

Interactive Web-Based Scaffolding for Online Reading Comprehension: A Conceptual Framework

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ABSTRACT

Online reading requires learners to understand academic content while also navigating a digital environment. This can be demanding for tertiary ESL learners, who must read in a second language while deciding how to approach the text, check their understanding, and evaluate what they have learned. This concept paper proposes a framework for embedding metacognitive scaffolding in an interactive web-based reading environment. The framework focuses on planning, monitoring and regulation, and evaluation. These processes are linked mainly to the before-, during-, and after-reading stages and supported through stage-specific digital scaffolds. The framework brings together metacognitive regulation, reading stages, and digital delivery in one design, while treating technology acceptance as a separate evaluation lens. Pre-reading prompts support planning; in-text checkpoints and repair prompts support monitoring and regulation; and post-reading tasks support evaluation. The Technology Acceptance Model (TAM) is used to examine perceived usefulness and perceived ease of use of the web-based delivery, not to explain the reading process itself. The framework therefore offers a clear, theory-based foundation for designing and later evaluating support for strategic online academic reading among tertiary ESL learners.

Keywords: Metacognitive Strategies, Online Reading Comprehension, Interactive Scaffolding, Technology Acceptance Model, Higher Education

INTRODUCTION

Online reading is now a routine part of university learning. Students read journal articles, course materials, electronic books, webpages, and other academic texts on screen. However, digital reading involves more than reading the same content in a different format. Readers may need to manage navigation, information sources, digital tools, and distractions while trying to understand the text. For second-language learners, these demands come on top of language difficulties. A systematic review by Reiber-Kuijpers et al. (2021) found that second- and foreign-language digital reading requires additional skills, strategies, time, and concentration, and that the link between strategy use and comprehension is complex.

The key issue is not only whether learners know reading strategies, but whether they can use the right strategy at the right time. Recent studies show that metacognitive strategy instruction can strengthen this ability. Khellab et al. (2022) found that explicit metacognitive reading strategy instruction improved both strategy awareness and reading performance among university engineering students. Khurram (2023) similarly reported that sustained metacognitive instruction helped tertiary ESL learners become more aware of their reading strategies and use them more deliberately. In online reading, Anggia and Habók (2024) found that university students' metacognitive awareness of global, problem-solving, and support strategies was associated with English reading comprehension.

These findings highlight the importance of metacognitive regulation: the ability to manage one's own reading process. Metacognition broadly refers to knowledge and regulation of cognition (Flavell, 1979). Planning, monitoring, and evaluation are commonly identified as key parts of this regulation (Schraw & Moshman, 1995). A reader plans how to approach a text, monitors whether it makes sense, adjusts the approach when difficulty occurs, and evaluates the quality of understanding.

The challenge is that learners may know a strategy without using it when it is needed. A student may know that rereading is useful but fail to recognise when to reread. Another may understand the value of setting a reading purpose but still begin a difficult article without one. This gap between knowing a strategy and using it at the right time is the starting point for the present framework.

Digital environments can help close this gap because support can be built directly into the reading task. Recent work shows that digital scaffolds can prompt self-regulated learning actions rather than simply add more technological features. van der Graaf et al. (2023), for example, showed that digital scaffolds can be timed to prompt specific self-regulated learning actions among university students. In digital reading, List and Lin (2023) found that metacognitive monitoring and evaluative processing were relevant to undergraduates' learning from multiple digital texts. Sinas et al. (2024) reported better online comprehension after learners were taught to apply metacognitive strategies while reading webpages and hyperlinked texts. Mekheimer (2025) also showed the potential of digital scaffolding organised around pre-, during-, and post-reading activities.

Together, these studies show the value of metacognitive instruction, the demands of digital reading, and the potential of digital scaffolding. However, they do not clearly show how these elements should be combined in a reading design: which metacognitive process should be supported, when it should be supported, and what kind of digital support should be used. The present paper addresses this gap with a stage-specific mapping. Planning is mainly supported before reading, monitoring and regulation during reading, and evaluation after reading. This is an organising structure rather than a fixed sequence; the processes may recur whenever needed.

