

Retrieval, repetition, and retention: unveiling vocabulary acquisition strategies for ESL learners

Abstract

This paper explores the practical implementation of retrieval practice techniques for improving English as a Second Language (ESL) vocabulary acquisition. Effective strategies for fostering long-term retention and comprehension of vocabulary are of utmost importance in the field of ESL education. Three key retrieval practice techniques, namely, The Brain Dump, Low-Stakes Quizzes, and Flashcards, were examined, and their advantages, drawbacks, and potential impact on ESL learners were discussed. Additionally, the integration of digital technology with traditional retrieval practice tools is discussed, highlighting the evolving landscape of language learning strategies. This discussion emphasizes the significance of retrieval practice in enhancing ESL vocabulary acquisition, offering educators and learners valuable tools to reinforce memory traces, engage in active recall, and promote metacognition. However, challenges, such as time constraints, test anxiety, and rote memorization, must be carefully considered in their implementation. Overall, this paper provides insights into the practical utilization of retrieval practice techniques, offering educators a nuanced perspective on improving ESL learners' long-term vocabulary retention and comprehension.

Keywords: practice techniques, English, second language, vocabulary acquisition

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Introduction

In the field of English as a Second Language (ESL) education, it is crucial to identify effective strategies to foster long-term retention and comprehension, particularly in vocabulary acquisition. Among the various instructional approaches, retrieval practice has been recognized as a vital technique, playing a key role in mastering vocabulary, which is essential for achieving proficiency in ESL. Despite the recognition of retrieval practice, there is a noticeable gap in customizing this technique to address the specific needs of ESL vocabulary acquisition. Traditional teaching methods tend to focus on input-based approaches, primarily emphasizing the introduction of new vocabulary; however, output-oriented techniques that emphasize vocabulary retrieval from students have demonstrated superior long-term retention and comprehension of language concepts. This paper aims to bridge this gap by exploring a range of evidence-based retrieval practice techniques specifically tailored for ESL vocabulary learning contexts. The goal is to provide language educators with practical tools that can be easily integrated into their teaching practices, without requiring additional resources or time investment. By meticulously examining these methodologies and discussing their potential benefits for both educators and learners, this paper aims to provide valuable insights into how best practices can be effectively implemented in various educational settings, thus enhancing the effectiveness of ESL vocabulary instruction and significantly aiding learners' progress towards language proficiency.

Literature review

Introduction to retrieval practice

The use of retrieval practice as a pedagogical strategy has been found to significantly improve learning outcomes in the acquisition of ESL vocabulary. By encouraging active recall of previously learned words, this technique strengthens the retention and retrieval processes, providing a strong basis for advanced language comprehension and usage.

The shift from traditional input-based learning paradigms to a more dynamic output-oriented approach facilitated by retrieval practice represents a paradigm shift in pedagogy. This transition emphasizes active recall and reinforcement of previously learned materials, as opposed to primarily presenting new information to learners. This approach fosters a more engaged and active learning environment, which is particularly crucial for English as a Second Language (ESL) learners seeking to achieve linguistic proficiency. Active retrieval and utilization of vocabulary are key factors in the pursuit of linguistic mastery and effective communication in the English language. Empirical evidence provides robust support for claims regarding the efficacy of retrieval practice. For example, Roediger and Karpicke¹ demonstrated a notable improvement in memory retention and academic performance through retrieval practice. This study found that learners who engaged in retrieval practice had superior retention rates compared to those who merely reviewed the material. A subsequent study by Karpicke and Roediger² further supports this claim by examining the limitations of traditional learning methods and highlighting the superior outcomes associated with retrieval practices. Additionally, studies by Agarwal et al.³ and McDaniel et al.⁴ in diverse educational contexts and age groups provide a broad validation of the claim, confirming the powerful impact of retrieval practice in enhancing long-term retention and promoting a deeper understanding of the material.

