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# Effects of Strategy Instruction Types and Working Memory on English Reading Skills of Middle School Students*

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This study investigates the efficacy of metacognitive strategy instruction and private speech promotion strategy instruction on the inferential and critical reading skills of middle school students, considering the role of working memory. While existing literature has established that general metacognitive strategies can enhance learning outcomes, such approaches may neglect content knowledge and inadvertently lead to a mechanistic application of strategies. Grounded in Vygotsky's cultural-historical theory, which posits that private speech plays an important role in cognitive development in subject matters, this research addresses a gap regarding the impact of private speech promotion on English reading comprehension. The study yielded several key findings. Firstly, students with higher working memory capacity demonstrated superior performance compared to their peers with lower working memory. Secondly, participants receiving strategy instruction exhibited significantly enhanced inferential and critical reading skills compared to those in a general instruction group. Notably, the private verbal facilitation strategy instruction group outperformed the metacognitive strategy instruction group in these areas. Finally, an interaction effect was observed between the types of strategy instruction and the visuospatial sketchpad's influence on critical reading skills.

*Keywords : Strategy instruction, Metacognitive strategy instruction, Private speech promotion strategy instruction, Working memory, Reading skills*

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## Introduction

In secondary school education, reading is not only the key to academic success but also an important factor in the overall development of individuals. According to Ahmadi et al. (2013), EFL/ESL students struggle with English reading comprehension. Successful reading comprehension is not a passive process but rather relies on intentional metacognitive processing.

Over the past three decades, metacognitive strategy instruction has emerged as a prominent and pivotal area of focus in educational research (Koda, 2007). Reading teaching that integrates metacognitive strategies into learner's reading activities and promotes strategic reading behavior is helpful to the development of student's reading skills (Aghaie & Zhang, 2012; Dabarera et al., 2014; Fathi & Afzali, 2020; Tavakoli & Koosha, 2016). Researchers (Fisher & Frey, 2008) have expressed apprehension that the implementation of strategy instruction may lead to excessive rigidity. Building knowledge is an important but neglected part of improving language comprehension (Cabell & Hwang, 2020). According to Catts and Kamhi (2017), individualizing reading comprehension instruction based on students' abilities, using specific texts and tasks, and incorporating accessible content knowledge is what optimizes the effectiveness of reading comprehension instruction. General strategy instruction may be overly focused on strategies at the expense of content knowledge. Petscher et al. (2020) suggest that reading instruction and content-area learning can be taught and integrated simultaneously, a promising but not yet compelling area of research.

In Vygotsky's cultural-historical theory, cognitive development is understood as a process of conceptual appropriation and internalization of scientific concepts, mediated through interpersonal interactions between a teacher and a student. Consequently, effective teaching and learning processes that foster cognitive development must incorporate high-quality language activities. Vygotsky (1986)

posited that language development unfolds in three stages: first, children acquire social language through interactions; next, they progress to private speech, wherein they verbalize thoughts without regard for an audience; and finally, this private speech evolves into inner speech, which serves to guide behavior and thought processes. Teaching, therefore, is a process of mediating scientific concepts through language activities, while the learning process is fundamentally driven by the learner's inner speech. Liu (2023) suggests that the implementation of scaffolding instruction through private speech is a viable pedagogical strategy that can effectively facilitate students' task completion and problem-solving skills. The current literature has a dearth of empirical studies that address the significance of language activities in the classroom. In this study, language activities were implemented as a strategy to enhance students' private speech and, consequently, their reading comprehension.

Working memory is acknowledged as a crucial component in the comprehension process, contributing to individual differences in comprehension abilities (Baddeley, 2017). A robust positive correlation between working memory and reading comprehension has been consistently demonstrated, not only in both first-language (L1) and second-language (L2) contexts (Chow et al., 2021; Li & Clariana, 2019; O'brien et al., 2007). Furthermore, various studies have indicated that metacognitive strategies can enhance working memory performance. Research suggests that readers with learning disabilities tend to employ metacognitive strategies more extensively, enabling them to reflect on and regulate their cognitive processes, as well as to utilize compensatory mechanisms to mitigate their deficits in vocabulary and working memory (Swanson & Trahan, 1996).

In the study conducted by Jones et al. (2020), the MetaCogmed intervention-an integration of working memory training and metacognitive strategy instruction-was found to enhance mathematical reasoning. However, the addition of metacognitive strategy instruction did not yield any significant benefits for mathematics or reading comprehension when compared to the Cogmed intervention, which focused solely

on working memory. One potential explanation for this finding is that the application of newly acquired strategies may impose additional demands on limited working memory capacity (Carpenter et al., 1990), thereby diminishing the efficacy of the MetaCogmed intervention. Consequently, this study aims to provide novel insights into the interplay between strategy interventions and working memory interventions by examining whether an interaction exists between strategy instruction and working memory.

Numerous studies have investigated reading skills as a unified construct, often overlooking the multilayered complexity of comprehension that occurs during second language learners' interactions with texts. Each level of comprehension demands distinct cognitive processes (Rawson & Kintsch, 2005). Consequently, reliance on literal reading alone fails to yield a comprehensive understanding of the content (King, 2007). Inferential reading skills are essential for effective text comprehension (Saadatnia et al., 2017). Furthermore, critical reading has been insufficiently addressed in the literature, despite its significance across various educational domains (Wallace, 2003). Narrative texts, which are prevalent in middle school curricula, provide valuable opportunities for readers to engage critically with the author's perspectives, language choices, character roles, and both implicit and explicit ideas, as well as to make inferences about the plot's content.

As mentioned above, the research questions set in this study are as follows:

First, is private speech promotion instruction a more effective strategy than metacognitive strategy instruction in enhancing middle school students on inferential and critical English reading skills?

Second, do strategy instruction type and working memory have main and interaction effects on inferential and critical reading skills in middle school English reading?

# Literature Review

## Reading skills

Reading aims to construct meaning through context (Sweet & Snow, 2002). This interaction with the text occurs when readers bring their background knowledge to the text and make connections between the pieces of information presented, resulting in the creation of a mental representation (Meneghetti et al., 2006), or constructing a situation model (Graesser et al., 1994). The concept of three levels of reading was first proposed by Herber in 1970 and further developed by Vacca in 1999. These three levels include literal reading, inferential reading, and critical reading.

Literal reading skills are the most fundamental and rudimentary level of reading proficiency, which enables readers to comprehend information presented directly in the text (Basaraba et al., 2013). It solely presents the author's propositional information without generating novel insights to expand and refine the text base for its integration with the situational representation of the actual content. Inferences are crucial for comprehending a text, as texts typically do not provide all the relevant information about situations or events, resulting in fragmented and disconnected meanings. Therefore, to comprehend a text successfully, the reader must generate inferences to fill any gaps and construct a coherent mental model that integrates all information presented in the text (McNamara,2021; Zwaan & Singer, 2003). Critical reading involves establishing connections between the content of the reading material and personal values, attitudes, and standards (Din, 2020). It requires a deeper cognitive processing of information to make judgments about reality, facts, and opinions.

## Strategy instruction types and reading skills

### Metacognitive strategy instruction and reading skills

Metacognition, though subject to varying definitions by different theorists, is broadly understood to encompass both metacognitive knowledge and the processes involved in planning, monitoring, controlling, revising, and evaluating one's cognitive activities (Kim, 1994). The metacognitive theory provides the foundational framework for the development of metacognitive strategies. Flavell (1979) defined metacognitive strategies as the cognitive and behavioral adjustments learners implement during the learning process to meet specific educational goals. In the context of language learning, O'Malley and Chamot (1990) described metacognitive strategies as involving the acquisition of diverse knowledge types, the establishment of learning objectives and plans, continuous monitoring of the learning process, and the evaluation of learning outcomes. These strategies require learners to engage in active reflection on their cognitive processes throughout the learning experience. In this study, metacognitive strategies include pre-reading planning, monitoring, controlling, revising while reading, and post-reading evaluation. Planning strategy refers to planning and completing tasks, predicting outcomes, selecting strategies, imagining solutions to problems, and estimating the efficacy of these solutions in relation to the specific goals of cognitive activities, before the commencement of reading activities. Cognitive monitoring, controlling, and revising refers to monitoring and controlling the planning or understanding of the text during reading and proposing "correction" strategies when meaning is disrupted. Cognitive evaluation is the process of concluding and adjusting individual learning after reading.

