

Empowering EFL/ESL Digital Readers through Online Metacognitive Strategies and Scaffolding: A Systematic Review of Insights, Practices, and Challenges

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Abstract

With the increasing prevalence of digital reading in EFL/ESL instruction, online metacognitive strategies and scaffolding have become essential for supporting reading comprehension and self-regulated reading. However, existing research remains fragmented, particularly because studies of learners' strategy awareness and use are often discussed together with intervention studies on digital scaffolding and platform-supported training. Following the PRISMA 2020 guidelines, this systematic review synthesized 31 empirical studies retrieved from Web of Science, Scopus, and ERIC. The findings show that current research is concentrated mainly in higher education contexts and selected Asian contexts, with limited attention to K-12 learners and wider regional settings. Methodologically, the field is dominated by quantitative designs, self-report measures, and short-term interventions. Intervention studies indicated that explicit strategy instruction, platform-supported scaffolds, annotations, learning journals, feedback, and specialized reading tools can support reading comprehension, metacognitive awareness, and self-regulation. However, these effects are not automatic and are shaped by platform usability, cognitive load, digital text features, learner readiness, and instructional support. Future research should examine younger learners, longitudinal strategy development, and the alignment among digital texts, platforms, scaffolds, and instructional contexts to provide more sustainable guidance for EFL/ESL digital reading instruction.

Keywords: EFL/ESL, digital reading, online metacognitive strategies, scaffolding, systematic review

1. Introduction

Reading is a fundamental means by which EFL/ESL learners acquire linguistic input and construct meaning. With the increasing integration of information and communication technologies (ICT) into language education, reading has gradually shifted from the conventional linear, paper-based reading to digital reading environments (Düz et al. 2024). Compared with traditional print-based reading, digital reading is often characterized by multimodal information, non-linear navigation, and hypertextual links (Batchelor et al. 2026). This shift has expanded learners' access to language input and changed the way in which they interact with texts (Astri, 2024).

However, digital reading also creates additional challenges for EFL/ESL learners. When navigating hyperlinks, managing interface features, and evaluating information from multiple sources, learners may experience disorientation, distraction, and increased cognitive load (Balaskas et al., 2025). Fragmented information and digital interface distractions may weaken deep processing and meaning construction, thereby reducing learners' reading engagement and comprehension (Kramarski & Feldman, 2000; Gilbert, 2017; Zhang, 2024).

Metacognitive strategies provide an important means of supporting such regulation. They involve higher-order processes such as planning, monitoring, and evaluating, which help learners clarify reading goals, check comprehension, and adjust strategies when difficulties occur (Flavell, 1999; Bouknify, 2023). In digital reading environments, metacognitive support may appear in two related forms. The first concerns learners' existing awareness and use of online reading strategies, such as planning, problem-solving, support strategy use, and self-monitoring. The second concerns instructional scaffolding, in which teachers or digital tools make these strategies explicit through prompts, feedback, annotations, learning logs, process monitoring, or platform-supported activities (Uğak & Kartal, 2023).

Despite the growing empirical research in this field, current knowledge about online metacognitive strategies and scaffolding in EFL/ESL digital reading remains fragmented. Existing studies are unevenly distributed across educational stages and geographical contexts, therefore limiting the generalizability of the findings to younger learners and other educational settings (Rianto, 2021a, 2021b; Çolak & Razi, 2026). In addition, digital reading tasks vary considerably across studies, including web navigation, hypertext reading, multimodal comprehension, and platform-based reading, which makes it difficult to compare tools, tasks, and outcomes consistently (Akopyan & Saks, 2022). Intervention studies also differ in instructional intensity, platform design, scaffolding procedures, and the role of teachers or researchers, which further complicates comparison across studies (Babashamasi et al., 2022). Moreover, implementation challenges related to technical access, cognitive load, learner readiness, and individual differences have not been sufficiently synthesized.

For this reason, a systematic review is needed to clarify the current state of research on online metacognitive strategies and scaffolding in EFL/ESL digital reading. This review distinguishes between non-intervention studies, which examine learners' existing strategy awareness, strategy use, and related factors, and intervention studies, which examine digital scaffolding, platform-supported strategy instruction, effects, and implementation challenges. By making this distinction, the review aims to provide a clearer synthesis of how online metacognitive strategies are understood, supported, and implemented in EFL/ESL digital reading contexts.

RQ1: In which educational stages and geographic regions has research on online metacognitive strategies and scaffolding in EFL/ESL digital reading been conducted?

RQ2: What research designs have been employed in intervention and non-intervention studies on online metacognitive strategies in EFL/ESL digital reading?

RQ3: What patterns of online metacognitive strategy awareness, use, and related learner/contextual factors have been reported in non-intervention studies?

RQ4: What platforms, cognitive tools, and instructional frameworks have been used to scaffold online metacognitive strategies in intervention studies?

RQ5: What effects and implementation challenges have been reported in online metacognitive strategy scaffolding or intervention studies?

These research questions aim to provide a comprehensive review of online metacognitive strategy research in EFL/ESL digital reading. By distinguishing between non-intervention studies and intervention studies, this review clarifies learners' existing strategy awareness and use, examines how digital platforms and tools have been used to support strategy instruction, and identifies the reported effects and implementation challenges of online metacognitive scaffolding. Thus, the review offers research-based insights for designing more effective and sustainable EFL/ESL digital reading instruction.

2. Methods

2.1 PRISMA Framework and Literature Sources

To ensure transparency and systematicity, this study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). PRISMA was used to guide the identification, screening, eligibility assessment, and final inclusion of studies. Three databases were searched: Web of Science (WoS), Scopus, and ERIC. These databases were selected to balance broad interdisciplinary coverage and education-specific literature. Web of Science and Scopus were used to identify peer-reviewed research in applied linguistics, educational technology, and language education, while ERIC was used to locate education-focused studies on EFL/ESL reading and digital learning.

2.2 Systematic Review Process for Selecting Articles

2.2.1 Identification

The literature search was conducted in January 2026 and covered studies available up to the date of the search. No lower year limit was applied in order to capture both early and recent studies on online metacognitive reading strategies. The search strategy was developed around three dimensions: reading modality, metacognitive or strategy-related constructs, and target learner population. Wildcards were used where appropriate to capture word variants.

