

Working Memory, Cognitive Load, and Multitasking in Second Language Acquisition: A Review of Digital Learning in Low-Exposure EFL Contexts

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Article Info	Abstract
Article type: Research Article Article history: Received May 23, 2026 Received in revised form September 15, 2026 Accepted September 20, 2026 Published online September 27, 2026 Keywords: Cognitive Processing, Mental Effort, Dual-Task Performance, Low-exposure EFL contexts, Technology-mediated instruction	Technology-supported second language (L2) acquisition relies on three key cognitive factors: working memory (WM) capacity, cognitive load, and multitasking. Digital tools provide plentiful target-language input. Yet we know surprisingly little about the mental strain they impose in low-exposure English as a Foreign Language (EFL) classrooms where natural practice is scarce. To address this gap, this systematic narrative review synthesizes peer-reviewed empirical research examining how these cognitive variables interact during digital vocabulary and grammar learning. This synthesis reveals three primary patterns. First, learners possessing greater WM capacity consistently show superior lexical and grammatical retention, especially under heavy processing demands. Second, digital task architecture directly influences cognitive load. When activities incorporate scaffolded, multimodal designs, extraneous strain drops significantly, which optimizes language processing. Third, although juggling multiple digital tasks taxes working memory in low-exposure settings, a robust WM capacity may function as a vital compensatory buffer against performance loss. Well-structured digital platforms help learners allocate cognitive resources efficiently, whereas cluttered tasks exacerbate mental demands. Ultimately, internal memory capacity may help offset limited linguistic exposure outside the classroom. Future empirical studies must explore these dynamics to guide adaptive digital pedagogical interventions tailored for low-exposure environments.

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Introduction

Second Language Acquisition (SLA) is a complex cognitive process, which is mediated by an interaction between individual learner characteristics and environmental factors. Working memory (WM) is at the heart of the temporary storage, processing, and integration of linguistic input within this cognitive architecture, which is particularly crucial in the acquisition of L2 vocabulary and grammar (Namaziandost et al., 2020). Modern SLA frameworks increasingly recognize the role of cognitive mechanisms such as selective attention, executive control, and memory consolidation in the way language learners process incoming linguistic stimuli (Parween et al., 2025). This cognitive processing is also further challenged in current educational contexts by the rapid proliferation of technology-mediated instructional tools. Learners interacting with digital platforms (e.g., mobile applications, online courses, blended learning environments) often face increased cognitive load and are frequently induced to multitask. This is because digital learning environments require learners to manage, filter, and process information from multiple sources simultaneously. Hence, it is important to understand the interrelationship of these cognitive processes in digital environments (Deng, 2026).

This is particularly important when considering the increasing use of digital platforms for language learning, which present unique pedagogical opportunities but also severe cognitive challenges. Well-designed digital environments can, on one hand, provide rich multimodal input, interactive tasks, and immediate personalized feedback; on the other hand, they can impose high extraneous cognitive demands and promote multitasking behaviors that may ultimately interfere with deeper cognitive processing and long-term retention (Bahari, 2023). This review, by synthesizing the influence of working memory capacity and cognitive load on L2 processing in multitasking contexts, offers important theoretical and practical implications for low-exposure EFL contexts. Such insights are critical to designing effective instructional strategies, suitable tasks for digital implementation, and adaptive digital platforms tailored to the cognitive constraints of modern learners.

While cognitive factors in SLA are receiving much attention from scholars, there is a dearth of studies that specifically target low-exposure EFL contexts. In settings such as the Iranian academic context, learners rarely have access to naturalistic English-speaking communities or informal input reinforcement outside the classroom (Baleghizadeh et al., 2025). Hence, these learners must rely much more heavily on their internal working memory capacity to actively process, rehearse, and retain vocabulary and grammar (Esfandiari & Allaf-Akbary, 2024; Khezzinejad et al., 2026). This dependence is consistent with previous studies which suggested that learners with less exposure to the target language depend more on working memory capacity for the processing and consolidation of new linguistic forms (Alharbi, 2025; Juffs, 2006). Yet, it is unclear how working memory capacity compensates for the lack of real-world communicative input and environmental reinforcement. Moreover, despite the rapid growth of technology-enhanced language learning (TELL) in low-exposure

environments like Iran, research on the combined effects of cognitive load and digital multitasking on comprehension and retention for this population is scarce. The possible costs of multitasking may be especially severe in settings where limited environmental reinforcement is available to compensate for divided attention, but this issue has not been synthesized adequately (Broda et al., 2025; Subardjo & Khan, 2025).