Proficient readers generate inferences by integrating textual information with prior knowledge, facilitating the construction of new meanings during the reading process (Van den Broek et al., 2001). Effective readers demonstrate metacognitive awareness by recognizing the boundaries of their existing knowledge and identifying gaps when encountering new information. They continuously monitor and control their

cognitive processes, making necessary adjustments to optimize comprehension efficiency. Nicolielo-Carrilho et al. (2018) found that children with lower proficiency in problem comprehension, particularly inference-related tasks, exhibited lower scores on the metacognitive reading strategies scale. Inciarte-González et al. (2024) showed that with a positive correlation between the categories of metacognitive strategies and inferential reading comprehension. Critical comprehension tasks necessitate that readers evaluate newly acquired information in relation to their prior knowledge or experiences to assess its relevance and contribution to their understanding of the text's subject matter. Halpern (1998) integrated metacognition and critical thinking into a unified model, positing that a critical thinker is one who actively governs their cognitive processes, a control facilitated by metacognitive strategies (Halpern, 1998; Sadeghi et al., 2014). A notable positive correlation was observed between critical thinking and the utilization of metacognitive strategies in reading (Marboot et al., 2020). Consequently, it can be predicted that the application of metacognitive strategy instruction exerts a positive influence on both inferential comprehension and critical reading abilities.

**Private speech promotion strategy instruction and reading skills**

Vygotsky (1987) asserts that all functions in a child's cultural development are internalized twice: first on the social plane and later on the individual plane. He introduced the concept of the Zone of Proximal Development (ZPD), which refers to the range of tasks that a child is unable to perform independently but can accomplish with the guidance and support of a more knowledgeable individual. Vygotsky (1997) also emphasized that instrumental activities serve as a link between the human world and others, where material tools mediate human interactions with external objects. In contrast, psychological tools-such as symbols, signs, and language-are internally oriented, transforming basic cognitive processes into more advanced mental functions. The concept of mediated activity, as introduced by Vygotsky, was further expanded by researchers like Leontiev, leading to the

development of activity theory.

Language, in Vygotsky's view, is the most powerful tool available to humans. He (1986) identified three stages in language development: social speech (up to age 3), where speech is used to control the behavior of others and express basic thoughts and emotions; private speech (ages 3-7), during which children verbalize their thoughts aloud to guide their actions, regardless of an audience; and inner speech, which becomes silent and is used to direct internal thought processes. Vygotsky (1986) argued that through private speech, children engage in self-regulation and problem-solving, using language to formulate plans that guide their cognitive activities.

Figure 1 depicts Vygotsky's model of teaching and learning processes (Werani, 2018). At the instructional level, teachers must recognize that they serve as models for students to imitate, especially when demonstrating language activities. The externalization of teachers' cognitive processes is vital for the development of students' inner speech, as teachers use external speech to provide instruction and guidance throughout the learning process. Students should be encouraged to actively engage in self-directed speech, which plays a key role in the internalization of language. In this context, private speech offers valuable insights into learners' cognitive processes within the classroom. The shift from external speech to inner speech represents a dynamic formative process, where ongoing internalization fosters the development of inner speech, ultimately contributing to higher psychological functioning.

In the teaching process, the development of private speech should focus on two key aspects: first, teachers should provide scaffolding through knowledge and model effective language activities, enabling their instructional language to serve as a framework for students' internalization. This allows students to adopt and apply effective language activities. Second, students must practice using constructive and effective self-directed speech in order to internalize these processes. Teachers should intervene when necessary to correct ineffective language use, ensuring that students engage in positive and functional self-directed speech that supports their cognitive

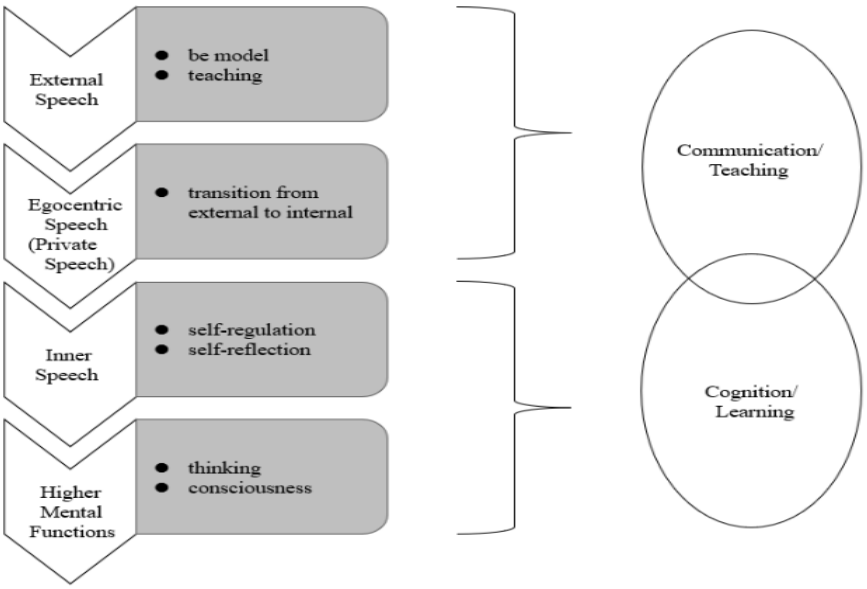


*Figure 1*. Vygotsky's model of teaching and learning processes (Werani, 2018)

development.

When encountering unfamiliar words during reading, inner speech functions as an internal rehearsal mechanism, facilitating the retrieval of meanings for unknown or infrequent vocabulary items. Concurrently, this internal dialogue enables the storage and retrieval of information and supports metacognitive processes, which involve making inferences about one's knowledge. An expanding body of research indicates that private or inner speech improves children's performance on a range of memory, planning, and problem-solving tasks (Lidstone et al., 2010; Vygotsky, 1986). Salmon (2008) found that the application of thinking routines fosters positive attitudes toward thinking and learning, as these routines promote the development of metacognitive and critical thinking skills in children, thereby increasing their awareness of situations that require cognitive engagement. According to Salmon, private speech enhances critical thinking by facilitating the consideration of alternatives and consequences, and it supports reasoned decision-making. Thus, it can be inferred that the implementation of instructional strategies aimed at

promoting private speech positively influences both inferential and critical reading skills.

Based on the aforementioned discussion, it can be posited that both metacognitive strategy instruction and private speech promotion strategies can enhance students' inferential and critical reading comprehension. The utilization of metacognitive strategies affords learners the capacity to exert greater control over their learning processes and cognitive approaches. Private speech serves as a significant tool for metacognitive regulation, playing a vital role in cognitive processing by aiding students in organizing their thoughts, strengthening memory and comprehension, and regulating their attention and behavior. Consequently, it can be inferred that instruction focused on promoting private speech yields superior outcomes in inferential and critical reading comprehension compared to traditional metacognitive strategy instruction.

## Working memory and reading skills

### Multi-component model of working memory

In the field of cognition and neuropsychology, working memory is a system that temporarily holds and manipulates information needed for complex tasks such as comprehension, learning, and reasoning (Baddeley, 1992). Baddeley (1983) proposed that human working memory encompasses various functions and components that facilitate complex cognitive processes. These include the central executive, the phonological loop, and the visuospatial sketchpad (see Figure 2).

The central executive is a crucial component of working memory and acts as a control system with limited attention resources. It plays a vital role in coordinating the activities of the phonological loop and the visuospatial sketchpad, allocating and controlling attention resources, and employing selective attention and conversion strategies. The phonological loop handles voice-based information, such as reading text or listening to speech, and consists of voice storage and the process of

articulatory rehearsal. The visuospatial sketchpad is involved in the formation and manipulation of mental images. Working memory swiftly extracts and utilizes information from long-term memory to accomplish tasks.

