and Rojas-Sánchez et al. (2023). Articles were prioritized if they addressed vocabulary learning, acquisition, retention, or teaching methods in ESL/EFL contexts. Exclusions included conference papers, book chapters, non-peer-reviewed literature, and studies outside ESL/EFL or vocabulary learning in other contexts, as advised by Liu et al. (2022) and Montazeri et al. (2023). These criteria ensured a high-quality dataset aligned with the study's focus on vocabulary instruction, enhancing the reliability of the bibliometric analysis.

FINDINGS AND DISCUSSION

This section presents and discusses the key findings from the bibliometric analysis conducted on vocabulary learning research from 2010 to 2024. The findings include the annual publication trends, leading authors, top contributing institutions, highly influential articles, and a citation analysis that identifies research trends and emerging gaps. The following subsections delve into these aspects in detail, answering the research questions and offering insights into the current state of vocabulary learning research.

The Annual Trend in Publication

Figure 2 illustrates the annual distribution of research publications in vocabulary learning from 2010 to 2024. The data reveals fluctuating trends, with periods of growth and stabilization. Between 2010 and 2015, publication counts were relatively low, reaching a minimum in 2010 with 5 publications (1.48% of the total), indicating limited early attention to the field. A significant increase occurred in 2016, peaking at 50 publications (14.79% of the total), likely due to heightened interest and new methodologies or technologies. From 2017 to 2020, annual output stabilized, ranging between 22 and 27 publications (approximately 6–8% of the total). The counts were highest in 2017 and 2020, with 27 and 25 publications, showing consistent focus during this period. A slight decline is observed from 2021 onward, with 23 publications in 2021 and 2022 (6.81% each) and minor increases in 2023 (25 publications, 7.40%) and 2024 (30 publications, 8.88%). Notably, 2024 data may be incomplete. Overall, these trends illustrate sustained interest in vocabulary learning research, particularly since 2016, with recent variability suggesting the field's ongoing relevance and adaptation.

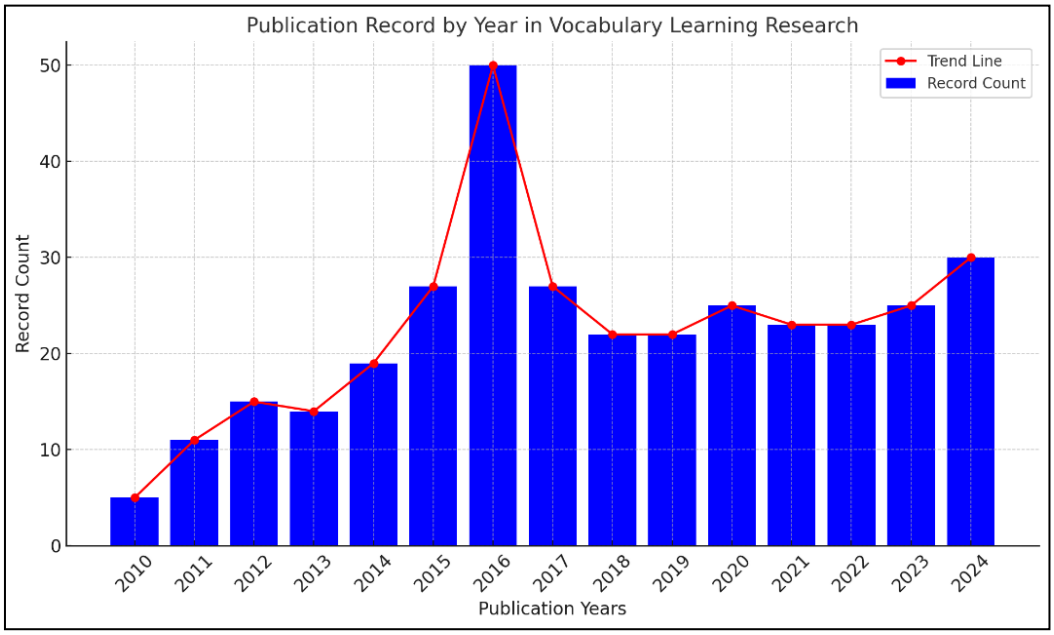

Figure 2: *Publication record by year in vocabulary learning research*

The Leading Authors in Vocabulary Learning Research

This bibliometric analysis of 338 records reveals influential and diverse contributions in vocabulary learning research. Figure 3 shows Sadighi as the most prolific author, with 6 records (1.78%), followed by Gorjian and Zou with 5 records each (1.48%). Their work advances personalized instructional strategies, retention techniques, and technology integration, contributing to more effective vocabulary learning environments. Biria and Reynolds, each with 4 records (1.18%), have explored explicit and implicit vocabulary instruction, gamification, and task-based learning, enriching pedagogical approaches. Additionally, Bagheri, Ghaemi, Hanh, Teng, and Valizadeh (3 records each, 0.89%) introduce fresh perspectives, focusing on glossing, code-switching, self-regulation, and mobile learning. Together, these authors contribute to a more comprehensive understanding of vocabulary acquisition across varied educational and cultural contexts.

