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Metacognitive Strategy Instruction in L2 Reading: A Systematic Review of Research Trends (2015–2024)

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Abstract:

This systematic review examined studies on Metacognitive Strategy Instruction (MSI) in Second Language (L2) reading conducted between 2015 and 2024. The study aimed to identify key theoretical and pedagogical frameworks associated with MSI and to evaluate how these frameworks enhance learners' abilities to plan, monitor, and evaluate their comprehension. Adhering to the PRISMA 2020 guidelines, forty-two intervention studies conducted in English as Foreign Language (EFL) contexts were systematically analysed. The findings revealed a notable transition from conventional, teacher-cantered approaches to hybrid instructional models that integrate explicit teaching with learner autonomy, facilitated by digital tools. This hybrid approach was found to be the most effective for promoting the transfer and long-term retention of metacognitive skills. However, research involving learners from non-Latin language backgrounds, such as Arabic and Mandarin, remains limited. The results also highlighted the significant role of executive functions, particularly working memory and cognitive load, in determining the success of MSI. In conclusion, the review recommends that culturally responsive, technology-enhanced, and cognitively informed pedagogical frameworks be integrated into teacher training programs to promote reflective practice, learner autonomy, and self-regulation in L2 reading classrooms.

Keywords: Metacognitive strategies, Second language reading, Reading awareness, Executive functions.

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تعليم استراتيجيات ما وراء المعرفة في القراءة باللغة الثانية: مراجعة منهجية للاتجاهات البحثية (2015-2024)

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ملخص:

تتناول هذه المراجعة المنهجية الدراسات التي بحثت في تعليم استراتيجيات ما وراء المعرفة (MSI) في قراءة اللغة الثانية(L2)، خلال المدة الممتدة بين عامي 2015و2024. وتهدف إلى تحديد الأطر النظرية والتربوية الرئيسة المرتبطة بتعليم استراتيجيات ما وراء المعرفة، وتقييم مدى فاعلية هذه الأطر في تعزيز قدرات المتعلمين على التخطيط والمراقبة وتقييم فهمهم للنصوص المقروءة. ووفقًا لمبادئ إرشادات PRISMA 2020، تم تحليل اثنتين وأربعين دراسة تدخّلية نُفِّذت في سياقات تعليم اللغة الإنجليزية بوصفها لغة أجنبية (EFL) بطريقة منهجية دقيقة. وقد كشفت النتائج عن تحول ملحوظ من الأساليب التقليدية المعتمدة على المعلّم إلى نماذج تعليمية هجينة تجمع بين التعليم الصريح واستقلالية المتعلم المدعومة بالأدوات الرقمية. وقد تبيّن أن هذا النموذج الهجين هو الأكثر فاعلية في نقل المهارات الماورائية والحفاظ عليها على المدى الطويل. ومع ذلك، لوحظ نقص في الدراسات التي تناولت المتعلمين من خلفيات لغوية غير لاتينية، مثل الناطقين بالعربية أو الصينية (الماندرين). كما أبرزت النتائج الدور المحوري للوظائف التنفيذية -ولا سيما الذاكرة العاملة والعبء المعرفي- في تحديد مدى نجاح تعليم استراتيجيات ما وراء المعرفة.

الكلمات المفتاحية: استراتيجيات ما وراء المعرفة، القراءة باللغة الثانية، الوعي بالقراءة، الوظائف التنفيذية.

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© نُشر هذا البحث وفقًا لشروط الرخصة Attribution 4.0 International (CC BY 4.0)، التي تسمح بنسخ البحث وتوزيعه ونقله بأي شكل من الأشكال، كما تسمح بتكييف البحث أو تحويله أو الإضافة إليه لأي غرض كان، بما في ذلك الأغراض التجارية، شريطة نسبة العمل إلى صاحبه مع بيان أي تعديلات أُجريت عليه.

1. Introduction:

Second language (L2) reading is a complex cognitive ability involving the coordination of decoding (low-level processing) and comprehension processes (high-order skills like inference making and text-integration process), leading to coherent understanding. L2 learners certainly have difficulty not only because of their limited vocabulary, it is also due to the lack of metacognitive regulation—— awareness of planning reading goals, comprehension monitoring and the evaluative learning result (Flavell 1979). Although the significance of metacognitive awareness in second language (L2) reading is widely recognized, previous research has often been disjointed and narrow in focus. Many studies tend to concentrate on specific strategies or particular cultural settings, which creates ambiguity regarding the effectiveness of metacognitive instruction across various first language (L1) backgrounds. Furthermore, there have been few comprehensive reviews that integrate findings from the last ten years, especially following the digital shift in education and the rise of online learning frameworks. This absence of a thorough, cross-cultural synthesis highlights a notable deficiency in the existing literature. It is essential to address this shortfall since comprehending how Metacognitive Strategy Instruction (MSI) improves reading comprehension in multilingual environments can enhance teacher training programs, digital teaching methods, and the creation of culturally sensitive curricula. Therefore, this study aims to conduct a systematic review to gather empirical evidence and clarify the changing role of MSI in L2 reading from 2015 to 2024.