The same conceptual search string was adapted to the search fields and syntax of each database. In Web of Science, the search was conducted in the Topic field, including title, abstract, author keywords, and Keywords Plus. In Scopus, the search was conducted in the TITLE-ABS-KEY field. In ERIC, the search was conducted across title, abstract, and descriptor/subject fields. The following search string was used and adapted according to database requirements:

("digital reading" OR "online reading" OR "blended reading" OR "hypertext reading" OR "e-reading" OR "screen-based reading") AND ("metacognit*" OR "self-regulat*" OR "strategy instruction" OR "reading strateg*" OR "comprehension strateg*") AND ("EFL" OR "ESL" OR "L2" OR "English as a Foreign Language" OR "English as a Second Language" OR "second language learner*")

The initial search retrieved 161 records: 52 from Web of Science, 50 from Scopus, and 59 from ERIC. All records were exported to Zotero for reference management. After automated and manual deduplication, 126 unique records were retained for title and abstract screening.

2.2.2 Screening

The 126 unique records were screened by title and abstract according to predefined inclusion and exclusion criteria. Studies were included if they met all of the following criteria:

- Publication type: Peer-reviewed primary empirical studies published in English;
- Target Population: EFL/ESL or L2 English learners
- Reading context: digital, online, screen-based, web-based, hypertext, or blended reading environment

- d. Central focus: online metacognitive reading strategies including learners' strategy awareness, strategy use, instructional design, scaffolding, implementation, or effectiveness;
- e. Empirical basis: studies reporting original quantitative, qualitative, or mixed-methods data.

Studies were excluded if they met any of the following criteria:

- a. Non-empirical publications, such as reviews, editorials, theoretical papers, commentaries, or conference abstracts without full empirical data;
- b. Studies not focused on EFL/ESL or L2 English learners;
- c. Studies not situated in a digital, online, screen-based, web-based, hypertext, or blended reading context;
- d. Studies in which metacognitive reading strategies were not a central construct;
- e. Studies focused only on general language learning, listening, writing, speaking, or digital literacy without a clear online reading component;
- f. Studies lacking sufficient methodological or empirical information for synthesis.

Based on these criteria, 88 records were excluded during title and abstract screening, leaving 38 full-text articles for eligibility assessment.

2.2.3 Eligibility

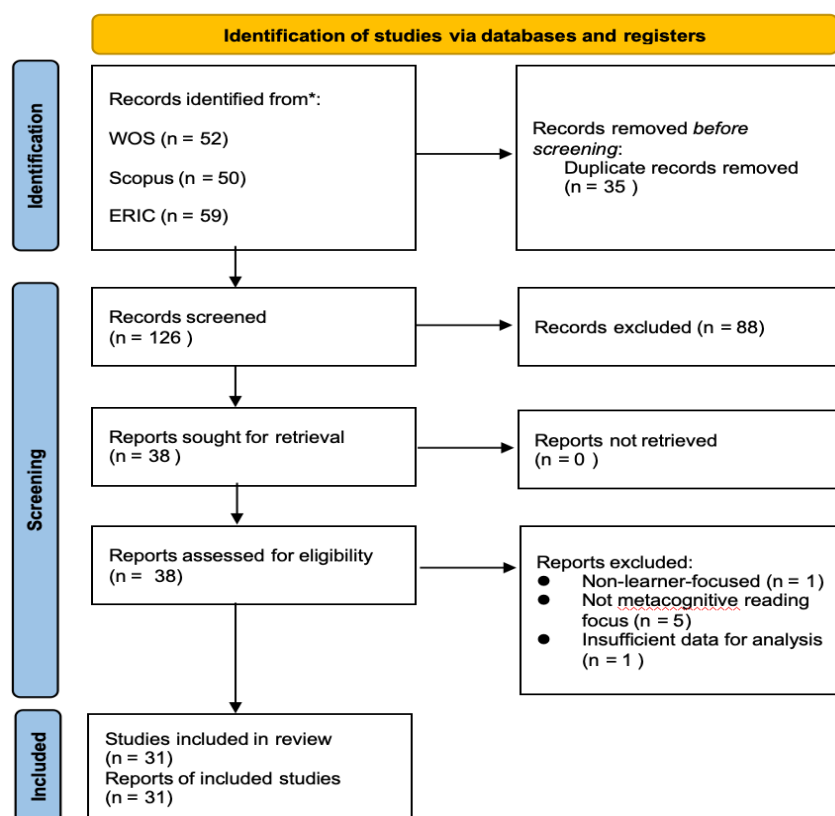


Figure 1. Article selection process for bibliometric mapping analysis and systematic review

The 38 full-text articles were then assessed for data completeness, methodological relevance, and conceptual alignment with the review focus. At this stage, seven articles were excluded: one did not focus on the target learner population, five did not treat online metacognitive reading strategies as a central construct, and one lacked sufficient empirical data for analysis. As this review included both intervention and non-intervention studies, studies were not excluded simply because they did not implement an instructional intervention. Instead, both studies examining learners' existing online metacognitive strategy awareness or use and studies examining online strategy instruction or scaffolding were retained if they met the inclusion criteria. In total, 31 empirical studies were included in the final synthesis, as shown in Figure 1.

2.3 Data Processing and Analysis

This study used an integrative synthesis approach to analyze quantitative, qualitative, and mixed-methods studies. Descriptive statistics were used to summarize publication characteristics, educational stages, geographical distribution, and research designs. Qualitative

content analysis was then used to synthesize findings related to online metacognitive strategy awareness and use, platform and tool design, instructional frameworks, intervention effects, and implementation challenges.

Before synthesis, the 31 included studies were coded according to study type. Intervention studies were defined as studies in which learners received explicit online metacognitive strategy instruction, digital scaffolding, platform-supported training, or tool-mediated reading support. Non-intervention studies were defined as descriptive, correlational, comparative, or validation studies that examined learners' online metacognitive strategy awareness, reported use, individual differences, or reading-related outcomes without implementing a structured instructional treatment. This distinction was used throughout the analysis. RQ1 and RQ2 drew on all included studies; RQ3 focused mainly on non-intervention studies; and RQ4 and RQ5 focused primarily on intervention and scaffolding studies.