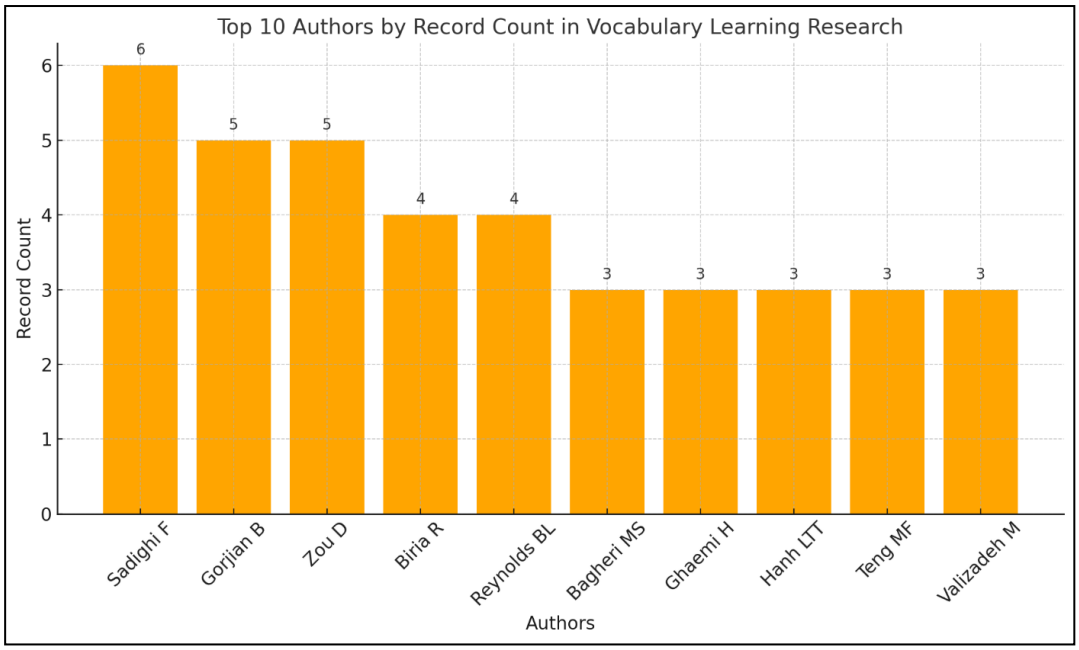

Figure 3: *Distribution of publications by leading authors in the field of vocabulary learning*

Top Ten Institutes Publishing Studies in Vocabulary Learning

Figure 4 provides an overview of the top ten institutes contributing to vocabulary learning research by publication volume. Islamic Azad University leads with 71 publications (21.01% of the total), reflecting its active role in advancing vocabulary learning research, particularly in regions focused on language education and applied linguistics. Following are the Education University of Hong Kong (EDUHK) and National Taiwan Normal University, with 8 (2.37%) and 7 publications (2.07%), respectively, known for their innovative approaches in language teaching and vocabulary acquisition strategies.

Other notable institutions, including Universiti Kebangsaan Malaysia and Aristotle University of Thessaloniki, contribute between 4 and 5 publications each, representing diverse regions across Asia, Europe, and the Middle East. This geographical distribution underscores global interest in vocabulary learning research, although the concentration of publications from a few institutions suggests that a select group has a more prominent influence in shaping the field. This trend highlights opportunities for broader participation and collaboration across lesser-represented regions and institutions.

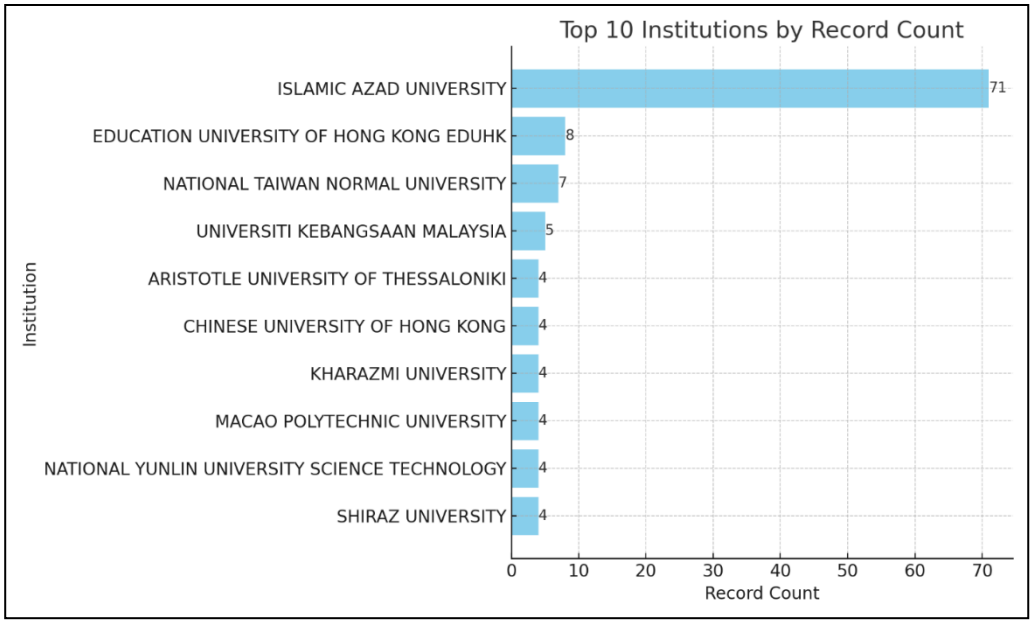

Figure 4: The top ten institutes that have published studies in vocabulary learning