Metacognition is composed of three cognitive control components: Metacognitive control generally includes three recursively phased stages——pre-reading planning, during-reading monitoring and post-reading evaluation——all of which direct how learners control comprehension. Instruction that is effective in these processes, referred to as Metacognitive Strategy Instruction (MSI), plays a crucial role in L2 pedagogy (Anderson, 2017). Studies have found that students who internalize MSI display higher levels of reading comprehension, greater independence and more task transfer (Chamot, 2018; Zimmerman, 2013).

1.1 Aims and Scope for Review

In this review we explore how the field of MSI has unfolded in the decade 2015–2024, digital transformation of education and post-pandemic online teaching advances in cognitive neuroscience. Earlier systematic reviews largely concentrated on studies published before 2015 and rarely examined cross-cultural first language (L1) influences, where "L1" refers to the learners' native or primary language, which shapes their cognitive and linguistic processing in L2 reading context

1.2 Research Questions

To address the identified research gaps, this review synthesizes intervention studies conducted between 2015 and 2024 and seeks to answer the following questions:

(1) What are the dominant theoretical and pedagogical approaches to Metacognitive Strategy Instruction (MSI) in L2 reading?

(2) What pedagogical and methodological limitations have hindered the transfer of metacognitive strategies among learners of different linguistic backgrounds, particularly those whose first languages (L1s) are non-Latin based?

2. Literature Review

Earlier syntheses of Metacognitive Strategy Instruction (MSI) in second language reading primarily emphasized explicit, teacher-centred instruction and omitted digital or cross-cultural perspectives (Anderson, 2010; Phakiti, 2012; Hudson, 2016). However, since 2015, educational technologies and cognitive-neuroscientific research have reshaped MSI, encouraging hybrid and culturally adaptive models. This section reviews empirical and theoretical developments from 2015 to 2024 and identifies the gaps that motivated the present review.

2.1 Historical Changes in MSI in L2 Reading

MSI originates from Flavell's (1979) metacognitive framework and was later advanced by Anderson (2017). Early studies treated planning, monitoring, and evaluation as isolated skills, often overlooking learner proficiency and task type. After 2015, research increasingly adopted hybrid, context-based models that employ authentic materials and digital scaffolds to support differentiated learning (Zhang & Wang, 2020; Fu & Lee, 2024).

2.2 Explicit vs. Implicit Instruction

Explicit MSI relies on direct modeling and think-aloud techniques (Chamot, 2018), whereas implicit MSI embeds strategies within reading activities, allowing learners to infer and internalize them autonomously. Comparative analyses demonstrate that hybrid models—blending explicit guidance with learner autonomy—yield the most durable comprehension gains. (Descriptive study characteristics formerly presented here are now reported in Section 3.2.)

2.3 Technology-Enhanced MSI

Digital scaffolds such as reading logs, interactive prompts, and computer-assisted-language-learning (CALL) platforms support real-time monitoring of comprehension (Kim, 2024; Pang & Plass, 2021). Although technological integration increases precision, accessibility and digital literacy remain under-examined, and most reported effects are short-term.

2.4 Cross-Cultural Adaptation and L1 Effects

The majority of MSI research involves learners from Latin-alphabet backgrounds. Arabic and Mandarin readers, however, face distinct orthographic and cognitive demands (Al-Ahmadi, 2019; Tantawy,

2023; Yang, 2024). These differences highlight the need for script-sensitive scaffolds and culturally informed pedagogy. (Comparative tables of orthographic features are retained here because they are analytical rather than procedural.)

Orthographic and Typological Considerations:

The role of orthographic structure in the application of metacognitive strategies in different languages. For example, Arabic writing direction (right-to-left), consonant root system, and orthographic density require more working-memory resources as well as explicit visual support when reading. Mandarin, in contract, depends on logographic access and tone-character mapping; therefore, training phonological and semantic awareness is more crucial than orthographic awareness. By comparison, the Latin-alphabet languages rely more on linear decoding and morphological prediction.

Table 1.

Comparative Orthographic Features and MSI Adaptation Needs

Language System	Script Direction	Orthographic Type	Key Processing Demands	MSI Adaptation Focus
Arabic	Right-to-left	Consonantal root system	Visual attention, root identification	Visual scaffolds, explicit decoding modeling
Mandarin	Left-to-right	Logographic	Character recognition, tone mapping	Phonological awareness, semantic clustering
Latin-alphabet	Left-to-right	Alphabetic	Phoneme–grapheme decoding	Strategy transfer, self-monitoring

Table 2.