3. Findings

3.1 Educational Stages and Countries Studied

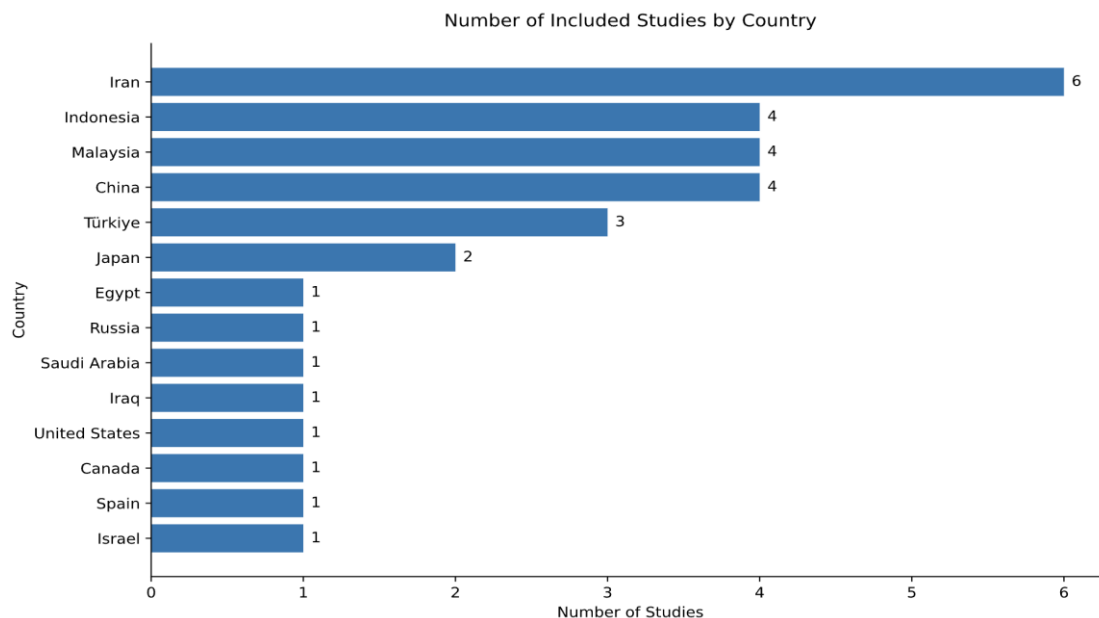


Figure 2. Distribution and number of studies by country

Figure 2 shows the distribution of the included studies by country. The 31 studies covered 14 countries. The largest number of studies was conducted in Iran ($N = 6$), followed by China, Indonesia, and Malaysia ($N = 4$ each), and Türkiye ($N = 3$). Japan accounted for two studies ($N = 2$), while Egypt, Russia, Saudi Arabia, Iraq, the United States, Canada, Spain, and Israel each accounted for one study ($N = 1$). Overall, the reviewed studies were concentrated in the Middle East/West Asia, Southeast Asia, and East Asia, whereas studies from Europe and North America were relatively limited. No included study was identified from Latin America, Oceania, or Sub-Saharan Africa.

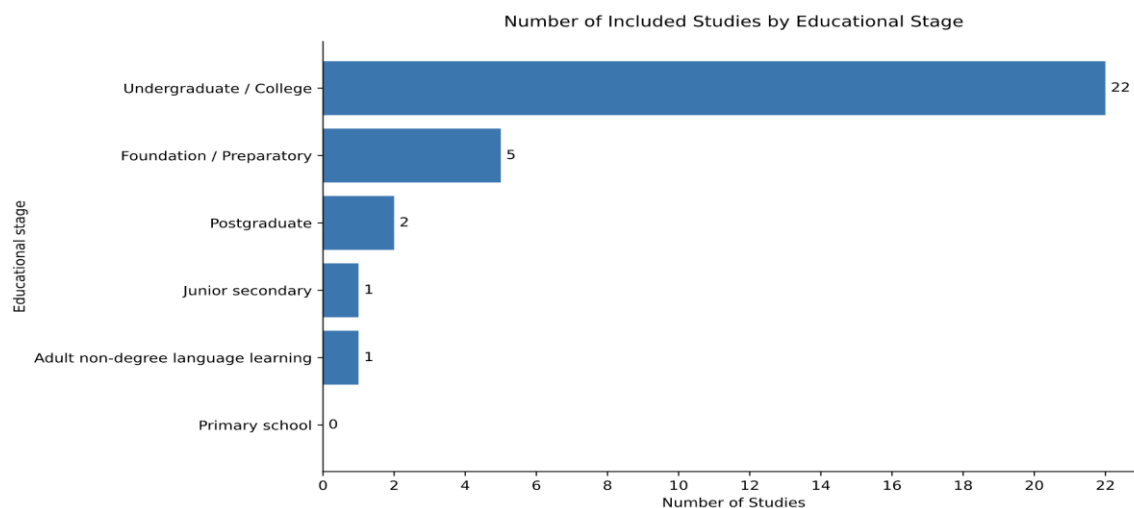


Figure 3. Distribution of studies by educational stages

Figure 3 shows the distribution of the included studies by educational stage. The reviewed literature was highly concentrated in higher education ($N = 29$). Within this group, undergraduate or college-level learners formed the largest category ($N = 22$), followed by foundation or preparatory students ($N = 5$) and postgraduate students ($N = 2$). In contrast, studies involving basic education learners were scarce. Only one study focused on junior secondary learners ($N = 1$), and one examined adult non-degree language learners ($N = 1$). No study in the review focused on primary school learners ($N = 0$). This distribution suggests that current research on online metacognitive strategies and scaffolding in EFL/ESL digital reading remains heavily oriented toward adult or higher education contexts, with limited attention to younger learners.

3.2 Study Design and Classification of Intervention and Non-intervention Studies

The summary of results presented in the Appendix (Table 1) shows that quantitative studies comprised the majority of the reviewed literature ($N=20$), including quasi-experimental designs, descriptive, correlational, comparative, and path analysis design. Mixed-methods studies were the second most common design ($N = 9$), while fully qualitative research were limited ($N = 2$). This distribution suggests that research on online metacognitive strategies in EFL/ESL digital reading has relied mainly on quantitative approaches, with relatively limited qualitative investigation of learners' real-time strategy regulation.

The included studies were further classified into intervention and non-intervention studies. Intervention studies refer to studies that implemented explicit online metacognitive strategy instruction, digital scaffolding, platform-supported training, or tool-mediated reading support. Non-intervention studies refer to descriptive, correlational, comparative, or validation studies that examined learners' existing strategy awareness, reported use, individual differences, or related reading variables without a structured instructional treatment. Based on this distinction, the review included 14 intervention studies and 17 non-intervention studies. The following synthesis therefore separates findings on existing strategy awareness and uses from findings on scaffolding design, intervention effects, and implementation challenges.

