The Effects of Metacognitive Reading Strategy Instruction on Thai EFL Engineering Students: Metacognitive Strategy Use and Students' Attitudes

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Abstract

Metacognition is pivotal in reading comprehension. Therefore, Metacognitive Reading Strategy Instruction (MRSI) is crucial for improving reading comprehension, particularly in English as a Foreign Language (EFL) contexts. The study explores the role of MRSI in enhancing reading comprehension, specifically for 145 engineering students, who were divided into the experimental group (n=82) and control group (n=63). The experimental group was instructed in metacognitive reading strategies, whereas the control group was taught textbook-based instruction. Over 13 weeks, two groups of Thai engineering students were given pre and post-tests on reading comprehension and an attitude questionnaire. Both descriptive and inferential statistics were conducted to analyze the data. The analysis revealed that the experimental group that received MRSI outperformed the control group on the reading comprehension test. The findings showed that the experimental and control groups improved their post-test scores compared to pre-test scores. The experimental group increased from a mean score of 35.30% to 50.04%, while the control group improved from 35.58% to 43.28%. The participants also expressed positive attitudes towards planning (84.32%), monitoring (90.24%), and evaluating (82.95%) strategies, showing a strong emphasis on metacognitive engagement in enhancing reading comprehension. In addition, the data from an attitude questionnaire reflected a positive impact of MRSI on students' attitudes, with high agreement on the effectiveness of planning, monitoring, and evaluating strategies. The study concludes that integrating MRSI into ESP classes can effectively enhance reading comprehension and provide pedagogical recommendations for its implementation.

Keywords: ESP, metacognitive reading strategy instruction, metacognitive reading strategies, reading comprehension, Thai EFL engineering students

1. Introduction

Reading is a complex cognitive process essential for personal and educational development, requiring active engagement to connect ideas and comprehend the writer's message (Li & Wilhelm, 2008; Norris, 1998). For EFL students, mastering reading skills is crucial for language proficiency and academic success (Muhid et al., 2020). Reading in a second language (L2) is vital as it significantly influences language proficiency and academic performance (Aebersold & Field, 2002). L2 reading presents challenges, such as unfamiliar vocabulary and complex sentence structures, which can impede comprehension (Anderson, 1991; Ur, 2012). Practical strategies and background knowledge are essential for overcoming these difficulties (Carrell & Eisterhold, 1983; Kulaç & Walters, 2016).

Reading in a foreign language (FL) poses significant challenges due to the necessity of navigating between two or more languages. Studies on FL reading identify factors contributing to these challenges, including prior knowledge, proficiency in both the first language (L1) and second language (L2), and metacognitive skills. Mastery of FL reading requires considerable time and effort for learners to see substantial improvements (Phaiphimai & Meesri, 2015). In English as a Foreign Language (EFL), reading is a fundamental skill, yet integrating practical English language skills into national curricula in non-Anglophone countries faces numerous sociocultural barriers. Additionally, the role of teachers and assessment methods further complicate the situation (DeWaelsche, 2015; Djamà, 2016; Fahim & Sa'eepour, 2011; Shaaban, 2014; Zhao & Zhu, 2012; Zhou et al., 2015).

The utilization of metacognition in reading comprehension is widely acknowledged in research literature. Numerous scholars affirm the pivotal role of metacognitive strategies in enhancing reading comprehension, asserting that students require instruction in these strategies to improve their reading skills. Studies indicate that students who struggle with reading lack metacognitive strategies for planning, monitoring, and evaluating their comprehension processes. Metacognitive strategies enable learners to reflect on their learning, plan for tasks, monitor comprehension during reading, and evaluate their progress afterwards. These may include setting a purpose or plan for reading, previewing texts for length and organization, and using typographical aids such as tables and figures. Research has consistently shown the significant impact of metacognitive strategies on reading comprehension (Batha & Carroll, 2007; Çubukcu, 2008; Donker et al., 2014; Flavell, 1979; Guterman, 2003; Imtiaz, 2004; Karbalaei, 2010; Kitichaidateanan & Sukying, 2024; Okkinga et al., 2018b; Pressley & Gaskins, 2006; Zhang & Seepho, 2013).