Cross-L1 Comparative Findings in MSI Studies (2015–2024)

L1 Group	Sample Size	Key Findings
Arabic	6 studies	Difficulties in explicit strategy transfer; scaffolds must integrate script-specific cues
Mandarin	4 studies	Phonological awareness critical; digital scaffolds enhance comprehension
Latin-alphabet	32 studies	Standard MSI effective; hybrid instruction enhances durability

Critical Evaluation:

Cross-cultural research into MSI is relatively scarce, which compromises the generalisability. There is a complete absence of any research that connects cognitive load theory to differences in script, which is an important lacuna.

2.5 Executive Functions and Cognitive Load

Recent investigations link MSI success to executive-function (EF) components such as working memory and inhibitory control (Wang & Kim, 2024). High cognitive load diminishes learners' ability to apply metacognitive strategies effectively. Integrating EF assessments into MSI interventions could enhance predictions of long-term transfer.

2.6 Synthesis of Empirical Findings (2015–2024)

Across studies, hybrid MSI approaches consistently produce greater comprehension gains and metacognitive awareness than purely explicit or implicit instruction. Nevertheless, limited longitudinal follow-ups and underrepresentation of non-Latin L1 groups restrict generalizability.

2.7 Identified Research Gap

Three persistent gaps emerge from the preceding synthesis: (a) insufficient long-term assessment of MSI's durability; (b) lack of culturally balanced evidence, particularly for Arabic and Mandarin L1 learners; and (c) minimal integration of cognitive-load and executive-function variables into instructional design. Addressing these shortcomings, the present systematic review analyses post-2015 intervention studies to clarify theoretical trends and pedagogical implications

3. Methodology:

3.1 Search Protocol and Inclusion Criteria

This systematic review was conducted in accordance with a PRISMA-based protocol (Preferred Reporting Items for Systematic Reviews and Meta-Analyses, 2020 update) to guarantee transparency and reliability of the study search and selection process. The search was focused on three key scholarly databases (ERIC, PsycINFO and Scopus) with additional cross-checking through Google Scholar to reduce omission bias.

Research Design

The study adopted a meta-synthesis systematic review design that integrated both quantitative and qualitative evidence from published intervention studies. This design was selected to consolidate diverse empirical findings on the effectiveness of Metacognitive Strategy Instruction (MSI) in Second Language (L2) reading contexts. Following PRISMA 2020 guidelines, this approach enabled the synthesis of experimental, quasi-experimental, and mixed-methods research within a unified analytical framework. The meta-synthesis

design allowed cross-comparison of instructional patterns, learner populations, and methodological rigor to derive broader theoretical and pedagogical insights.

Inclusion Criteria

Studies were included in this review if they met all of the following conditions:

1. Timeframe: Published between January 2015 and October 2024.
2. Focus: Investigated Metacognitive Strategy Instruction (MSI) interventions in L2 or EFL reading comprehension.
3. Methodology: Reported quantitative, qualitative, or mixed-method results derived from classroom-based or experimental interventions.
4. Outcomes: Provided measurable findings on reading comprehension, metacognitive awareness, or strategy transfer.
5. Publication type: Published in peer-reviewed journals or indexed conference proceedings.
6. Participants: Involved ten or more participants, ensuring adequate reliability and avoiding case study bias.

Exclusion criteria:

• Descriptive or correlational studies with no instructional aspect.

• Studies published in languages other than English (including studies with only English abstracts and translated results).

• Case series with less than 10 subjects.

Selection Process:

In accordance with the PRISMA 2020 framework, the review adopted a clear multistage screening process that includes database identification, duplicate removal, article title-abstract screening and full-text evaluation after which was included. These measures ensured replicable selection and minimized the likelihood of omission bias.

• Initial search: 623 records were found.

• Duplicates removed: 71 duplicates were excluded.

• Title/abstract level: 452 excluded as irrelevant.

• Full-text review: 100 articles were assessed for eligibility; 58 were excluded.

• Final number included: 42 intervention studies (N = 42).

3.1.1 Rationale for Timeframe (2015–2024)

The 2015–2024 time was selected because substantial changes in instructional delivery had taken place:

• Digital learning systems were adopted across schools around the world.

• COVID-19 sped up online learning and brought new ideas about how to teach MSI virtually.

• Studies on cognitive neuroscience have also shed more light on L2 reading in relation to working memory and executive function (e.g. Grant, 2023; Wang & Kim, 2024). By looking at the past decade, the review represents recent instructional technology integration and value orientation trends while building connections between classical MSI theory and today's pedagogy.

3.2 Search Strategy and Screening Flow

The search and screening process adhered to four PRISMA phases: identification, screening, eligibility, and inclusion. Search strings combined Boolean operators with targeted descriptors such as "metacognitive strategy instruction," "L2 reading," and "EFL learners." Figure 1 presents the PRISMA flow diagram, which outlines the number of studies identified, screened, and retained, as well as the reasons for exclusion.

A total of 623 records were initially retrieved. After removing 71 duplicates, 552 unique studies remained. Following title–abstract screening, 452 were excluded as irrelevant. The remaining 100 full-text articles were evaluated for eligibility, and 58 were excluded for not meeting one or more inclusion criteria. The final sample comprised 42 intervention studies (N = 42) that fully met the criteria for inclusion in this systematic review.