3.3 Online Metacognitive Strategy Awareness, Use, and Related Factors in Non-intervention Studies

3.3.1 Patterns of Online Metacognitive Strategy Use

This section focuses on non-intervention studies that examined learners' existing online metacognitive strategy awareness and reported strategy use. Across these studies, EFL/ESL learners were found to use global, problem-solving, and support strategies in digital reading environments. Problem-solving strategies, such as rereading, adjusting reading speed, and inferring meaning, were frequently reported (Ahmadian & Pasand, 2017; Mukhlif & Amir, 2017; Rianto, 2022). Support strategies, including note-taking, using reference tools, and consulting online resources, were also commonly identified (Mohd Ramli et al., 2011; Rianto, 2021b). However, higher-order metacognitive processes, particularly systematic planning before reading and evaluation after reading, appeared less consistently in the reviewed studies. This suggests that learners' reported strategy awareness may not necessarily translate into a complete planning-monitoring-evaluation cycle during online reading.

3.3.2 Learner and Contextual Factors

Non-intervention studies also indicate that online strategy use is associated with learner and contextual factors. Gender, academic major, language proficiency, self-efficacy, first-language background, and learning context may shape learners' reported strategy choices and online reading performance (Ahmadian & Pasand, 2017; Pradita, 2020; Rianto, 2021a, 2021b; Taki, 2016). For example, some studies reported gender or disciplinary differences in strategy use, while others identified relationships among online metacognitive strategy use, reading self-efficacy, reading-related dispositions, and online reading comprehension (Ahmadian & Pasand, 2017; Rianto, 2022; Yaghi, 2021). Comparisons between print and digital reading further suggest that strategy use may shift when learners move from linear printed texts to hypertext or web-based reading environments (Marandi & Mokhtarnia, 2008; Taki, 2016).

3.3.3 Limits of Self-reported Strategy Findings

However, these studies also reveal an important methodological limitation. Much of the research depends on self-reported strategy use, often through online reading strategy questionnaires or related measurement instruments (Hassaskhah & Gaskari, 2014). Although such instruments are useful for mapping perceived strategy use, they may not fully reflect actual online reading behavior. Learners may report frequent strategy use but still struggle to regulate attention, evaluate information, or monitor comprehension effectively during digital reading. Process-oriented studies have also indicated a possible gap between reported strategy awareness and actual online reading behavior (Azman et al., 2017; Gilbert, 2017). Therefore, non-intervention studies are useful for mapping strategy profiles and related factors, but they cannot by themselves establish the effects of online metacognitive strategy instruction.

3.4 Platforms, Tools and Instructional Frameworks in Intervention Studies

3.4.1 General-purpose Learning Platforms

In contrast to non-intervention studies, intervention studies examined how online metacognitive strategies were taught or scaffolded through digital platforms, tools, and instructional frameworks. One group of studies used general-purpose learning or communication platforms, including Moso Teach and WeChat (Peng et al., 2025), Microsoft Teams (Babashamasi et al., 2022), WhatsApp (Muhammadpour & Sabet, 2024), Moodle (Roy, 2014; Roy & Crabbe, 2015), and learning management systems (Mohd Ramli et al., 2011). These platforms supported task delivery, online discussion, peer interaction, teacher feedback, and mobile-assisted learning. However, their scaffolding value depended on how strategy prompts, reflection tasks, and instructional guidance were embedded into

reading activities.

3.4.2 Specialized Reading and Scaffolding Systems

Another group of studies used specialized or researcher-developed systems, such as Meta-S (Uğak & Kartal, 2023), Readvise (Akopyan & Saks, 2022), I-CARE (Al-Kalefawi & Al-Amrani, 2021), computerized RMSA systems (Reshadi-Gajan et al., 2020), and hypertext or hypermedia reading environments (Shang, 2016, 2018). Compared with general-purpose platforms, these systems offered more targeted metacognitive support by embedding functions such as annotations, glossaries, reading logs, reflection journals, self-assessment tools, forums, and process monitoring features. These functions were designed to make learners' planning, monitoring, and evaluation processes more visible during online reading.

3.4.3 Instructional and Theoretical Frameworks

The intervention studies were also guided by instructional and theoretical frameworks. Instructional models such as Reciprocal Teaching, CALLA, the Metacognitive Pedagogical Sequence, and the Structured Reading Experience were used to organize explicit strategy instruction, including prediction, questioning, clarification, monitoring, and evaluation (Babashamasi et al., 2022; Çolak & Razi, 2026; Peng et al., 2025; Reshadi-Gajan et al., 2020; Shang, 2018; Uğak & Kartal, 2023). Design-oriented frameworks, including Cognitive Load Theory, Multimedia Learning Theory, ADDIE, and social constructivist perspectives, were used to explain or support the design of digital scaffolds, multimodal materials, and collaborative online reading environments (Al-Kalefawi & Al-Amrani, 2021; Mekheimer, 2025; Mohd Ramli et al., 2011; Zhang, 2024). Overall, these studies suggest that online metacognitive scaffolding does not depend on technology alone; its effectiveness depends on the alignment among platform functions, reading tasks, strategy instruction, and learner support.

3.5 Effects of Online Metacognitive Strategy Scaffolding

3.5.1 Positive Effects on Reading and Self-regulation

This section draws only on intervention studies because claims about effectiveness require an instructional treatment or scaffold. Overall, the reviewed intervention studies suggest that online metacognitive scaffolding can support EFL/ESL digital reading, although the effects are not uniform. Several studies reported gains in reading comprehension when learners received explicit strategy instruction or used scaffolded digital tools, such as digital mind maps, highlighting and annotation, MALL-based instruction, Microsoft Teams-based training, computerized RMSA systems, and electronic-text strategy training (Babashamasi et al., 2022; Mekheimer, 2025; Peng et al., 2025; Reshadi-Gajan et al., 2020; Zenotz, 2012; Zhang, 2024). Beyond reading performance, these interventions also supported metacognitive awareness, strategy use, self-regulated reading, autonomy, motivation, or confidence by helping learners organize information, monitor comprehension, and apply strategies such as questioning, inferencing, and synthesizing.

3.5.2 Limited or Non-significant Effects

Nevertheless, the effects of online metacognitive scaffolding were not consistent across studies. Some interventions improved learners' motivation or process awareness but did not produce clear gains in reading comprehension or metacognitive awareness (Kramarski & Feldman, 2000; Uğak & Kartal, 2023). Other findings showed that online reading tasks alone were insufficient to improve reading performance without explicit and sustained strategy integration (Altay & Altay, 2017). In hypertext reading, only certain strategies or scaffolded conditions appeared to be associated with comprehension outcomes (Shang, 2016, 2018). These findings suggest that digital platforms do not automatically enhance reading outcomes; rather, the effectiveness of online metacognitive scaffolding depends on explicit instruction, task relevance, intervention duration, platform usability, and learners' readiness for self-regulated reading.