Metacognitive Reading Strategy Instruction (MRSI) is an instructional approach designed to enhance students' mastery of metacognitive knowledge and strategies (Goh & Vandergrift, 2021). Numerous studies have demonstrated that MRSI can contribute to developing learners' awareness and ability to plan their reading process. It also aids in regulating their reading activities by facilitating information processing and managing obstacles by applying appropriate strategies. Additionally, MRSI supports learners in self-appraising their reading outcomes. Recognizing its importance, Mokhtari and Reichard (2002) have highlighted the need for further investigations involving diverse target groups with varying language proficiency levels and in different learning contexts. Such studies can provide deeper insights into the usage and effectiveness of metacognitive strategies. Various worldwide studies have investigated the impact of Metacognitive Reading Strategy Instruction (MRSI) on English as a Foreign Language (EFL) learners' reading comprehension. For the ESP context, one of the metacognitive reading strategies, drawing on background knowledge and confirming background knowledge, provided effective results to the learners' reading comprehension proficiency (Tabataba'ian & Zabihi, 2011). In China, research by Zhang and Seepho (2013) revealed that Chinese EFL students benefited from MRSI, showing a positive relationship between metacognitive strategy use and reading proficiency. Ismail and Tawalbeh (2015) also found significant improvement in reading comprehension among Saudi Arabian university students after MRSI. In Indonesia, Muhid et al. (2020) identified nine metacognitive strategies contributing to reading achievement, with positive results observed in the reading comprehension scores. Babashamasi et al. (2022) in Malaysia noted higher comprehension scores in students trained in metacognitive strategies. Khellab et al. (2022) found improved reading proficiency among engineering students after MRSI in Libya. In Iraq, Abd Ali et al. (2023) reported enhanced reading comprehension among Iraqi students after metacognitive strategy instruction. They also showed that metacognitive reading strategies provided strong positive results in the learners' reading comprehension (Naushan et al., 2024). In Thailand, Seedanont and Pookcharoen (2019) observed increased awareness of reading strategies and better reading test scores among Thai EFL students following MRSI. Banditvilai (2020) found that English major students at Kasetsart University showed improved reading comprehension skills after receiving reading strategy training. These studies collectively highlight the effectiveness of MRSI in enhancing reading comprehension among EFL learners globally and within the Thai educational context.

An increasing body of literature highlights the importance of reading in higher education, as students' academic success depends on their reading proficiency. Effective reading involves various factors, including text processing fluency, lexical resources, background knowledge, motivation, and metacognitive strategies. However, many EFL learners enter tertiary education unprepared for the reading demands of their academic programs. Reading in an English for Specific Purposes (ESP) context requires significant student effort. Studies have shown that traditional reading instruction methods often fall short, while teaching metacognitive strategies can enhance students' reading skills, especially for specialized texts (Ahangari & Mohseni, 2016; Ajideh et al., 2018; Dhieb-Henia, 2003; Khoshsima & Samani, 2015). Simply presenting a list of strategies is insufficient; explicit instruction in metacognitive strategies is necessary for practical application and improved comprehension (Chumworatayee, 2017; Wichadee, 2011).

In Thailand, many studies focused on students' awareness of metacognitive strategies and their efficacy in enhancing reading comprehension (Munsakorn, 2012; Wichadee, 2011) through these reading comprehension models: Bottom-Up, Top-Down, and Interactive. Further research revealed that less successful tertiary-level students faced difficulties due to focusing on word-by-word understanding rather than broader context (Chutichaiwirath & Sitthitikul, 2017). Instruction based on reading strategies positively influenced engineering and science students' systematic thinking and reading comprehension (Akkakoson & Setobol, 2009. Recent findings indicated that explicit reading strategy instruction positively impacted Thai EFL adult learners, contributing to their independence in learning. A study in an ESP context showed students benefited from metacognitive reading strategies, improving reading comprehension and attitude towards instruction. These insights suggested the importance of instructing students in these strategies to apply them effectively in various reading situations, benefiting both students and teachers. Despite increasing research on MRSI in educational settings, limited studies in Thailand specifically addressed it in ESP contexts, warranting further exploration.

This study aimed to explore the effects of metacognitive reading strategy instruction on the reading comprehension of mechanical engineering students. It focused on three key objectives: first, to evaluate how much the instruction improved their reading comprehension; second, to identify the specific metacognitive strategies they used when working with English for Specific Purposes (ESP) materials, shedding light on their metacognitive processes and reading experience; and third, to investigate their attitudes towards the instruction, assessing its perceived effectiveness in enhancing their reading comprehension. Ultimately, the study sought to provide insights into the role of metacognitive strategies in improving reading comprehension among these students.