Because the support is delivered online, the usability of the technology also matters. The Technology Acceptance Model (TAM) provides a secondary lens for this purpose. TAM identifies perceived usefulness (PU) and perceived ease of use (PEOU) as key perceptions that shape technology acceptance (Davis, 1989). Lin and Yu (2023) showed that both constructs remain relevant to students' attitudes towards digital academic reading tools in higher education. In this framework, TAM does not explain the metacognitive reading process. It is used only to evaluate whether learners find the web-based delivery useful and manageable.

This concept paper therefore brings together metacognitive regulation, online reading stages, and web-based scaffolding in one framework while keeping technology acceptance separate. Its purpose is to guide the design of support that prompts strategic regulation at useful points in tertiary ESL academic reading and to show how that design could later be evaluated.

LITERATURE REVIEW

Metacognitive Regulation in Reading

Metacognition includes both knowledge about cognition and the regulation of cognitive activity (Flavell, 1979). Metacognitive knowledge helps learners recognise relevant features of themselves, the task, and available strategies. Regulation is how learners use this knowledge to manage their performance.

Schraw and Moshman (1995) identify planning, monitoring, and evaluation as central parts of metacognitive regulation. These processes are useful for explaining strategic reading because comprehension develops throughout the reading task.

Before reading, learners can set a purpose, activate prior knowledge, examine how the text is organised, predict what it may contain, and decide how closely different sections need to be read. These decisions give the task direction and help the reader begin with a clear plan.

During reading, readers check whether the text makes sense, whether new information fits with what they already understand, and whether their current approach is working. When understanding breaks down, monitoring can lead to regulation. The reader may reread a passage, slow down, review earlier information, use contextual clues, consult another resource, or change the reading approach. Effective regulation therefore requires both recognising a problem and choosing a suitable response.

After reading, readers evaluate how well they understood the text. They consider whether they achieved their original purpose, whether they can explain the main ideas or argument, what remains unclear, and whether their strategies were effective. This evaluation may lead them back to the text to reconsider an interpretation or try a different strategy.

These processes are related and do not follow a strict linear sequence. Monitoring may cause a reader to revise an earlier plan, and evaluation may reveal a gap that requires further reading. Planning, monitoring, and evaluation therefore provide a useful structure without suggesting that effective reading follows a fixed three-step procedure.

Recent evidence supports making these processes explicit. Khellab et al. (2022) found significant gains in reading performance when university students received direct instruction in metacognitive reading strategies, while Khurram (2023) reported that tertiary ESL learners became more aware of their strategy use and applied the strategies more deliberately. A systematic review and meta-analysis by Wongdaeng and Higgins (2023) also identified explicit instruction, clear pedagogical sequencing, and regulation of skills as important features of successful metacognitive interventions in tertiary EFL contexts. Together, these findings suggest that knowing strategies is not enough; learners also benefit from structured support in using and regulating them while reading.

Metacognition in Online Reading

Online reading changes how metacognitive regulation takes place. Readers may move between sections, hyperlinks, tools, or sources while trying to maintain an understanding of the text. Reiber-Kuijpers et al. (2021) found that digital reading can offer useful features but can also increase demands on concentration, navigation, information management, and strategy selection.

The review also found that using more strategies did not consistently lead to better comprehension. This matters because strategic reading is not about using as many strategies as possible. A strategy is useful when it responds to an actual reading need.

Anggia and Habók (2024) provide recent evidence from higher education. In a study of 1,412 university students, global, problem-solving, and support strategies were collectively associated with English reading comprehension in online reading. The study shows a relationship between metacognitive awareness and comprehension, but its correlational design does not show that awareness alone causes better reading performance.

Sinas et al. (2024) examined this issue through instruction. Students were taught metacognitive online reading comprehension strategies while working with webpages and hyperlinked texts. They used strategies such as rereading, checking keywords and meanings, moving between sections, and consulting digital resources. Their online comprehension scores improved after the intervention. The findings show how metacognitive regulation can be put into practice through specific actions in a digital reading environment.

Research on digital academic reading also shows that the quality of strategy use matters. List and Lin (2023) examined undergraduates reading multiple digital texts with highlighting and annotation tools. Simply providing these tools did not consistently improve comprehension. However, forms of processing linked to

metacognitive monitoring and evaluation were associated with better multiple-text learning. This suggests that digital tools are not useful simply because they are available; what matters is how learners use them.

