

Metacognitive Awareness in EFL Reading Comprehension for Senior High School Students: Predictive Insights

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Abstract: Metacognitive awareness is widely recognized as an important factor influencing English as a Foreign Language (EFL) reading comprehension. However, evidence regarding the contributions of its components remains inconclusive, particularly in the Indonesian context. This study examined the relationship between metacognitive awareness and EFL reading comprehension among Indonesian high school students and investigated gender differences in metacognitive awareness. A total of 72 students (42 males and 30 females) participated in the study. Data were collected using the Metacognitive Awareness Inventory (MAI) and a reading comprehension test. The Rasch model implemented in the Quest program was used to analyze item difficulty, and One-Way MANOVA was used to examine gender differences. To investigate the structural relationships between metacognitive awareness dimensions and reading comprehension, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed. PLS-SEM was selected because it is suitable for exploratory models and can accommodate relatively small samples when model complexity is limited; however, the sample size remains a limitation of the study. The Rasch analysis revealed that items requiring inference of unstated information were the most difficult, whereas vocabulary inference based on contextual clues was the easiest. MANOVA results indicated that female students demonstrated higher levels of metacognitive awareness than male students. The PLS-SEM analysis showed that metacognitive regulation was not significantly associated with reading comprehension. In contrast, metacognitive knowledge exhibited a stronger positive relationship with reading comprehension, suggesting that students' awareness of their cognitive processes contributes more substantially to reading performance than their regulatory strategies. Although metacognitive regulation did not significantly predict reading performance, metacognitive knowledge emerged as a more meaningful contributor. These results suggest that EFL instruction should place greater emphasis on fostering students' metacognitive knowledge to enhance reading comprehension. Future research should employ larger and more diverse samples to improve the generalizability of the findings.

Keywords: EFL learners, gender differences, metacognitive awareness, metacognitive knowledge, reading comprehension.

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■ INTRODUCTION

Cognitive factors alone do not determine reading comprehension success (Zoghi et al., 2010). Metacognitive awareness is the understanding and regulation of one's learning that supports reading processes (Anggia & Habók, 2023). However, a gap remains regarding the structural relationship between metacognitive

knowledge and regulation, especially in EFL contexts.

Previous EFL reading research has focused on isolated strategies, often overlooking metacognitive regulation (Muhid et al., 2020). While informative, it rarely examines how metacognitive knowledge and regulation jointly influence comprehension. Moreover, studies

commonly use tools such as the MARS questionnaire, which primarily assesses regulation (Sheorey & Mokhtari, 2001; Al-Mekhlafi, 2018).

To address these gaps, this study used the Metacognitive Awareness Inventory (MAI) by Schraw and Dennison (1994), which measures both metacognitive knowledge and regulation. This is important, as students often struggle to distinguish among reading strategies, which affects their metacognitive awareness and comprehension (Fisher, 2021).

This study also examines gender differences in metacognitive awareness. Some studies report higher awareness among female students (Köse & Güneş, 2021; Sheorey & Mokhtari, 2001), while others find no significant differences (Chen, 2015; Baba & Aydogmus, 2021).

In summary, this study addresses key gaps by examining the relationships among metacognitive knowledge, regulation, and EFL reading comprehension using the MAI.

This study aims to examine the relationship between metacognitive knowledge, metacognitive regulation, and EFL reading comprehension. Metacognitive knowledge involves awareness of cognitive processes, while regulation refers to managing them during reading. Understanding their interaction helps explain how students monitor and improve reading strategies, highlighting the role of metacognitive skills in EFL reading success.

Beyond examining metacognitive awareness and comprehension, this study identifies the cognitive tasks students find most difficult or most manageable, ranging from word recognition to higher-order skills such as inference and synthesis. Pinpointing these helps educators target difficulties and build on students' strengths to support reading development.

This study also examines whether gender influences students' metacognitive awareness in EFL reading. By comparing male and female

students' strategies, this study explores potential differences in their metacognitive approaches and implications for differentiated instruction.

Based on insights from the literature, this study proposes several hypotheses to understand the relationship between metacognitive awareness and reading comprehension, with a specific focus on gender differences. The first hypothesis (H1) posits that female students are more likely to demonstrate higher levels of metacognitive awareness than their male counterparts.

The second hypothesis (H2), related to research question 2, posits that metacognitive knowledge is positively associated with English reading comprehension.

Closely related to this, the third hypothesis (H3), related to research question number two, suggests that metacognitive regulation is also positively associated with English reading comprehension. While metacognitive knowledge involves awareness of strategies, metacognitive regulation refers to the active control and management of those strategies during the learning process. This includes skills such as planning how to approach a reading task, monitoring one's comprehension during reading, and adjusting strategies as needed to enhance understanding.