The Highly Influential Articles

The analysis of the top 10 most cited articles offers valuable insights into the highly influential contributions within the domain of vocabulary learning. Table 1 presents the leading articles based on their total citations, revealing key trends and patterns in research impact. At the forefront, Sydorenko's (2010) study on modality in vocabulary acquisition (150 citations) reflects the ongoing intersection of technology and language learning. Yang et al. (2020), with 94 citations, underscores the rise of gamified, cognitively complex learning strategies, while Jia et al. (2012) highlights the flipped classroom model's role in vocabulary acquisition (70 citations). Chen et al. (2021) and Hava (2021) demonstrate growing interest in VR and digital storytelling for immersive, retention-focused vocabulary learning, with 59 and 52 citations respectively. These articles reflect a field increasingly focused on technology-enhanced, learner-centered methods, with continued reliance on foundational studies alongside rapidly cited innovations.

Table 1: *The ten most cited articles*

Authors	Title	Source Title	Total Citations	Publication Year
Sydorenko, Tetyana	Modality of Input and Vocabulary Acquisition	Language Learning & Technology	150	2010
Yang, Qi-Fan; Chang, Shao-Chen; Hwang, Gwo-Jen; Zou, Di	Balancing cognitive complexity and gaming level: Effects of a cognitive complexity-based competition game on EFL students' English vocabulary learning performance, anxiety and behaviors	Computers & Education	94	2020
Jia, Jiyou; Chen, Yuhao; Ding,	Effects of a vocabulary acquisition and assessment system on students' performance in	Computers & Education	70	2012

continued

Zhuhui; Ruan, Meixian	a blended learning class for English subject			
Chen, Ching-Huei; Hung, Hsiu-Ting; Yeh, Hui-Chin	Virtual reality in problem-based learning contexts: Effects on the problem-solving performance, vocabulary acquisition and motivation of English language learners	Journal of Computer Assisted Learning	59	2021
Hava, Kevser	Exploring the role of digital storytelling in student motivation and satisfaction in EFL education	Computer Assisted Language Learning	52	2021
Danan, Martine	Dubbing projects for the language learner: a framework for integrating audiovisual translation into task-based instruction	Computer Assisted Language Learning	52	2010
Hao, Yungwei; Lee, Kathryn S.; Chen, Szu-Ting; Sim, Sin Chie	An evaluative study of a mobile application for middle school students struggling with English vocabulary learning	Computers in Human Behavior	51	2019
Li, Huiyong; Majumdar, Rwitajit; Chen, Mei-Rong Alice; Ogata, Hiroaki	Goal-oriented active learning (GOAL) system to promote reading engagement, self-directed learning behavior, and motivation in extensive reading	Computers & Education	50	2021
Lin, Chi-Jen; Hwang, Gwo-Jen; Fu, Qing-Ke; Cao, Ya-Han	Facilitating EFL students' English grammar learning performance and behaviors: A contextual gaming approach	Computers & Education	41	2020
Zhang, Yining; Lin, Chin-Hsi; Zhang, Dongbo; Choi, Yunjeong	Motivation, strategy, and English as a foreign language vocabulary learning: A structural equation modelling study	British Journal of Educational Psychology	41	2017

Citation Analysis: Identifying Influential Research and Emerging Trends

This citation analysis highlights the most influential studies in vocabulary learning research from 2010 to 2024, with an h-index of 7, indicating sustained impact. Highly cited works like Hao et al. (2019) on mobile-assisted vocabulary learning and Gu (2018) on ESL vocabulary strategies have shaped research paradigms, while studies by Bytheway (2015) and Khan (2018)

emphasize the role of interactive environments. Emerging trends reveal a growing interest in technology-enhanced and self-regulatory learning approaches, as seen in recent studies on MMORPGs (Ng et al., 2022) and metacognitive strategies (Teng & Mizumoto, 2024). While mobile-assisted language learning has been extensively researched, gaps remain in areas such as long-term vocabulary retention and applications of AI, VR, and AR, highlighting opportunities for future research. Overall, this analysis underscores key works driving vocabulary learning research and points to evolving trends in technology integration and autonomous learning.

