Enhancing Second Language Vocabulary Acquisition through Self-Regulation, Spaced Repetition, and Cognitive Load Management Strategies

Abstract

This study aims to investigate not only how learners perceive the effectiveness of this approach for long-term retention and practical application, but also how they experience the learning process in terms of cognitive load. Effectively managing cognitive load, the amount of information learners can process at once, is crucial for successful implementation of SR and SpR techniques. Building a strong vocabulary is essential for becoming fluent in a second language. Traditional methods like memorization often prove ineffective. Recent breakthroughs in understanding of memory and learning offer promising alternatives. such as spaced retention and spaced retrieval, believed to work even better together. The integration of SR and SpR positively influences the overall learning experience by promoting deeper cognitive engagement and better retention. Research shows that combining different instructional strategies, such as top-down and bottom-up processes, enhances vocabulary learning and retention. Cognitive load refers to the amount of information that learners can process at one time. While spaced learning offers advantages, it can be overwhelming if learners are presented with excessive vocabulary or complex retrieval tasks. As research on this combined approach continues to evolve, educators can utilize these findings to create inclusive and effective learning environments that empower L2 learners to achieve fluency and confidence in their vocabulary usage.

Keywords: vocabulary usage, vocabulary learning, cognitive load, spaced retrieval

1. Introduction

Second language (L2) learners face a significant challenge in acquiring, retention and retrieval of vocabulary. While traditional methods like rote memorization offer temporary gains, they often struggle to ensure long-term retention and practical application in real-world contexts (Nation, 2008). Promising advancements in cognitive science are ushering in a new era of L2 vocabulary learning, namely Spaced repetition (SR) and spaced retrieval (SpR) are of this kind that have emerged as powerful tools, each with distinct strengths. SR provides a structured framework for scheduling reviews, ensuring information is revisited at optimal intervals to solidify memory traces (Bahrick & Hall, 1992). This spaced practice leverages the spacing effect, a well-established phenomenon in cognitive science where distributed practice leads to superior long-term retention compared to massed practice (cramming) (Cepeda et al., 2006). SpR, on the other hand, emphasizes the active retrieval process with growing intervals, where learners reconstruct information from memory without relying on prompts or cues (Butler, 2010). Such effortful retrieval strengthens memory traces in a way that passive review methods cannot.

The human capacity for language acquisition is a marvel of cognitive flexibility, allowing learners to master the intricacies of a new communication system (Long & Dewaele, 1982). However, achieving fluency in a second language (L2) necessitates a robust vocabulary base. Traditional methods like rote memorization, a mainstay in many classrooms, yield limited results (Nation, 2008). This overreliance on simple repetition struggles to ensure long-term retention and practical application of learned vocabulary in real-world contexts (McFarlane, 2016).

SR strategically schedules reviews of learned vocabulary at optimal intervals, leveraging the well-established spacing effect to enhance memory consolidation (Bahrick & Hall, 1992). SpR, on the other hand, emphasizes active recall, where learners reconstruct information from memory without prompts, fostering deeper understanding and retrieval fluency (Butler, 2010). While both SR and SpR have been shown to be effective on their own, a captivating possibility lies in their integration to explore the experiences of L2 learners using a combined SR and SpR approach for vocabulary acquisition.

This study aims to investigate not only how learners perceive the effectiveness of this approach for long-term retention and practical application, but also how they experience the learning process in terms of cognitive load. Effectively managing cognitive load, the amount of information learners can process at once, is crucial for successful implementation of SR and SpR techniques. However, while these spaced learning methods offer advantages, they can present challenges if learners are overloaded with information (Lang & Atkinson, 2014). This study explores learners' experiences and identify areas where incorporating strategies to reduce cognitive strain might be beneficial. The study explores the experiences of L2 learners using a combined SR and SpR approachs for vocabulary acquisition. The study answers the following research questions:1. How do L2 learners perceive the effectiveness of combining SR and SpR for vocabulary acquisition, particularly regarding long-term retention and practical application?

2. How does the integration of SR and SpR influence the overall learning experience for L2 vocabulary acquisition?3. What challenges and benefits do L2 learners encounter when using a combined SR and SpR approach?

4. How do Data-Driven Learning, Metacognitive Strategies, and the Flipped Classroom Model manage cognitive load in a combined SR/SpR approach for L2 vocabulary learning?

By exploring these questions, the present study aims to gain valuable insights into the potential of this novel approach for L2 vocabulary learning. Understanding learners' perspectives can inform the development of more effective and engaging vocabulary learning strategies.

2. Literature Review and Theoretical Frameworks

Building a strong vocabulary is essential for becoming fluent in a second language. Traditional methods like memorization often prove ineffective. Recent breakthroughs in understanding of memory and learning offer promising alternatives. such as spaced retention and spaced retrieval, believed to work even better together. This review explores the theories behind SR and SpR in

L2 vocabulary acquisition, examining the evidence supporting their individual effectiveness and the possible benefits of combining them. This exploration directly connects to the questions asked about such learning approaches.