1.1 Research Questions

The following research questions guided this study:

1. To what extent does MRSI affect the reading comprehension of mechanical engineering students?

2. What are the students' attitudes towards MRSI in improving their reading comprehension?

3. What are the students' attitudes toward metacognitive reading strategy instruction in improving their reading comprehension?

1.2 Theoretical Framework

The information processing approach (IPA) is a theoretical framework explaining how information is acquired, processed, and stored in the human mind (Baddeley & Hitch, 1974). This approach likens the human mind to a computer that receives, processes, and outputs information. The IPA has been utilized in various areas of cognitive psychology, such as memory, language, and working memory (Miller,

1956). Key concepts in the IPA include the sensory register, short-term memory, and long-term memory. The sensory register is the first stage of information processing, where sensory information is briefly retained in its original form (Atkinson & Shiffrin, 1968). Short-term memory, also known as working memory, is a system with a limited capacity to hold and manipulate information for short durations (Baddeley & Hitch, 1974). In contrast, long-term memory is an unlimited-capacity system that stores information over long periods (Tulving, 1972).

2. Method

Utilizing a quasi-experimental research design, this study investigated the effects of Metacognitive Reading Strategy Instruction (MRSI) on the reading comprehension of EFL engineering undergraduates. It explored how the instruction improved their reading comprehension. It also examined students' attitudes toward MRSI. This section describes the research design, participants, setting, instruments, data collection, and analysis procedures, all carried out over 13 weeks with three-hour sessions each week.

2.1 Research Design

This mixed-methods research investigated the effects of metacognitive reading strategy instruction (MRSI) on the reading comprehension of mechanical engineering undergraduate students at a public university in Thailand. Mixed-methods research combines qualitative and quantitative approaches, providing a comprehensive perspective on complex research questions. Quantitative data were collected through a reading comprehension pretest and posttest to measure improvements in reading comprehension, and an attitude questionnaire was used to assess students' attitudes towards MRSI. Qualitative data were gathered from semi-structured interviews to understand how mechanical engineering undergraduate students used metacognitive strategies to enhance their comprehension of English for Specific Purposes (ESP) materials.

2.2 Participants

The study included 145 Thai EFL mechanical engineering students, 63 in the control group and 82 in the experimental group. All participants were second-year undergraduates (aged 18-22) in Mechanical Engineering with similar English proficiency (mean entrance exam scores of 62.50 for the control group and 64.73 for the experimental group). Students had completed prerequisite English courses before taking the English Reading for Academic Purposes course, which covered seven units. The university prioritized practical programs and emphasized reading skills across faculties. The control group received traditional instruction, while the experimental group received MRSI. The study was conducted at a technology university in northeastern Thailand, focusing on practical Engineering, Technical Education, and Business Administration programs. Strong reading skills were essential for comprehending academic reading texts in these programs.

2.3 Research Instruments

2.3.1 Reading Comprehension Pretest and Posttest

The study utilized Reading Comprehension Tests (Versions A1, A2, B1, and B2) to assess the participants' reading comprehension with 50-60 items per test, escalating in complexity from beginner to elementary levels. The reading comprehension tests in this study varied in complexity, ranging from A1 and A2 for beginner and elementary levels to B1 and B2 for intermediate and upper-intermediate proficiency levels. The choice of test versions significantly influenced data interpretation, with B1 and B2 requiring higher language complexity, including advanced vocabulary, complex sentence structures, and idiomatic expressions. Tasks at B1 and B2 levels involved skills such as inference, synthesis of information, and evaluation from diverse sources, contrasting with the simpler tasks at A1 and A2 levels. These differences in question quantity and complexity enabled a comparative analysis of the participants' reading comprehension skills across proficiency levels.

2.3.2 Attitude Questionnaire

A 30-item attitude questionnaire (SAQ) using a 5-point Likert scale was used to evaluate the participants' attitudes towards metacognitive reading strategies instruction. Part 1 gathered demographic details (gender, age, program, year, English learning duration), while Part 2 focused on specific attitudes towards these strategies. Responses ranged from "I strongly disagree" to "I strongly agree," with scoring criteria translating into categories from "Very Low" to "Very High" based on average scores. To ensure inclusivity, the questionnaire underwent translation into Thai, and its reliability and validity were assessed by five experts. The back-translation process was overseen by an experienced translator to maintain accuracy across languages.