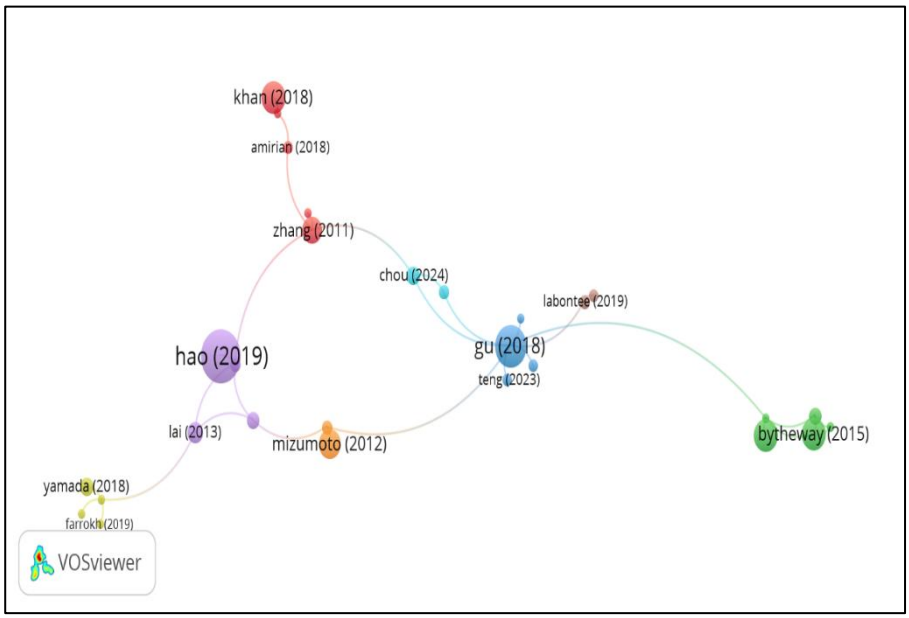

Figure 5: *Citation network of key authors in vocabulary learning research (2010–2024)*

Key Thematic Clusters in Vocabulary Learning Research From 2010 To 2024

Vocabulary learning research has experienced significant shifts in focus over the past decade, reflecting the changing needs of learners and the integration of new pedagogical and technological advancements. Using co-word analysis on 338 studies published between 2010 and 2024, this bibliometric analysis identifies seven key thematic clusters that represent the main areas of research. The clusters are analyzed based on their total link strength and occurrences, which provide insights into the relative importance and interconnectedness of these themes within the field. This section presents a detailed exploration of each cluster and the key studies that have contributed to these thematic developments.

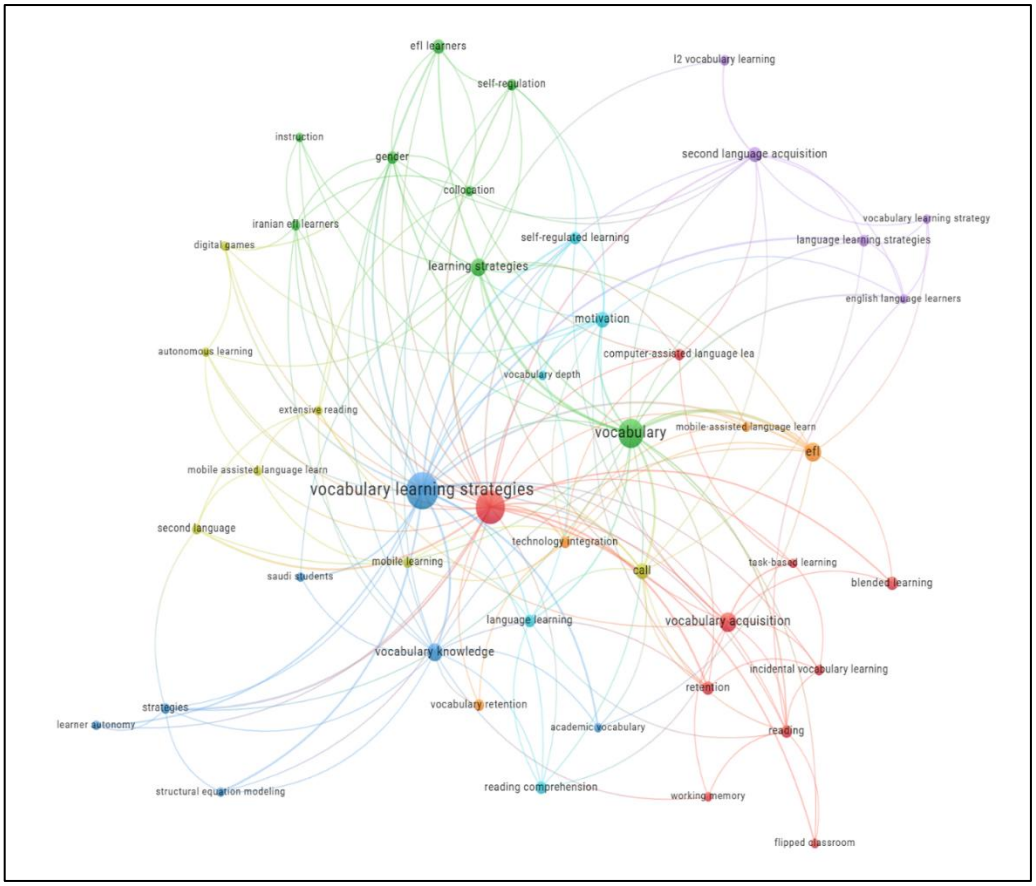

Figure 6: *Co-word network of author keywords in vocabulary learning research (2010–2024)*