Synthesis of findings from the broader international literature is of paramount importance given the limited empirical evidence directly available from low-exposure contexts. Such a synthesis offers invaluable theoretical and practical insights for optimizing technology-supported language learning in resource-constrained, low-exposure environments worldwide, whilst addressing the specific challenges faced by Iranian learners. The present systematic narrative review seeks to address these gaps by providing an integrated synthesis of studies on working memory, cognitive load, and multitasking in digital L2 learning, specifically in low-exposure EFL contexts. This paper offers a unified review, examining the cumulative interaction of these cognitive dimensions, rather than treating them in isolation. This review has three main aims: first, to synthesize the role of working memory capacity in L2 vocabulary and grammar acquisition in low-exposure environments; second, to examine how cognitive load and multitasking interact to modulate L2 comprehension and retention in technology-mediated settings; and third, to discuss how modern digital technologies influence the allocation of cognitive resources in input-poor settings. This review specifically addresses two primary research questions:

How does individual working memory capacity modulate second language vocabulary and grammatical processing in technology-mediated learning environments?

How do cognitive load and digital multitasking interact to influence L2 comprehension and retention, particularly in low-exposure EFL contexts?

Literature review

Working Memory and Second Language Acquisition

Researchers in second language acquisition (SLA) have long treated working memory (WM) as a foundational cognitive driver, enabling learners to hold and process linguistic information simultaneously during real-time comprehension and production. Cognitive psychologists theorize this construct through several distinct frameworks, each carrying clear ramifications for L2 processing. Baddeley's (2003) multi-component model, for instance, conceptualizes WM as a modular architecture where a central executive oversees phonological and visuospatial subsystems alongside an episodic buffer. Conversely, Cowan's (2001) embedded-processes model conceptualizes WM as the activated part of long-term memory that is directly in the focus of attention. Engle's (2002) executive attention theory focuses on individual differences in the ability to maintain attention in the presence of distraction or cognitive interference. In SLA research, individual differences in WM capacity have been linked to the learners' ability to attend to, process, and temporarily store lexical and

grammatical items, especially under cognitively demanding instructional conditions (Jackson, 2016; Michel et al., 2019; Pavlekovic & Roehr-Brackin, 2024).

Indeed, there is a growing body of literature demonstrating a significant association between WM capacity and L2 vocabulary learning (Bui et al., 2024; Handley & Kelland, 2024). Recent research across various EFL settings indicates that learners with higher WM capacity perform better in lexical recall, retention, and contextual use (Alshehri, 2024; Deng, 2026). These effects are found across technology-mediated learning environments, suggesting that WM is involved not only in initial lexical encoding but also in longer-term consolidation (Chang & Aberash, 2026). Likewise, experimental research has shown that WM training may have potential observable benefits for vocabulary learning. This emphasizes the potential plasticity of cognitive resources and their pedagogical utility (Esquivel-Gómez & Julio, 2025).

In addition to vocabulary acquisition, WM has also been found to play an important role in online language processing, over and above the effects of offline vocabulary knowledge, extending to real-time L2 reading comprehension (Huang & Jiang, 2022; Parween et al., 2025). Eye-tracking evidence has revealed a fine-grained profile of how WM capacity influences attentional deployment during L2 reading, especially when readers process unfamiliar grammatical or lexical structures. Participants with larger WM capacity demonstrate more efficient processing patterns during text presentation, such as shorter fixation durations on novel words and more strategic regressions, and achieve higher comprehension scores, indicating that WM capacity is closely associated with both real-time processing efficiency and learning outcomes (Huang & Jiang, 2022; López-Rojas et al., 2026). These findings are consistent with studies reporting that task demands, input modality, and processing load in technology-mediated learning environments, where learners must simultaneously integrate verbal and visual information, significantly modulate learning performance (Ansarin & Khabbazi, 2021). These observations are supported by multidisciplinary research demonstrating that working memory operates in concert with broader cognitive processes, such as selective attention and executive control, reinforcing its centrality in managing linguistic information (Parween et al., 2025).

Methodological Developments in Working Memory Research

Despite the wealth of evidence pointing to WM as an important factor in SLA, the methods used to measure WM capacity remain methodologically challenging. Traditional complex span tasks, such as reading span, operation span, and backward digit span, are widely used, but researchers have questioned their ecological validity for L2 learning contexts because they tend to tap domain-general cognitive processing rather than language-specific tasks (Liu & Murao, 2025). To address this challenge, recent research has developed content-embedded WM tasks in which linguistic processing is part of the WM measurement procedure.