Taken together, these studies shift the focus from whether learners know reading strategies to how they can be supported in making strategic decisions while reading online.

Digital Scaffolding of Metacognitive Processes

Scaffolding is temporary support that helps learners carry out processes they cannot yet perform consistently on their own. In a digital environment, this support can take the form of prompts, questions, hints, checkpoints, or other features placed within the task.

The timing and purpose of a scaffold matter. van der Graaf et al. (2023) found that digital scaffolds should have a clear purpose, appear at meaningful points in the learning process, suggest concrete actions, and avoid unnecessary text. These principles are useful here because metacognitive support should help readers regulate their reading without becoming another distraction.

In online reading, Sinas et al. (2024) showed that learners can be guided to monitor and regulate comprehension while working with digital texts. Mekheimer (2025) also used a digital scaffold organised around activities before, during, and after reading. Learners who used the scaffold showed substantially stronger online reading comprehension than those using conventional approaches and engaged more deliberately with the reading process.

Mekheimer's (2025) study is especially relevant to the structure proposed here, but the present framework is not a replication of that intervention. The digital mind magnet focused mainly on narrative reading among intermediate EFL learners. University academic reading has different demands. Learners may need to identify arguments, distinguish claims from evidence, trace relationships among ideas, compare information, and evaluate a writer's position.

The present framework therefore adopts the broader idea of stage-specific digital scaffolding but links each stage directly to metacognitive regulation. It does not prescribe one fixed set of digital activities. Instead, it identifies which metacognitive process should be supported at each major point in the reading task.

Technology Acceptance as an Evaluation Lens

A web-based scaffold can only work as intended if learners can and are willing to use it. Technology acceptance therefore matters, but it remains separate from the metacognitive mechanism of the framework.

Davis (1989) identifies perceived usefulness and perceived ease of use as two core TAM constructs. Perceived usefulness is the extent to which users believe a technology helps them perform a task better. Perceived ease of use concerns how much effort the technology requires.

These constructs are relevant to digital academic reading. Lin and Yu (2023) found that perceived usefulness and perceived ease of use contributed to higher-education students' attitudes towards digital academic reading tools. They also found that not every conventional TAM relationship was supported, so TAM should be used cautiously rather than treated as a universal causal model.

In this framework, PU and PEOU answer one question: how do learners experience the web-based delivery of the metacognitive scaffold? A scaffold may be theoretically sound but poorly implemented. Frequent interruptions, unclear instructions, or unnecessary steps may make it difficult to use. On the other hand, an easy-to-use system has little value if its prompts do not support meaningful regulation.

For future implementation, PU would refer to whether learners feel that the scaffold helps them manage and understand an academic reading task. PEOU would refer to how clear and easy the system is to navigate and use. These constructs should be measured with validated or appropriately adapted TAM items (Davis, 1989; Lin & Yu, 2023) and analysed separately from comprehension and metacognitive regulation. In short,

metacognitive theory determines what the scaffold should support, while TAM evaluates how learners experience the technology used to deliver it.

Positioning the Proposed Framework

The studies reviewed above contribute different pieces to the proposed framework. Metacognitive theory identifies the regulatory processes; digital-reading research explains the demands and strategies involved in online reading; digital-scaffolding research shows how prompts can support self-regulation; and TAM helps evaluate the technology. The present framework brings these pieces together in a stage-specific design for tertiary ESL academic reading while keeping the reading process separate from the evaluation of the technology. Table 1 shows how the framework builds on the existing work.

Table 1. Positioning of the Proposed Framework in Relation to Existing Work

Existing work	Primary contribution	How the proposed framework builds on it
Schraw & Moshman (1995)	Planning, monitoring, and evaluation as central processes of metacognitive regulation.	Uses these processes as the theoretical basis and links each one to the reading stage where support is most useful.
Reiber-Kuijpers et al. (2021)	Additional demands, skills, and strategies involved in second- and foreign-language digital reading.	Addresses these demands by placing metacognitive support inside the digital reading task rather than treating online reading as only a change of medium.
Sinas et al. (2024)	Metacognitive online reading strategy instruction using webpages and hyperlinked texts.	Extends this strategy-based approach into a stage-specific framework that can be used beyond one intervention.
van der Graaf et al. – (2023)	Design principles for digital scaffolds that prompt self-regulated learning actions.	Applies these design principles to metacognitive support for tertiary online reading.
Mekheim er (2025)	Before-, during-, and after-reading digital scaffolding for EFL online reading.	Keeps the before-, during-, and after-reading structure, but links each stage directly to metacognitive regulation and adapts it for tertiary academic reading.
Lin & Yu (2023)	TAM-based examination of students' acceptance of digital academic reading tools.	Uses PU and PEOU only to evaluate the web-based delivery, separate from the metacognitive reading process.