It is common for critics to advocate for traditional input-based methods because of their structured and gradual approach to knowledge acquisition. This structured approach is particularly beneficial for learners in the initial stages of language learning as it offers a scaffolded learning environment that progressively introduces new vocabulary and concepts, thereby reducing cognitive overload and promoting incremental learning. While traditional learning methods have merit, compelling empirical evidence supporting the long-term retention and understanding of retrieval practice is difficult to ignore. Furthermore, a blended approach combining retrieval practice with other effective learning strategies, such as spacing and interleaving, has the potential to provide an optimized learning

environment for ESL learners. This integration of strategies leverages the strengths of both paradigms, offering a structured, yet dynamic, learning experience that actively engages learners and reinforces memory retention. Empirical research, such as studies by Dunlosky, Rawson, Marsh, Nathan, and Willingham⁵ and Kang⁶ support the efficacy of this integrated approach, demonstrating significant improvements in learners' retention and understanding of new vocabulary. Moreover, classroom implementation of these strategies has shown promise in enhancing ESL learners' engagement and linguistic proficiency. This nuanced approach, supported by a wealth of empirical evidence and practical classroom success, highlights the potential of retrieval practice as a key component of contemporary ESL pedagogy, promising a more engaged, effective, and enriched learning experience.

Considering the established importance of retrieval practice, it is essential to explore the underlying theoretical principles that support its effectiveness, particularly the Retrieval Effort Hypothesis. This hypothesis, rooted in cognitive psychology, extends beyond the practical applications of retrieval practice to shed light on the cognitive mechanisms that drive effective learning and recall. By examining the Retrieval Effort Hypothesis, we can gain a deeper understanding of not only the importance but also the subtle implications of incorporating retrieval practice in the acquisition of ESL vocabulary.

The retrieval effort hypothesis

The Retrieval Effort Hypothesis is a theoretical framework that posits that the process of actively recalling information, even if it requires effort and is challenging, significantly enhances its retention. In other words, when learners engage their memory in retrieving previously learned material, the act of retrieval itself strengthens their memory of the information. This hypothesis is particularly relevant in the context of ESL vocabulary acquisition, as it suggests that actively recalling and using new vocabulary words can lead to more effective and long-lasting learning outcomes, even if difficult.

The Retrieval Effort Hypothesis is partly based on Bjork's Desirable Difficulty Framework,⁷ which suggests that learning is enhanced when challenges are adjusted to match the learner's capacity, resulting in more active engagement and better comprehension. The hypothesis proposes that the process of recalling information is enhanced when it is challenging. This is particularly relevant in the context of ESL learning, in which learners often struggle to retain and recall new vocabulary. By implementing tailored challenges, as advocated by this hypothesis, learners can experience more engaging and enriching learning experiences as they navigate the linguistic complexities of a new language.

Empirical evidence supporting the Retrieval Effort Hypothesis is extensive and compelling. For example, the study conducted by Smith, Roediger, and Karpicke⁸ provides a seminal contribution to the validation of this hypothesis, as it demonstrates that learners who engage in challenging retrieval practices exhibit superior retention of material over extended periods, compared to those who engage in less challenging retrieval scenarios. This finding directly supports the claim that retrieval effort is a critical factor in promoting long-term retention of vocabulary in ESL learning scenarios. Furthermore, the retrieval effort hypothesis has been validated across a variety of educational contexts, including Karpicke et al.,⁹ and McDaniel et al.,⁴ further reinforcing its applicability and effectiveness. The direct link between the evidence and the claim highlights the practical benefits of implementing challenging retrieval practices in ESL vocabulary-learning scenarios.

The significance of retrieval effort as a learning strategy has been acknowledged, but its application in the acquisition of L2 vocabulary has been criticized. Critics have suggested that excessively difficult vocabulary acquisition tasks may result in frustration and feelings of being overwhelmed, which could ultimately prevent the achievement of vocabulary-related goals.