Initial evidence suggests that these content-embedded tasks have greater predictive validity for L2 reading comprehension and developmental achievement than traditional span tasks,

especially in instructional or intentional learning conditions (Zalbidea & Issa, 2025). These methodological advances suggest a shift toward context-sensitive frameworks that incorporate cognitive dimensions of SLA. Crucially, the cognitive load imposed by technology-mediated learning environments is directly linked to how instructional material is presented, thereby resolving the dichotomy between the internal capacity of a learner's working memory and the external cognitive load of digital tasks.

Cognitive Load in Technology-Mediated L2 Learning

Cognitive Load Theory (CLT) offers a solid theoretical basis for explaining how learners utilize their limited working memory resources in digital language learning. CLT suggests that optimal learning occurs when total cognitive load, comprising intrinsic load related to task difficulty and extraneous load imposed by instructional design, does not exceed the working memory capacity of the learner (Sweller, 1994; Bahari, 2023). In technology-mediated language learning, digital environments can either scaffold cognitive processing or overload the learner's cognitive system, depending on how instructional materials are presented.

A critical synthesis of the literature, including a comprehensive review by Bahari (2023), highlights the dual nature of technology-enhanced language learning. While digital features such as multimodal visual displays and scaffolded task sequencing can reduce extraneous cognitive load and enhance vocabulary retention, poorly designed digital interfaces can fragment attention and overwhelm the learner's WM capacity. Additionally, empirical evidence shows that instructional strategies such as spaced repetition, self-regulation, and scaffolded task sequencing can reduce cognitive overload and enhance vocabulary retention (Aghdam et al., 2025; Ibrayeva et al., 2026).

Evidence from Iranian EFL contexts indicates that structured digital instruction can significantly enhance learners' academic engagement and self-confidence (Kamaie & Baharloo, 2023; Namaziandost et al., 2025). These findings suggest that technology-mediated environments influence not only cognitive resource allocation but also the psychological and affective dimensions of language learning (Baharloo & Kamaie, 2023). Consequently, digital learning settings shape both affective and cognitive aspects of the learning process, requiring instructional designs to actively support how learners manage cognitive resources within these environments.

While AI-enabled language learning platforms can optimize cognitive load through adaptive feedback and individualized instruction, their integration is not without cognitive costs. Under certain conditions, poorly structured AI tools can increase distraction and cognitive fatigue (Mahmoodi & Aref, 2026; Feng, 2025). To mitigate these negative effects, interventions such as digital mindfulness, defined as the deliberate cultivation of present-moment awareness during technology use, have been introduced. Digital mindfulness has been shown to reduce cognitive load by enhancing learners' cognitive control and sustaining their focus on highly demanding tasks, such as computer-assisted writing (Wang, 2025).

Multitasking, Attention, and Cognitive Constraints

Digital learning environments are characterized by multitasking, which involves the simultaneous or rapid sequential processing of multiple streams of information. The human brain does not perform parallel processing; instead, it engages in rapid attention switching, which imposes a substantial cognitive surcharge. Under such conditions, executive control resources within working memory and attention are heavily taxed, often leading to shallower semantic processing and reduced long-term retention of L2 input. Although research suggests that learners with higher working memory capacity navigate multitasking demands more effectively, even high-capacity individuals exhibit marked performance decrements when engaging in multiple digital tasks simultaneously (Subardjo & Khan, 2025).

Although very common in modern education, the role of multitasking in second language acquisition has been poorly investigated. This problem is particularly relevant for low-exposure EFL settings, where one is unlikely to rely on exposure or external factors to facilitate input processing (Broda et al., 2025). As such, attempting to perform several tasks at once while studying another language may have a detrimental effect on one's progress (Zhang et al., 2024). The ability to effectively balance and prioritize digital tasks depends on an individual's working memory, according to multidisciplinary research (Parween et al., 2025).

Low-Exposure EFL Contexts and the Need for Integrated Perspectives

Most SLA research centers on high-exposure or semi-immersive settings. This leaves low-exposure EFL contexts, like Iran, poorly represented in empirical studies (Baleghizadeh et al., 2025). Where target language input is scarce, learners cannot rely on naturalistic immersion to acquire vocabulary and grammar. In these settings, working memory capacity may act as a crucial compensatory mechanism to support language processing (Broda et al., 2025; Juffs, 2006). A related problem is that past work has examined working memory capacity, cognitive load, and technology-mediated instruction as separate phenomena (Bahari, 2023). Each was examined individually, resulting in only a fragmented understanding of how they might interact in an instructional setting. This is of particular interest with regard to technology-mediated learning, where cognitive factors are inseparable from the process of language learning itself. The question, then, emerges of how these cognitive factors interact with one another, what role each plays in the L2 learning environment, and how they together shape the learning process when exposure to the target language is low?