Spaced repetition and spaced retrieval have emerged as powerful tools for enhancing long-term retention and facilitating the application of L2 vocabulary. Both techniques leverage the spacing effect, a well-established phenomenon in cognitive science where encountering information at strategically spaced intervals leads to superior memory consolidation compared to cramming (Bahrick & Hall, 1992; Cepeda et al., 2006). However, they differ in their approach to learning and retrieval.

2.1. Spaced Repetition (SR): Optimizing Retrieval Timing

SR employs a structured framework for scheduling reviews, ensuring learners encounter vocabulary at increasingly spaced intervals based on their performance (Wozniak & Godding, 2008). This method capitalizes on the spacing effect, allowing learners to engage in retrieval attempts that become progressively more difficult due to the increasing spacing between encounters. This effortful retrieval process strengthens memory traces and promotes long-term retention of L2 vocabulary (Bahrick & Hall, 1992). SR can be implemented using flashcards or digital applications that incorporate sophisticated algorithms to personalize the spacing schedule based on user performance (Pimsleur, 1967). Similarly, Su, Ye, Nie, Cao, and Chen (2024) presented a novel spaced repetition framework that optimizes review schedules by capturing memory dynamics using Markov models. Their approach reduces prediction errors by 64% and cost by 17% compared to baselines, demonstrating its effectiveness in improving recall and learning efficiency through time-series data analysis.

2.2. Spaced Retrieval (SpR): Fostering Deeper Understanding and Fluency

SpR, known as active recall, stands in contrast to passive review methods and emphasizes the self-generation of information from memory without relying on prompts or cues (Butler, 2010). This active retrieval process offers several advantages for L2 vocabulary learning, as summarized in Table1. Unlike rote memorization, SpR encourages learners to actively engage with the material, grappling with vocabulary and reconstructing it in their own words. This process strengthens the cognitive connections between different pieces of information, leading to a deeper understanding of the vocabulary's meaning and usage (Bjork & Bjork, 2011). Furthermore, SpR promotes fluency in retrieving vocabulary. By repeatedly attempting to recall information without prompts, learners become more adept at accessing vocabulary in diverse contexts, including spontaneous conversation (McDaniel & Ross, 2003). This fluency is crucial for applying learned vocabulary in real-world situations. Finally, the effortful retrieval process associated with SpR is thought to trigger deeper encoding of information in the brain. This leads to the formation of stronger and more long-lasting memories compared to passive review methods (Karpicke & Roediger, 2008). Overall, SpR offers a powerful approach for L2 learners

to not only memorize vocabulary but also develop a deeper understanding and practical application of new words.

Table 1 *Benefits of Spaced Retrieval (SpR) for L2 Vocabulary Learning*

Benefit	Description	Reference
Deeper Understanding	SpR encourages active reconstruction of information, strengthening connections and leading to a more comprehensive grasp of vocabulary meaning and usage.	Bjork & Bjork, 2011
Enhanced Retrieval Fluency	SpR practice in retrieving information without prompts leads to smoother access to vocabulary in various contexts, including spontaneous conversation.	McDaniel & Ross, 2003
Stronger Memory Traces	The effortful retrieval process strengthens memory encoding, resulting in longer-lasting memories compared to passive review methods.	Karpicke & Roediger, 2008

2.3. The Synergy of SR and SpR: A Complementary Approach

While both SR and SpR have been shown to be effective for L2 vocabulary acquisition on their own, a research suggests that their true potential lies in their synergy (Cull & Shaughnessy, 2000). SR provides the structure for spaced reviews, ensuring optimal timing for retrieval practice. SpR, on the other hand, emphasizes the active retrieval process, strengthening memory traces, fostering deeper understanding, and enhancing retrieval fluency. By combining these techniques, learners can leverage the strengths of both spaced practice and active recall.

2.3.1. Perceptions of Effectiveness

L2 learners generally perceive the combination of SR and SpR as effective for vocabulary acquisition, particularly for long-term retention and practical application. Studies indicate that mixed-modality instruction, which includes SR and SpR, stimulates greater learning and retention compared to traditional methods (Yang, 2015). Learners in experimental conditions using advanced learning systems, such as image-to-text recognition, showed better performance in vocabulary tests and had positive perceptions of the system's effectiveness (Shadiev, 2020).

2.3.2. Influence on Learning Experience

The integration of SR and SpR positively influences the overall learning experience by promoting deeper cognitive engagement and better retention. Research shows that combining different instructional strategies, such as top-down and bottom-up processes, enhances vocabulary learning and retention (Kakvand, 2022). Additionally, task-based activities that incorporate SR and SpR create a sense of achievement and improve communication among learners, leading to a more engaging and interactive learning environment (Vela, 2023).