Together, these hypotheses aim to deepen the understanding of how metacognitive processes influence reading comprehension and how these relationships may differ across genders. By examining these factors in tandem, the study seeks to provide a more nuanced view of the cognitive and motivational dynamics that contribute to reading success, particularly in the context of English language learning. The following is a hypothetical model showing the relationship among the variables.

To address the research objectives, this study formulated the following research questions: (1) Are there significant gender differences in students' metacognitive awareness? (2) Does a structural relationship exist between metacognitive

knowledge, metacognitive regulation, and English reading comprehension?

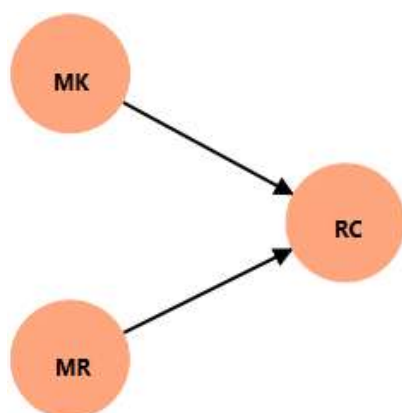


Figure 1. The hypothetical model that shows the relationship among the variables. Note: MK = Metacognitive knowledge/knowledge of cognition, MR = Metacognitive regulation/regulation of cognition, RC = Reading Comprehension

Reading comprehension in English as a Foreign Language (EFL) contexts is determined not only by learners' linguistic knowledge but also by cognitive and metacognitive factors. Research has shown that successful EFL readers actively engage in planning, monitoring, and evaluating their understanding as they interact with texts (Schraw & Dennison, 1994). Metacognitive awareness, defined as learners' awareness of and control over their own cognitive processes, plays a crucial role in enabling learners to comprehend texts effectively, particularly when reading in a foreign language, where processing demands are higher (Al-Mekhlafi, 2018).

Schraw & Dennison (1994) conceptualized metacognitive awareness as comprising two main components: metacognitive knowledge and metacognitive regulation. Metacognitive knowledge refers to what learners know about their cognition, including declarative, procedural, and conditional knowledge. In contrast, metacognitive regulation involves the strategies learners use to control their cognition, such as

planning, monitoring, information management, debugging, and evaluation. These components are considered essential for self-regulated learning and effective reading comprehension.

Previous studies on metacognitive awareness in EFL reading have largely emphasized metacognitive regulation rather than metacognitive knowledge. Many empirical studies have employed instruments such as MARS, MARS, and SORS, which primarily focus on regulatory strategies, including global, problem-solving, and support strategies (Sheorey & Mokhtari, 2001; Al-Mekhlafi, 2018; Khreisat, 2022). Findings from these studies consistently indicate that the use of metacognitive reading strategies positively contributes to reading comprehension achievement (Alkhateeb et al., 2021; Khellab et al., 2022; Villanueva, 2022).

However, the emphasize on regulatory strategies alone has been criticized for providing an incomplete picture of learners' metacognitive awareness. Fisher (2021) found that EFL learners often struggle to distinguish between different reading strategies, suggesting that their metacognitive awareness does not function as a unified construct. This indicates the importance of examining metacognitive knowledge, which underpins learners' ability to select and apply appropriate strategies. Without sufficient knowledge about strategies and their conditions of use, learners may fail to regulate their reading effectively (Schraw & Dennison, 1994).

The Metacognitive Awareness Inventory (MAI) offers a more comprehensive framework by integrating both metacognitive knowledge and metacognitive regulation. Studies using the MAI have highlighted that these two components, although related, may function differently in predicting academic performance (Stephanou & Mpiontini, 2017). This distinction is particularly relevant in EFL reading contexts, where learners must consciously manage unfamiliar vocabulary, complex sentence structures, and limited background knowledge.

EFL reading comprehension involves multiple cognitive processes, including identifying main ideas, understanding specific information, making inferences, interpreting vocabulary in context, and answering questions about unstated details. Research indicates that these processes vary in difficulty and require different levels of metacognitive engagement (Muhid et al., 2020). Rasch-based analyses have shown that inference-making and unstated detail questions are among the most challenging tasks for EFL learners, as they require deeper textual integration and higher-order thinking skills (Polat et al., 2022).

In contrast, vocabulary questions that rely on contextual clues are often easier for learners, particularly when they can activate prior knowledge and employ basic inferencing strategies. These findings suggest that learners' metacognitive awareness may be more strongly activated when dealing with cognitively demanding tasks. Understanding which reading processes pose the greatest challenges can help educators design instruction that targets both cognitive and metacognitive development.