3.6 Implementation Challenges in Online Metacognitive Strategy Scaffolding

3.6.1 Technical, Platform, and Digital Literacy Constraints

The implementation of online metacognitive scaffolding may be constrained by technical, platform-related, and digital literacy issues. Network instability, delayed feedback, unfamiliar interfaces, and limited digital literacy among learners can interrupt online reading instruction and reduce the effective use of scaffolding tools (Çolak & Razi, 2026; Mohd Ramli et al., 2011; Uğak & Kartal, 2023). Hyperlinks, multiple windows, and multimodal materials may also increase navigation demands or distract learners from comprehension, particularly when they need to evaluate online information while processing the main text (Gilbert, 2017; Kramarski & Feldman, 2000). These findings suggest that technical accessibility and platform usability are necessary conditions for effective online metacognitive scaffolding.

3.6.2 Linguistic Difficulty and Cognitive Load

Linguistic difficulty and cognitive load may also limit the effectiveness of online metacognitive scaffolding. Vocabulary limitations, complex texts, and unfamiliar disciplinary content can place considerable pressure on basic decoding and comprehension processes (Babashamasi et al., 2022; Eghlidi et al., 2014; Muhammadpour & Sabet, 2024). In digital reading environments, fragmented information, multimedia elements, hyperlinks, and platform instructions may further increase cognitive load if scaffolds are not carefully designed (Mekheimer, 2025; Zhang, 2024). Therefore, online scaffolding should provide strategic support without adding unnecessary processing demands.

3.6.3 Limited Metacognitive Readiness and Strategy Transfer

Limited metacognitive readiness may further constrain the implementation of online scaffolding. Many learners are accustomed to teacher-led or print-based reading and may not automatically transfer planning, monitoring, and evaluating strategies to digital reading environments (Al-Kalefawi & Al-Amrani, 2021; Babashamasi et al., 2022; Peng et al., 2025). In addition, a gap may exist between reported strategy awareness and actual online reading behavior (Azman et al., 2017). This suggests that online metacognitive scaffolds need to be supported by explicit modeling, repeated guided practice, and reflection before they can be internalized as independent reading strategies.

3.6.4 Motivation, Engagement, Self-regulation, and Learner Differences

Motivation, engagement, self-regulation, and learner differences also shape the implementation of online metacognitive scaffolding. In independent online reading, learners may lose engagement if they lack clear guidance, time-management skills, or proactive help-seeking strategies (Akopyan & Saks, 2022; Uğak & Kartal, 2023). Learner-related factors, including language proficiency, disciplinary background, gender, self-efficacy, and cultural context, may further influence strategy use and responses to online scaffolding (Ahmadian & Pasand, 2017; Pradita, 2020; Rianto, 2021a, 2021b; Taki, 2016). These findings suggest that online metacognitive scaffolding should be adapted to language level, digital literacy, prior strategy knowledge, and instructional context.

4. Discussion

4.1 Research Base and Contextual Imbalance in Online Metacognitive Strategy Research

The findings indicate that research on online metacognitive strategies in EFL/ESL digital reading has developed a recognizable research base, but it remains unevenly distributed across educational stages and geographical contexts. Most studies were conducted with university, college preparatory, graduate, or adult learners (Eghlidi et al., 2014; Taki, 2016; Ahmadian & Pasand, 2017; Pradita, 2020; Rianto, 2021a, 2021b, 2021c; Uğak & Kartal, 2023; Çolak & Razi, 2026). This concentration is important because findings based mainly on older learners may not fully represent younger learners, who may have different levels of linguistic proficiency, digital familiarity, and self-regulated learning capacity.

The limited representation of K-12 learners creates a significant gap in the field. Apart from studies involving junior secondary learners or adult basic ESL learners (Kramarski & Feldman, 2000; Gilbert, 2017), little systematic research has examined how younger EFL/ESL learners develop, transfer, and sustain metacognitive strategies in digital reading environments. This gap is not only a matter of sample distribution. It also affects the applicability of existing scaffolding models, many of which assume that learners can independently follow prompts, monitor comprehension, evaluate online information, and manage digital tools. Such assumptions may not be appropriate for younger or less autonomous learners.

The geographical distribution of the reviewed studies also limits the generalizability of the findings. Research has been concentrated in Asian and Middle Eastern contexts, including Iran, Indonesia, Malaysia, China, and Turkey, whereas studies from other regional contexts remain limited. This pattern suggests that current findings are shaped by specific institutional, linguistic, and cultural conditions. Therefore, future research should not simply replicate existing intervention models across new contexts, but should examine how educational stage, digital infrastructure, language proficiency, and classroom culture influence learners' need for metacognitive support.

4.2 Study Designs and the Intervention/Non-intervention Boundary

A central issue emerging from this review is the need to distinguish more clearly between studies of online metacognitive strategy use and studies of online metacognitive strategy scaffolding. Non-intervention studies provide useful findings on learners' reported strategy awareness, strategy preferences, individual differences, and contextual influences (Ahmadian & Pasand, 2017; Pradita, 2020; Rianto, 2021a, 2021b, 2022; Taki, 2016). However, these studies cannot demonstrate whether strategy instruction or digital scaffolding improves reading outcomes. Intervention studies, by contrast, can examine effects, but their findings are shaped by intervention design, duration, platform, instructional procedures, and outcome measures (Babashamasi et al., 2022; Peng et al., 2025; Uğak & Kartal, 2023; Zhang, 2024).

This boundary is important for interpreting the field. If descriptive findings on strategy use and findings on intervention effects are treated as the same type of research, the review risks overstating what online metacognitive strategies can achieve. For example, a high level of reported strategy use does not necessarily mean that learners can regulate comprehension effectively during real-time digital reading. Process-oriented studies suggest that learners' reported strategy awareness may differ from their actual online reading behavior (Azman et al., 2017; Gilbert, 2017). Therefore, questionnaires such as OSORS or MARSİ are useful for mapping perceived strategy use, but they should be complemented by system logs, think-aloud protocols, screen recordings, eye-tracking, or multimodal learning analytics to capture the dynamic regulation of online reading.

The methodological pattern also shows that the field remains dominated by quantitative and short-term designs. Although quasi-experimental and survey-based studies provide useful findings, they offer limited insight into how learners internalize strategies over time. Future research should therefore move beyond immediate pre-test/post-test comparisons and examine strategy development, scaffold fading, and delayed transfer to determine whether online metacognitive scaffolding produces temporary task gains or more durable self-regulated reading competence.