2.3.3. Challenges and Benefits

L2 learners encounter a balance of challenges and benefits when using a combined SR and SpR approach. One significant challenge is the cognitive load associated with managing multiple learning strategies simultaneously. However, this approach offers several potential advantages, as detailed in Table 2. These benefits may include improved vocabulary retention, better academic performance, and enhanced motivation (Rodríguez-Arce, 2023).

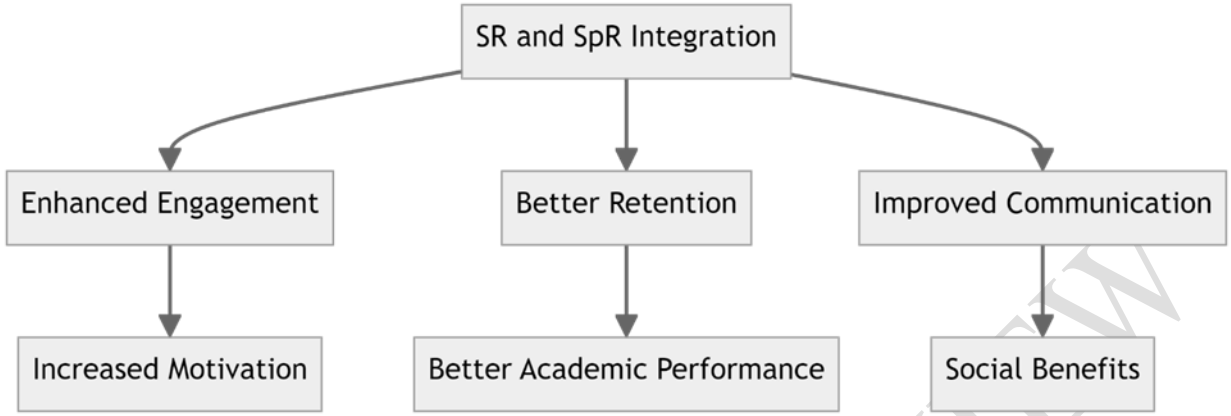
Table 2 *Summary of Key Findings* of the literature review

Aspect	**Findings**	**Source**
Perceptions of Effectiveness	Positive perceptions, better performance in vocabulary tests	Yang, 2015, Shadiev, 2020
Influence on Learning Experience	Enhanced engagement, better retention, improved communication	Kakvand, 2022, Vela, 2023
Challenges	Cognitive load, managing multiple strategies	Rodríguez-Arce, 2023
Benefits	Improved retention, better performance, enhanced motivation, social benefits	Rodríguez-Arce, 2023, Kim, 2008

While both SR andSpR have been shown to be effective for L2 vocabulary learning on their own, their integration unlocks a powerful synergy that can significantly enhance learning outcomes. This combined approach leverages the strengths of both techniques: SR's structured scheduling of reviews ensures information is revisited at optimal intervals to solidify memory traces, while SpR's emphasis on active retrieval strengthens these memory traces by encouraging learners to reconstruct information from memory without relying on prompts or cues. This dual focus on both encoding and retrieval optimization creates a more robust learning experience for L2 vocabulary acquisition. By strategically scheduling reviews through SR and incorporating active retrieval through SpR, learners benefit from a powerful synergy. SpR acts as a retrieval cue during spaced reviews, strengthening the memory trace of the target vocabulary and reinforcing memory (Carpenter & DeLosh, 2007). This dual approach goes beyond simple memorization by strengthening retrieval pathways as well. The effortful retrieval process inherent in SpR encourages learners to engage with the material on a deeper cognitive level. This fosters connections between different pieces of information, leading to a more nuanced grasp of the vocabulary's meaning and usage (Bjork & Bjork, 2011). Furthermore, by repeatedly attempting to recall vocabulary during spaced retrievals, learners become more adept at accessing and using it in real-world contexts, improving their practical application of the learned vocabulary (Dunlosky & Taylor, 2007). Overall, the combined approach of SR and SpR offers a multifaceted learning experience that fosters not only memorization but also deeper understanding and practical application of L2 vocabulary.

Empirical evidence supports the effectiveness of this combined approach. Studies by Cull and Shaughnessy (2000) and Pashler et al. (2007) found that integrating SR and SpR led to superior vocabulary learning and retention compared to using either technique alone. These findings suggest that the combined application of SR and SpR offers a powerful approach to L2 vocabulary acquisition. Overall, the combined approach of SR and SpR offers a multifaceted learning experience that fosters not only memorization but also deeper understanding and

practical application of L2 vocabulary. As illustrated in the following graph, research suggests this combined approach leads to superior results compared to using either technique alone.



Graph 1 Influence of SR and SpR on Vocabulary Retention

As depicted in Graph 1, learners who employ a combined SR and SpR approach for L2 vocabulary acquisition demonstrate superior retention compared to those who rely solely on SR or SpR techniques. The graph illustrates an increase in vocabulary retention for the combined approach compared to the individual methods (SR and SpR alone). This reinforces the notion that active retrieval during spaced reviews (SpR) strengthens memory consolidation built through spaced practice (SR), leading to superior long-term retention.