2.4 Research Procedures

This study involved 145 participants selected from two intact classes: the control group, consisting of 63 participants, received regular English classes without specific instruction on MRSI, while the experimental group, comprising 82 participants, received explicit instruction on MRSI. Two sets of tests, Reading Comprehension Test A1 and B1 and Reading Comprehension Test A2 and B2 were administered to all participants at two stages: a pretest before treatment and a posttest after treatment. A five-point Likert scale questionnaire, adapted from Mokhtari and Reichard (2002), assessed the participants' attitudes towards MRSI.

2.5 Data Analysis

The study employed paired-samples t-tests to analyze pretest and posttest scores, assessing their reading comprehension improvements in Thai EFL mechanical engineering students after instructional interventions. Attitudes towards MRSI were analyzed through mean,

percentage, and standard deviation.

3. Results

3.1 Effects of MRSI on Reading Comprehension of the Participants

The finding indicated that participants in both groups demonstrated higher scores on posttests than pretests across both test versions. Specifically, before MRSI, the participants in the experimental group achieved a mean score of 35.30% on the reading comprehension version A (SD=12.90). In contrast, those in the control group achieved a mean score of 35.58% (SD=8.00). Following the instruction, the participants in the experimental group obtained a mean score of 50.04% (SD=13.24), while those in the control group achieved a mean score of 43.28% (SD=9.75). Additional data are provided in Table 1.

Table 1. A Summary of Descriptive Statistics of the Reading Comprehension Tests

Version	Group	Time	Mean	(%)	SD	Skewness	Kurtosis
A	Control (n=63)	Pre-test	21.67	35.58	8.00	0.112	-0.619
		Post-test	25.00	43.28	9.75	0.029	-0.945
	Experimental (n=82)	Pre-test	15.00	35.30	12.90	1.494	1.899
		Post-test	31.67	50.04	13.24	1.210	0.959
B	Control (n=63)	Pre-test	12.00	31.39	11.50	0.322	-0.738
		Post-test	18.00	37.90	11.23	-0.049	-0.711
	Experimental (n=82)	Pre-test	14.00	30.97	12.56	0.923	1.055
		Post-test	18.00	43.41	13.87	0.935	0.979

Table 2. Comparisons Between Pre-Test and Post-Test

	Pre-test		Post-test	*t*-value	Effect size (*d*)
Experimental group	Read A	*VS*	Read A	29.15	1.12***
(*n* = 82)	Read B	*VS*	Read B	19.76	0.94***
Controlled group	ReadA	*VS*	ReadA	8.85	0.86**
(*n* = 63)	Read B	*VS*	Read B	15.24	0.57**

Notes: ***p < 0.001, **p < 0.01

As shown in Table 2, based on the scores of the participants of the experimental group, the two times (pre-test and post-test) of the reading comprehension version A were significantly different, indicating a large effect size (t=29.15, p < 0.001, d=1.12). The two times (pre-test and post-test) of the reading comprehension version B were also statistically different, revealing a large effect size (t=19.76, p < 0.001, d=0.94). In addition, the results of the control group showed that there was also a significant difference between the pre-test and post-test in the reading comprehension version A with a large effect size (t=8.85, p < 0.01, d=0.86). The two times (pretest and posttest) of the reading comprehension version B were also statistically different, revealing a large effect size (t=15.24, p < 0.01, d=0.57). Figure 1 shows a comparison between the reading comprehension improvement of an experimental group and a control group, indicating a statistically significant difference after the treatment.