Most working memory research in SLA centers on high-exposure settings. That leaves low-exposure EFL contexts, such as Iran, underexplored. Since Iranian students lack naturalistic access to English, they rely heavily on working memory to acquire vocabulary and grammar (Baleghizadeh et al., 2025; Juffs, 2006). Theoretically, in input-scarce environments, working memory capacity compensates for missing environmental exposure, though Broda et al. (2025) observe that this hypothesis has yet to be empirically synthesized.

Technology-mediated instruction is expanding rapidly through mobile apps, online platforms, and hybrid classrooms. Yet we still know very little about how cognitive load, multitasking, and working memory interact in low-exposure EFL contexts. These digital tools force learners to process dense, heterogeneous information streams at once. As Bahari (2023) notes, this heavy digital input can easily strain working memory capacity. Because prior work examined these factors separately (Parween et al., 2025; Zhang et al., 2024), we lack a clear picture of their joint impact on L2 comprehension, retention, and acquisition.

This study makes a novel contribution by integrating working memory, cognitive load and multitasking in a single framework, specifically targeting technology-mediated, low-exposure EFL environments. Contrary to previous studies, it investigates the interaction between these cognitive factors and their cumulative effect on vocabulary and grammar acquisition, with particular emphasis on the compensatory effect of working memory in the absence of naturalistic exposure. Furthermore, by synthesizing evidence from emerging digital learning contexts, including mobile-assisted learning, online instruction, and hybrid classrooms, the study provides an in-depth, context-sensitive perspective on the cognitive challenges of modern SLA and bridges gaps between cognitive theory and educational technology.

Method

The present study utilizes a systematic narrative review design to address the stated research objectives. Following the PRISMA 2020 guidelines (Page et al., 2021), this approach combines the systematic review's rigorous and transparent procedures for search and screening with the thematic and integrative synthesis of the narrative review, thereby offering an in-depth view of the interaction of cognitive factors in digital L2 environments. This ensures a comprehensive and transparent literature search and a synthesis that is sensitive to the qualitative nuances and theoretical frameworks of cognitive SLA.

Search Strategy and Database Selection

Four bibliographic databases and one academic search engine, Scopus, Web of Science, ERIC, PsycINFO, and Google Scholar, were systematically searched for peer-reviewed empirical articles published between 2005 and 2025. Specific search strings with Boolean operators were designed to capture the interface of cognitive psychology and computer-assisted language learning:

For Working Memory & L2 Processing: “working memory” AND “second language acquisition”, “working memory capacity” AND “vocabulary acquisition”, “working memory capacity” AND “grammar acquisition”. For Cognitive Load & Multitasking: “cognitive load” AND “second language acquisition”, “multitasking” AND “L2 comprehension”, and (“digital learning” OR “mobile-assisted language learning” OR “MALL” OR “artificial intelligence” OR “AI tutor”) AND “cognitive load”.

Studies retrieved from the database searches were screened against pre-defined inclusion and exclusion criteria:

Inclusion Criteria:

Studies were included if they: (a) were peer-reviewed empirical papers, (b) were published between 2005 and 2025, (c) explicitly measured working memory capacity (using established cognitive tasks such as reading span, operation span or n-back tasks) and/or measured cognitive load or multitasking in L2 learning contexts, (d) focused on L2 vocabulary, grammar acquisition or reading/listening comprehension, and (e) adopted experimental, quasi-experimental or correlational research designs.

Exclusion Criteria:

Studies were excluded if they: (a) were non-empirical papers (e.g., conceptual frameworks, literature reviews, or opinion pieces), (b) did not focus on L2/FL learning, or (c) investigated general cognitive factors outside of technology-mediated or low-exposure instructional settings.

Study Selection and Screening (PRISMA Flow Diagram)

The study selection process was conducted in accordance with the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency, objectivity, and reproducibility (Figure 1). The search protocol shows that the initial database search resulted in a total of 280 records. After removing 110 duplicate records, the remaining 170 unique studies were screened by title and abstract, leading to the exclusion of 125 records that did not meet the eligibility criteria. The full texts of the remaining 45 articles were then thoroughly reviewed and 27 studies were excluded due to particular methodological or contextual constraints (e.g., no objective cognitive measures or non-digital settings). The qualitative synthesis incorporated a final pool of 18 peer-reviewed empirical studies that met all inclusion criteria. Additional theoretical, methodological, and background sources were used to contextualize and interpret the findings.