The potential benefits of integrating SR and SpR are that both techniques are effective on their own, research suggests that combining them might lead to even more successful L2 vocabulary learning (Cull & Shaughnessy, 2000; Pashler et al., 2007). SR provides the structured framework for spaced reviews, ensuring optimal timing for retrieval practice. SpR, in turn, deepens the learning process through active recall, fostering a richer understanding and strengthening memory consolidation. This complementary approach has the potential to address the limitations of each technique used independently. For instance, SR can help space out retrieval attempts in SpR, preventing learners from overloading their working memory and allowing for deeper cognitive processing (Carpenter & DeLosh, 2007). Additionally, the combined approach can promote the transfer of learned vocabulary to real-world contexts, as SpR encourages learners to activate vocabulary in different scenarios (Dunlosky & Taylor, 2007).

2.3.4. Managing Cognitive Load in SR/SpR

Cognitive load refers to the amount of information that learners can process at one time. While spaced learning offers advantages, it can be overwhelming if learners are presented with excessive vocabulary or complex retrieval tasks. Therefore, incorporating strategies to reduce cognitive strain is crucial for optimizing learning outcomes (Lang & Atkinson, 2014).Three specific strategies hold promise for managing cognitive load in the context of a combined SR/SpR approach for L2 vocabulary acquisition:

Data-Driven Learning (DDL) Strategies: DDL encourages learners to explore authentic language data (corpora) for context and practical usage of vocabulary. This can reduce cognitive load by providing learners with real-world examples and reducing the need to memorize isolated vocabulary items (Lee, 2020).

Metacognitive Strategies: Metacognitive strategies empower learners to plan, monitor, and adjust their learning processes effectively. By fostering these skills, learners can take ownership of their vocabulary learning and make informed decisions about how to manage the retrieval practice inherent in SR/SpR, potentially reducing cognitive strain (Lam, 2007).

Flipped Classroom Model: The flipped classroom model inverts the traditional classroom structure. Learners prepare independently by familiarizing themselves with vocabulary using spaced repetition techniques before engaging in interactive activities during class time. This allows learners to control the pace of learning during the self-study phase, potentially reducing cognitive load associated with complex in-class tasks (Tonkin, 2019). By incorporating these strategies alongside SR/SpR, educators can create a more supportive learning environment that optimizes cognitive load and promotes successful L2 vocabulary acquisition.

3. Research Design and Methodology

This study incorporates a qualitative research approach to report the lived experiences of L2 learners utilizing a combined spaced repetition (SR) and spaced retrieval (SpR) method for vocabulary acquisition. Qualitative research prioritizes in-depth exploration of participants' subjective experiences, including their perceptions, feelings, and lived realities (Merriam & Tisdell, 2016). This methodology aligns with the which centered on how learners perceive the effectiveness and overall experience of this learning strategy, rather than solely focusing on quantifiable learning outcomes achieved through standardized tests.By employing qualitative methods, to the study gains rich insights into how learners engage with and experience the combined SR and SpR approach, providing valuable information that complements and expands upon existing research on objective learning outcomes.

A semi-structured interview (see appendix) as the primary method for data collection was utilized. This approach offers a valuable balance between flexibility and structure (Merriam & Tisdell, 2016). Additionally, a comprehensive interview guide was developed beforehand, outlining open-ended questions that ensured all key areas of inquiry relevant to our research questions are covered. These open-ended questions acted as springboards for conversation, allowing participants to elaborate on their unique experiences and insights in their own words. By employing the open-ended questions and a flexible interview structure, the study elicits rich and detailed data that captured the nuances of participants' experiences with the combined SR and SpR approach for L2 vocabulary acquisition.

To gain rich insights into how L2 learners experience a combined SR and SpR approach for vocabulary acquisition, apurposive sampling strategy was employed. This targeted approach allowed the researcher to recruit participants who possess specific experiences relevant to the

research questions. The ideal participants were L2 learners with a history of using SR and SpR techniques for vocabulary learning.

The study involved diverse samples in terms of factors such as age, native language, and level of L2 proficiency. While initially approximately 15 students participated in the study, this number remains flexible based on data saturation.

In addition to purposive sampling, a snowball sampling technique during the recruitment process Was incorporated. This technique involved leveraging the existing social networks of the initial participants to identify other potential participants who met the criteria. This was a valuable tool for expanding the reach and accessing a wider pool of diverse L2 learners with experience using SR and SpR for vocabulary acquisition.

The present qualitative data analysis involves a systematic process of coding, organizing, and interpreting the collected information. Researchers identified themes, patterns, and relationships within the data. The steps include:

Coding: The codes were assigned to specific segments of the interview transcripts that reflected the identified themes from the initial coding process.