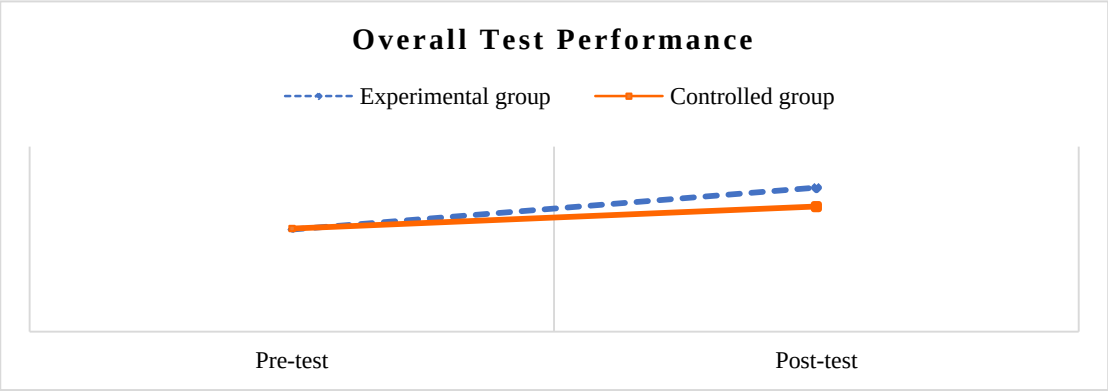

Figure 1. Comparison Between Experimental and Control Groups

As shown in Figure 1, the comparison between experimental and control groups from the combined reading comprehension version A and the reading comprehension version B tests was significantly different, revealing a large effect size (t=26.55, p < 0.001, d=0.55). More specifically, the participants of the experimental group scored better on reading comprehension version A at about 93.45% (M=46.72, SD=12.48) than the participants in the control group's scores of approximately 67.65% (M=40.59, SD=9.18). The results revealed that the experimental group exhibited an improved reading comprehension level compared to the control group at the post-test. It was also noticed that there was a significant difference in the overall mean reading comprehension scores for the experimental group between the pre-and

post-test.

3.2 Participants' Attitudes towards MRSI

The study delved into the attitudes of Thai EFL mechanical engineering students towards MRSI. The Likert scale attitude questionnaire revealed the positive attitudes towards MRSI among the participants. Planning strategies received the highest mean score, followed by monitoring and evaluating strategies. Explicit instruction in metacognitive reading strategies enhanced reading comprehension, particularly planning, monitoring, and evaluating. The participants appreciated the structured planning approaches, recognized the importance of monitoring for reading achievement, and emphasized the proactive role of evaluating strategies in optimizing comprehension and learning outcomes. Table 3 shows a summary of the participants' attitudes towards MRSI.

Table 3. The Participants' Attitudes towards MRSI

Metacognitive strategies	No. of items	Mean	%	SD	Meaning
Planning	10	4.22	84.32	0.65	very high
Monitoring	10	4.20	84.05	0.63	High
Evaluating	10	4.15	82.95	0.66	High
Total	**30**	**4.19**	**83.77**	**0.65**	**High**

Note: N=82

The results also showed that the participants expressed positive attitudes towards MRSI, especially valuing planning, monitoring, and evaluating strategies since these strategies helped them organize their reading tasks more effectively, track their reading progress, and assess their outcomes, ultimately enhancing their overall reading experience and reading engagement. The study supports the integration of MRSI into ESL classes to enhance reading comprehension and academic achievement, recommending periodic assessment and broader application of these strategies across subjects.

Table 4. The Participants'Attitudes towards Planning Strategies

Rank	Statement	Mean	%	SD	Meaning
1	Creating a detailed plan for my reading is an essential step (pre-, while, and post-reading steps) that significantly improves my overall experience.	4.51	90.24	0.55	very high
2	Trying different planning strategies is an exciting way to explore and enrich my reading experience.	4.33	86.59	0.61	very high
3	I consistently take the time to plan my reading, finding it essential for a better understanding.	4.32	86.34	0.61	very high
4	Planning my reading provides structure and guidance, helping me stay focused on the reading material.	4.29	85.85	0.64	very high
5	Setting specific goals for my reading tasks is crucial to enhancing my comprehension.	4.28	85.61	0.65	very high
6	I consider that planning the reading strategies is so beneficial.	4.27	85.37	0.61	very high
7	I recognize the importance of planning my reading tasks and try not to skip this step.	4.26	85.12	0.68	very high
8	I adapt my reading strategy based on the type of material, ensuring a tailored approach for each.	4.02	80.49	0.75	high
9	Flexibility in planning approaches, allowing me to explore various methods.	3.95	79.02	0.65	high
10	I believe that planning impacts my overall reading experience.	3.93	78.54	0.73	high
	Total	**4.22**	**84.32**	**0.65**	**very high**