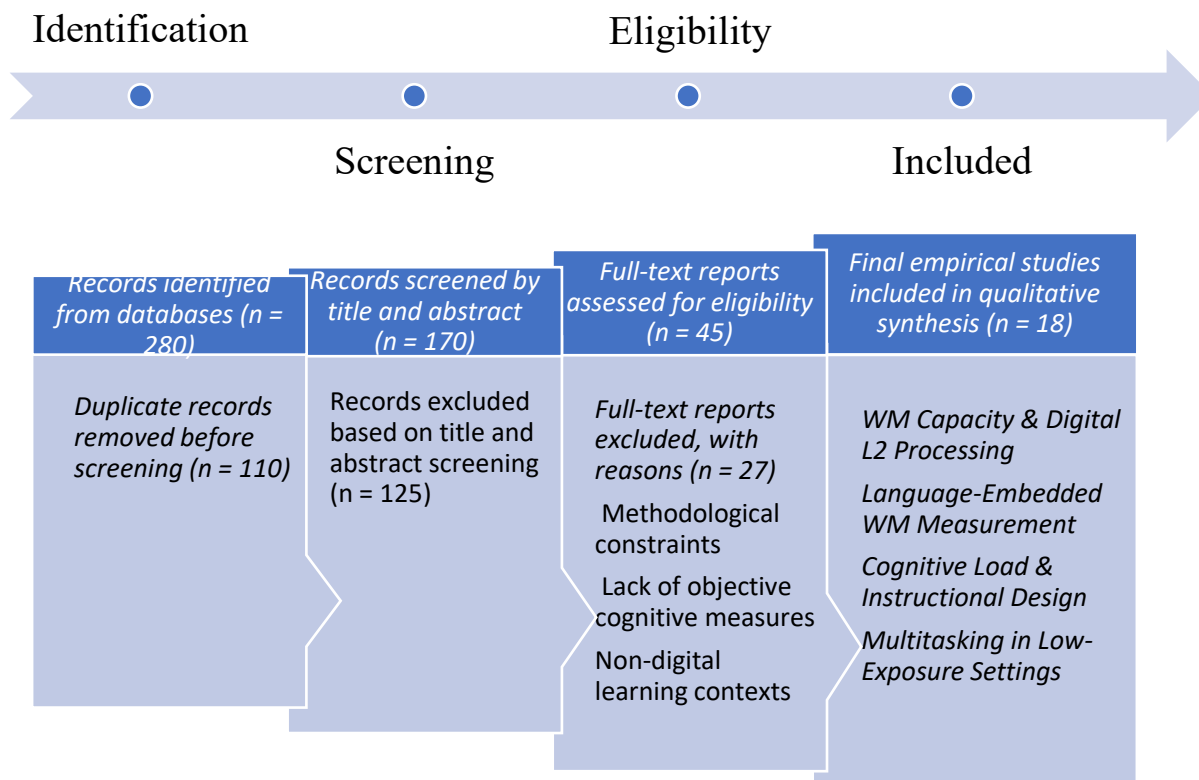


Figure 1: PRISMA 2020 Flow Diagram of the Study Selection and Screening Process.

Data Extraction and Coding

Data from the 18 included studies were systematically extracted into a standardized matrix. The extracted variables included: author(s) and year of publication, geographical and educational context, sample characteristics (size, age, and proficiency), digital tools used (e.g., MALL, CALL, AI platforms), cognitive measures (WM span tasks, subjective cognitive load scales, eye-tracking metrics), and L2 learning outcomes (retention, comprehension, vocabulary/grammar gains). Two independent reviewers coded a random sample of 30% of the retrieved studies to ensure the reliability of the screening and data extraction process. Inter-rater reliability was calculated using Cohen's Kappa. The coefficient was 0.85, suggesting a high level of agreement. Differences of opinion between reviewers were resolved by discussion and consensus.

Data Analysis

The extracted data were then qualitatively synthesised using thematic narrative synthesis, rather than traditional experimental categories (e.g., independent or dependent variables), to explore patterns, methodological characteristics, and findings across the literature. This approach allowed the findings to be classified into four major analytical themes: (1) the predictive power of WM capacity in digital L2 processing, (2) methodological advancements in language-embedded WM measurement, (3) the role of digital instructional designs in

shaping cognitive load, and (4) the attention-switching constraints of multitasking under low-exposure digital conditions.

Findings

Rather than reviewing studies individually, this section groups the empirical evidence into four main thematic categories. This structure compares how different language sub-skills, digital platforms, and individual cognitive profiles interact. In doing so, it surfaces both shared consensus and conflicting evidence across cognitive SLA research.