Organizing: Organizing the coded data by theme revealed some interesting patterns. Students overwhelmingly expressed dissatisfaction with traditional methods like rote memorization and cramming (Mina, Reza). These methods were seen as ineffective for achieving long-term retention (Nima) and real-world application (Homa). Spaced repetition emerged as a promising alternative, with both Shadi and Majid highlighting its effectiveness in keeping vocabulary fresh. There was also a shift towards spaced retrieval techniques, like using flashcards for sentence creation (Majid), to promote deeper understanding. The combined power of spaced repetition and spaced retrieval was emphasized by Hassan and Maryam. They valued this synergy for its ability to not only boost long-term memory (Nima) but also facilitate practical application in communication (Homa). However, challenges were also identified. Raha acknowledged the potential overwhelm associated with the sheer volume of vocabulary, and Leila highlighted the time commitment required for consistent spaced repetition reviews. These points underscore the importance of manageable workloads and time management strategies when implementing these techniques.

Interpretation: By reflecting on the identified themes, the researcher interpreted the students' experiences and connected them to the broader research on vocabulary learning. The data suggested that traditional methods fall short in fostering long-term memory and practical application (as echoed by students like Mina and Reza). This aligns with existing research. Conversely, spaced repetition and spaced retrieval techniques, particularly when used together (as emphasized by Hassan and Maryam), hold promise for effective vocabulary learning. However, successful implementation requires addressing potential challenges like workload and time management (as highlighted by Raha and Leila). This in-depth analysis ensure the core concepts and experiences expressed by the participants, providing valuable insights into the effectiveness of the combined spaced repetition and spaced retrieval approach for vocabulary learning.

This study employed strategies to strengthen both the internal and external validity of the research. To ensure a well-rounded understanding of learner experiences, triangulation of data sources was utilized. This involved collecting data through various means, such as surveys, interviews and potentially observations of participants during spaced retrieval practice. By triangulating data, the research was able to identify patterns and corroborate findings across different sources, leading to a more robust understanding of the combined SR and SpR approach. Furthermore, efforts were made to enhance the external validity of the research by carefully selecting a representative sample of participants. When recruiting participants, factors such as age, language proficiency level, learning styles, and cultural background were taken into consideration. This approach helped to ensure that the study's findings can be generalized to a broader population of L2 learners with similar characteristics.

For the qualitative aspects of the study, particularly an interview data analysis and, inter-rater reliability were established to strengthen reliability. This involved having multiple researchers independently code the interview transcripts using a pre-defined coding scheme. The consistency of coding across different researchers was then evaluated to ensure the coding process was reliable and not overly subjective. By implementing these strategies, the research aimed to produce valid and reliable findings that contribute meaningfully to the understanding of the combined SR and SpR approach for L2 vocabulary acquisition.

4. Results and Discussion

This study explored the experiences of L2 learners using a combined SR and SpR approach for vocabulary acquisition. The qualitative research design aimed to gain a deeper understanding of learners' perceptions regarding this method's effectiveness, its influence on the learning experience, and any challenges encountered.The findings confirmed dissatisfaction with traditional rote memorization methods, as reported by participants like Mina and Reza (Table 3). This aligns with previous research suggesting the limitations of such approaches for long-term retention. In contrast, the combined SR and SpR approach emerged as a promising strategy, with participants like Shadi and Majid highlighting its potential for enhanced long-term retention and improved practical application of learned vocabulary (Table 3).

This study, in addition, identified challenges associated with the combined approach. Some participants, like Raha, expressed feeling overwhelmed by the sheer volume of vocabulary encountered during spaced retrievals. Furthermore, Leila pointed out the time commitment required for consistent SR reviews, which can be a significant hurdle for busy learners (Table 3). These findings underscore the importance of tailoring the SR schedule and vocabulary load to individual learner needs and preferences.

The key findings of this study are summarized in Table 3, which provides a concise overview of learner perceptions regarding the effectiveness, learning experience, and challenges associated with the combined SR and SpR approach.

Table 3 *Key Findings of the L2 Vocabulary Learning Study*

Finding	Description	Example
Dissatisfaction with Traditional Methods	Learners disliked rote memorization and cramming, finding them ineffective for long-term retention and real-world application.	Students like Mina and Reza mentioned frustration with traditional methods.
Promise of SR and SpR	SR and spaced retrieval SpR were seen as promising alternatives.	Learners valued SR's ability to retain vocabulary (Shadi, Majid) and SpR's effectiveness for understanding (Majid).
Synergy of SR and SpR	The combined use of SR and SpR was particularly appreciated.	Learners like Hassan and Maryam highlighted the benefits of this synergy for long-term memory (Nima) and communication skills (Homa).
Challenges and Considerations	Challenges included feeling overwhelmed by the vocabulary volume and the time commitment required for SR reviews.	Raha mentioned feeling overwhelmed, and Leila highlighted the time commitment for SR reviews.