4.3 Scaffolding Design: From Technology Use to Strategy-task Alignment

The reviewed intervention studies show that online metacognitive scaffolding is not defined by technology use alone. General-purpose platforms, such as Moso Teach, WeChat, Microsoft Teams, WhatsApp, Moodle, and learning management systems, can support task distribution, communication, feedback, and collaboration (Mohd Ramli et al., 2011; Roy, 2014; Babashamasi et al., 2022; Muhammadpour & Sabet, 2024; Peng et al., 2025). However, these platforms do not automatically create metacognitive scaffolding. Their pedagogical value depends on how strategy prompts, reflection tasks, peer interaction, and feedback are embedded into reading activities.

Specialized systems, such as Meta-S, Readvise, I-CARE, computerized RMSA systems, and hypertext or hypermedia environments, provide more targeted support for planning, monitoring, and evaluation through annotations, glossaries, reading logs, reflection journals, self-assessment tools, and process monitoring features (Al-Kalefawi & Al-Amrani, 2021; Akopyan & Saks, 2022; Reshadi-Gajan et al., 2020; Shang, 2016, 2018; Uğak & Kartal, 2023). Nevertheless, these tools also require careful instructional integration. They can support metacognitive regulation only when learners understand when, why, and how to use them during reading.

The theoretical frameworks used in the reviewed studies reinforce this point. Reciprocal Teaching, CALLA, the Metacognitive Pedagogical Sequence, and the Structured Reading Experience provide procedures for explicit strategy instruction, while Cognitive Load Theory and Multimedia Learning Theory help explain how digital scaffolds can be designed to reduce unnecessary processing demands (Babashamasi et al., 2022; Mekheimer, 2025; Peng et al., 2025; Reshadi-Gajan et al., 2020; Uğak & Kartal, 2023; Zhang, 2024). Therefore, future research should move beyond asking whether a particular platform or tool is effective and examine how platform affordances, reading tasks, strategy instruction, and learner readiness interact. In this sense, the central design issue is not technology adoption itself, but the alignment between strategies, tasks, tools, and learners' needs.

4.4 Effects and Conditions of Online Metacognitive Strategy Scaffolding

The intervention findings suggest that online metacognitive scaffolding can support EFL/ESL digital reading, but its effects are conditional rather than automatic. Positive outcomes were reported in studies using digital mind maps, highlighting and annotation, MALL-based explicit strategy instruction, Microsoft Teams-based metacognitive training, computerized RMSA systems, and electronic-text strategy training (Babashamasi et al., 2022; Mekheimer, 2025; Peng et al., 2025; Reshadi-Gajan et al., 2020; Zenotz, 2012; Zhang, 2024). These interventions supported reading comprehension, metacognitive awareness, strategy use, and self-regulated reading by helping learners organize information, monitor comprehension, and apply strategies such as questioning, inferencing, and synthesizing.

However, not all intervention studies reported consistent benefits. Some interventions improved motivation or process awareness without producing clear gains in comprehension or metacognitive awareness (Kramarski & Feldman, 2000; Uğak & Kartal, 2023). Other studies found that online reading tasks alone were insufficient to improve reading performance (Altay & Altay, 2017), while hypertext research suggested that only certain strategies or scaffolded conditions were associated with comprehension outcomes (Shang, 2016, 2018). These findings challenge the assumption that digital environments are inherently beneficial for reading development.

These mixed findings suggest that online metacognitive scaffolding is more likely to be effective when it is explicit, sustained, task-relevant, and cognitively manageable. Digital tools can support strategy use, but they may also increase cognitive load if learners must process language, navigate interfaces, evaluate hyperlinks, and manage multiple forms of input at the same time. Therefore, intervention outcomes depend on instructional design, scaffold-task alignment, guided practice, platform usability, and learners' prior strategy knowledge. Future studies should report these design conditions more systematically so that intervention effects can be compared across contexts.

4.5 Implementation Challenges and Future Directions

The implementation challenges identified in this review suggest that online metacognitive scaffolding cannot be treated as a simple technological solution. Rather, its effectiveness depends on the interaction among technological conditions, text complexity, learner readiness, and instructional support. Technical instability, unfamiliar interfaces, fragmented digital information, and linguistic difficulty may reduce the usefulness of scaffolding tools if learners are not given clear guidance and manageable tasks (Babashamasi et al., 2022; Gilbert, 2017; Mekheimer, 2025; Uğak & Kartal, 2023; Zhang, 2024). Similarly, learners who are accustomed to teacher-led or print-based reading may not automatically transfer planning, monitoring, and evaluating strategies to online reading environments without explicit modeling and repeated practice (Al-Kalefawi & Al-Amrani, 2021; Babashamasi et al., 2022; Peng et al., 2025).

Future online metacognitive scaffolding should therefore move beyond adding digital tools to reading tasks. Strategy instruction should be embedded in meaningful reading activities, while platform design should keep prompts, annotations, logs, and feedback simple and task-relevant. Future research should also examine long-term strategy internalization, scaffold fading, and transfer across different text types and learning contexts. These directions can help explain the conditions under which online metacognitive scaffolding becomes sustainable support for EFL/ESL digital reading.

5. Limitations and Future Prospects

This review synthesized current research on online metacognitive strategies and scaffolding in EFL/ESL digital reading. Since the reviewed studies remain concentrated in higher education and selected regional contexts, future research should examine this topic across broader educational levels and cultural settings, particularly among K-12 learners. In addition, many non-intervention studies rely on self-report instruments, which may not fully capture actual online reading behavior (Azman et al., 2017; Gilbert, 2017). Future studies

could use process-based methods such as think-aloud protocols, system logs, or learning analytics. More longitudinal intervention studies are also needed to examine strategy internalization and transfer, especially because existing studies have reported both positive effects (Babashamasi et al., 2022; Peng et al., 2025; Mekheimer, 2025; Zhang, 2024) and limited or non-significant effects (Altay & Altay, 2017; Kramarski & Feldman, 2000; Uğak & Kartal, 2023). Finally, future work should further examine how digital text types, task demands, platform affordances, and learner characteristics interact in shaping strategy use and reading outcomes.

6. Conclusion

With the growing role of digital reading in EFL/ESL instruction, online metacognitive strategies and scaffolding have become increasingly important. This systematic review synthesized 31 empirical studies and found that current research is concentrated mainly in higher education and Asian contexts, with limited attention to K-12 learners and wider regional settings. The reviewed studies were largely quantitative, often relying on self-report measures and short-term interventions. Non-intervention studies have examined learners' strategy awareness, use, and related factors, while intervention studies suggest that explicit instruction, platform-supported scaffolds, annotations, journals, and feedback can support reading comprehension, metacognitive awareness, and self-regulation. However, these effects depend on platform design, task demands, cognitive load, learner readiness, and instructional support. Future research should further examine younger learners, longitudinal strategy development, and the alignment among digital texts, platforms, scaffolds, and instructional contexts.