Attentional Resource Allocation and Working Memory Capacity

A critical examination of the reviewed pool of research literature suggests that the domain-general working memory (WM) capacity construct plays an essential predictive role in learning second language (L2), particularly with respect to acquiring the target language's lexical and syntactic elements. Multiple EFL studies found lexical and syntactic use and retention to be better among participants with higher working memory capacity (Alshehri, 2024; Bui et al., 2024). These studies collectively suggest that working memory capacity makes a significant contribution to input encoding and subsequent memory storage and retrieval in L2 learning, in both classroom-taught, tech-assisted, and technology-mediated environments (Handley & Kelland, 2024). The experimental intervention of implementing working memory-based training was suggested to produce a positive effect on lexical learning in the L2 learning process (Alshehri, 2024).

To better understand the underlying cognitive processes that give rise to these outcomes, researchers have increasingly adopted eye-tracking methodologies. This approach captures learners' fine-grained, online cognitive processing during language tasks, bridging the gap between static testing and dynamic attentional deployment. Eye-tracking evidence shows that individual differences in WM capacity have a direct effect on the allocation of attention during L2 reading. In particular, learners with higher WM capacity processed text more efficiently. These students spent less time looking at unfamiliar words, made more strategic regressive eye movements, and ultimately scored higher in reading comprehension (Huang & Jiang, 2022). Multi-method research supports this view (Ansarin & Khabbazi, 2021), showing how WM capacity predicts and shapes real-time language processing.

Most importantly, the results suggest that the predictive power of WM capacity is not consistent and is dependent on the particular L2 sub-skill and the proficiency level of the learners. For example, the literature suggests that WM capacity is a stronger predictor of explicit, rule-based grammatical processing than of implicit, incidental vocabulary acquisition. Furthermore, conflicting evidence indicates that the predictive role of WM capacity may diminish with higher levels of L2 proficiency, suggesting that established linguistic knowledge may partially bypass working memory constraints (e.g., Jackson, 2016; Pavlekovic & Roehr-Brackin, 2024).

Importantly, it is necessary to differentiate working memory capacity (the stable limit of cognitive resources for an individual) from working memory load (the temporary processing requirement of a task). Higher WM capacity supports better L2 performance, yet a high working memory load, worsened by poorly structured digital tasks, can overwhelm even high-capacity learners, leading to attention fragmentation and degraded comprehension (Huang & Jiang, 2022; Ansarin & Khabbazi, 2021).

Methodological Implications in L2 Working Memory Research

Recent work in cognitive SLA has changed how working memory is measured. However, traditional complex span tasks have been criticised for their ecological validity. Researchers have questioned whether simpler language-specific tasks are more ecologically valid for L2 processing. To address this, scholars have turned to content-embedded WM tasks, which test language processing directly during performance (Zalbidea & Issa, 2025). These language-embedded tasks predict L2 aptitude and reading comprehension in classroom settings far better than traditional span tests. This approach helps researchers track how a learner's cognitive resources handle the linguistic demands of digital tasks in real time, creating a more realistic framework for digital SLA research.

Cognitive Load Management in Digital Instructional Designs

The examined empirical studies demonstrate that technology-mediated tasks in language learning are not always beneficial for the learners since they can experience difficulties with processing the input due to the limited working memory capacity. Rather than a uniform picture, the review of the literature presents a different perspective on the management of cognitive load. Indeed, the study conducted by Bahari (2023) was focused on the role of design elements in reducing extraneous cognitive load. The findings highlight that visual displays, dual-display interfaces, and adaptive scaffolding features can help manage cognitive load in technology-mediated environments. However, the execution of ill-structured digital tasks was found to increase cognitive load and cause the depletion of the learner's attention. In contrast, the study by Aghdam et al. (2025) was dedicated to cognitive learning strategies. The results of the research indicate that incorporating self-regulation, spaced repetition, and task scaffolding can help learners reduce extraneous cognitive load and support the allocation of cognitive resources toward the acquisition of form-meaning connections and new words.

Furthermore, modern technologies such as artificial intelligence (AI) play a sophisticated role. On the one hand, AI language-learning systems can improve cognitive processing by individualizing the task difficulty based on the cognitive capacity of the learner (Feng, 2025; Huang & Teng, 2025). However, this innovation is not always beneficial, as several studies have revealed that the use of AI tools under certain conditions (e.g., excessive graphical information, quick feedback, or low customization) may induce a “split-attention” effect that overwhelms the learner with additional information and distracts learners.

To solve this issue, researchers have proposed the concept of digital mindfulness, defined as the deliberate cultivation of present-moment, non-judgmental awareness during digital interactions to mediate the adverse effects of technology on cognitive processing (Wang, 2025). Digital mindfulness practices help reduce the cognitive load of language learners and increase cognitive control and attentional focus during computer-assisted writing tasks, thereby improving the learners' ability to manage their cognitive processing and resist distractions.