Vocabulary Acquisition and Retention (Red Cluster)

The vocabulary acquisition and retention cluster, marked by high link strength (520) and occurrences (98), represents a prominent area in co-word analysis. This cluster encompasses diverse studies on how learners acquire and retain vocabulary, focusing on methods like task-based learning (Eskandari et al., 2024; Rabie-Ahmed & Mohamed, 2022), flipped classroom models (Sahin & Tavil, 2023), and various vocabulary strategies (Li & Wang, 2024; Othman, 2024). The flipped classroom, shown to enhance vocabulary retention in primary learners (Sik & Topkaya, 2024; Sahin & Tavil, 2023), highlights a learner-centered approach, while task-based learning, involving cognitively engaging tasks like composition writing, underscores the importance of task complexity in vocabulary acquisition (Eskandari et al., 2024). Additionally, the keyword method (KWM) is found more effective for collocation retention, though learners perceive rote learning (RLM) as easier but less reliable (Zhang & Reynolds, 2023). Techniques like the Student Response System (SRS) paired with think-pair-share (Çelik & Baran, 2022) and textual-based instruction (Kiasi & Gilakjani, 2023) further demonstrate efficacy in vocabulary retention. Together, these studies reflect a shift toward interactive, learner-centered approaches that prioritize retention as a key outcome.

Learning Strategies and Motivation (Green Cluster)

Learning strategies and motivation form a critical cluster, with a link strength of 432 and 85 occurrences. This area highlights strategies learners use for vocabulary acquisition and the motivational factors that influence success. Research shows self-regulation significantly aids

vocabulary learning, with motivation acting as a key mediator in proficiency outcomes (Ranalli, 2012; Li & Wang, 2024). Intrinsic motivation positively impacts vocabulary depth and breadth (Lee, 2020), while extrinsic motivation, supported by game-based learning, enhances short-term vocabulary gains (Lin et al., 2020). Mobile learning tools also boost motivation and retention (Palakova & Klimova, 2022). Overall, this research reflects a shift towards understanding cognitive and psychological factors that drive learner engagement and vocabulary success.

Vocabulary Knowledge and Mobile Learning (Blue Cluster)

The integration of mobile learning tools in vocabulary instruction is a key theme, with this cluster showing a link strength of 389 and 73 occurrences. Mobile-assisted language learning (MALL) supports vocabulary retention and engagement, with studies highlighting Quizlet's effectiveness in vocabulary acquisition (Özdemir & Seckin, 2024; Nguyen & Le, 2023) and the benefits of consistent flashcard app use (Daly, 2022). Mobile apps also enhance learning efficiency and self-regulation (Samimi & Abadi, 2016; Lei et al., 2022). These findings underscore MALL's potential to improve vocabulary retention and foster learner autonomy.

Autonomous Learning and Extensive Reading (Yellow Cluster)

Autonomous learning, especially in extensive reading, is a notable theme with a link strength of 315 and 60 occurrences. Autonomous strategies, like MMORPGs for vocabulary (Bytheway, 2015) and blended learning (Krishnan & Yunus, 2019), have been effective in promoting vocabulary retention and self-directed learning, particularly among low-proficiency learners. Platforms like Facebook as an Online Learning Platform (FOLP) also enhance vocabulary, though challenges like social loafing exist (Mukhlif & Challob, 2021). Extensive reading has shown significant effects on vocabulary acquisition, with self-directed learners demonstrating greater engagement and retention (Li et al., 2021). Additionally, reading context impacts vocabulary recall, whether in or out of class (Modirkhamene & Gowrki, 2011; Reynolds, 2022). These findings underscore the value of personalized, context-driven strategies for fostering autonomous vocabulary development.

Second Language Acquisition and Learning Strategies (Purple Cluster)

The SLA and Learning Strategies cluster, with a link strength of 298 and 58 occurrences, explores how vocabulary strategies enhance acquisition and retention across diverse linguistic contexts. Studies reveal low digital tool usage for vocabulary among Romanian students due to limited guidance and digital literacy, indicating challenges in integrating MALL into SLA (Cojocnean, 2016). In contrast, concept mapping and notebook keeping have been shown to improve both self-regulation and vocabulary retention (Naderifar, 2018). Vocabulary strategies like those associated with larger receptive vocabulary sizes (Castellano-Risco, 2018) and tools such as Quizlet, effective across cognitive profiles, further support SLA (Nguyen & Le, 2023). Afghan learners favor strategies like repetition, reading, and dictionary use, underscoring cultural influences on learning approaches (Rahmani, 2023). These findings highlight the value of adaptable, context-specific vocabulary strategies in second language acquisition.