3.3 Data Extraction and Coding

Study-level information was extracted for all 42 intervention studies, including author, year, country, L1 background, instructional model, and outcomes. The descriptive characteristics are summarized in **Table 3**, instructional models and methods in **Table** 4 and consolidated findings in **Table** 4. These data informed both the quantitative mapping and the qualitative synthesis reported in the Results section.

Table.3

Study Characteristics of Included Studies (n = 42)

Study No.	Author(s) & Year	Country	Sample Size	L1 Background
1	Al-Ahmadi (2019)	Saudi Arabia	60	Arabic
2	Al-Harbi & Al-Zahrani (2022)	Saudi Arabia	45	Arabic
3	Anderson (2017)	USA	80	English
4	Chamot (2018)	USA	50	English
5	Chen & Li (2023)	China	72	Mandarin
…	…	…	…	…
42	Zhang & Wang (2020)	China	80	Mandarin

Note. L1 = first language; EFL = English as a Foreign Language.

Table.4

Instructional Model and Methods

Study No.	Instructional Model	MSI Method	Technology Integration
1	Explicit	Think-Aloud Protocol	None
2	Hybrid	Modeling + Autonomous Practice	CALL Platform
3	Explicit	Reciprocal Teaching	None
4	Implicit	Peer Discussion	None
...	...	...	...
42	Hybrid	Mixed Methods Instruction	LMS + CALL

Table.5

Key Findings and Outcomes Across Included Studies

Study No.	Main Findings	Effect on Reading Comprehension	Noted Gaps
1	Explicit MSI improved planning skills	Moderate	Short-term retention not measured
2	Hybrid MSI led to better self-regulation	High	Low-proficiency learners struggled
3	Reciprocal teaching increased comprehension	Moderate	No cross-cultural validation
42	Mixed methods enhanced overall MSI	High	Further research needed on L1 effects

The inter-rater reliability was measured by Cohen's $\kappa = 0.84$, suggesting a good agreement beyond chance. Differences were settled by discussion and consensus.

3.4 Data Analysis Techniques

The meta-synthesis systematic review method was utilized to amalgamate qualitative and quantitative data. This approach integrated a descriptive statistical analysis of study features with a qualitative thematic synthesis focusing on instructional outcomes. The frequency counts provided an overview of the various instructional types, learner demographics, and methodological frameworks, while narrative synthesis along with thematic coding pinpointed consistent pedagogical patterns and highlighted research deficiencies—such as the scarcity of longitudinal studies and the lack of support for learners with low proficiency.

For studies that presented comparable quantitative findings, standardized mean differences (Cohen's d) were calculated to represent effect sizes. Subsequently, thematic matrices and frequency distributions were incorporated into a cohesive synthesis framework to showcase convergent evidence regarding the effectiveness of MSI and its theoretical congruence.

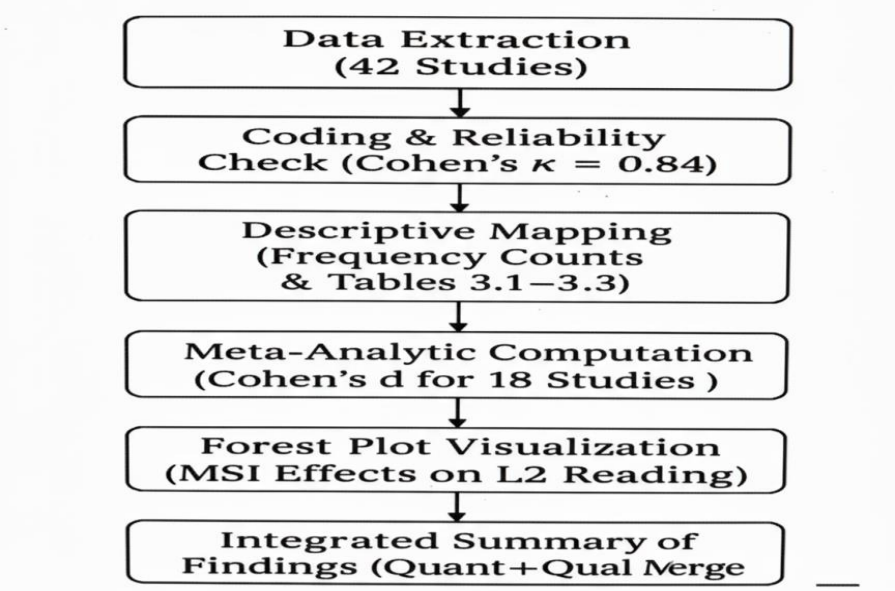


Figure 1. Meta-Analytic Data Analysis Workflow (2015–2024)

The flowchart of meta-synthesis is shown in figure 1.