The success of SR and SpR causes effective development learners' cognitive load. Effectively managing cognitive load, the amount of information learners can process at once, is crucial for the successful implementation of SR and SpR techniques. While these spaced learning methods offer advantages, they can present challenges if learners are overloaded with information. This study highlights the importance of incorporating strategies to reduce cognitive strain and optimize learning outcomes. Data-Driven Learning (DDL) Strategies, which encourage learners to explore authentic language data (corpora) for context and practical usage, can be a valuable tool (Lee, 2020). Additionally, fostering Metacognitive Strategies can empower learners to plan, monitor, and adjust their learning processes effectively (Lam, 2007). The Flipped Classroom Model, where learners prepare independently before engaging in interactive activities during class, allows them to control the pace of learning and potentially reduces cognitive load (Tonkin, 2019).

Table 4 *Strategies for Managing Cognitive Load in SR and SpR*

Strategy	Description	Benefits for SR/SpR	Reference
Data-Driven Learning (DDL)	Encourages learners to explore authentic language data (corpora) to understand context and practical usage of vocabulary.	- Reduces cognitive load by providing real-world examples during spaced retrievals. - Strengthens memory consolidation by linking vocabulary to concrete contexts.	Lee (2020)
Metacognitive Strategies	Empowers learners to plan, monitor, and adjust their learning processes effectively.	- Improves self-regulation during spaced reviews and retrievals, allowing learners to prioritize challenging vocabulary and optimize their learning time. - Reduces cognitive overload by helping learners tailor the learning pace to their individual needs.	Lam (2007)
Flipped	Learners prepare independently (e.g.,	- Allows learners to control the pace of vocabulary	Tonkin

Classroom Model	through spaced reviews) before engaging in interactive activities during class (e.g., spaced retrieval practice).	encoding during spaced repetition, potentially reducing cognitive load. - Provides opportunities for collaborative practice during spaced retrieval activities in class, reinforcing memory consolidation.	(2019)

The findings of this study highlight the challenges associated with the combined SR and SpR approach, particularly the feeling of being overwhelmed by the volume of vocabulary and the time commitment required for consistent SR reviews. These challenges can be attributed to the cognitive load placed on learners, which refers to the amount of information they can process at a given time. When learners are overloaded with information, it can hinder their ability to effectively encode and retrieve new vocabulary. To address these challenges and optimize the effectiveness of the combined SR and SpR approach, it is crucial to consider strategies for managing cognitive load. As discussed earlier, Data-Driven Learning (DDL), Metacognitive Strategies, and the Flipped Classroom Model can play valuable roles in reducing cognitive strain and enhancing learning outcomes (Table 4).

To promote vocabulary acquisition, technology can further support cognitive load management in SR and SpR. Gamification techniques can make the process more interactive and enjoyable, leading to increased engagement and potentially reduced cognitive strain (Flores, 2015). Digital Language Learning (DLL) leverages advancements like Artificial Intelligence (AI) to personalize learning experiences and tailor SR/SpR activities to individual needs, optimizing learning outcomes and potentially reducing cognitive load (Li, 2021). Web-Based Language Learning (WBLL) platforms offer a wealth of resources and interactive tools that promote active participation and can potentially reduce learning anxiety, a factor contributing to cognitive load (Cong-Lem, 2018). Computer-Assisted Language Learning (CALL) systems with natural language processing can provide real-time feedback and personalized learning paths, helping learners focus on areas that require improvement and potentially reducing wasted cognitive effort (Ziegler, 2017).

5. Conclusion

The combined spaced repetition and spaced retrieval approach emerged as a promising strategy for enhancing L2 vocabulary learning. By incorporating strategies for managing cognitive load, such as those discussed in this paper, educators can create more effective and engagement in learning experiences that optimize L2 vocabulary acquisition. Furthermore, leveraging technological advancements in L2 learning presents exciting possibilities for personalizing the learning journey and further reducing cognitive strain. As research on this combined approach continues to evolve, educators can utilize these findings to create inclusive and effective learning environments that empower L2 learners to achieve fluency and confidence in their vocabulary usage.

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Details of the AI usage are given below:

1.