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Author contributions

Ronghua Wei was responsible for data collection and drafting the initial manuscript. Dr. Azlina Abdul Aziz and Dr. Nur Ainil Binti Sulaiman were responsible for the study design and supervisions. All authors read and approved the final manuscript.

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Appendix

Table 1. Research methods, tools/platform/framework, and findings of online metacognitive strategy for ESL/EFL

Author	Aim	Method/Design	Tool / Platform / Framework	Main findings
Çolak and Razi (2026)	To examine peer coaching-supported strategy-based EFL reading instruction.	Mixed-methods (qualitative dominant case study)	Online breakout rooms/shared documents; peer coaching and reciprocal reading	Online instruction improved reading comprehension in the short term, but gains attenuated over time.
Peng et al. (2025)	To examine the effects of MALL-delivered explicit metacognitive intervention on Chinese EFL students' listening, reading, and metacognitive awareness.	Quantitative (quasi-experimental; pretest-posttest control-group design)	Moso Teach and WeChat; MALL-delivered explicit metacognitive intervention; Metacognitive Pedagogical Sequence (planning-monitoring-evaluation).	The intervention improved listening, reading, and metacognitive awareness, with stronger effects on reading.
Mekheimer (2025)	To investigate the impact of digital mind magnets on EFL students' online narrative reading	Mixed-methods (quasi-experimental; non-equivalent control-group pretest-posttest design)	Google Slides-based digital mind magnet; metacognitive scaffolding; Cognitive Load Theory.	Digital mind magnets significantly improved online reading comprehension and promoted deeper

	comprehension.			analytical and metacognitive processing.
Zhang (2024)	To investigate the effects of highlights and annotations on EFL learners' reading comprehension within the CAIR model.	Mixed-methods (randomized experimental; four-group pretest-posttest design).	Adobe Acrobat Reader; highlights and annotations; CAIR model; Cognitive Load Theory and Multimedia Learning Theory.	Highlights and annotations improved reading comprehension, with the combined condition producing the strongest gains.
Muhammadpour and Sabet (2024)	To examine the impact of an online hybrid reading intervention on ESP students' reading comprehension and strategy use.	Quantitative (experimental; pretest-posttest control-group design)	WhatsApp-based online hybrid reading intervention; cognitive and metacognitive reading strategy instruction.	The intervention significantly improved reading comprehension and strategy use, especially inferring, synthesizing, and questioning.
Uğak and Kartal (2023)	To examine the effects of online strategy training on EFL students' reading comprehension, metacognitive awareness, and engagement.	Quantitative (quasi-experimental; pretest-posttest control-group design).	Meta-S online scaffolding tool; reciprocal teaching; scaffolding design guidelines; multimedia design principles.	Both experimental groups improved reading comprehension and metacognitive awareness; the in-class group also showed significant engagement gains.
Rianto (2022)	To explore the relationship between metacognitive online reading strategy use and online reading comprehension among Indonesian EFL university students across different majors.	Quantitative (survey and correlational design).	Blended learning context; metacognitive awareness theory.	Metacognitive online reading strategy use was generally high across majors, but significant correlation and predictive effects were found only among language-major students.
Babashamasi et al. (2022)	To investigate the effect of explicit online metacognitive strategy training on undergraduate EFL students' reading comprehension.	Mixed-methods (quasi-experimental; nonrandomized pretest-posttest control-group design).	Microsoft Teams; CALLA; explicit metacognitive strategy instruction.	Explicit metacognitive strategy training significantly improved online reading comprehension and increased metacognitive awareness.
Akopyan and Saks (2022)	To examine whether the web-based Readvise platform can improve tertiary students' L2 reading skills and support the development of self-regulated reading skills.	Mixed-methods (design-based research; pretest-posttest single-group intervention).	Readvise web-based reading platform; self-regulated reading.	Readvise improved L2 reading skills and encouraged changes in reading behaviour, metacognitive engagement, and intrinsic reading motivation, with potential to enhance self-regulated reading over time.
Yaghi (2021)	To examine the impact of metacognitive online reading strategies on Saudi EFL learners' online reading dispositions.	Mixed-methods (questionnaire survey with semi-structured interviews).	Online reading environment; metacognitive online reading strategies and online reading dispositions.	Metacognitive online reading strategies positively influenced online reading dispositions; support strategies were most frequently used, and reflection was the most frequently reported disposition.
Rianto (2021a)	To investigate Indonesian EFL	Quantitative (descriptive survey;	Online reading environment; online language learning strategies/new	Support strategies were most frequently

	university students' metacognitive online reading strategies before and during the Covid-19 pandemic.	comparative design).	literacies framework.	used before and during the pandemic, and overall strategy use increased significantly during the pandemic.
Rianto (2021b)	To examine gender differences in metacognitive online reading strategies, online reading ability, and English proficiency among Indonesian EFL university students.	Quantitative (survey and correlational design).	Blended learning and online reading context; metacognitive online reading strategies.	Female students reported higher overall, problem-solving, and support strategy use, but no gender differences were found in online reading ability or English proficiency.
Al-Kalefawi and Al-Amrani (2021)	To investigate the effectiveness of the I-CARE program in improving Arab EFL students' reading strategies.	Qualitative (case study).	I-CARE web-based CALL program; ADDIE instructional design model; behaviorist, cognitive, constructivist, and multimedia theories.	I-CARE enhanced students' use of reading strategies and supported more autonomous reading, with cognitive strategies reported more frequently than metacognitive and social-affective strategies.
Reshadi-Gajan et al. (2020)	To investigate reading metacognitive strategy awareness and use through three inventory techniques and examine the effect of a computerized RMSA system on reading comprehension.	Mixed-methods (pretest-posttest single-group intervention).	Computerized RMSA System; reciprocal teaching; semi-direct metacognitive strategy training.	The three inventory techniques produced significantly different results, and the computerized RMSA system significantly improved reading comprehension.
Pradita (2020)	To investigate whether gender influences EFL college students' selection of metacognitive online reading strategies and the extent of its contribution.	Quantitative (descriptive survey; comparative design).	Online reading context; metacognitive online reading strategies.	Gender significantly influenced strategy selection, with female students reporting higher overall use, especially in support strategies.
Shang (2018)	To investigate EFL medical students' metacognitive strategy use in printed-text and hypertext reading, and the impact of hypertext on reading comprehension.	Mixed-methods (comparative intervention study).	Researcher-developed hypertext system; Scaffolded Reading Experience (SRE).	Problem-solving strategies were most frequently used in both settings, and hypertext reading significantly improved comprehension.
Mukhlif and Amir (2017)	To investigate Iraqi EFL undergraduates' metacognitive online reading strategies and the difficulties they face when reading online academic texts.	Quantitative (questionnaire survey).	Online academic reading context; SORS/metacognitive online reading strategies.	Problem-solving strategies were used most frequently, followed by support and global strategies.
Gilbert (2017)	To explore ESL students' online reading strategies and perceptions of digital reading.	Qualitative (interpretive study).	Web-based reading environment; digital literacy; metacognitive online reading strategies.	Students used different strategies for web and print reading, drew on more strategies online, and showed a need for digital literacy instruction.
Azman et al.	To explore EFL	Mixed-methods	iELLS hypermedia reading platform;	Online hypermedia