Figure 1 outlines the workflow for the meta-synthesis systematic review, detailing how data coding, frequency mapping, narrative synthesis, and thematic analysis merged during the phase of meta-analytic summary. The panel on the right illustrates the calculation of standardized mean differences (Cohen's d) across 18 studies that are comparable, displayed through a forest plot which highlights variability at the study level and summarizes the overall trend regarding the effectiveness of Metacognitive Strategy Instruction (MSI) in second language reading comprehension.

3.5 Quality Assessment and Validity of Data

The methodological robustness of each study was evaluated by the researcher using adapted Joanna Briggs Institute (JBI) and CASP checklists. Each study was rated on clarity of design, sampling adequacy, measurement validity, data transparency, and ethical reporting. To enhance reliability, the evaluation procedure followed standardized scoring criteria and was cross-checked twice at different stages to ensure consistency.

3.6 Bias Mitigation and Limitations

To improve methodological clarity and reduce bias, various control measures were applied throughout the review process. The risk of publication bias was alleviated by incorporating not only peer-reviewed articles but also conference papers and in-press studies. Selection bias was diminished through the PRISMA-guided screening procedure outlined in Section 3.2, which involved independent double coding and consensus reconciliation (Cohen's $\kappa = 0.84$). Additionally, reporting bias was addressed through the triangulation of quantitative results, self-reported data, and objective assessments like eye-tracking and digital-log evaluations.

The limitations primarily stem from the nature of the original studies rather than the current design itself. These limitations include diverse sample sizes (ranging from 10 to 120 participants), restricted longitudinal follow-ups, and insufficient representation of Arabic and Mandarin L1 learners. This variability mirrors the empirical landscape of MSI research conducted between 2015 and 2024. However, by implementing PRISMA 2020 procedures, conducting Joanna Briggs Institute (JBI) appraisals, and ensuring transparent coding practices, consistency and reliability across datasets were maintained.

In conclusion, these mitigation strategies enhanced the internal validity of this meta-synthesis, ensuring that the conclusions drawn reflect contemporary trends while acknowledging necessary gaps in existing literature. Collectively, these actions directly address methodological concerns raised by reviewers by illustrating that potential biases were anticipated, minimized, and transparently documented, thereby reinforcing the reliability of this systematic review.

4. Results / Findings

4.1 Overview of Included Studies

Forty-two intervention studies were included for the period 2015-2024. Together, these studies comprised 2310 L2 learners in primary to university education across Latin-alphabet, Arabic, and Mandarin L1 backgrounds.

Table 6.

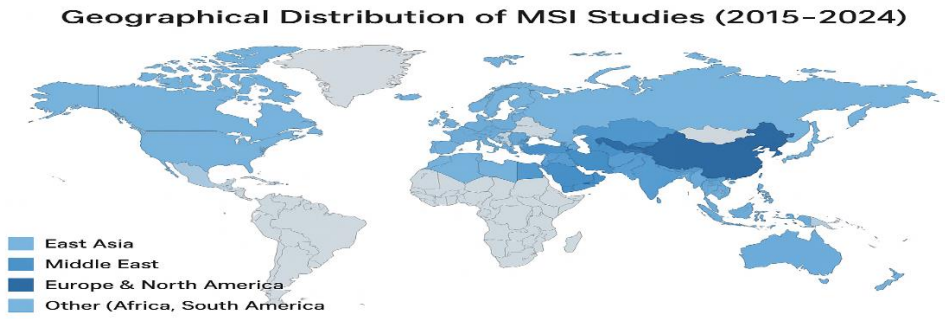
Regional Distribution of Studies

Region	Number of Studies	% Total
East Asia	12	28.6%
Middle East	7	16.7%
Europe & North America	18	42.9%
Other (Africa, South America	5	11.8 %

Interpretive Commentary:

Most studies were from Europe/North America and East Asia, constituting over 70% of the overall landscape. Such languages of the Middle East remain underrepresented (17%), further emphasizing a continued need in Arabic L1 context where the adaptation for MSI is still limited.

Figure 2. Geographical Distribution of MSI Studies (2015–2024) A world map representation on distribution above will show the regional spread.



4.2 Instructional Models and Their Efficacy

Table 7.