The literature acknowledges the aforementioned concerns and recognizes the need to calibrate the challenge level of retrieval tasks to match learners' abilities. The personalized customization of such tasks ensures that they are challenging enough to promote cognitive engagement without being overwhelmingly difficult. Supportive learning strategies, such as providing formative feedback and fostering a supportive learning environment, can help mitigate the potential negative effects of challenging retrieval tasks. By implementing such strategies, educators can leverage the benefits of the Retrieval Effort Hypothesis and create a supportive and conducive learning environment for learners. Studies by Pyc and Rawson¹⁰ and Roediger and Butler¹¹ have demonstrated the significant impact of adjusting the level of challenge and providing supportive feedback on enhancing learners' engagement and retention of information.

Given the established theoretical underpinnings of the Retrieval Effort Hypothesis, it is essential to examine how its principles interact with other learning strategies that promote effective learning. Among these, the notion of spacing stands out as a complementary approach to retrieval practice. By integrating these strategies, a comprehensive and structured learning environment can be created that has been demonstrated to significantly enhance the acquisition of ESL vocabulary and provide a robust framework for effective learning and long-term retention.

Interplay between retrieval practice and spacing

The interaction between retrieval practice, which entails the active recall of information and spacing, and the deliberate distribution of learning sessions over time, has been determined to create a favorable learning pathway. This interplay is rooted in cognitive and educational theories that underscore the importance of active engagement and distributed practice in enhancing memory retention and facilitating learning. Particularly, it paves the way for substantial long-term retention and efficient acquisition of ESL vocabulary, making it a robust framework that fosters an optimal learning environment, especially for learners who grapple with the challenges of a new language.

Spacing plays a crucial role in the gradual assimilation of information, which is essential for embedding new vocabulary into the long-term memory of ESL learners. When combined with retrieval practice, spacing provides a strong learning scaffold that promotes internalization and effective retrieval of vocabulary. This combined approach engages learners in deeper interaction with the material, moving beyond mere recognition to the level of mastery necessary for effective language use.

Research on the interplay between retrieval practice and spacing has substantially been illuminated by studies such as those conducted by Pashler et al.,¹² and Cepeda et al.,¹³ which highlight the benefits of spaced retrieval practice for long-term knowledge retention. In the experiment by Pashler et al.,¹² participants were engaged in a two-session exercise across consecutive days to learn Eskimo-English word pairs. During the first day, each word pair was encountered three times: initially in a study trial, followed by two test trials with variable lags between them. The following day featured a no-feedback test. Interestingly, the results exhibited a trend where longer lags between

the test trials on Day 1 led to reduced performance on the immediate second test, yet significantly improved retention on the Day 2 test. This demonstrated the advantageous role of spacing in augmenting long-term retention, even in the face of initial errors during the learning phase.

On the other hand, Cepeda et al.,¹³ conducted a comprehensive meta-analysis concerning the distributed practice effect, examining 839 assessments from 317 experiments across 184 articles. The analysis delved into the effects of spacing (consecutive massed presentations vs. spaced learning episodes), lag (less spaced vs. more spaced learning episodes), and the expanding inter-study interval effects. A notable finding from this meta-analysis was the joint operation of inter-study interval (ISI) and retention interval in affecting final test retention. Specifically, the optimal ISI for maximal retention extended as the retention interval increased. This comprehensive analysis not only reinforced the benefits of spaced retrieval practice but also hinted at the necessity of considering temporal variables in learning and retention.

These cornerstone studies, along with classroom-based research, particularly in ESL settings, underpin the effectiveness of combining retrieval practice and spacing in promoting vocabulary retention and retrieval among ESL learners. For instance, a study in an ESL classroom demonstrated that learners who engaged in spaced retrieval practice could recall and use new vocabulary more efficiently in their communication.¹⁴ The amassed evidence accentuates the significant role of the interaction between retrieval practice and spacing in cultivating a conducive learning environment for ESL vocabulary acquisition.

Some critics argue that the simultaneous implementation of retrieval practice and spacing may dilute the unique benefits of each strategy. They suggest that focusing on one strategy at various points during the learning process allows for a more thorough understanding and mastery of each strategy's benefits. This perspective posits that a deeper engagement with either strategy individually could potentially yield better retention outcomes, as opposed to a combined approach which may spread the learner's cognitive resources too thinly.