Technology Integration (Orange Cluster)

The Technology Integration cluster, with a link strength of 280 and 50 occurrences, illustrates the evolution of vocabulary learning from early Computer-Assisted Language Learning (CALL)

to advanced tools like Mobile-Assisted Language Learning (MALL), Augmented Reality (AR), Virtual Reality (VR), Artificial Intelligence (AI), and Digital Game-Based Learning (DGBL). Initial studies on CALL (Li, 2010; Hirschel & Fritz, 2013) introduced digital tools for structured classroom settings. The emergence of MALL (Zakian et al., 2022; Daly, 2022) enabled autonomous, flexible learning, while recent developments in AR (Hung & Yeh, 2023) and VR (Chen et al., 2021) offer immersive contexts for vocabulary acquisition. AI (Zhang & Huang, 2024) and DGBL (Zhang et al., 2024) now support adaptive, personalized learning experiences. This cluster highlights a shift toward interactive, immersive, and individualized vocabulary learning.

The co-word analysis of studies from 2010 to 2024 reveals six key thematic clusters in vocabulary learning research, each marking significant developments. The Vocabulary Acquisition and Retention (Red Cluster) highlights instructional methods like task-based learning and flipped classrooms, reflecting a shift toward interactive, learner-centered approaches for long-term retention. Learning Strategies and Motivation (Green Cluster) emphasizes self-regulation and motivation, with intrinsic and extrinsic factors, along with mobile tools, shown to enhance vocabulary acquisition. In the Vocabulary Knowledge and Mobile Learning (Blue Cluster), mobile-assisted tools like Quizlet significantly boost vocabulary retention and learner autonomy. Autonomous Learning and Extensive Reading (Yellow Cluster) demonstrates the effectiveness of self-directed learning, particularly through extensive reading, in vocabulary growth. The Second Language Acquisition and Learning Strategies (Purple Cluster) underscores adaptable strategies tailored to diverse linguistic and cultural contexts in SLA. Finally, the Technology Integration (Orange Cluster) reflects the evolution from traditional computer-assisted tools to immersive technologies like AR, VR, AI, and digital games, promoting personalized, contextual, and interactive learning environments. Together, these findings demonstrate a diversification of approaches in vocabulary learning, with a growing emphasis on learner autonomy, motivation, and technology integration.

Evolution Of Vocabulary Learning Research Focus From 2010 To 2024

Vocabulary learning research has evolved considerably over the past 14 years, driven by technological advancements, shifts in educational theories, and changing learner needs. This bibliometric analysis tracks these developments across three distinct periods—2010–2014, 2015–2019, and 2020–2024—highlighting trends, key studies, and emerging gaps to understand how research has adapted to new pedagogical approaches and technological tools, including mobile learning, autonomous learning, and computer-assisted language learning (CALL).

Early Trends (2010–2014)

From 2010 to 2014, vocabulary research focused primarily on traditional instructional strategies. Studies during this time emphasized explicit vocabulary instruction, rote memorization, and contextual clue usage to support vocabulary comprehension, particularly in English as a Foreign Language (EFL) context. Golaghaei & Sadighi (2011), for example, examined how personality traits like extroversion and introversion influenced vocabulary use, highlighting the need for different instructional approaches for distinct learner profiles. Similarly, Hyso & Tabaku (2011) emphasized teaching vocabulary through reading comprehension exercises, especially for advanced EFL learners. These studies, while informative, reflect a broader reliance on traditional, teacher-directed methods centered on vocabulary breadth rather than depth or retention. Technology integration in this period was minimal, with most studies, such as Bölükbas (2013), focusing on language learning strategies

without significant digital enhancement. Ishikawa et al. (2014) provided a rare example of technology use, exploring an EFL reading practice system, but such instances were isolated. Overall, this period marked a conservative approach to vocabulary learning, relying on established techniques rather than digital tools or mobile learning, which had not yet become central in vocabulary research.

Mid-Period Shifts (2015–2019)

The period from 2015 to 2019 represents a clear shift from traditional methods to more interactive, personalized, and technology-driven instructional approaches. Mobile apps, personalized learning platforms, and game-based learning emerged as important tools for supporting both vocabulary acquisition and long-term retention (Cojocnean, 2016; Hao et al., 2019; Xie et al., 2019). These tools reflected a deeper understanding of how digital resources could enhance learning engagement and outcomes, with studies showing that mobile apps supported not only vocabulary acquisition but also retention through interactive features.

The rise of flipped classrooms and blended learning models further emphasized the need for adaptive and flexible environments that could accommodate diverse learner needs (Yang et al., 2019; Krishnan & Yunus, 2019). By 2019, the vocabulary learning field had embraced learner-centered approaches that provided more control to students, allowing for active engagement through gamified and personalized content (Zhonggen, 2018). This trend aligns with broader educational movements prioritizing differentiated instruction and technology integration to support a variety of learning pathways (Yang et al., 2019; Ko, 2019).

Overall, the period from 2015 to 2019 reflects an interdisciplinary approach in vocabulary research, integrating insights from technology, pedagogy, and cognitive science. By combining these fields, vocabulary learning became more engaging and accessible across different contexts and proficiency levels.