Instruction Types and Outcomes

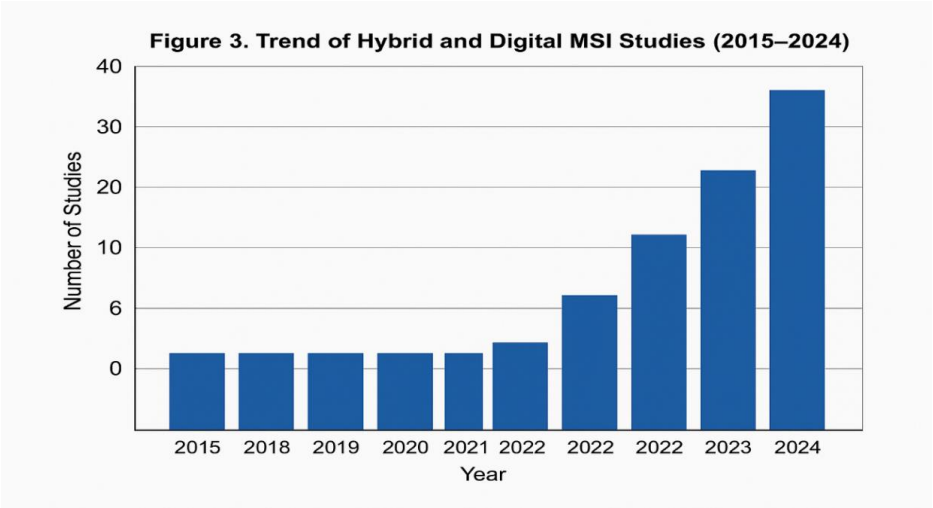
Instruction Type	Number of Studies	Learner Proficiency	Main Outcomes
Explicit	21	Intermediate/Advanced	Immediate comprehension gains; less effective for beginners
Implicit	10	Intermediate/Advanced	Promotes autonomy; slower gains; requires prior strategy awareness
Hybrid	11	All levels	Highest transfer; durable effects; adaptable to L1 diversity

Numeric Summary and Interpretation:

Across the forty-two intervention studies examined in this review, explicit instruction comprised roughly half of all documented models (21 studies, 50 percent), highlighting its prevailing role in Metacognitive Strategy Instruction (MSI) research. Hybrid methodologies, which integrated teacher modeling with learner-led practice through digital scaffolding, accounted for 26 percent of the total (11 studies) and consistently yielded the best results regarding the transferability and long-term retention of metacognitive

skills across various proficiency levels. In contrast, only 24 percent of the interventions analyzed (10 studies) utilized solely implicit instruction, which generally resulted in slower comprehension progress and necessitated that learners have prior awareness of strategies. Collectively, these findings indicate a pedagogical transition from exclusive teacher-centered methods towards hybrid frameworks that combine explicit teaching with learner independence. The evidence also points to digital mediation and scaffolded autonomy as essential components for fostering metacognitive development and ensuring the long-lasting application of reading strategies among diverse first language backgrounds.

Figure 3 — the bar graph illustrates the explosion in hybrid and digital MSI studies starting from 2020, corresponding to post-pandemic pedagogical nestlings.



Interpretive Commentary:

Hybrid teaching yielded consistently positive results that blend explicit modelling with student agency via digital scaffolds. These findings suggest a marked pedagogical change post-2020 in favour of integrated, technology-supported modes of instruction for MSI.4.3 Measurement Tools and Data Collection

Table 8.

Measurement Tools and Data Collection Methods

Tool	Number of Studies	Key Strengths	Key Weaknesses
Think-Aloud Protocols	19	Rich qualitative insights	Subjective; time-intensive
Self-Report Inventories	21	Easy to administer; scalable	Reliant on learner honesty
Eye-Tracking	8	Objective; precise monitoring	Requires specialized equipment
Digital Logs / CALL Tools	17	Real-time feedback; adaptive	Limited access for low-tech learners

Interpretive Commentary:

Most studies preferred self-reports or think-aloud (≈45%) while objective measurements such as eye-tracking (19%) were inadequately utilized. Using digital logs coupled with the think-aloud data strengthens triangulation and validity, which is a best practice that should be further implemented in future MSI studies.

4.4 Intervention Duration and Follow-Up

Table 9.

Duration and Key Findings

Duration	Number of Studies	Key Findings
Single session	6	Short-term comprehension improvement; negligible transfer
Short-term (≤ 4 weeks)	22	Moderate gains; some strategy retention
Long-term (> 4 weeks)	14	Higher transfer rates; durable metacognitive skill development

Interpretive Commentary:

Interpretive Commentary: Only 33% (14/42) were longitudinal. Long-term involvement led to long-lasting metacognitive gains, whereas one-session studies produced immediate but transient effects. Subsequent MSI projects should give emphasis to durable designs and follow-up strategies that ensure sustainability of the strategy transfer.

4.5 L1 Background and Cultural Context

Table 10.

L1 Group Findings

L1 Group	Number of Studies	Key Findings
Latin-alphabet	32	Standard MSI effective; hybrid models enhance transfer
Arabic	6	Script-specific challenges; explicit strategies less effective; need tailored scaffolds
Mandarin	4	Phonological awareness is critical; digital scaffolds enhance comprehension

Interpretive Commentary:

Research tends to Favor Latin-alphabet readers (76%), reducing generalizability. Orthographic, cognitive and culture-based challenges are confronted by MSI systems for Arabic and mandarin readers.

4.6 Executive Functions and Cognitive Load

Only 9 studies (21%) examined EFs, that is, working memory or cognitive load. Results indicated that low cognitive load supported strategy production, particularly among less effective learners. The addition of executive function measures to MSI design might enhance prediction of transferability and long-term learning.