The combination of retrieval practice and spacing has been empirically demonstrated to promote long-term retention and a favorable learning environment. The integration of these strategies results in a learning scaffold that is greater than the sum of its components. By combining the active recall inherent in retrieval practice with distributed learning facilitated by spacing, educators can create an optimized learning experience. Research studies by Karpicke and Bauernschmidt¹⁵ and Sobel et al.,¹⁶ have provided convincing evidence of the enhanced effectiveness of this combined approach, showing significant improvements in retention and comprehension among learners, thus reinforcing the superior benefits derived from the interaction between retrieval practice and spacing.

The theoretical foundations of retrieval practice and spacing provide a solid basis for exploring practical applications in an ESL learning environment. Central to these theories is the Retrieval Effort Hypothesis, which posits that the effort involved in recalling information enhances subsequent retention.^{7,10} Flashcards and the Leitner System are tangible implements that exemplify the principles discussed, serving as a bridge between theoretical comprehension and practical implementation. By utilizing these tools, both learners and educators can directly experience the benefits of retrieval practice and spacing, thereby enhancing the ESL vocabulary acquisition process and making it more engaging and effective.

Practical implementations: flashcards and the leitner system

The utilization of flashcards, a simple yet versatile learning tool consisting of a set of small cards with questions, terms, or images on one side and corresponding answers or explanations on the other, in conjunction with the Leitner System, a spaced repetition method that optimizes learning by sorting flashcards into different groups or boxes based on learners' familiarity with the content on each card, represents a practical integration of retrieval practice and spacing. These resources provide concrete strategies for improving ESL vocabulary acquisition, bridging the divide between cognitive science theories and practical applications in ESL classrooms, thereby fostering effective language learning.

The Leitner System and flashcards are powerful tools for promoting self-regulated learning. By allowing learners to control their learning experiences, they create an inclusive and adaptive learning environment that can cater to a wide range of learner profiles. These tools are effective because they seamlessly integrate the principles of active recall and spaced repetition, leading to effective ESL vocabulary acquisition.

The advent and widespread use of digital technology in educational settings has facilitated the integration of traditional learning tools, such as flashcards and the Leitner System, into contemporary digital learning environments. Numerous applications and platforms now offer digital flashcards and spaced repetition systems, delivering the same benefits as their traditional counterparts but with added features such as multimedia integration, real-time performance tracking, and collaborative learning opportunities. For example, platforms such as Quizlet and Anki enable users to create, share, and interact with digital flashcards, embodying the principles of retrieval practice and spaced repetition in a modern tech-savvy manner.

Recent developments have incorporated artificial intelligence (AI) and machine learning algorithms to further personalize the learning experience. These technological advancements enable the creation of adaptive learning pathways, in which the difficulty and frequency of flashcard reviews are adjusted in real time based on the learner's performance.¹⁷ Moreover, with the growing body of research supporting the efficacy of gamified learning experiences, platforms are now incorporating gamification elements to enhance engagement and motivation among learners.¹⁸

Furthermore, recent studies have explored the impact of digital integration on ESL vocabulary acquisition. Preliminary findings suggest that the combination of digital flashcards, spaced repetition, and retrieval practice in a gamified, interactive setting can significantly enhance vocabulary retention and recall among ESL learners, aligning with the broader trend towards blended and online learning in contemporary educational practice.¹⁹

This integration not only enhances the accessibility and appeal of these tools, but also aligns with the evolving educational landscape, where digital literacy and online learning are becoming increasingly prevalent. By combining traditional learning strategies with modern technological advancements, educators can create a more engaging, effective, and enriched learning environment for ESL vocabulary acquisition.

Empirical evidence supports the effectiveness of these tools in promoting long-term retention and facilitating active recall. Studies conducted by Nguyen & Le²⁰ have demonstrated the efficacy of flashcards and the Leitner System in enhancing ESL vocabulary retention. Classroom-based studies have also shown that

incorporating these tools into daily learning routines significantly improves ESL students' vocabulary recall and usage. For example, a study conducted in a classroom setting found that ESL students who utilized a digital version of the Leitner System were able to recall vocabulary items more effectively than those who did not. Research by Kornell, Castel, Eich, and Bjork²¹ also extends the narrative, highlighting the significant impact of flashcards in fostering active engagement with the material and promoting a deeper understanding of the target vocabulary. The real-world impact of these tools is evident in numerous ESL classrooms, where digital flashcards and spaced repetition systems are used to enhance vocabulary acquisition and promote active learning.