The data analysis in Table 4 provided insightful details regarding the participants' attitudes towards planning strategies. 84.32% of the participants exhibited a very high level of attitude toward planning strategies. Notably, the majority (90.24%) regarded creating a detailed plan for their reading as an indispensable step, emphasizing its significant role in enhancing their overall reading experience. Furthermore, a substantial proportion (86.59%) expressed enthusiasm towards exploring diverse planning strategies, viewing it as an avenue to enrich their reading experience. This sentiment was echoed in the affirmation of 86.34% of the participants, who found that planning imparted structure and guidance, aiding in maintaining focus on the reading material. Similarly, 85.85% asserted that consistent planning was pivotal for a deeper understanding of the content. Moreover, 85.61% acknowledged the importance of not bypassing the planning stage, recognizing its inherent value in facilitating effective reading tasks. Setting specific goals for reading tasks was deemed crucial by 85.37% of the participants, underscoring the significance of goal-oriented approaches in enhancing reading comprehension. Additionally, a substantial portion (80.49%) emphasized the necessity of adapting reading strategies based on the nature of the material, advocating for a tailored approach to optimize learning outcomes. Although a minority (78.54%) held a contrasting belief, stating that planning significantly impacted their reading experience, the overwhelming consensus among the participants towards planning strategies signified a prevalent inclination towards structured MRSI to enhance reading comprehension and overall engagement.

Table 5. The Participants'Attitudes towards Monitoring Strategies

Rank	Statement	Mean	%	SD	Meaning
1	Monitoring my comprehension is a crucial aspect that significantly contributes to my overall reading satisfaction.	4.51	90.24	0.57	very high
2	Monitoring my comprehension enhances my overall reading achievement.	4.37	87.32	0.62	very high
3	Adjusting my reading pace based on comprehension is a practice I find valuable for a more effective reading experience.	4.29	85.85	0.53	very high
4	I consistently notice when I lose focus while reading and actively address it.	4.24	84.88	0.56	very high
5	I believe that being aware of time limitations contributes significantly to my reading.	4.21	84.15	0.64	very high
6	I actively consider the effectiveness of my reading strategies, reflecting on my approach to enhance comprehension.	4.18	83.66	0.67	high
7	I find it essential to adapt my reading pace based on the complexity of the material.	4.17	83.41	0.66	high
8	I am attentive to time constraints, ensuring I allocate my time wisely during reading sessions.	4.16	83.17	0.69	high
9	I consistently check my understanding as I progress through a text, ensuring a thorough grasp of the content.	3.95	79.02	0.65	high
10	Reflecting on my reading habits interests me; I prefer to read without analyzing my approach.	3.94	78.78	0.74	high
	Total	**4.20**	**84.05**	**0.63**	**high**

The finding from Table 5 demonstrated the participants' attitudes towards monitoring strategies. Indeed, the data underscored a pervasive recognition among the participants of the importance of monitoring strategies, with a majority (90.24%) mentioning its crucial role in fostering overall reading satisfaction. This sentiment was further corroborated by 87.32% of the participants who attributed their reading achievement to effective comprehension monitoring, acknowledging its crucial role in academic or personal reading goals. Moreover, the high percentage (85.85%) of the participants valuing the practice of adjusting reading pace based on comprehension underscored the integration of metacognitive awareness into reading strategies. Similarly, 84.88% of participants demonstrated MRSI in addressing lapses in focus during reading sessions, which resonated with the literature on attentional control and its implications for reading comprehension. Furthermore, the participants' emphasis on time management, with 84.15% acknowledging its significance in reading, reflected an awareness of the temporal constraints inherent in reading tasks. Additionally, reflecting on reading strategies and adapting reading pace according to material complexity (83.66% and 83.41%) underscored integrating self-regulatory processes into reading behaviors.

Table 6. Engineering students' attitudes toward evaluating strategies

Rank	Statement	Mean	%	SD	Meaning
1	Note-taking is the appropriate strategy that promotes reading comprehension.	4.48	89.51	0.61	very high
2	I see value in restating information in my own words to deepen my understanding of the content.	4.23	84.63	0.61	very high
3	I have confidence in the effectiveness of my reading strategies, believing they significantly impact my comprehension of the text.	4.22	84.39	0.61	very high
4	I recognize the importance of verifying whether I comprehend the content or task during reading.	4.17	83.41	0.64	high
5	I put my concentration on the text content for the appropriateness of the reading purposes.	4.16	83.17	0.64	high
6	Achieving reading goals and objectives is a priority for me, as it enhances my comprehension of the material being read.	4.15	82.93	0.74	high
7	I actively evaluate the success of my reading experiences, seeking continuous improvement.	4.13	82.68	0.68	high
8	Comparing the effectiveness of different reading strategies is a valuable practice that helps me refine my approach.	4.12	82.44	0.64	high
9	I regularly reflect on my reading skills and habits, engaging in self-assessment for continual growth.	3.98	79.51	0.68	high
10	I believe that evaluating my performance and progress through reading tasks is essential; I just read.	3.84	76.83	0.71	high
	Total	**4.15**	**82.95**	**0.66**	**high**