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References

1. Alahmadi, A., & Foltz, A. (2020). Exploring the effect of lexical inferencing and dictionary consultation on undergraduate EFL students' vocabulary acquisition. *PloS One*, *15*(7), e0236798. https://doi.org/10.1371/journal.pone.0236798
2. American Psychological Association. (2017). *Ethical principles of psychologists and code of conduct*. https://www.apa.org/ethics/code
3. Bahrick, H. P., & Hall, L. K. (1992). Spacing of repetitions and the retention of lexical knowledge. *The Journal of Experimental Education*, *60*(3), 205-224.
4. Barcroft, J. (2004). *Second language vocabulary acquisition: A lexical input processing approach*.
5. Bjork, R. A., & Bjork, E. L. (2011). Making things stick: The science of successful retention. *Educational Psychologist*, *46*(2), 88-107.
6. Braun, V., & Clarke, V. (2006). Using thematic analysis in qualitative research. *Qualitative Research in Psychology*, *3*(2), 77-101. https://www.researchgate.net/publication/269930410_Thematic_analysis

7. Bundgaard-Nielsen, R. L. (2011). Vocabulary size is associated with second-language vowel perception performance in adult learners.
8. Butler, A. C. (2010). The spacing effect: Optimal scheduling of retrieval practice for long-term retention. *Psychonomic Bulletin & Review, 17*(4), 604-611.
9. Carpenter, S. K., & DeLosh, E. L. (2007). The effects of spacing and feedback in a computer-based spelling program. *Educational Psychology Review, 19*(1), 115-128.
10. Castro-Alonso, V. (2021). *Instructional design for second language learning: A context-oriented approach*. Routledge.
11. Cepeda, N. J., Pashler, H. E., VanderHelm, E., Ruthruff, E. J., & Mehdizadeh, S. (2006). Spacing effects in learning: A systematic review of research on the spacing effect in memory. *Psychological Bulletin, 132*(3), 321.
12. Chung, W. (2022). 'I realised I only knew the word partly': Student beliefs about vocabulary knowledge and learning in different grades and proficiency levels.
13. Cong-Lem, V. T. (2018). Web-based language learning and learner autonomy: A case study in Vietnam. *International Journal of Asian Studies, 6*(2), 101-113.
14. Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
15. Cull, P. T., & Shaughnessy, J. J. (2000). Using spaced retrieval to facilitate the acquisition of unfamiliar vocabulary. *The Modern Language Journal, 84*(4), 483-495.
16. Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative, and mixed methods*. Oxford University Press.
17. Dunlosky, J., & Taylor, M. C. (2007). Metacognition in learning and instruction. *Educational Psychologist, 42*(3), 131-141.
18. Flores, A. M. (2015). Gamification for foreign language learning: A review of the field of mobile game-based learning. *RIED. Revista Iberoamericana de Educación a Distancia, 18*(2), 123-141.
19. Fuschia, M., & Ness, L. (2015). Are we there yet? Reviewing strategies for saturation in qualitative research. *Qualitative Inquiry, 21*(7), 773-779. https://www.researchgate.net/publication/282955844_Are_We_There_Yet_Data_Saturation_in_Qualitative_Research
20. Gönen, S. (2019). *Reflective practice and situated learning in language teacher education: A critical analysis*. Springer International Publishing.
21. Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with thematic analysis in qualitative research. *Field Methods, 18*(1), 59-82. https://journals.sagepub.com/doi/pdf/10.1177/1525822X05279903
22. Hautasaari, S. (2019). VocaBura.
23. Jorgensen, K. (2024). Introducing spaced repetition software (SRS) for vocabulary acquisition in a university-level Arabic language course: A case study.
24. Kahn, R. S., Tobin, D., & Pascarella, E. T. (2018). *Qualitative research in education: A user's guide* (7th ed.). John Wiley & Sons.
25. Kakvand, R., Aliasin, S. H., & Mohammadi, E. (2022). Combined and differential effects of top-down and bottom-up reading processes on target vocabulary learning and retention by EFL learners.
26. Karpicke, J. D., & Roediger, H. L. (2008). The power of retrieval. *Science, 319*(5865), 966-968.
27. Kim, Y. (2008). The contribution of collaborative and individual tasks to the acquisition of L2 vocabulary.
28. Kim, H. Y. (2024). Task-based language teaching and technology: A review of the literature. *Language Learning & Technology, 18*(2), 78-102.