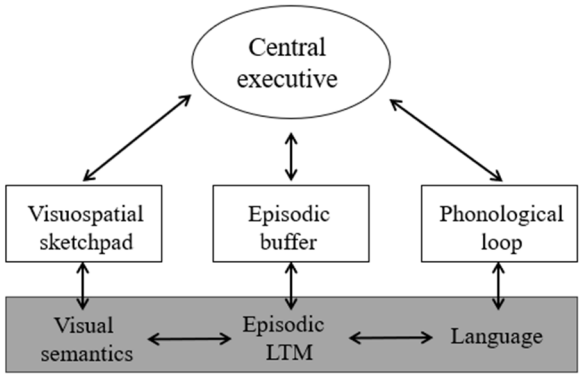


*Figure 2*. Multi-component Model of Working Memory (Baddeley, 2000)

**Working memory and inferential reading skills, critical reading skills.**

Working memory is utilized during reading to retain new information in short-term storage, retrieve relevant data from long-term memory, and integrate this information to construct an accurate representation of the text's meaning. In this capacity, working memory is essential for both information processing and storage. In tasks involving information processing, such as reading, the cognitive load increases with the number of elements being processed simultaneously, which can ultimately lead to cognitive overload. This overload impairs the ability to recall information and negatively impacts learning outcomes. The inherent difficulty level associated with a task may not be easily altered by external factors such as instructions or learning experiences (Chandler & Sweller, 1991). In simple comprehension tasks, differences in readers' performance may be less noticeable. However, in more difficult or demanding tasks, the differences become more apparent (Just & Carpenter, 1992). The increased cognitive load required for inferential and critical understanding may explain why students find inferential and critical reading

questions more challenging than those focused on basic literal comprehension

Varol and Ercetin (2021) demonstrate that individuals with low working memory capacity face substantial challenges in constructing a coherent mental representation of the text, leading to diminished inferential comprehension. At the critical reading level, individuals are required to analyze and evaluate the information acquired through reading in relation to their prior knowledge and experiences, while simultaneously encoding this knowledge into long-term memory and retaining the relevant text information in working memory (Basaraba et al., 2013). It can be inferred that a low working memory capacity impairs the ability to effectively manage complex cognitive processes, such as inferential and critical reading.

The phonological loop plays a critical role in the process of reading text. When processing textual information, linguistic symbols must first be interpreted, which significantly contributes to the initial decoding process. This mechanism facilitates the effective allocation of attention, memory, and reasoning skills toward text comprehension (Wagner et al., 1987). Similarly, the visuospatial sketchpad is essential for both the formation and manipulation of mental images (Quinn & Ralston, 1986). For instance, when individuals receive directions to a route through auditory or written instructions, they may generate mental imagery, such as visualizing themselves navigating the route or conceptualizing the spatial arrangement of described elements. These mental images aid in constructing a coherent understanding of the described situation, thereby enhancing the processing of visuospatial passages (De Beni & Moè, 2003). In other words, during reading, the activation of mental imagery occurs concurrently with the formation of a novel mental model. The central executive function is related to memory and comprehension of texts. It is responsible for connecting and integrating verbal and visuospatial information, temporarily storing previously encountered information in working memory, and processing new information. Additionally, the central executive governs the allocation of attention to relevant information and the retrieval of pertinent details from long-term memory. Consequently, students with high

working memory capacity-encompassing the phonological loop, visuospatial sketchpad, and central executive-are likely to outperform their peers with low working memory capacity in inferential and critical reading skills.

## Strategy instruction type and working memory

The acquisition of novel strategies is contingent upon declarative representations and serial cognitive processes that are reliant on a substantial working memory capacity (Anderson, 1987). When the demands of cognitive processes performed at a given point in time exceed capacity constraints, they interfere with each other, leading to impaired or slowed-down performance. It is reasonable to assume that these two general principles also apply to the interaction of metacognitive reading strategies with other cognitive processes. Kanfer and Ackerman (1989) demonstrated that in complex tasks, excessive metacognitive activity can be counterproductive if the necessary skills for task completion are not sufficiently automated. Most learners' working memory resources are needed for basic reading, so children with relatively small working memory capacity may be easily overburdened by metacognitive strategies, which may even lead to poor learning effects after training.

According to Baddeley's model of working memory, inner speech is an important part of working memory. Inner speech is also the voice used to activate the articulatory loop, a mechanism that generates speech sounds in the mind to facilitate the processing of verbal information, whether seen or heard. The articulatory loop is utilized for the subvocalization of auditory and visual stimuli during language processing. This helps to store limited information in multiple processing units at any time (Baddeley, 2007) and eventually convert it into long-term memory, enhancing working memory, via the phonological loop (Marvel & Desmond, 2012; Baddeley, 1986), and can greatly reduce the cognitive load in working memory (Eysenck & Keane, 1995).

Higher working memory capacity is associated with enhanced attentional control,

enabling individuals to effectively manipulate information while minimizing processing interference (Angelopoulou et al., 2021; Engle, 2002). In contrast, individuals with low working memory capacity are more inclined to rely on contextual cues that may activate irrelevant information, resulting in slower and less accurate recall (Unsworth & Engle, 2007). Building on the reviewed research, it can be anticipated that individuals with high working memory capacity may experience less improvement in achievement from additional strategy instruction (Turley-Ames & Whitfield, 2003). This is because they are capable of independently engaging in cognitive activities to solve problems, such as comprehending sentences and constructing related mental models, without the need for strategic assistance.

Consequently, for students with high working memory, there may be no significant difference in inferential and critical reading skills when comparing metacognitive strategy instruction with private speech promotion strategy instruction. Conversely, for students with low working memory capacity, those who receive instruction in private speech promotion strategies are likely to demonstrate higher levels of inferential and critical reading skills compared to their peers who receive metacognitive strategy instruction.

# Method

## Participants

In China, students begin to systematically study English in middle school, and the Compulsory Education English Curriculum Standards (2022) emphasize the development of reading comprehension skills, particularly focusing on inferential and critical thinking abilities. Eighth-grade students, having completed seventh grade, possess a foundational vocabulary and basic grammar knowledge, which establishes a preliminary reading base. Ninth-grade students, facing considerable academic

pressure, experience learning across all subjects primarily centered around examination preparation. Consequently, selecting the eighth grade as the focus of this study is both a rational and necessary decision.

The participants in this experiment consisted of three eighth-grade classes at a middle school in Fuyang City, China. The sample comprised 120 students, with 40 assigned to the control group (general instruction) and 40 each in experimental group 1 (metacognitive strategy instruction) and experimental group 2 (private speech promotion strategy instruction). Due to some absences, data analysis was conducted on a total of 112 participants, consisting of 60 male students and 52 female students. The demographics of the participants are presented in Table 1. The ages of the students ranged from 13 to 16 years. Despite the varying ages, all participants were in the eighth grade and attended school in the same region of China, thereby receiving comparable curriculum content and educational experiences. The experiment was conducted within the context of a standard English course, with all three classes instructed by the same teacher using a uniform textbook, thereby ensuring a consistent classroom atmosphere conducive to effective experimentation. Neither the control group nor the experimental groups received any metacognitive or private speech promotion strategies before the study.

Table 1
*The Demographics of the Three Groups*

| Group | Male<br>N (Percent) | Female<br>N (Percent) | Total<br>N (Percent) |
|---|---|---|---|
| MSI | 22(19.6%) | 15(13.4%) | 37(33.0%) |
| PSPSI | 18(16.1%) | 19(17.0%) | 37(33.0%) |
| Control group | 20(17.9%) | 18(16.1%) | 38(33.9%) |
| Total | 60(53.6%) | 52(46.5%) | 112(100%) |

Note. MSI = metacognitive strategy instruction; PSPSI= private speech promotion strategy instruction.