Table 6 demonstrates engineering students' attitudes towards evaluating strategies in their reading comprehension, demonstrating a notable emphasis on metacognitive engagement and comprehension evaluation.82.95% of the participants predominantly valued evaluation strategies, highlighting MRSI to optimize reading comprehension.Notably, the majority (89.51%)underscored the significance of self-testing and textual evidence verification, indicative of a strong commitment to ensuring understanding—a strategy aligned with cognitive psychology's emphasis on self-testing as a practical learning tool.Moreover, the participants prioritized restating material in their terms (84.63%) and assessing confidence in understanding (84.39%), reflecting a metacognitive awareness of comprehension processes.

Additionally, the participants'recognition of stress cues (83.41%) and consistent assessment of reading efficacy (83.17%) further emphasized integrating affective and reflective components into reading comprehension, showcasing a holistic approach towards comprehension enhancement. Despite a minority expressing a higher priority for assessing performance (76.83%), the prevailing trend towards valuing evaluating strategies underscored their perceived importance in optimizing reading comprehension and learning outcomes among engineering students.

4. Discussion

The study explored the effects of MRSI on the reading comprehension of Thai EFL engineering undergraduates. Results indicated significant improvements in reading comprehension after MRSI, with notable score increases for the experimental group compared to the control group's post-test scores. This suggested MRSI's potential to enhance reading comprehension. The experimental group's performance in the post-test showed substantial improvement from the pretest, underscoring MRSI's efficacy in improving reading comprehension. These findings aligned with prior research, highlighting the benefits of cognitive and metacognitive strategies in improving reading comprehension (Ketworrachai & Sappapan, 2022; Oranpattanachai, 2023). The literature supported the positive impact of explicit strategy instruction and metacognitive strategies in fostering deeper text understanding and more effective reading practices.

The improvement in reading comprehension can be attributed to MRSI's emphasis on planning, monitoring, and evaluation. In the planning phase, students prepared for reading by engaging in anticipatory activities such as analyzing images, diagrams, titles, and subtitles to form preliminary understandings of the text. During the reading (monitoring) phase, they practiced self-assessment and employed strategies like making predictions, inferring, and using visual organizers to navigate the text. In the evaluation phase, students critically reflected on their reading, assessing the information's relevance and reliability and engagement and development as readers.

Students reported that learning and applying these strategies helped them overcome reading challenges and improve their comprehension scores. The methodology of explicitly teaching metacognitive reading strategies, followed by guiding students towards autonomous application, significantly boosted their metacognitive strategy awareness, leading to improved reading outcomes.

Additionally, the improvements in reading comprehension were linked to activating students' existing knowledge before introducing new reading materials. This preparatory step involved discussing the text's title, analyzing associated imagery, and providing definitions and context for key vocabulary terms. Engaging in preliminary discussions helped students frame an initial understanding of the text, facilitating more effective engagement with the main ideas. This approach was supported by existing literature, which posited that activating background knowledge enhanced organizational skills and comprehension (Johnson & Keier, 2010; Kintsch, 1998; Marzano, 2004; Willingham, 2007).

The study's 13-week duration and structured reading tasks effectively applied MRSI. Student feedback indicated a steady improvement in reading comprehension, consistent with research suggesting that metacognitive skills developed gradually with time and direct instruction (Chamot, 2005; Hacker, 1998; Livingston, 1997; Paris & Winograd, 1990). The study emphasized the need for commitment and consistent effort in mastering these strategies, with challenging yet achievable tasks encouraging the development of strategic reading habits.

Overall, the study demonstrated that MRSI, through its structured approach to planning, monitoring, and evaluating reading strategies, significantly enhanced the reading comprehension of EFL engineering students, supporting their academic success. This research underscored MRSI's effectiveness as a pedagogical approach, blending quantitative improvements with qualitative insights to highlight its comprehensive impact on reading comprehension.

The results revealed that the participants had positive attitudes toward MRSI. Over 80**%** of the students reported favorable opinions about the planning, monitoring, and evaluating strategies incorporated in MRSI. This response underscored MRSI's effectiveness in fostering an encouraging learning environment and enhancing reading comprehension.