It is conceivable that some educators may advocate for more structured or directed learning methods, as they believe that self-regulated learning aids, such as flashcards and the Leitner System, require a high degree of learner autonomy and motivation, which may be problematic for some learners, particularly those in the early stages of language learning.

While structured approaches to learning have their merits, the use of tools such as flashcards and the Leitner System offers learners a personalized learning pathway that empowers them to take charge of their own learning journey. The flexibility and adaptability of these tools enable learners to navigate their own self-regulated learning processes, while educators can provide initial guidance and ongoing support to help learners make the most of these resources. Several studies have demonstrated the effectiveness of this blended approach, showing that the guided use of flashcards and the Leitner System can significantly enhance the acquisition and retention of ESL vocabulary.

Implementing retrieval practice techniques: the brain dump, low-stakes quizzes, and flashcards

In this section, four retrieval practice techniques—The Brain Dump, Low-Stakes Quizzes, and Flashcards—are explored in the context of improving vocabulary acquisition in ESL settings. Each technique was accompanied by a description, a practical example demonstrating its application in ESL settings, and an evaluation of its advantages and drawbacks.

The brain dump

Brain Dump is a technique that involves actively recalling and jotting information from memory without external resources. This approach is particularly beneficial in the realm of ESL education for vocabulary acquisition. By recalling vocabulary items, this technique reinforces memory traces and aids in the consolidation of newly acquired vocabulary into long-term memory.

In a practical classroom setting, the Brain Dump can be employed following a lesson on professional vocabulary. Learners are given a time frame, usually between five and ten minutes, to write down vocabulary items related to professions. Learners are further encouraged to write sentences using these vocabulary items to promote deeper processing and understanding of the words.

The Brain Dump technique has numerous benefits that make it a highly effective tool for solidifying vocabulary in memory. The utilization of active recall, a cornerstone of memory retention, facilitates the promotion of vocabulary mastery. Furthermore, the Brain Dump allows for the identification of vocabulary items that have been effectively learned and those that require additional review, thus providing a diagnostic window for both educators and learners. This technique also fosters metacognitive awareness in learners as they reflect on their lexical knowledge and retrieval capabilities,

leading to more effective learning. Additionally, the Brain Dump can be executed collaboratively, enabling learners to compare and discuss their lists after retrieval, thus promoting peer learning and collective knowledge construction.

However, the implementation of a Brain Dump presents certain challenges. It has the potential to be time consuming, particularly in situations where classroom time is limited. Additionally, some learners may experience anxiety when engaged in this process, especially if they struggle to recall their vocabulary under time constraints. Furthermore, the comparison of learners' recall with their peers may cause them to feel demotivated. These challenges necessitate a carefully considered approach to the use of the Brain Dump, including the assessment of learners' proficiency levels, establishment of a supportive learning environment, and provision of constructive feedback to support learners' future vocabulary acquisition efforts.

Low-stakes quizzes

Low-stakes quizzes are an effective tool for assessing learners' understanding and recall without the pressure associated with high-stake testing environments. In the context of vocabulary acquisition for ESL learners, these quizzes provide an opportunity to gauge learners' retention and comprehension of newly introduced vocabulary items.

For example, following a lesson that introduces vocabulary related to weather conditions, a low-stakes quiz can be administered. This quiz may include matching exercises, fill-in-the-blank sentences, or multiple-choice questions that test the learners' knowledge of the vocabulary items covered in the lesson. The objective of the quiz is to have learners recall and apply the vocabulary in a structured setting while minimizing the stress often associated with high-stake testing.