## Measures

**Working memory capacity.**

Working memory includes central executive, phonological loop, and visuospatial sketchpad according to Baddeley's working memory model. We used the star counting tests used in Oberauer's (2000) study, the reading span test, and the pattern transformation test developed by Kim (2011) for Korean students. Students were divided into high and low working memory groups based on their median scores on each test. In this study, the alpha value of the star counting test was 0.83, the alpha value of the reading span test was 0.85, and the alpha value of the pattern transformation test was 0.80, indicating satisfactory reliability.

**Inferential reading skills and critical reading skills**

In this study, a self-designed middle school English reading test was used as a data collection tool (there were two sets of pretest and posttest). The pretest and posttest reading texts were taken from previous mock exam papers that the test content aligns with the competence requirements for eighth grade. These texts were chosen and compiled by the responsible teaching instructor, and input was also sought from three English teachers and one English supervisor within the school. The test paper format is identical. Each exam contains 20 questions, there were 12 inference questions and 8 critical questions. The alpha values of 0.80 and 0.83 for the pretest and posttest, inferential reading skills, and the alpha values of 0.76 and 0.72 for the pretest and posttest critical reading skills.

**Learning time**

In this study design, learning time is regarded as a covariate. The instruction time of the control group was 30 minutes for general instruction, the instruction time of the metacognitive strategy instruction group was 40 minutes for metacognitive strategy guidance based on general instruction, and the instruction time of the private

speech promotion strategy instruction group was 45 minutes for providing scaffolding. And the same class of students after the teacher's instruction, their own learning time is different. Each student was required to use a timer to record their learning time for each class from the beginning of the teacher's instruction until the end of individual study. Calculate the average for each group.

**Experimental design**

A non-equivalent control group pretest-posttest design was used for this study (see Table 2).

Table 2
*Non-equivalent Control Group Pretest-posttest Design*

| Groups | Pre-tests | Instructional treatments | Post-tests |
|---|---|---|---|
| G1 | O1 O2 O3 | | O4 O5 |
| G2 | O1 O2 O3 | X1 | O4 O5 |
| G3 | O1 O2 O3 | X2 | O4 O5 |

G1: Control group: General instruction
G2: Experiment group 1 X1: Metacognitive strategy instruction
G3: Experiment group 2 X2: Private speech promotion strategy instruction
O1: Working memory test
O2, O4: Pretest, posttest of inferential reading skills
O3, O5: Pretest, posttest of critical reading skills

## Experimental settings and materials

**Metacognitive strategy instruction settings**

Based on general instruction, emphasis is placed on direct and explicit instruction in metacognitive strategies.

Before formal instruction, the teacher and Experimental Group 1 had a general discussion on metacognitive strategies. Following the instruction plan, the teacher focused on strengthening metacognitive strategy training in reading classes (see Table 3).

Table 3
*Metacognitive Strategy Instruction*

| | | |
|---|---|---|
| Pre-reading | Planning | After the simple question was introduced into the teaching, The teacher taught new words and phrases from the article.<br>The teacher emphasized the planning strategies and demonstrated how to use them. The students were asked to decide on a reading plan based on questions. Include:<br>1. What is my goal?<br>2. What kind of information and strategies do I need?<br>3. How much time will I need? |
| While-reading | Monitoring<br>Controlling<br>Revising | Before the students officially began reading, the teacher emphasized the monitoring, controlling, and revising strategies and demonstrated how to use them. Teachers made students know how to ask questions about the reading content and answer the questions. Include:<br>1. How much do I know about what I am reading?<br>2. Am I reaching my goal?<br>3. what part of the text is blocking my understanding?<br>4. Is the strategy effective? Do I need to modify it?<br>5. Can I find the relevant content in the text to answer each question?<br>The students read the article on their own. The teacher guided the students in analyzing and questioning the main ideas, inferences, and the author's intent in the text. Then, the teacher revisited the learned phrases and grammar in context. The students re-read the article and completed the exercises. |
| Post-reading | Evaluating | After reading, the teacher demonstrated how to conduct a reflective evaluation of their reading and then guided the students to conduct a reflective evaluation themselves. Include:<br>1. Check that I have accomplished my reading goals. Is my reading plan reasonable?<br>2. Assessed learning outcomes, how effectively were the strategies used?<br>3. How much do I understand?<br>4. What problems did I encounter in reading, and how did I solve them?<br>Then, the teacher asked the students to memorize the keywords and phrases, the grammar, and the key sentence patterns in the articles. |

Table 4

*Private Speech Promotion Strategy Instruction*

| | | |
|---|---|---|
| Pre-reading | | After the introduction of a simple question into the teaching process, elucidated scientific concepts about text A1.<br>Cognitive scientific concepts: vocabulary, grammar, topic concepts.<br>Metacognitive scientific concepts: planning, monitoring, controlling, modification, evaluating. |
| While-reading | scaffolding | The students read the article on their own. The teacher assisted students in the instruction of reading A1, teaching reading in combination with the use of scientific concepts, and analyzing and questioning the main ideas, inferences, and the author's intent in the text. The teacher expressed their reading and thought process in detail. During this time, The teacher used "questions", "reminders", "hints" and "explanations" to build help students understand the text.<br>Questions: "What are their volunteer activities?", or "How do they feel about volunteering?" to help students focus on the main ideas of the article and check their understanding.<br><br>Reminders: The teacher can remind the students of relevant vocabulary words or sentence structures that they have learned before, such as "animal hospital" and "want to do sth".<br><br>Hints: When teaching the word "volunteer".<br><br>Explanation: In the passage, it mentions that Mario and Mary give up several hours each week to help others. What do you think this suggests about the meaning of "volunteer"?<br>The students re-read the article and completed the exercises. |
| Post-reading | practice | Students read text A2 independently and answered the relevant questions. Encouraged students to freely express their thoughts during the comprehension process.<br><br>Pre-reading, the teacher reminded the students:<br>1. Recall the scientific concepts learned in teaching and what the teacher said in teaching text A1.<br>2. Think carefully about what missed. If missed something, use it again to solve the problem. |

**Private speech promotion strategy instruction settings**

The teacher, as a model, has internalized many scientific concepts and should focus on using effective language activity patterns. The instruction process was divided into two parts, the teacher provided scaffolding in text A1 and students practiced in text A2 (see Table 4). A1 and A2 had similar themes.

**Control group settings (General instruction)**

Following the instruction plan, the mode of instruction was 'word-sentence-text. (see Table 5).

Table 5
*General Instruction*

| | |
|---|---|
| Pre-reading | After introducing a simple question into the lesson, the teacher displayed pictures related to the topic to stimulate students' interest.<br>The teacher taught new words and phrases from the article. Then, the students were asked to read the article and understand the words in context. |
| While-reading | The students read the article on their own and summarized its main points. The teacher guided the students in analyzing and questioning the main ideas, inferences, and the author's intent in the text. Then, the teacher revisited the learned phrases and grammar in context. The students re-read the article and completed the exercises. |
| Post-reading | The teacher asked students to memorize the keywords and phrases, the grammar, and the key sentence patterns in the articles. |

**Experimental procedure**

After consulting with the teacher responsible for the instruction, assistance was provided in recruiting participants for the study. Explanatory texts outlining the study's objectives and procedures were distributed across the three classes, accompanied by detailed explanations regarding the experiment's content; recruitment was conducted on a voluntary basis. Prior to deciding on participation, discussions were held with parents about the study. All participating students

submitted a written commitment statement, and their parents or guardians were also provided with explanatory texts and asked to sign a commitment statement. The three classes were randomly assigned to experimental group 1 (metacognitive strategy), experimental group 2 (private speech promotion strategy), and the control group (general instruction) through a lottery system.

One week prior to the commencement of the experiment, students were required to complete pre-reading assessments and working memory evaluations. Subsequently, six English lessons were conducted by the same experienced English teacher for each group, with one narrative text analyzed in each lesson. During each session, the three groups were instructed to monitor their learning time. Following the six lessons, the students undertook a reading posttest.