The framework does not claim to introduce new metacognitive processes or new TAM constructs. Its contribution is to connect four elements clearly: the purpose of the metacognitive support, the reading stage where the support is placed, the web-based mechanism used to deliver it, and a separate evaluation of that technology.

DISCUSSION

Proposed Conceptual Framework

The framework begins with metacognitive regulation because the main problem addressed in this paper is not whether learners know reading strategies, but whether they can activate and adjust them when comprehension demands change. It therefore focuses on three regulatory processes: planning; monitoring

and regulation; and evaluation (Flavell, 1979; Schraw & Moshman, 1995). Planning is linked primarily to before reading, monitoring and regulation to during reading, and evaluation to after reading because these stages provide practical points for support. The relationship is flexible rather than fixed: learners may revise a plan while reading, regulate their approach when comprehension breaks down, or return to monitoring after evaluating their understanding.

This metacognitive logic determines the role of the web-based scaffold. The technology does not create a separate learning process; it delivers support when a particular regulatory process is most useful. Before reading, prompts can help learners set a purpose and prepare an approach. During reading, prompts can help them check understanding and respond to difficulty. After reading, prompts can help them evaluate what they understood and how effectively they approached the text. The wording, frequency, and form of these prompts may vary with the text, learner, and reading purpose, but their underlying metacognitive purpose remains the same.

TAM is included at a different level of the framework: it evaluates the technological delivery of the scaffold rather than the reading process itself. Perceived usefulness (PU) concerns whether learners view the scaffold as helpful for managing the reading task, while perceived ease of use (PEOU) concerns whether the system is clear and manageable to use (Davis, 1989; Lin & Yu, 2023). These perceptions do not explain metacognitive regulation or comprehension; they show how learners experience the system through which the support is delivered. Figure 1 brings these relationships together: metacognitive demands define what support is needed, the reading stages indicate when it is most useful, web-based scaffolding delivers that support, and TAM evaluates learners' experience of the delivery.