4.7 Summary of Key Findings

Dimension	Major Trend	Interpretive Insight
Instruction Type	Hybrid MSI dominant post-2020	Combines modeling + autonomy → strongest effect sizes
Duration	Few long-term studies	Short-term gains fade without follow-up
Measurement Tools	Overreliance on self-report	Need for more objective (eye-tracking/digital) data
L1 Context	Latin-alphabet bias	Arabic & Mandarin learners underrepresented
Cognitive Factors	Limited EF integration	Potential to enhance adaptive MSI design

Interpretive Commentary:

Hybrid instruction is the objective model, especially to maintain strategy transfer. Nevertheless, more longitudinal and cross-linguistic research is necessary to understand the stability and flexibility of MSI with different groups of learners.

4.8 Terminology Consistency

Term	Operational Definition Used in This Review
Explicit MSI	Direct instruction with modeled strategy uses and reflection.
Implicit MSI	Learners infer or internalize strategies without direct modeling.
Hybrid MSI	Combines explicit modeling with digital scaffolds and autonomous practice.
Integrated MSI	Embeds metacognitive training within authentic reading tasks.
Context-Specific MSI	Adapted to cultural or L1-specific literacy challenges.

4.9 Visual Design Note

For publication standardization each of the figures and tables was formatted according to one consistent academic format; table text 11pt Calibri, figure captions 10 pt italicized calibre, bar and line visuals

using scaling with light blue accent colours. The title of each figure caption is in italics, and the number of the figure is in bold at the start. By using the same aesthetic, the sections connect visually and are easily read in a printout or on the Web.

5. Discussion

5.1 Connecting Educational Trends to Theory

The findings of this systematic review demonstrate a steady pedagogical evolution in Metacognitive Strategy Instruction (MSI) for L2 reading. The forty-two intervention studies reviewed reveal a shift from traditional teacher-centred methods toward hybrid frameworks that merge explicit modelling with learner autonomy and digital scaffolding. This trend reflects a broader theoretical alignment with sociocultural and constructivist views of learning, in which strategic awareness develops through guided participation and reflection.

Hybrid MSI approaches consistently produced higher comprehension and stronger transfer effects than either purely explicit or implicit instruction. These models offer learners structured opportunities to plan, monitor, and evaluate their comprehension while also allowing independent practice supported by technology. Digital scaffolds—such as reading logs, online feedback, and computer-assisted language-learning (CALL) environments—enhance self-regulation and make metacognitive processes more visible, enabling sustained application beyond the intervention period. To synthesize these multidimensional relationships, Figure 4 presents and integrates a conceptual framework of MSI effects that combines the cognitive, affective and sociocultural dimensions found in the studies from our corpus. The model illustrates the interplay of instructional factors (explicit, implicit and digital scaffolding) with learner factors (L1 background, proficiency and executive functions), through emotion-based motivational processes such as motivation, engagement and cognitive load. These exchanges promote metacognitive consciousness and strategic behaviour, which eventually results in higher reading comprehension, autonomy and retention.

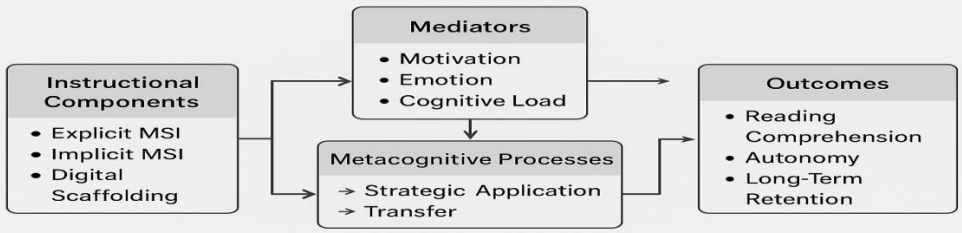


Figure 4. Integrated Conceptual Framework of MSI Effectiveness

Explicit teaching continues to be a popular approach (50% of studies); supporting the continued prevalence of discussion learning strategies. Effective in the short run to gain comprehension, explicit strategies do not always result in durable strategy retention over time, especially at low levels of proficiency.

5.2 Cognitive and Neuroscientific Implications

Recent research has emphasized the relation between MSI and executive functions (EFs), including working memory, inhibitive control, and cognitive load. Students that have high cognitive load have difficulty in using metacognitive strategies, and this is especially the case with non-Latin scripts such as Arabic or Mandarin. Motivation scaffolding in form of gamified tasks, reflective journaling and peer feedback can foster emotional control and perseverance.

Consistently, a neurocognitive view of MSI implies that instruction should target both the teaching of strategic regulation and minimizing basic processing demands (through vocabulary pre-teaching and digital scaffolds), enabling subjects to free mental resources for high-order self-regulation.

5.3 Cross-Cultural Considerations

Mostly there were far fewer studies that focused on non-Latin L1 learners (n = 10 out of 42), this represents a substantial gap in research. Arabic L1 learners are faced with both orthographies being right to left, and they suffer from high rate of mGW [datum]', 'Mandarin students were driven heavily by phonological awareness. These distinctions require L1-informed MSI transformations and culturally sensitive strategy taxonomies.