## Data analysis

In this study, the independent variables are strategy instruction types and working memory: central executive (CE), phonological loop (PL), and visuospatial sketchpad (VSSP). There were three groups: a control group, a metacognitive strategy instruction group (MSI), and a private speech promotion strategy instruction group (PSPSI). There were two levels of students' working memory: high or low. The covariates were a pretest of inferential reading skills (PreIRS), a pretest of critical reading skills (PreCRS), and learning time. Besides, the dependent variables are inferential reading skills (IRS), and critical reading skills (CRS). SPSS 25.0 was utilized for data analysis. First, descriptive statistics and the correlation coefficient between variables were presented. Second, a two-way ANCOVA, along with planned comparisons and simple comparisons, was conducted to investigate the effects of different types of strategy instruction and working memory on inferential and critical reading skills, while controlling for pretest scores in inferential and critical reading skills and learning time. Statistical hypothesis testing was performed at a significance level of .05.

# Results

## Descriptive statistics

This study aimed to examine the impacts of strategy instruction type and working memory on inferential reading skills, and critical reading skills. As shown in Table 6, all variables had a normal distribution since the absolute values of skewness and kurtosis were less than 1 and 7.

Table 6
*Descriptive Statistics among Variables*

| | M | SD | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| PreIRS | 11.21 | 3.93 | 2 | 18 | .225 | .417 |
| PreCRS | 8.87 | 2.26 | 4 | 14 | .014 | .135 |
| IRS | 17.54 | 4.09 | 8 | 24 | .324 | .605 |
| CRS | 12.09 | 3.38 | 2 | 18 | .368 | .127 |

## Effects of strategy instruction type and working memory on inferential reading skills

Two-way ANCOVA was conducted respectively to analyze the effects of strategy instruction type and working memory on inferential reading skills. No significant difference was found among the three groups in the pretest scores of inferential reading skills: $F(2,112) = 1.28$, $p > .05$, implying that all groups had a similar level of inferential reading skills.

**Effects of strategy instruction type and central executive.**

After checking that the regression homogeneity assumption was not violated, Two-way ANCOVA was conducted. As shown in Table 7, the main effect of strategy

instruction [F (2, 112) = 8.13, p < .05, $\eta^2$= .135] and central executive [F (1, 112) = 4.93, p < .05, $\eta^2$ = .045] was statistically significant. Specifically, the high central executive had significantly better than the low central executive (low=15.92; high=18.62). NO significant effect for the strategy instruction × central executive [F (2, 112) = .37, p >.05, $\eta^2$ = .007). Planned comparisons were conducted to compare the effect of strategy instruction type. The findings revealed that the experimental groups demonstrated significantly superior performance compared to the control group, the score difference between the PSPSI group and the control group was 11.80 (p < 0.05), and between the MSI group and the control group was 5.03 (p < 0.05). Students who received PSPSI better inferential reading skills compared to those who received MSI, with a score difference of 6.77(p < 0.05).

Table 7

*Two-Way ANCOVA Results of Inferential Reading Skills by Strategy Instruction Type and Central Executive*

| Source | SS | df | MS | F | p | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| PreIRS | 60.61 | 1 | 60.61 | 5.14 | .026 | .047 |
| Learning time | 70.72 | 1 | 70.72 | 5.99 | .016 | .054 |
| Strategy Instruction(A) | 192.02 | 2 | 96.01 | 8.13 | .001 | .135 |
| CE (B) | 58.23 | 1 | 58.23 | 4.93 | .029 | .045 |
| A × B | 8.84 | 2 | 4.42 | .37 | .689 | .007 |
| Error | 1227.61 | 104 | 11.81 | | | |

**Effects of strategy instruction type and phonological loop.**

After checking that the regression homogeneity assumption was not violated, Two-way ANCOVA was conducted. As shown in Table 8, the main effect of strategy instruction [F (2, 112) = 8.38, p < .05, $\eta^2$= .139], and phonological loop [F (1, 112) = 402.48, p < .05, $\eta^2$ = .310] was statistically significant. Specifically, the high phonological loop was significantly better than the low phonological loop

Table 8

*Two-Way ANCOVA Results of Inferential Reading Skills by Strategy Instruction Type and Phonological Loop*

| Source | SS | df | MS | F | p | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| PreIRS | 33.74 | 1 | 33.74 | 3.92 | .036 | .035 |
| Learning time | 55.56 | 1 | 55.56 | 6.46 | .012 | .058 |
| Strategy Instruction(A) | 144.16 | 2 | 72.08 | 8.38 | .000 | .139 |
| PL (B) | 402.48 | 1 | 402.48 | 46.81 | .000 | .310 |
| A × B | 1.66 | 2 | .83 | .100 | .908 | .002 |
| Error | 894.293 | 104 | 8.60 | | | |

(low=15.85; high=21.10). NO significant effect for the strategy instruction × phonological loop [F (2, 112) = 0.10, $p > .05$, $\eta^2 = .002$]. Planned comparisons were conducted to compare the effect of strategy instruction type. The findings revealed that the experimental groups demonstrated significantly superior performance compared to the control group, the score difference between the PSPSI group and the control group was 10.36 ($p < 0.05$), and between the MSI group and the control group was 5.30 ($p < 0.05$). Students who received PSPSI better inferential reading skills compared to those who received MSI, with a score difference of 5.06 ($p < 0.05$).

**Effects of strategy instruction type and visuospatial sketchpad.**

After checking that the regression homogeneity assumption was not violated, Two-way ANCOVA was conducted. As shown in Table 9, the main effect of strategy instruction [F (2, 112) =10.00, $p < .05$, $\eta^2 = .161$] and visuospatial sketchpad [F (1, 112) = 5.46, $p < .05$, $\eta^2 = .05$] was statistically significant. Specifically, the high visuospatial sketchpad was significantly better than the low visuospatial sketchpad (low=17.20; high=18.64). NO significant effect for the strategy instruction × visuospatial sketchpad [F (1, 112) = .78, $p > .05$, $\eta^2 = .015$]. Planned comparisons were conducted to compare the effect of strategy instruction type. The findings

revealed that the experimental groups demonstrated significantly superior performance compared to the control group, the score difference between the PSPSI group and the control group was 13.41 ($p < 0.05$), and between the MSI group and the control group was 6.66 ($p < 0.05$). Students who received PSPSI better inferential reading skills compared to those who received MSI, with a score difference of 6.76 ($p < 0.05$).

Table 9

*Two-Way ANCOVA Results of Inferential Reading by Strategy Instruction Type and Visuospatial Sketchpad*

| Source | SS | df | MS | F | p | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| PreIRS | 49.30 | 1 | 49.30 | 4.19 | .043 | .039 |
| Learning time | 114.90 | 1 | 114.90 | 9.77 | .002 | .086 |
| Strategy Instruction(A) | 235.24 | 2 | 117.62 | 10.00 | .000 | .161 |
| VSSP (B) | 64.22 | 1 | 64.22 | 5.46 | .021 | .050 |
| A × B | 18.40 | 2 | 9.20 | .780 | .460 | .015 |
| Error | 1223.22 | 104 | 11.76 | | | |

## Effects of strategy instruction type and working memory on critical reading skills

Two-way ANCOVA was conducted respectively to analyze the effects of strategy instruction type and working memory (central executive, phonological loop, and visuospatial sketchpad) on critical reading skills. No significant difference was found among the three groups in the pretest scores of critical reading skills: $F(2,112) = .076$, $p > .05$, implying that all groups had a similar level of critical reading skills.

**Effects of strategy instruction type and central executive.**

After checking that the regression homogeneity assumption was not violated, Two-

way ANCOVA was conducted. As shown in Table 10, the main effect of strategy instruction [F (2, 112) = 17.47, $p < .05$, $\eta^2 = .257$] and central executive [F (1, 112) = 3.75, $p < .05$, $\eta^2 = .26$] was statistically significant. Specifically, the high central executive had significantly better than the low central executive (low=11.76; high=12.45). NO significant effect for the strategy instruction × central executive [F (2, 112) = .09, $p > .05$, $\eta^2 = .002$]. Planned comparisons were conducted to compare the effect of strategy instruction type. The findings revealed that the experimental groups demonstrated significantly superior performance compared to the control group, the score difference between the PSPSI group and the control group was 10.07 ($p < 0.05$), and between the MSI group and the control group was 6.08 ($p < 0.05$). Students who received PSPSI better inferential reading skills compared to those who received MSI, with a score difference of 3.99 ($p < 0.05$).