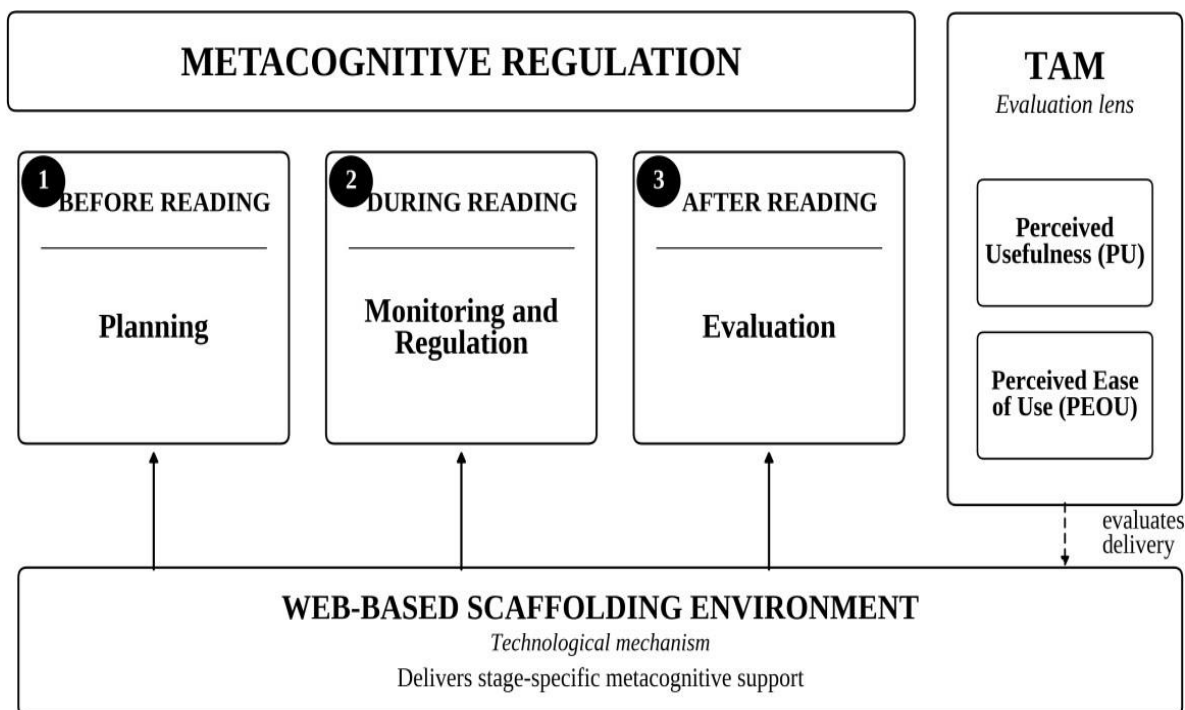


Figure 1. Conceptual Framework for Metacognitive Scaffolding in Online Reading

Note. The reading stages indicate the primary points at which the three metacognitive processes are scaffolded; the processes may recur as reading demands change. TAM evaluates the web-based delivery through PU and PEOU and is not part of the metacognitive reading mechanism.

Table 2 moves from this conceptual relationship to practical examples of how each metacognitive process can be prompted during online reading.

Table 2. Operationalisation of Metacognitive Processes in Online Reading

Reading Stage	Metacognitive Process	Purpose of Scaffold	Possible Web-Based Support
Before reading	Planning	Set a clear purpose and approach	Purpose-setting prompt, prior-knowledge prompt, text preview or prediction
During reading	Monitoring	Check whether the text is being understood	Short comprehension checkpoint, confidence or understanding check
		Adjust reading when understanding breaks down	Rereading cue, contextual-clue prompt, reminder to review an earlier section or adjust reading pace
During reading	Regulation		
		Check overall understanding and reflect on what worked	Main-idea or argument synthesis, understanding check, brief strategy-reflection prompt
After reading	Evaluation		

These examples are not a fixed set of platform features. They simply show how each metacognitive process can be turned into a practical reading activity.

Conceptual Contribution

The framework shifts attention from knowing reading strategies to using them when they are needed. Existing studies show that metacognitive instruction can strengthen strategy awareness and use (Khellab et al., 2022; Khurram, 2023; Wongdaeng & Higgins, 2023), while online-reading research links metacognitive strategy use with comprehension and shows how strategies can be used in digital reading (Anggia & Habók, 2024; Sinas et al., 2024). The present framework adds a clear design map: what regulatory process needs support, where that support should appear in the reading task, and how it can be delivered.

The framework also clarifies the role of technology. The web-based environment does not produce learning by itself; it delivers metacognitive support at appropriate points. TAM is used only to evaluate whether learners find that delivery useful and easy to use (Davis, 1989; Lin & Yu, 2023). This keeps the theory and the technology clearly separated while still making the framework practical to implement.

Design Considerations

A scaffold should support reading without taking over the task. More prompts do not necessarily mean better support. Research suggests that digital scaffolds need a clear purpose, good timing, concrete actions, and concise wording (van der Graaf et al., 2023). Research on digital annotation also shows that simply adding more tools or activities does not automatically improve comprehension (List & Lin, 2023).

The timing of a scaffold should match its purpose. Pre-reading support should be brief and appear before sustained reading begins. During-reading checkpoints should appear after meaningful sections or difficult passages rather than at fixed intervals. They should ask learners to check their understanding, not simply add another factual comprehension question.

Repair prompts should still leave the learner in control. When a learner notices difficulty, the system may suggest rereading, reviewing the context, slowing down, or returning to an earlier section, but it should not immediately provide the answer. The aim is to support regulation, not replace it.

Post-reading support should help learners evaluate their understanding, not simply confirm that they finished the task. Depending on the text, learners may summarise an argument, explain relationships among ideas,

identify supporting evidence, evaluate a writer's position, or identify what remains unclear.