(2017)	postgraduate students' online reading processes, including their sensory pathways, metacognitive strategies, and use of hypermedia tools in hypertext reading.	(exploratory case study).	new literacy theory, cognitive theory of multimedia learning, and interactive reading theory.	reading altered students' preferred sensory pathways and metacognitive strategy use, with hypermedia tools significantly shaping strategy choice and supporting comprehension.
Altay & Altay (2017)	To investigate the impact of online reading tasks and metacognitive reading strategies on EFL learners' reading test scores.	Quantitative (quasi-experimental; pretest-posttest control-group design).	E-mail-delivered online reading tasks; metacognitive reading strategies (MARSI).	Online reading tasks did not significantly improve reading test scores, and metacognitive reading strategies showed no significant effect on reading performance.
Ahmadian and Pasand (2017)	To investigate EFL learners' online metacognitive reading strategies and their relationship with reading self-efficacy, with attention to gender differences.	Mixed-methods (questionnaire survey and correlational design).	Online reading context; metacognitive online reading strategies; reading self-efficacy.	Problem-solving strategies were used most frequently, and online metacognitive strategy use was positively related to reading self-efficacy; females reported higher global strategy use, whereas males reported higher reading self-efficacy.
Taki (2016)	To explore whether readers from different L1 backgrounds use similar metacognitive online reading strategies and whether L1 strategy use influences L2 online reading.	Quantitative (comparative survey and correlational design).	Weblog-based online reading tasks; new literacies; metacognitive online reading strategies.	Canadian English L1 readers reported higher, more top-down strategy use, whereas Iranian readers in both L1 and L2 showed medium-level, more bottom-up strategy use; strategy awareness was positively related to reading performance.
Shang (2016)	To examine the effects of online metacognitive strategies, hypermedia annotations, and motivation on EFL learners' hypertext comprehension.	Quantitative (survey and path analysis design).	Researcher-developed hypertext system with word glossaries, sentence translations, and background information; online metacognitive strategies and motivation model.	Online metacognitive strategies significantly predicted motivation, and motivation directly affected hypertext comprehension; strategies and annotations showed no direct effect on comprehension
Roy and Crabbe (2015)	To explore EFL learners' ability to analyze an English-language website, comprehend its content, and report usability perceptions and reading strategy awareness.	Mixed-methods (three-week classroom-based case study).	Belize tourism website; website analysis; digital literacy and CALL.	Students showed generally good website information comprehension, varied usability perceptions, and greater use of problem-solving strategies than global or support strategies.
Roy (2014)	To explore how website analysis and design pedagogy could support analytical thinking and English language	Mixed-methods (classroom-based website analysis experiment).	Moodle-based website analysis tasks; website analysis and design pedagogy; CALL and metacognitive reading strategies.	Students showed reasonable ability to analyze English websites, but no significant practice

	production in an EFL context.			effect was found over time; metacognitive strategy use was significantly correlated with analysis accuracy.
Hassaskhah and Gaskari (2014)	To develop and validate an Online Reading Strategy Inventory (ORSI) for Iranian EFL college readers and explore their online reading strategy use.	Quantitative (instrument development and validation study; questionnaire survey with exploratory factor analysis).	Online Reading Strategy Inventory (ORSI); activity theory.	ORSI showed a three-factor structure including general reading, online-specific reading, and metacognitive strategies, demonstrating a significant correlation with online reading comprehension.
Eghlidi et al. (2014)	To investigate the type and frequency of metacognitive online reading strategies used by Iranian EFL graduate students, compare proficient and less proficient readers, and identify their online reading difficulties.	Mixed-methods (questionnaire survey, proficiency test, and think-aloud comparison study).	Online academic reading context; OSORS/metacognitive online reading strategies.	Global strategies were used most frequently; proficient and less proficient readers differed significantly in 18 strategies, and vocabulary was the main reported difficulty.
Zenotz (2012)	To examine whether metacognitive strategy training can improve EFL learners' online reading and raise awareness for online reading.	Mixed-methods (quasi-experimental; pretest-posttest control-group design).	Authentic electronic texts and online reading tasks; metacognitive strategy training; Winograd and Hare's strategy instruction model.	Metacognitive strategy training improved online reading comprehension, but did not increase the number of strategies used.
Ramli et al. (2011)	To investigate the metacognitive online reading strategies used by adult ESL learners in an LMS environment.	Quantitative (questionnaire survey; comparative design).	i-Class LMS; metacognitive online reading strategies; socio-constructivist perspective.	Learners mainly used global strategies, followed by problem-solving and support strategies, with no significant differences between semester 1 and semester 2 learners.
Marandi and Mokhtarnia (2008)	To compare Iranian EFL learners' metacognitive awareness of reading strategies in hypertext and printed environments.	Quantitative (comparative questionnaire survey; within-subject design).	Hypertext and printed reading environments; metacognitive reading strategies (global, problem-solving, and support).	Printed-text reading showed higher overall strategy awareness than hypertext reading; significant differences were found in overall, problem-solving, and support strategies, but not in global strategies.
Kramarski and Feldman (2000)	To examine the effects of internet-based metacognitive instruction on EFL students' reading comprehension, motivation, and metacognitive awareness.	Mixed-methods (pretest-posttest control-group design).	Internet classroom/hypertext reading; metacognitive instruction based on Polya's four-stage strategy.	The internet group showed higher motivation, but no advantage in reading comprehension or metacognitive awareness.