The use of low-stakes quizzes in vocabulary acquisition has numerous advantages. First, they present a structured opportunity for learners to actively recall and apply vocabulary, thereby reinforcing lexical memory. Second, they provide immediate feedback to both the learners and the educator regarding the learners' understanding and retention of vocabulary, which can be instrumental in guiding subsequent instruction. Third, the low-stakes nature of these quizzes can foster a more relaxed learning environment in which learners are more focused on recalling and understanding vocabulary rather than worrying about grades. Finally, the data obtained from these quizzes can be used to customize instruction and ensure that the teaching and learning processes are as effective as possible.

On the other hand, the challenges associated with low-stakes quizzes include the possibility that some learners may not take them seriously due to the lack of high-stakes, which could undermine their effectiveness as a retrieval practice tool. Furthermore, creating, administering, and grading quizzes may require additional time and resources from the educator, which could be deterrents in some educational settings. Additionally, despite being low stakes, some learners may still experience test anxiety, which could impede their ability to accurately demonstrate their vocabulary knowledge during the quizzes.

Low-stakes quizzes provide learners with an opportunity to review, recall, and apply newly acquired vocabulary in a supportive and organized setting. However, the efficacy of these quizzes is contingent upon learners' participation and the educator's ability to develop and administer them appropriately within the instructional framework.

Flashcards

Flashcards, a traditional educational tool, have been widely utilized in vocabulary learning and second-language acquisition. These cards

typically feature a target word on one side and its corresponding meaning, translation, or sentence incorporating the word on the other side. In an ESL classroom, flashcards can be employed to reinforce vocabulary related to daily conversations. For example, a flashcard could display the word “grocery” on one side and a picture of a grocery store or the sentence “I am going to the grocery store” on the other side to provide context. The utility of flashcards lies in their simplicity and effectiveness in promoting active recall and self-testing, which are crucial for effective vocabulary learning. They provide a straightforward method for learners to engage in retrieval practice, thereby reinforcing memory traces of newly acquired vocabulary. Flashcards are highly versatile and can be adapted to suit individual or paired study sessions as well as catering to the specific learning needs and pace of each learner. Moreover, they are suitable for visual learners, and can be incorporated into various activities to make vocabulary learning more interactive and enjoyable.

There are inherent challenges in the utilization of flashcards for vocabulary acquisition, including the possibility of rote memorization without a comprehensive understanding of the word’s usage or context. This leads to a lack of ability to use words accurately in a sentence or conversation, which undermines the objective of achieving functional language proficiency. Furthermore, the efficacy of flashcards is contingent on learners’ diligence in consistently using them for regular reviews. There is also the risk of learners developing a false sense of mastery, particularly if they engage with flashcards passively or in the same order every time, without shuffling them to promote better retrieval practice.

Flashcards are a highly effective means of acquiring ESL vocabulary, promoting active recall, enabling self-assessment, and spaced repetition. They provide individualized learning experiences that can significantly improve vocabulary retention and usage. However, their efficacy is contingent upon the methodology employed in their utilization, and educators must ensure that flashcards are integrated into a comprehensive, context-rich vocabulary learning strategy to mitigate the risks associated with rote memorization and foster deeper lexical understanding and functional language proficiency.

Conclusion

The exploration of retrieval practice techniques within the context of ESL vocabulary acquisition provides a valuable perspective on effective language-learning strategies. This paper highlighted three distinct retrieval practice techniques: brain dump, low-stakes quizzes, and flashcards. Each of these techniques offers a unique approach to encourage active recall and reinforce vocabulary knowledge among ESL learners.

The Brain Dump enables learners to assess and reinforce their vocabulary knowledge through immediate retrieval practice. Low-Stakes Quizzes provide a structured yet relaxed setting for learners to revisit and apply newly acquired vocabulary while receiving immediate feedback on their progress. Flashcards, being versatile and individualized tools, offer a straightforward way for learners to engage in retrieval practice, reinforcing the memory traces of new vocabulary.

Furthermore, the discussion has extended to the integration of digital technology with traditional retrieval practice tools, reflecting a step towards aligning language learning strategies with the evolving educational landscape. The advent of digital flashcards and spaced repetition systems enriched with gamification elements represents an adaptive approach to modern day learning.