The amount of scaffolding should vary. Learners with lower proficiency or less familiarity with a text type may initially need more explicit and frequent prompts. More proficient or experienced learners may need shorter, less frequent, or optional support. Task difficulty also matters: a dense passage may justify a checkpoint even for a stronger reader. These are proposals for future testing, not fixed rules.

Pedagogical Implications

The framework allows metacognitive strategy instruction to be built into academic reading itself. Instead of teaching a list of strategies separately and expecting students to remember them later, instructors can place brief support inside the texts students already need to read.

The metacognitive function can stay the same while the content of the scaffold changes by academic genre. For an argumentative text, planning may involve identifying the issue and anticipating competing positions; monitoring may focus on whether claims are supported by evidence; and evaluation may involve judging how coherent or persuasive the argument is. For an expository text, the same processes may focus on definitions, relationships among concepts, causes, sequences, or examples.

This flexibility matters because the framework is not tied to one text type or digital tool. What stays constant is the link between the reading task and the metacognitive purpose of the scaffold. The wording, frequency, and form of support can change to suit the instructional context.

The framework also does not require a complex system. The support could be built into a lightweight browser-based environment or an existing digital learning platform. The technology should serve the instructional need, not drive it.

Directions for Future Research

Future research should test the framework empirically. An initial study could use a lightweight prototype with pre-reading planning prompts, strategically placed monitoring and repair prompts, and post-reading evaluation tasks. Learners could complete comparable academic reading tasks with and without the scaffolds, preferably using standardised or carefully matched texts and objective comprehension measures.

Each construct should be measured separately. Planning indicators could include purpose setting, activating prior knowledge, previewing the text, and making predictions. Monitoring indicators could include recognising confusion, checking developing understanding, and judging confidence. Regulation could be shown through actions such as rereading, reviewing earlier sections, using contextual clues, or adjusting reading pace and approach. Evaluation could include summarising main ideas or arguments, identifying what remains unclear, and reflecting on which strategies worked. Depending on the research design, evidence could come from interaction logs, brief learner reflections, think-aloud protocols, or validated metacognitive strategy measures.

Reading comprehension should also be measured separately through outcomes such as identifying main ideas, making inferences, synthesising information, understanding argument structure, and evaluating ideas. Technology acceptance should remain a separate outcome. PU and PEOU can be measured with validated or appropriately adapted TAM items (Davis, 1989; Lin & Yu, 2023) that focus on whether the scaffold is useful for the reading task and how clear and easy it is to navigate and use. These perceptions should not be treated as direct measures of comprehension or metacognitive regulation.

Future studies should also test the timing, frequency, and intensity of the support. They could compare different proficiency levels and academic genres, examine strategically placed prompts against fixed-frequency prompts, and test whether more explicit support is especially useful for less proficient or less experienced readers.

Future research should also test whether the effects transfer to independent reading. A scaffold may improve performance while it is available without changing how learners read on their own. Studies could therefore reduce the support gradually and then use unscaffolded reading tasks to see whether learners continue to plan, monitor, regulate, and evaluate without external prompts. This would show whether the framework supports only immediate performance or also more independent metacognitive regulation.

CONCLUSION

This concept paper proposes a framework for embedding metacognitive scaffolding in tertiary ESL online academic reading. Metacognitive regulation, rather than technology, is the starting point. Planning, monitoring and regulation, and evaluation determine what support learners need, while the before-, during-, and after-reading stages provide a practical structure for deciding where that support should appear.

These processes are supported through stage-specific web-based scaffolds. The framework is not strictly linear: readers may move back to earlier processes as their needs change. The form and amount of support can also vary according to proficiency, academic genre, and reading purpose.

TAM is used separately to evaluate the web-based delivery through perceived usefulness and perceived ease of use. Keeping TAM outside the core metacognitive sequence makes a clear distinction between the reading support itself and learners' views of the technology used to deliver it.

The framework does not propose a new list of reading strategies. Its main contribution is a clear link between the purpose of metacognitive support, the point in the reading task where it is needed, the digital method used to deliver it, and a separate evaluation of the technology. This provides a practical conceptual basis for developing lightweight web-based reading support and for future research on its effects on comprehension, metacognitive regulation, and independent strategy use.

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