Recent Trends (2020–2024)

The most recent period, from 2020 to 2024, has been marked by a shift towards integrating advanced technologies, including mobile-assisted language learning (MALL), augmented reality (AR), virtual reality (VR), and artificial intelligence (AI). These technologies have supported more personalized and immersive learning environments, making vocabulary acquisition more interactive and learner-centered (Chen et al., 2021; Alqarni, 2024). MALL has remained central, with studies demonstrating its effectiveness in improving vocabulary retention and fostering learner autonomy through real-time feedback and personalized learning pathways (Alqarni, 2024; Al-Abri et al., 2024).

AR and VR have introduced new possibilities for context-rich vocabulary learning. For instance, Hung & Yeh (2023) showed that AR-based learning, particularly in flipped classrooms, boosts vocabulary acquisition and creative thinking, while Chen et al. (2021) illustrated VR's potential in creating immersive contexts that aid retention by simulating real-world interactions. Additionally, AI-powered tools, such as chatbots, have become increasingly common for facilitating vocabulary learning. Zhang & Huang (2024) demonstrated that AI-driven chatbots can support personalized learning and enhance long-term retention, providing students with adaptive, responsive experiences.

In summary, the period from 2020 to 2024 highlights an increasing reliance on advanced technologies to support vocabulary learning, with a strong focus on personalization, learner autonomy, and immersive experiences. This evolution aligns with broader educational trends emphasizing adaptive learning and real-time interaction, indicating a shift in vocabulary learning from traditional, static methods to dynamic, interactive, and context-sensitive

approaches that engage learners in new and effective ways (Chen et al., 2021; Hung & Yeh, 2023; Zhang & Huang, 2024).

Gaps and Under-Researched Areas in Vocabulary Learning Studies (2010–2024)

The objective of Research Question 3 (RQ3) is to identify research gaps and under-explored areas in vocabulary learning studies conducted between 2010 and 2024. Despite notable advancements in technology-enhanced learning and vocabulary acquisition strategies, significant gaps persist in critical domains. Existing research has largely concentrated on short-term vocabulary acquisition outcomes, with insufficient attention paid to long-term retention, particularly in the context of emerging technologies such as Artificial Intelligence (AI) and Augmented Reality (AR). Furthermore, cognitive factors such as working memory and motivation remain inadequately investigated, especially in younger learners within digitally supported environments. This section synthesizes these research gaps and proposes future directions for addressing these limitations in vocabulary learning studies.

Gaps in Longitudinal Studies on Vocabulary Retention

A significant gap in vocabulary learning research from 2010 to 2024 is the predominant focus on short-term acquisition, with limited attention to long-term retention. Numerous studies emphasize immediate learning outcomes without tracking how effectively vocabulary is retained over time. This shortfall remains despite increased use of digital tools like Computer-Assisted Language Learning (CALL), Mobile-Assisted Language Learning (MALL), and AI applications, which have potential to support long-term retention.

During 2010–2014, research primarily concentrated on short-term gains. Studies by Liao and Chen (2012), Wei and Attan (2014), and Uzun (2013) focused on immediate acquisition, while Hirschel and Fritz (2013) highlighted the need for studies exploring retention beyond post-tests. The trend continued from 2015 to 2019, with Tajik (2018) and Khalifa (2015) examining vocabulary strategies and teaching methods without assessing long-term retention. Similarly, studies incorporating technology, such as Moosazadeh and Motallebzadeh (2017), explored digital tools but did not include longitudinal data on retention.

From 2020 to 2024, studies continued to prioritize short-term acquisition, even as advanced technologies became more common. For example, Çelik and Baran (2022) and Nguyen and Le (2023) investigated technology integration without exploring retention, while Zhang and Reynolds (2023) and Xodabande et al. (2022) examined digital learning tools with limited attention to retention outcomes.

The persistent lack of longitudinal research limits insights into vocabulary durability, particularly with digital tools. Although short-term gains are valuable, understanding vocabulary retention over extended periods is essential to assess the true impact of learning strategies and optimize digital tools like CALL, MALL, and AI for sustained vocabulary acquisition.

Under-Explored Cognitive and Psychological Factors

Despite gradual progress over the past decade, cognitive factors like working memory, motivation, and self-regulation remain under-explored in vocabulary learning, especially within digital environments. Studies from 2010 onward began acknowledging these elements' importance but often failed to examine their interactions with digital tools, particularly for younger learners. For instance, Mizumoto (2012) and Jalali and Dousti (2012) investigated aspects like self-regulation and motivation but did not explore the role of working memory or

its interaction with emerging digital resources for primary students.

The period from 2015 to 2019 showed some advances, with studies beginning to incorporate digital learning settings. However, many works still focused on isolated cognitive elements without examining their combined impact in technology-enhanced environments. Sendag, Gedik, and Toker (2018) and Ping et al. (2015) emphasized motivation and self-regulation but did not address working memory or its interaction with these factors. Although this period saw a growing interest in cognitive dimensions, a comprehensive approach that examines their integration in digital learning for younger learners was largely absent.

In 2020–2024, the trend of integrating digital tools with cognitive factors gained traction, yet studies often overlooked developmental differences among younger learners. Research such as Lee et al. (2022) explored working memory and digital tools but lacked detailed analysis on how these interactions affect vocabulary retention in primary school contexts. Similarly, Al-Abri et al. (2024) examined lexical fluency without investigating working memory's influence on vocabulary retention for younger learners.