Table 10

*Two-Way ANCOVA Results of Critical Reading Skills by Strategy Instruction Type and Central Executive*

| Source | SS | df | MS | F | p | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| PreCRS | 184.85 | 1 | 184.85 | 41.14 | .000 | .309 |
| Learning time | 31.95 | 1 | 31.95 | 7.52 | .007 | .067 |
| Strategy Instruction(A) | 148.29 | 2 | 74.25 | 17.47 | .000 | .257 |
| CE (B) | 15.92 | 1 | 15.92 | 3.75 | .032 | .026 |
| A × B | .72 | 2 | .360 | .090 | .92 | .002 |
| Error | 441.99 | 104 | 4.25 | | | |

**Effects of strategy instruction type and phonological loop.**

After checking that the regression homogeneity assumption was not violated, Two-way ANCOVA was conducted. As shown in Table 11, the main effect of strategy instruction [F (2, 112) = 17.27, $p < .05$, $\eta^2 = .249$] and phonological loop [F (1, 112) = 20.39, $p < .05$, $\eta^2 = .046$] was statistically significant. Specifically, the high

phonological loop was significantly better than the low phonological loop (low=11.83; high=12.80). NO significant effect for the strategy instruction × phonological loop [F (2, 112) = 1.58, p > .05, $\eta^2$= .029]. Planned comparisons were conducted to compare the effect of strategy instruction type. The findings revealed that the experimental groups demonstrated significantly superior performance compared to the control group, the score difference between the PSPSI group and the control group was 9.56 (p < 0.05), and between the MSI group and the control group was 5.86 (p < 0.05). Students who received PSPSI better inferential reading skills compared to those who received MSI, with a score difference of 3.69 (p < 0.05).

Table 11

*Two-Way ANCOVA Results of Critical Reading Skills by Strategy Instruction Type and Phonological Loop*

| Source | SS | df | MS | F | p | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| PreCRS | 142.98 | 1 | 142.98 | 35.07 | .000 | .252 |
| Learning time | 20.66 | 1 | 20.66 | 5.07 | .026 | .046 |
| Strategy Instruction(A) | 140.80 | 2 | 70.40 | 17.27 | .000 | .249 |
| PL (B) | 20.39 | 1 | 20.39 | 5.00 | .027 | .046 |
| A × B | 12.45 | 2 | 6.23 | 1.58 | .220 | .029 |
| Error | 424.00 | 104 | 4.08 | | | |

**Effects of strategy instruction type and visuospatial sketchpad.**

After checking that the regression homogeneity assumption was not violated, Two-way ANCOVA was conducted. As shown in Table 12, the main effect of strategy instruction [F (2, 112) = 17.68, p < .05, $\eta^2$ = .254] and visuospatial sketchpad [F (1, 112) = 6.28, p < .05, $\eta^2$ = .057] was statistically significant. Specifically, the high visuospatial sketchpad was significantly better than the low visuospatial sketchpad (low=11.84; high=12.84). Significant effect for the strategy instruction ×

Table 12

*Two-Way ANCOVA Results of Critical Reading Skills by Strategy Instruction Type and Visuospatial Sketchpad*

| Source | SS | df | MS | F | p | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| PreCRS | 159.83 | 1 | 159.83 | 41.66 | .000 | .286 |
| Learning time | 25.52 | 1 | 25.52 | 6.65 | .011 | .060 |
| Strategy Instruction(A) | 135.70 | 2 | 67.85 | 17.68 | .000 | .254 |
| VSSP (B) | 24.11 | 1 | 24.11 | 6.28 | .014 | .057 |
| A × B | 32.96 | 2 | 16.48 | 4.30 | .016 | .076 |
| Error | 399.06 | 104 | 3.84 | | | |

visuospatial sketchpad [F (2, 112) = 4.30, $p < .05$, $\eta^2 = .076$]. Planned comparisons were conducted to compare the effect of strategy instruction type. The findings revealed that the experimental groups demonstrated significantly superior performance compared to the control group, the score difference between the PSPSI group and the control group was 9.26 ($p < 0.05$), and between the MSI group and the control group was 5.82 ($p < 0.05$). Students who received PSPSI better inferential reading skills compared to those who received MSI, with a score difference of 3.45 ($p < 0.05$).

Figure 3 displays the interaction effects between strategy instruction type and visuospatial sketchpad on critical reading skills. A simple effects analysis indicated that, as shown in Table 13, for students with low visuospatial sketchpad, there was no significant difference in critical reading skills between the experimental and control groups, F (1, 112) = 1.98, $p > .05$, $\eta^2 = .019$. However, there was a significant difference between the metacognitive strategy instruction group and the private speech promotion strategy instruction group, F (1, 112) = 42.12, $p < .05$, $\eta^2 = .288$. As for the students with high visuospatial sketchpad, there was a significant difference in critical reading skills between the experimental and control groups, F (1, 112) = 5.43, $p < .05$, $\eta^2 = .05$. However, there was a significant difference between

the metacognitive strategy instruction group and the private speech promotion strategy instruction group, $F(1, 112) = 18.53$, $p < .05$, $\eta^2 = .151$.

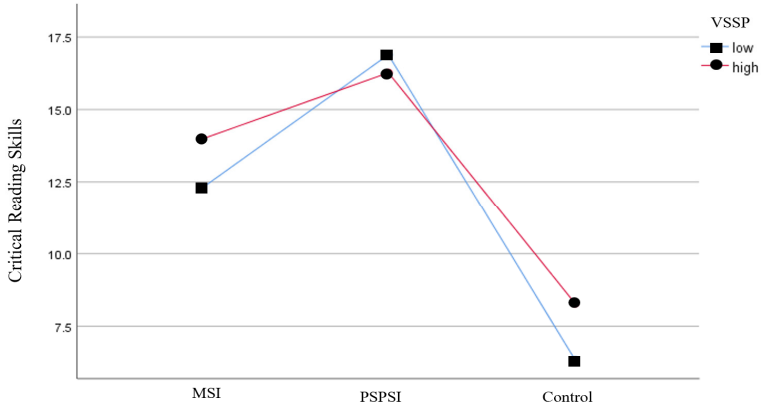


*Figure 3*. Interaction Effects between Strategy Instruction Type and Visuospatial Sketchpad on Critical Reading Skills

Table 13

*Analysis of Simple Main Effects of Strategy Instruction Type and Visuospatial Sketchpad on Critical Reading Skills*

| Source | *SS* | *df* | *MS* | *F* | *P* | *Partial* $\eta^2$ |
|---|---|---|---|---|---|---|
| SI @ low VSSP | | | | | | |
| Control vs. Experimental | 7.597 | 1 | 7.597 | 1.980 | .162 | .019 |
| MSI vs. PSPSI | 161.616 | 1 | 161.616 | 42.119 | .000 | .288 |
| SI @ high VSSP | | | | | | |
| Control vs. Experimental | 20.851 | 1 | 20.851 | 5.434 | .022 | .050 |
| MSI vs. PSPSI | 71.092 | 1 | 71.092 | 18.528 | .000 | .151 |
| Error | 399.059 | 104 | 3.837 | | | |

## Discussion and Conclusion

Based on the research outcome, students with high working memory (central

executive, phonological loop, and visuospatial sketchpad) students achieved significantly higher scores on inferential reading skills and critical reading skills than low working memory students. These findings are consistent with the viewpoints of many researchers (Archibald, 2017; Kim et al., 2002; Kim & Kim, 2013) that higher working memory leads to better learning outcomes because they have more cognitive resources. Therefore, more attention should be paid to working memory, not only in terms of overall working memory, but also in terms of the central executive, phonological loop, and visuospatial sketchpad, to improve learning outcomes in L2 reading comprehension.