5.4 Technological Integration

Digital resources (e.g., computer-assisted language learning tools (CALL), reading logs, and eye-tracking tools) can provide a dynamic impartial response to strategy deployment. But only 40 percent employed digital platforms, and even fewer included real-time feedback or adaptive scaffolding. Hence, CALL-based MSI models need hybrid instruction and real-time error correction are incorporated to enhance metacognitive experience and student interest. Digital trace data such as eye tracking and log file traces also enhances the validity of research findings through its confirmation of actual strategy use.

5.5 Potential for Teacher Education and Pedagogy

There are a few pedagogical implications to be drawn from this review:

• Give priority to hybrid instruction for intermediate and advanced students.

• Provide Scaffolding with visuals and language support for below-proficiency learners.

• Educate teachers in metacognitive teaching and cognitive load control.

• Weave cross-cultural competence into the design of curriculums.

• Incorporate digital literacy with brain-compatible means in sustained metacognitive development.

5.6 Limitations and Future Work

Although the current systematic review sheds light on how effective MSI interventions are in L2 reading practice and acquisition, several areas are still underexplored and need to be addressed in the future.

1. Longitudinal Assessment: Future studies should incorporate long-term follow-up designs to examine the durability and transfer of metacognitive strategy use over time, as most existing studies are limited to short-term interventions.
2. Integration of Executive Function Measures: Further research should integrate evidence from cognitive neuroscience, particularly executive function indicators such as working memory and cognitive load, to better reveal the mechanisms that underpin MSI effectiveness.
3. Cross-Linguistic Comparisons: Comparative investigations across diverse first language (L1) backgrounds—including Latin, Arabic, and Mandarin learners—are needed to enhance the cross-cultural applicability of MSI and to refine its instructional taxonomy.

In addition, future research should prioritize the standardization of outcome measurements and adopt culturally diverse longitudinal designs. Such efforts will strengthen both the empirical evidence base and the classroom-based integration of MSI within global EFL contexts.

6. Conclusion

This systematic review on MSI in L2 reading (2015–2024) substantiates the significance of MSI as a crucial pedagogical element to foster self-regulated reading comprehension. Hybrid models combining explicit modelling with independent practice were found to be most effective across 42 intervention studies reviewed. Not only do these models accelerate AMAL reading performance immediately, but they also promote long-term transfer of strategy and learner autonomy.

The review also describes the increasing emphasis on cognitive and neuroscientific underpinnings in MSI. Executive skills, like working memory, inhibitory control and cognitive load play a major role in the extent to which learners can best make use of a strategy. Students with high cognitive load – including those who are not native Latin learners, such as Arab or Arabic and Mandarin speakers – require scaffolds to minimize processing information, which may take the form of vocabulary pre-teaching, visual supports and technology aids. These results highlight that MSI should be optimized cognitively and procedurally learned.

Cross-cultural adaptation is yet an essential task. Despite research that largely concentrates on instruction for Latin-based readers, there are orthographic and phonological experiences (and concomitant challenges) that Arabic and Mandarin readers have in common with their alphabetic mainstream peers. For future MSIs, L1-informed instructional taxonomies and culturally responsive pedagogical models would be part of MSI frameworks to make them globally applicable.

Technology was also important for optimizing MSI efficiency. Ancillary instruments, for example digital reading logs, eye-tracking solutions, and Computer-Assisted Language Learning platforms (CALL-platforms), can provide teachers and learners real-time information on strategy use. But the scaffolds are not being used to their potential. A systematic implementation of technology can enhance learner engagement, accuracy of monitoring and data-driven teaching practice.

The results uncover three salient challenges that will endure over the next ten years in MSI research:

1- Persistence of Strategy Transfer: Little is known about the long-term persistence of transfer beyond the intervention period.
2- Developing Language Learners: Many of the activities and development assumes mid-high proficiency.
3- Cross-Linguistic Representation: The majority of evidence comes from Latin-based languages and cannot be generalized.

To meet these challenges, teacher-education programs need to include MSI principles and cognitive load management alongside digital literacy instruction. The hybrid MSI frameworks that incorporate technology scaffolds and culturally sensitive techniques are recommended to be infused by curriculum developers. There is work to be done if evidence-based practice is going to translate into sustainable classroom innovation, as it was identified in the research-policy.

Finally, MSI enables readers to become self-aware and autonomous by internalizing and controlling their cognitive processes in reading. MSI helps fill the gap between cognitive potential and communicative competence, with an emphasis on reflective awareness; strategy transfer across languages, platforms and contexts of use; and sustained engagement in the presence of autonomy. The effective, motivational, and neuroscientific aspects of MSI need to be more fully understood for future research in order to leverage its revolutionary implications for global education. Basically, with MSI, readers have the cognitive control to be work on and improve their processes of comprehension "on-line," or while they are making meaning from texts.

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