Across these periods, while cognitive factors are increasingly recognized as important, their combined role in digital learning for vocabulary retention—especially for younger students—remains insufficiently explored. Understanding these cognitive elements and their interaction with digital tools could be crucial for developing vocabulary strategies tailored to young learners' developmental needs. Despite strides in recent years, significant gaps persist in fully comprehending the role of cognitive factors in digital language learning environments.

Emerging Technologies: Artificial Intelligence, Augmented Reality and Virtual Reality

From 2020 to 2024, studies have increasingly explored the role of artificial intelligence (AI), augmented reality (AR), and virtual reality (VR) in vocabulary learning, highlighting each technology's potential to personalize and engage learners. However, despite these promising developments, significant gaps remain regarding the long-term effects on vocabulary retention and practical scalability across diverse educational settings.

AI has shown particular promise in creating adaptive learning environments that support vocabulary acquisition. For example, Lin et al. (2022) demonstrated the effectiveness of AI-powered robots for short-term vocabulary gains. While AI applications are valuable for immediate learning outcomes, few studies have examined how AI might support sustained retention of vocabulary over time, particularly in adaptive learning contexts. This gap is crucial for understanding AI's potential in fostering deep, long-term language proficiency.

AR has also shown benefits, particularly in blended and flipped classroom models. Khodabandeh and Mombini (2024) found that AR-enhanced activities significantly improved vocabulary performance and self-efficacy among high school students. Yet, scalability remains a challenge, with limited access to AR resources and insufficient teacher training hampering broader implementation. Furthermore, studies like Hung and Yeh (2023), which explored AR in game-based learning, focused on short-term outcomes without assessing the sustained retention of vocabulary, underscoring the need for research on AR's long-term impact.

Similarly, VR is gaining attention for its ability to create immersive learning experiences that enhance engagement and vocabulary comprehension. Chen et al. (2021) reported increased motivation and improved vocabulary retention in VR environments, where students interact with vocabulary in simulated real-world contexts. Fuhrman et al. (2021) also highlighted VR's effectiveness for contextualized learning, yet studies are needed to assess VR's lasting effects on vocabulary retention, as well as its accessibility and practicality for diverse classrooms.

Collectively, AI, AR, and VR demonstrate considerable potential to revolutionize vocabulary learning by providing interactive, personalized experiences. However, the emphasis

on short-term outcomes in current research limits understanding of these technologies' contributions to long-term vocabulary retention, an essential component of language proficiency. Additionally, challenges related to access, cost, and teacher training must be addressed to enable widespread implementation. Future research should prioritize examining these tools' sustained impact and scalability to enhance their applicability across varied educational contexts.

RECOMMENDATIONS FOR FUTURE RESEARCH

To advance vocabulary learning research and address key gaps identified in this analysis, several research directions are essential. First, more longitudinal studies on vocabulary retention are needed to assess how effectively learners retain vocabulary over time, particularly in technology-enhanced environments such as AI, CALL, and MALL. While many studies examine short-term gains, future research should include follow-up assessments to capture the long-term impact of these adaptive tools on sustained vocabulary knowledge.

Second, research should delve deeper into cognitive and psychological factors like working memory, motivation, and self-regulation, especially among younger learners. Understanding how these factors interact with digital tools in primary education settings could guide the development of age-appropriate, technology-enhanced interventions that foster better vocabulary retention.

Finally, as technologies like AI, AR, and VR become more integrated in education, studies must assess their scalability and feasibility in real-world settings. Current research highlights their potential for vocabulary acquisition, but future studies should examine practical challenges, including cost, accessibility, and teacher training, to ensure these tools can be sustainably implemented across diverse educational contexts. By addressing these research gaps—long-term retention, cognitive factors, and scalable technology use—future studies can significantly advance both theoretical understanding and practical approaches to vocabulary learning.

CONCLUSION

This bibliometric analysis of vocabulary learning research from 2010 to 2024 reveals key thematic clusters, including vocabulary acquisition, retention, learning strategies, mobile and autonomous learning, and technology integration. These themes highlight the field's shift from traditional methods toward digital tools and learner autonomy, underscoring the importance of motivation, self-regulation, and technology in promoting long-term vocabulary retention.

Despite these advancements, significant gaps remain. Most research continues to focus on short-term outcomes, leaving a need for longitudinal studies that assess vocabulary retention over time, especially in technology-enhanced environments like CALL and MALL. Additionally, interactions between cognitive factors (e.g., working memory and motivation) and digital tools, particularly among younger learners, require further exploration. Emerging technologies such as AI, AR, and VR offer potential for vocabulary instruction but face challenges related to scalability, cost, and accessibility that future research must address.

In summary, this analysis emphasizes the dynamic nature of vocabulary learning research. By focusing on long-term retention, cognitive factors, and scalable technology, future studies can enhance both theoretical insights and practical approaches for effective vocabulary instruction across varied educational contexts.

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