Multitasking and Attention-Switching Constraints in Digital L2 Learning

Digital learning environments pose a serious threat of cognitive overload through multitasking. In cognitive terms, multitasking is not parallel processing, but rapid, sequential switching of attention. Working memory is under an extraordinary executive load due to the constant switching among different information channels (e.g., usage of multiple browser tabs, translation tools and multimedia inputs), which leads to shallow processing and poor retention of L2 input (Zhang et al., 2024). However, multitasking does not have the same cognitive consequences, but heavily depends on multiple moderating variables, including task difficulty, input modality and individual cognitive profiles. Those with higher WM capacity are better at coping with the divided-attention demands and remembering secondary details than their lower-capacity peers, but multitasking usually causes some level of performance decrement for all learners (Zhang et al., 2024).

This constraint is especially strong in low-exposure EFL contexts, where learners are not provided with informal target language input or environmental reinforcement to consolidate what has been processed. In such cases, multitasking adds to the cognitive load even more. The results suggest that the negative effects of multitasking can be reduced when tasks are designed with lower cognitive difficulty or use complementary input modalities (e.g., pairing audio with target language subtitles rather than competing visual text streams).

Integration Across Cognitive Factors and Contexts

Taken collectively, the results of the studies under review reveal several important patterns in the dynamic interaction between working memory capacity, cognitive load, and multitasking. First, a high WM capacity is an important compensatory buffer against the negative effects of cognitive overload and divided attention, but this buffering is not absolute. Second, the interaction is moderated by technology-mediated environments: well-designed digital tools can optimize cognitive load, whereas poorly structured tasks amplify the limits of working memory.

Third, the operation of these cognitive factors is highly context-dependent. In low-exposure EFL contexts like Iran, working memory is an important compensatory mechanism for language acquisition in the absence of naturalistic exposure. Specifically, this compensatory function implies that in the absence of naturalistic exposure and environmental reinforcement, learners must engage in internal cognitive control, active phonological rehearsal, and focused

attentional allocation within working memory to actively process, retrieve, and consolidate new vocabulary and grammatical structures.

The findings ultimately suggest that working memory, cognitive load, and multitasking are closely interrelated cognitive factors associated with L2 performance in digital contexts. Managing these interactions requires an integrated perspective that aligns the cognitive resources of the learner with the complexity of the digital task.

Discussion

The findings of this systematic narrative review highlight the central role of working memory (WM) capacity in digital second language acquisition (SLA) environments and illustrate the dynamic role of cognitive load and multitasking in shaping the relationship. Rather than functioning as isolated cognitive variables, they interact constantly to modulate L2 vocabulary and grammar learning, especially in low-exposure EFL contexts.

Moving beyond the descriptive patterns reported in the findings, this discussion critically interprets these relationships using standard cognitive frameworks, contrasting with the descriptive patterns found in the results. First, the predictive role of WM capacity for digital vocabulary and grammar acquisition supports Engle's (2002) executive attention theory. Under this framework, individuals with higher capacity hold onto key task information in active memory far more effectively when distractions arise (Alshehri, 2024; Bui et al., 2024). In feature-rich digital learning spaces, high-capacity students can direct their attention to target language forms much more strategically, while lower-capacity peers get easily swamped by extra visual or auditory noise.

In addition, these findings contribute to the extension of Cognitive Load Theory (Sweller, 1994) by demonstrating the important role of digital instructional designs in shaping cognitive load. For instance, well-structured digital tools that adhere to CLT principles by segmenting multimodal input and providing scaffolded tasks reduce extraneous load and free up valuable working memory capacity for active language processing (Aghdam et al., 2025; Bahari, 2023). Such optimization is especially important for learners with lower levels of WM capacity, who are otherwise highly vulnerable to cognitive overload in multimedia learning situations. By contrast, AI-enabled platforms hold great promise for adaptive scaffolding, but poorly designed configurations can induce "split-attention" effects and increase cognitive fatigue (Feng, 2025; Huang & Teng, 2025), suggesting that technology integration should be guided by cognitive principles rather than technological novelty (Mahmoodi & Aref, 2026; Wang, 2025).

A closer look at digital multitasking helps refine our understanding of cognitive interactions. While juggling multiple tasks typically hurts L2 reading comprehension and memory, how much harm it causes depends largely on individual WM capacity. Learners with higher capacity can still hold onto secondary text ideas and details under split attention, a finding that fits the view of working memory as an attentional buffer.