The positive attitude towards MRSI among the participants highlighted the critical role of their attitudes in improving reading comprehension. Through MRSI, the participants engaged with metacognitive strategies- planning, monitoring, and evaluating- that enhanced their approach to complex academic texts. Feedback from the students reflected a keen appreciation for the structured support provided by MRSI. In the planning phase, students were encouraged to actively think about the reading material before beginning. For instance, a student identified as ST7 (L2) mentioned that the support and guidance from teachers helped them overcome difficulties and encouraged open communication and further inquiries. This indicated that initial planning and setting reading goals significantly boosted students' confidence and willingness to engage with the material. During the monitoring phase, students assessed their understanding in real time and adjusted their strategies as needed. ST5 (M2) expressed excitement in recalling vocabulary taught during classroom activities, highlighting the satisfaction of applying learned strategies to recognize and remember new words. This demonstrated the effectiveness of monitoring strategies in enhancing engagement and content recall. The evaluation phase allowed students to reflect critically on their reading and the strategies used. ST2 (H1) noted that participating in group work and dividing tasks helped them recognize their contributions, instilling a sense of pride. This underscored the value of evaluating strategy effectiveness and the role of collaborative learning in reinforcing comprehension skills.

The positive attitudes towards MRSI also influenced overall engagement with English reading comprehension. Students' motivation and engagement with reading tasks significantly improved as they became more confident in managing and overcoming reading challenges through these strategies. This successful application of metacognitive strategies led to enhanced comprehension, reinforcing these

strategies' value in creating a positive learning environment.

The feedback from the participants illustrated a transformation in their reading approach, shifting from passive to active engagement, facilitated by their positive reception of metacognitive reading strategies. The structured nature of MRSI and teacher support had improved students' reading comprehension and encouraged a shift towards autonomous learning. It was evident that MRSI had instilled a sense of ownership and responsibility towards their learning process.

In summary, the positive attitudes of engineering students towards MRSI significantly enhanced their reading comprehension through metacognitive strategies. These strategies, embraced with enthusiasm by the students, had led to substantial improvements in their reading skills, demonstrating the significant impact of positive attitudes towards MRSI on academic success.

5. Conclusion

The current study examined how MRSI impacted the reading comprehension of mechanical engineering students in the ESP context in Thailand. Statistical analysis demonstrated a significant difference in reading performance between the experimental group, which received MRSI, and the control group, which received traditional English instruction alone. Following MRSI, the experimental group outperformed the control group. Moreover, the students showed positive attitudes towards MRSI in enhancing their reading comprehension through three main metacognitive reading strategies: planning strategies, monitoring strategies, and evaluating strategies. The intervention effectively increased awareness and use of strategies among learners. Participants' positive attitudes toward MRSI underscored its crucial role in enhancing reading comprehension by employing metacognitive strategies such as planning, monitoring, and evaluating. Participants effectively engaged with complex academic texts. Feedback from students indicated a strong appreciation for the structured support offered by MRSI. This study provided significant insights into the effectiveness of MRSI in enhancing the reading comprehension of Thai EFL engineering students. The findings underscored the importance of metacognitive strategies in foreign language reading, aligning with and enriching existing theories (Lawrence, 2007; Pressley & Gaskins, 2006). Such strategies facilitated reading comprehension and empowered students to become independent readers while fostering their critical thinking abilities.

6. Recommendation for Future Research

The study had some limitations. Given that the research instruments were explicitly tailored to mechanical engineering content, future studies should consider customizing content to match the participant's field of study, ensuring relevance and effectiveness in assessing reading comprehension across disciplines. Building on the foundation laid by this study, future research should aim to explore the impact of MRSI across a broader range of disciplines and educational contexts. Investigating the application and effectiveness of metacognitive reading strategies among students in various academic fields could provide valuable insights into enhancing reading comprehension universally. Such research would contribute to a deeper understanding of metacognitive strategies' role in educational success and inform pedagogical practices that support students' development as proficient, autonomous readers.

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Authors' contributions

Both Jiraporn Noipa and Dr. Pilanut Phusawisot were responsible for study design and data analysis. Jiraporn Noipa mainly managed the literature review and data collection. Dr. Pilanut Phusawisot provided ongoing guidance and consultation throughout the entire research process. Both Jiraporn Noipa and Dr. Pilanut Phusawisot jointly analyzed the data, interpreted and discussed the findings. Jiraporn Noipa drafted the manuscript and Dr. Pilanut Phusawisot revised it. Both authors read and approved the final manuscript. The two authors have contributed equally to the study.

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