This study underscores the significant role that retrieval practice plays in enhancing long-term retention and effective vocabulary acquisition in ESL settings. The practical insights derived from this exploration serve as a valuable resource for language educators, aiding the enrichment of pedagogical practices to foster a conducive learning environment for ESL vocabulary acquisition. Through judicious integration of these retrieval practice techniques, educators are better positioned to support learners in their quest for language proficiency.

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Conflicts of interest

The authors declare that there is no conflict of interest.

References

1. Roediger HL, Karpicke JD. The power of testing memory: basic research and implications for educational practice. *Perspectives on Psychological Science*. 2006;1(3):181–210.
2. Karpicke JD, Roediger HL. The critical importance of retrieval for learning. *Science*. 2008;319(5865):966–968.
3. Agarwal PK, Bain PM, Chamberlain RW. The value of applied research: Retrieval practice improves classroom learning and recommendations from a teacher, a principal, and a scientist. *Educational Psychology Review*. 2012;24(3):437–448.
4. McDaniel M, Agarwal P, Huelser B, et al. Test-enhanced learning in a middle school science classroom: The effects of quiz frequency and placement. *Journal of Educational Psychology*. 2011;103:399–414.
5. Dunlosky J, Rawson KA, Marsh EJ, et al. Improving students’ learning with effective learning techniques promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest*. 2013;14(1):4–58.
6. Kang SHK. Enhancing visuospatial learning: The benefit of retrieval practice. *Memory & Cognition*. 2010;38(8):1009–1017.
7. Bjork RA. Memory and metamemory considerations in the training of human beings. In: Metcalfe J, Shimamura AP, editors. *Metacognition: Knowing about knowing*. MIT Press; 1994. p. 185–205.
8. Smith MA, Roediger HL, Karpicke JD. Covert retrieval practice benefits retention as much as overt retrieval practice. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 2013;39(6):1712–1725.
9. Karpicke JD, Butler AC, Roediger HL. Metacognitive strategies in student learning: Do students practice retrieval when they study on their own? *Memory*. 2009;17(4):471–479.
10. Pyc MA, Rawson KA. Why testing improves memory: mediator effectiveness hypothesis. *Science*. 2010;330(6002):335–335.
11. Roediger HL, Butler AC. The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*. 2011;15(1):20–27.
12. Pashler H, Zarow G, Triplett B. Is temporal spacing of tests helpful even when it inflates error rates? *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 2003;29(6):1051–1057.
13. Cepeda NJ, Pashler H, Vul E, et al. Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin*. 2006;132(3):354–380.
14. Nakata T, Tada S, Mclean S, et al. Effects of distributed retrieval practice over a semester: Cumulative tests as a way to facilitate second language vocabulary learning. *TESOL Quarterly*. 2021;55(1):248–270.
15. Karpicke JD, Bauernschmidt A. Spaced retrieval: Absolute spacing enhances learning regardless of relative spacing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 2011;37(5):1250–1257.

16. Sobel HS, Cepeda NJ, Kapler IV. Spacing effects in real-world classroom vocabulary learning. *Applied Cognitive Psychology*. 2011;25(5):763–767.
17. Webb SA, Nation ISP. How vocabulary is learned. Oxford University Press; 2017.
18. Subhash S, Cudney EA. Gamified learning in higher education: A systematic review of the literature. *Computers in Human Behavior*. 2018;87:192–206.
19. Xodabande I, Iravi Y, Mansouri B, et al. Teaching academic words with digital flashcards: Investigating the effectiveness of mobile-assisted vocabulary learning for university students. *Frontiers in Psychology*. 2022;13:893821.
20. Nguyen LQ, Le HV. Quizlet as a learning tool for enhancing L2 learners' Lexical retention: should it be used in class or at home? *Human Behavior and Emerging Technologies*. 2022:1–10.
21. Kornell N, Castel AD, Eich TS, et al. Spacing as the friend of both memory and induction in young and older adults. *Psychology and Aging*. 2010;25(2):498–503.