Students with strategic support acquired better inferential reading skills and critical reading skills than students without strategies. It is consistent with the previous research results that strategy instruction is beneficial to reading (Mahdavi & Tensfeldt, 2013; Yapp et al., 2023). Private speech promotion strategy instruction is superior to metacognitive strategy instruction. Metacognitive strategy instruction is often emphasized, while content knowledge remains a crucial factor for students to comprehend text effectively (Willingham & Lovette, 2014). With private speech promotion strategy instruction, students internalized more scientific concepts related to reading comprehension, including both cognitive and metacognitive science concepts (Karpov & Haywood, 1998). Meanwhile, metacognitive strategies are general reading strategies and students' general reading strategies may not be suitable for reading in more detailed content areas (Goldman et al., 2016). Private speech promotion strategy instruction is a strategy for specific tasks. Another explanation may be that metacognitive strategies may impose cognitive load because of students' limited working memory.

The type of strategy instruction and the level of working memory—encompassing the central executive, phonological loop, and visuospatial sketchpad—did not demonstrate any interaction effect on inferential reading skills. The effectiveness of strategy instruction remained consistent across varying levels of working memory, indicating that private speech promotion strategy instruction consistently facilitates

the acquisition of inferential reading skills more effectively than metacognitive strategy instruction.

Similarly, no interaction was observed between strategy instruction type and the central executive or phonological loop concerning critical reading comprehension skills. The effectiveness of strategy instruction did not fluctuate with different levels of working memory. However, an interaction was noted between the strategy instruction type and the visuospatial sketchpad regarding critical reading comprehension skills. Specifically, the private speech promotion strategy was particularly effective among students with low visuospatial sketchpad capacity, while metacognitive strategy instruction proved to be more beneficial for students with high visuospatial sketchpad working memory.

A plausible explanation for this disparity lies in the presence of illustrations in the reading comprehension materials. These visual aids can enhance students' intuitive understanding of concepts by providing additional recall pathways for information stored in long-term memory, thereby increasing the likelihood of retrieval (Moore & Scevak, 1994). Conversely, for students with low working memory capacity, the demands of critical reading may occupy the majority of their working memory resources, rendering the use of metacognitive strategies burdensome, which aligns with findings from previous studies (Naumann et al., 2008).

The contributions of this study are outlined below. The findings indicate that educators should consider integrating strategy instruction into their instructional practices to improve student's learning outcomes in English reading, particularly emphasizing private speech promotion strategy instruction. There is a pressing need for further development and investigation into the implementation of private speech promotion strategy instruction in future research. Additionally, varying levels of working memory have been shown to significantly influence inferential and critical thinking skills. Therefore, when designing instructional approaches aimed at enhancing students' critical reading skills, it is essential to account for their working memory capacities. Furthermore, future research efforts that focus on the design and

implementation of diverse strategy instruction approaches should consistently consider the role of working memory.

Nonetheless, the empirical results reported in this study have some limitations. Firstly, In the posttest, real-time measurement of students' private speech was not conducted. Therefore, in future research, this aspect can be added to acquire and analyze the development of students' private speech. Secondly, further research is required to extend the application of research findings beyond English reading.

# References

Aghaie, R., & Zhang, L. J. (2012). Effects of explicit instruction in cognitive and metacognitive reading strategies on Iranian EFL students' reading performance and strategy transfer. *Instructional Science*, *40*(6), 1063-1081.

Ahmadi, M. R., Ismail, H. N., & Abdullah, M. K. K. (2013). The Importance of Metacognitive Reading Strategy Awareness in Reading Comprehension. *English Language Teaching*, *6*(10), 235-244.

Anderson, J. R. (1987). Skill acquisition: Compilation of weak-method problem situations. *Psychological Review*, *94*(2), 192-210.

Angelopoulou, E., & Drigas, A. (2021). Working memory, attention and their relationship: A theoretical overview. Research, *Society and Development*, *10*(5), e46410515288.

Archibald, L. M. (2017). Working memory and language learning: A review. *Child Language Teaching and Therapy*, *33*(1), 5-17.

Baddeley, A. (1983). Working memory. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, *302*(1110), 311-324.

Baddeley, A. (1992). Working memory. *Science*, *255*(5044), 556-559.

Baddeley, A. (2000). The episodic buffer: a new component of working memory?. *Trends in cognitive sciences*, *4*(11), 417-423.

Baddeley, A. (2007). *Working memory, thought, and action* (Vol. 45). Oxford University Press.

Baddeley, A. (2017). *Exploring working memory: Selected works of Alan Baddeley*. Routledge.

Baddeley, A., Logie, R., Bressi, S., Sala, S. D., & Spinnler, H. (1986). Dementia and working memory. *The Quarterly Journal of Experimental Psychology Section A*, *38*(4), 603-618.

Basaraba, D., Yovanoff, P., Alonzo, J., & Tindal, G. (2013). Examining the structure of reading comprehension: Do literal, inferential, and evaluative comprehension truly exist? *Reading and writing*, *26*(3), 349-379.

Cabell, S. Q., & Hwang, H. (2020). Building content knowledge to boost

comprehension in the primary grades. *Reading Research Quarterly*, *55*(S1), S99-S107.

Carpenter, P. A., Just, M. A., & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices Test. *Psychological Review*, *97*(3), 404-431.

Catts, H. W., & Kamhi, A. G. (2017). Prologue: Reading comprehension is not a single ability. *Language, Speech, and Hearing Services in Schools*, *48*(2), 73-76.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and instruction*, *8*(4), 293-332.

Chow, B. W. Y., Mo, J., & Dong, Y. (2021). Roles of reading anxiety and working memory in reading comprehension in English as a second language. *Learning and Individual Differences*, *92*, 102092.

Dabarera, C., Renandya, W. A., & Zhang, L. J. (2014). The impact of metacognitive scaffolding and monitoring on reading comprehension. *System*, *42*(1), 462-473.

De Beni, R., & Moè, A. (2003). Presentation modality effects in studying passages. Are mental images always effective?. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, *17*(3), 309-324.

Din, M. (2020). Evaluating university students' critical thinking ability as reflected in their critical reading skill: A study at bachelor level in Pakistan. *Thinking Skills and Creativity*, *35,* 100627.

Engle R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, *11*, 19-23.

Eysenck, M. W., & Keane, M. T. (2020). *Cognitive psychology: A student's handbook*. Psychology Press.

Fathi, J., & Afzali, M. (2020). The Effect of Second Language Reading Strategy Instruction on Young Iranian EFL Learners' Reading Comprehension. *International Journal of Instruction*, *13*(1), 475-488.

Fisher, D., & Frey, N. (2008). Student and teacher perspectives on the usefulness of content literacy strategies. *Literacy Research and Instruction*, *47*(4), 246-263.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of

cognitive–developmental inquiry. *American psychologist*, *34*(10), 906-911.

Goldman, S. R., Snow, C., & Vaughn, S. (2016). Common themes in teaching reading for understanding: Lessons from three projects. *Journal of Adolescent & Adult Literacy*, *60*(3), 255-264.

Graesser, A. C., Singer, M., & Trabasso, T. (1994). Constructing inferences during narrative text comprehension. *Psychological review*, *101*(3), 371.

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American psychologist*, *53*(4), 449-455.

Inciarte-González, A., Arvilla-Herrera, R., & Mier-Rodríguez, S. (2024). Contributions of Metacognitive Strategies to the Inferential Reading Comprehension Level. *Kurdish Studies*, *12*(2), 5223-5239.

Jones, J. S., Milton, F., Mostazir, M., & Adlam, A. R. (2020). The academic outcomes of working memory and metacognitive strategy training in children: A double-blind randomized controlled trial. *Developmental science*, *23*(4), e12870.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: individual differences in working memory. *Psychological review*, *99*(1), 122.