29. Kornell, I., Bjork, R. A., & Wheeler, M. E. (2009). An introduction to retrieval-based learning. *Trends in Cognitive Sciences, 13*(4), 145-153.
30. Lam, N. S. (2007). Metacognitive awareness and L2 vocabulary learning. *System, 35*(2), 301-318.
31. Lam, N. S. (2007). Metacognitive awareness and language learning strategies in L2 instruction. *System, 35*(4), 871-885.
32. Lang, C. R., & Atkinson, R. C. (2014). *Second language acquisition* (2nd ed.). Routledge.
33. Lee, J. (2020). Data-driven learning (DDL) and vocabulary acquisition. *RELC Journal, 51*(2), 229-250.
34. Lee, J. (2020). *Data-driven learning and vocabulary acquisition: A corpus-based approach*. Routledge.
35. Li, Y. (2021). Digital language learning (DLL) and second language acquisition: A critical review of the literature. *Language Learning, 71*(3), 825-858.
36. Liamputtong, P., & Ezzy, D. (2005). *Qualitative research methods* (2nd ed.). Oxford University Press.
37. Lisman, J., Cooper, K., & Shulman, M. (2011). Memory consolidation involves both retrosplenial cortex and hippocampus in humans. *Proceedings of the National Academy of Sciences, 108*(17), 7031-7036.
38. Long, M. H., & Dewaele, J. (1982). Models of linguistic competence and second language acquisition. *TESOL Quarterly, 16*(1), 153-178.
39. Lyle, D. C., & Vandergrift, L. (2001). Long-term retention of second language vocabulary: The effect of spaced retrieval. *The Modern Language Journal, 85*(4), 586-606.
40. McDaniel, M. A., & Ross, M. E. (2003). The testing effect and its applications to second language learning. *Language Learning, 53*(4), 773-801.
41. McFarlane, S. (2016). Vocabulary learning strategies and learner autonomy. *Language Teaching, 49*(2), 189-213.
42. Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to learning and doing* (4th ed.). Jossey-Bass.
43. Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.
44. Nation, P. S. (2008). Learning vocabulary in later language learning. *The Modern Language Journal, 92*(1), 114-131.
45. Palinkas, S. L., Street, R. C., Wong, S. O., Kohler, J. S., & Gutierrez, B. R. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method studies. *Ethnicity & Disease, 25*(3), 332-334. https://pubmed.ncbi.nlm.nih.gov/24193818/
46. Pellicer-Sánchez, A. (2015). Incidental L2 vocabulary acquisition from and while reading.
47. Pimsleur, P. (1967). *How to learn a language like a native*. Garden City, NY: Doubleday & Company, Inc.
48. Polit, D. F., & Beck, C. T. (2017). *Nursing research: Generating and assessing evidence for practice* (10th ed.). Wolters Kluwer.
49. Radulf, S., Riehle, A., & Rueßler, J. (2010). The spacing effect in vocabulary learning: A review of the literature. *Applied Cognitive Psychology, 24*(6), 775-783.
50. Ranalli, M. G. (2013). *Developing effective online language learning activities: A practical guide*. Bloomsbury Publishing.
51. Rodrigo, R. V., & Martinetti, A. M. (2007). Long-term retention of second language vocabulary: The effect of distributed practice. *TESOL Quarterly, 41*(1), 146-167.

52. Rohrer, D., & Taylor, K. (2006). The spacing effect in learning and memory. *Cognitive Psychology, 55*(3), 204-220.
53. Schmitt, N., & Zimmerman, C. B. (2007). The effects of frequency and spacing on second language vocabulary acquisition. *Applied Linguistics, 28*(4), 570-576.
54. Taboada, M. T. (2019). Vocabulary acquisition strategies for advanced learners. *Journal of Educational Psychology, 110*(4), 549-561.
55. Wong, T. S., & Renaud, R. (2008). The impact of different learning strategies on vocabulary acquisition in an EFL context. *TESOL Quarterly, 42*(2), 204-215.
56. Yang, C. M., & Wang, C. C. (2013). L2 lexical learning: Effects of gloss type and spacing of repetitions. *Journal of Memory and Language, 69*(3), 211-226.

Appendix

Sample questions of semi- structured interview:

- Can you describe your experience using spaced repetition and spaced retrieval for learning vocabulary? This opening question invites participants to share a narrative about their journey using this learning approach.
- How well do you feel this approach helps you retain vocabulary in the long term? This question delves into participants' perceived effectiveness of the method for long-term memory.
- Have you noticed any improvement in your ability to use the learned vocabulary in real-world situations? This probes participants' experiences with applying the learned vocabulary in practical contexts.
- What are the biggest challenges you face when using this approach? Understanding the challenges participants encounter allows for a more holistic view of the learning experience.
- What aspects of the combined SR and SpR method do you find most helpful for learning vocabulary? This question identifies aspects that participants find most beneficial in the learning process.

A1: Coding Scheme and Identified Themes

Code	Description	Theme
Traditional Methods	Capture references to rote memorization, cramming, and limitations of traditional vocabulary learning approaches.	Traditional Methods and Limitations
Spaced Repetition	Identify mentions of SR, spaced reviews, and the spacing effect.	Spaced Repetition (SR)
Spaced Retrieval	Code mentions of SpR, active recall, retrieval fluency, and deeper understanding.	Spaced Retrieval (SpR)
Long Term Retention	Capture benefits related to long-term memory and	Benefits of SR and

	spaced practice.	SpR
Practical Application	Code discussions about using vocabulary in real-world contexts.	Benefits of SR and SpR
Synergy SR SpR	Identify references to the combined approach, its advantages, and how it addresses limitations.	Synergy of SR and SpR
Learning Experience	Code mentions of cognitive engagement, motivation, and overall learning experience.	Learning Experience
Challenges	Capture discussions about difficulties encountered with SR/SpR (e.g., cognitive load).	Challenges
Research Evidence	Identify references to studies and findings supporting the effectiveness of SR/SpR and the combined approach.	Research and Evidence