These dynamics are particularly salient in low-exposure EFL contexts such as the Iranian academic setting. Therefore, Iranian EFL learners may rely more on their internal WM resources to actively process and retain L2 input, due to the absence of naturalistic English-speaking environments (Baleghizadeh et al., 2025; Juffs, 2006). Under such resource-poor conditions, WM capacity might be a critical compensatory mechanism (Broda et al., 2025), allowing learners to consolidate vocabulary and grammar in the absence of environmental reinforcement (Khezrinejad et al., 2026). But, considering the heavy demand on this compensatory buffer by multitasking, we must express caution: even high-capacity learners in low-exposure contexts likely suffer a performance decrement when digital environments are poorly structured or demand simultaneous task management.

This review contributes by connecting WM, cognitive load, and multitasking, addressing the dynamic interrelationships among these variables in a single, integrated cognitive framework. Rather than looking at these factors in isolation, this multi-componential perspective shows how high working memory capacity and well-designed digital environments work together to buffer the impact of cognitive overload (Bahari, 2023; Feng, 2025). In contrast, cognitively overwhelming tasks have a negative impact on executive control (Zhang et al., 2024). Thus, cognitive factors in digital SLA should be investigated as an interrelated system.

Conclusion

To summarize, this systematic narrative review indicates that working memory capacity, cognitive load and multitasking are interrelated variables that jointly shape L2 performance in technology-mediated contexts. Higher WM capacity consistently correlates with better lexical and grammatical retention, real-time processing and resistance to cognitive overload, but this advantage is not absolute and remains subject to multitasking constraints. Instructional design plays an important role in shaping cognitive load, and consequently learning outcomes. Scaffolded tasks aid comprehension while poorly configured tasks increase extraneous load. In low-exposure contexts, such as Iranian EFL classrooms, working memory capacity may serve a compensatory role, offsetting the constraints of limited environmental input. Ultimately, successful digital language learning is not just a matter of technological exposure, but depends on the cognitively optimized alignment of task demands, digital tool configuration and individual working memory capacities.

Several limitations of this review should be borne in mind. First, the primary studies included in this synthesis differ widely in their methodological designs, participant profiles, and measures of working memory capacity, limiting direct comparability and generalizability across contexts. Second, there was no formal and standardized quality assessment system to evaluate the methodological rigor of the included studies, which may introduce selection bias. Finally, despite increasing scholarly attention to technology-mediated SLA, the empirical evidence base focusing on the interaction of working memory, cognitive load, and

multitasking in low-exposure EFL contexts remains limited, so caution must be exercised when generalizing these findings.

Future research needs to move beyond isolated variable studies and adopt integrated, context-sensitive research designs to further develop the theory and pedagogical applications of cognitive factors in digital SLA. Future work should consider the following areas for investigation: First, future studies need to empirically investigate the long-term developmental effects of working memory capacity on digital L2 vocabulary and grammar acquisition to verify the durability of compensatory cognitive mechanisms over time. Second, comparative studies should directly contrast cognitive resource allocation, cognitive load, and multitasking behaviors between high- and low-exposure EFL contexts to clarify the effect of environmental input on internal cognitive processing. Third, future research should empirically investigate the cognitive impact of specific, emerging digital technologies, such as generative AI tutoring systems, virtual reality (VR) platforms, and adaptive mobile-assisted language learning (MALL) tools, on learners' real-time cognitive load and multitasking constraints. Finally, empirical work should involve designing and testing digital instructional packages that are cognitively optimized (e.g., digital mindfulness or segmented task delivery) to assess their effectiveness in supporting and scaffolding learners with lower working memory capacities in resource-constrained environments.

From a theoretical and pedagogical perspective, the results advance the field of SLA by furthering the debate about how working memory, cognitive load, and multitasking interact in second language acquisition. In addition, the results raise pedagogical questions about how learning activities and tasks can be designed to optimize the effects of cognitive load on language learners. The findings suggest the following ideas for cognitively informed task design that could be investigated in SLA studies:

Developers of educational software and AI tutors should allow task segmentation or parsing for complex vocabulary items and explanations of grammatical phenomena to reduce cognitive load. Moreover, the cognitive load of the learners interacting with an AI tutor should be considered in the design and implementation of such tools; specifically, tutoring systems should adjust difficulty based on perceived cognitive load to maintain optimal levels. Likewise, in language learning contexts involving low exposure to target data (such as EFL settings with limited naturalistic input), instructors might explicitly encourage learning mindfulness techniques as a part of completing computer-assisted tasks to optimize engagement and reduce the negative impact of multitasking.

Bio-data

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