Kanfer, R., & Ackerman, P. L. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. *Journal of applied psychology*, *74*(4), 657-690.

Karpov, Y. V., & Haywood, H. C. (1998). Two ways to elaborate Vygotsky's concept of mediation. *American Psychologist*, *53*(1), 27.

Kim, H. S (1994). Effects of Metacognition and Hypertext Structure on Performance in Authoring System Learning. *Korean Journal of Educational Research*, *32*(5), 207-234.

Kim, H. S., Yum, S. C., & Schallert, D. L. (2002). Effects of prior knowledge, working memory, and navigation tools on performance with hypertext. *Journal of 112 Educational Technology*, *18*(1), 79-108.

Kim. J. Y., & Kim, H. S. (2013). The effects of navigation methods and working memory on learning achievement and cognitive load in hypertext. *The Journal of*

*Educational Information and Media*, *19*(1), 109-128.

King, A. (2007). Beyond literal comprehension: A strategy to promote deep understanding of text. *Reading comprehension strategies: Theories, interventions, and technologies*, 267-290.

Koda, K. (2007). Reading and linguistic learning: crosslinguistic constraints on second language reading development. *Language Learning*, *57*(1), 1-44.

Li, P., & Clariana, R. B. (2019). Reading comprehension in L1 and L2: An integrative approach. *Journal of Neurolinguistics*, *50*, 94-105.

Lidstone, J. S., Meins, E., & Fernyhough, C. (2010). The roles of private speech and inner speech in planning during middle childhood: Evidence from a dual task paradigm. *Journal of Experimental Child Psychology*, *107*(4), 438-451.

Liu, J. (2023). Educational Implications of Private Speech for Children's Problem-solving Abilities. *Journal of Education, Humanities and Social Sciences, 8,* 1621-1627.

Mahdavi, J. N., & Tensfeldt, L. (2013). Untangling reading comprehension strategy instruction: Assisting struggling readers in the primary grades. *Preventing school failure: Alternative education for children and youth*, *57*(2), 77-92.

Marboot, K., Roohani, A., & Mirzaei, A. (2020). Investigating Iranian EFL students' metacognitive online reading strategies, critical thinking, and their relationship: A mixed-methods study. *Issues in Language Teaching*, *9*(1), 151-182.

Marvel, C. L., & Desmond, J. E. (2012). From storage to manipulation: how the neural correlates of verbal working memory reflect varying demands on inner speech. *Brain and language*, *120*(1), 42-51.

McNamara, D. S. (2021). If integration is the keystone of comprehension: Inferencing is the key. *Discourse Processes*, *58*(1), 86-91.

Meneghetti, C., Carretti, B., & De Beni, R. (2006). Components of reading comprehension and scholastic achievement. *Learning and individual differences, 16*(4), 291-301.

Mohseni Takaloo, N., & Ahmadi, M. R. (2017). The effect of learners' motivation on their reading comprehension skill: A literature review. *International journal of research in English education, 2*(3), 10-21.

Moore, P. J., & Scevak, J. J. (1994). *Systematic forced processing of text and graphic information*. In Advances in psychology. *North-Holland*, *108*, 303-319.

Naumann, J., Richter, T., Christmann, U., & Groeben, N. (2008). Working memory capacity and reading skill moderate the effectiveness of strategy training in learning from hypertext. *Learning and Individual Differences*, *18*(2), 197-213.

Nicolielo-Carriho, A. P., Crenitte, P. A. P., Lopes-Herrera, S. A., & Hage, S. R., de V. (2018). Relationship between phonological working memory, metacognitive skills and reading comprehension in children with learning disabilities. *Journal of Applied Oral Science: Revista FOB*, *26*, e20170414.

O'brien, I., Segalowitz, N., Freed, B., & Collentine, J. (2007). Phonological memory predicts second language oral fluency gains in adults. *Studies in second language acquisition*, *29*(4), 557-581.

O'Malley, M. J., & Chamot, A. U. (1990). *Learning strategies in second language acquisition*. Cambridge University Press.

Petscher, Y., Cabell, S. Q., Catts, H. W., Compton, D. L., Foorman, B. R., Hart, S. A., & Wagner, R. K. (2020). How the science of reading informs 21st-century education. *Reading research quarterly*, *55,* S267-S282.

Quinn, J. G., & Ralston, G. E. (1986). Movement and attention in visual working memory. *The Quarterly Journal of Experimental Psychology Section A*, *38*(4), 689-703.

Rawson, K. A., & Kintsch, W. (2005). Rereading effects depend on time of test. *Journal of educational psychology*, *97*(1), 70.

Saadatnia, M., Ketabi, S., & Tavakoli, M. (2017). Levels of reading comprehension across text types: A comparison of literal and inferential comprehension of expository and narrative texts in Iranian EFL learners. *Journal of psycholinguistic research*, *46,* 1087-1099.

Sadeghi, B., Hassani, M. T., & Rahmatkhah, M. (2014). The Relationship between EFL Learners. Metacognitive Strategies, and Their Critical Thinking. *Journal of Language Teaching and Research*, *5*(5), 1167-1175.

Salmon, A. K. (2008). Promoting a culture of thinking in the young child. *Early Childhood Education Journal*, *35*(5), 457-461.

Smith, R., Snow, P., Serry, T., & Hammond, L. (2021). The role of background knowledge in reading comprehension: A critical review. *Reading Psychology*, *42*(3), 214-240.

Swanson, H. L., & Trahan, M. (1996). Learning disabled and average readers' working memory and comprehension: does metacognition play a role?. *British journal of educational psychology*, *66*(3), 333-355.

Sweet, A. P., & Snow, C. E. (2003). *Rethinking reading comprehension*. Guilford Press.

Tavakoli, H., & Koosha, M. (2016). The effect of explicit metacognitive strategy instruction on reading comprehension and self-efficacy beliefs: The case of Iranian University EFL students. *Porta Linguarum: Revista Internacional de Didáctica de Las Lenguas Extranjeras*, *25*(1), 119-133.

Turley-Ames, K. J., & Whitfield, M. M. (2003). Strategy training and working memory task performance. *Journal of Memory and Language*, *49*(4), 446-468.

Unsworth, N., & Engle, R. W. (2007). The nature of individual differences in working memory capacity: Active maintenance in primary memory and controlled search from secondary memory. *Psychological Review*, *114*(1), 104-132.

Van den Broek, P., Tzeng, Y., Risden, K., Trabasso, T., & Basche, P. (2001). Inferential questioning: Effects on comprehension of narrative texts as a function of grade and timing. *Journal of Educational Psychology*, *93*(3), 521-529.

Varol, B., & Erçetin, G. (2021). Effects of gloss type, gloss position, and working memory capacity on second language comprehension in electronic reading. *Computer Assisted Language Learning*, *34*(7), 820-844.

Vygotsky, L. S. (1987). *The collected works of LS Vygotsky: Problems of the theory and history of psychology* (Vol. 3). Springer Science & Business Media.

Vygotsky, L. S. (1986). *Thought and language*. MIT Press.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin*, *101*(2), 192-212.

Wallace, C. (2003). *Critical reading in language education*. Springer.

Werani, A. (2018). Inner speech and its impact on teaching and learning. In J. P.

Lantolf, M. E. Poehner, & M. Swain (Eds.), *The Routledge handbook of sociocultural theory and second language development* (pp. 136-151). Routledge.

Willingham, D. T., & Lovette, G. (2014). Can reading comprehension be taught? In P. Afflerbach, M. Hurt, & B. Y. Cho (Eds.), *Reading comprehension strategy instruction* (pp. 98-118). Routledge.

Yapp, D., de Graaff, R., & van den Bergh, H. (2023). Effects of reading strategy instruction in English as a second language on students' academic reading comprehension. *Language Teaching Research*, *27*(6), 1456-1479.

Zwaan, R. A., & Singer, M. (2003). Text comprehension. In A. C. Graesser, M. A. Gernsbacher, & S. R. Goldman (Eds.), *Handbook of discourse processes* (pp. 89-127). Routledge.

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