The role of gender in metacognitive awareness has been widely examined, yet findings remain inconsistent. Several studies have reported that female students demonstrate higher levels of metacognitive awareness and more frequent use of metacognitive strategies than male students (Sheorey & Mokhtari, 2001; Köse & Güneş, 2021). These differences are often attributed to females' greater tendency to engage in reflective learning and self-monitoring behaviors.

Conversely, other studies have found no significant gender differences in the use of metacognitive reading strategies. For example, Chen (2015) and Deliany and Cahyono (2020) reported that gender did not significantly influence students' awareness or use of metacognitive reading strategies. Khreisat (2022) similarly found that metacognitive strategy awareness varied with reading ability and academic level rather than with

gender. These conflicting findings indicate the need for further research, particularly in secondary school EFL contexts, to clarify whether gender plays a significant role in metacognitive awareness.

■ **METHOD**

Research design

This study employed a quantitative, cross-sectional research design to investigate the relationships among metacognitive awareness, gender, and English reading comprehension.

The cross-sectional design involved collecting data from participants at a single point in time, allowing for an efficient examination of students' metacognitive awareness profiles and reading comprehension performance. This design is particularly well-suited to exploring individual differences, such as gender-based variations in metacognitive awareness, and to identifying structural relationships among latent variables without manipulating instructional conditions.

To achieve the research objectives, self-report questionnaires and a standardized reading comprehension test were administered. The Metacognitive Awareness Inventory (MAI) was used to measure students' metacognitive knowledge and metacognitive regulation, while an English reading comprehension test adapted from TOEFL materials assessed students' reading performance across multiple cognitive processes. The collected data were analyzed using a combination of Rasch modeling, correlational analysis, One-Way MANOVA, and Partial Least Squares Structural Equation Modeling (PLS-SEM) to comprehensively examine measurement quality, group differences, and structural relationships among variables.

Participants

This cross-sectional study collected data from 72 senior high school students in Indonesia. We selected only the students who filled in the

consent form (Table 1). The students received two English lessons a week. The students' self-report data were collected using Google Forms.

Table 1. Demographics of participants

Characteristics	Number of Samples	Percentage (%)
Gender		
Male	42	58.4
Female	30	41.6

Instruments

The questionnaire consisted of items on metacognitive knowledge/knowledge of cognition that comprised declarative knowledge (e.g., I understand my intellectual strengths and weaknesses), procedural knowledge (e.g., I try to use strategies that have worked in the past), and conditional knowledge (e.g., I use different learning strategies depending on the situation). Then, the questionnaire also consisted of items on metacognitive regulation/regulation of cognition, comprising planning (e.g., I ask myself questions about the material before I begin) and monitoring (e.g., I consider several alternative to a problem before I answer), information management (e.g., I summarize what I've learned after I finish, and I slow down when I encounter important information), debugging skills (e.g., I ask others for help when I don't understand something), and evaluation. Each item was rated using a five-point response scale, namely, never = 0, occasionally = 1, sometimes = 2, normally = 3, and always = 5.

English Reading Comprehension Test. English reading comprehension was assessed using a 50-item multiple-choice test adapted from TOEFL reading materials (Rogers, 2007). The instrument was selected because it covers key reading comprehension processes commonly assessed in EFL contexts, including identifying main ideas, locating specific information, making

inferences, interpreting vocabulary in context, and recognizing unstated details. To ensure the content was appropriate for Indonesian senior high school students, the selected passages and items were reviewed and adapted by English language education specialists prior to administration.

Although TOEFL reading materials are originally designed for higher proficiency learners, the present study employed an adapted version rather than the original test. The adaptation process involved expert review to align the passages and items with the linguistic demands and reading competencies expected in the Indonesian senior high school curriculum. Moreover, Rasch measurement analysis provided empirical evidence supporting the instrument's suitability for the target population. The acceptable person reliability (0.81) and item reliability (0.86), together with the balanced distribution of item difficulty across students' ability levels, indicated that the test functioned appropriately for senior high school learners (Table 3). The person-item map further showed that most items were targeted to participants' reading-ability range, suggesting that the instrument adequately captured variation in reading comprehension without imposing excessive cognitive demands.

Evidence of instrument quality was established through Rasch measurement analysis. The results demonstrated acceptable reliability for both item estimates (0.86) and person estimates (0.81), indicating adequate consistency in measuring students' reading comprehension ability. Furthermore, item difficulty statistics indicated a meaningful distribution across cognitive reading processes, supporting the instrument's construct validity. The test also demonstrated excellent internal consistency (Cronbach's $\alpha = 0.99$). Although this coefficient is exceptionally high, it can be attributed to the relatively large number of items (50 items) and the homogeneous nature of the construct being

measured. It should be noted that Cronbach's alpha reflects the internal consistency of the overall test scores, whereas the Rasch analysis provides separate reliability indices for items and persons. The item reliability coefficient was 0.86, and the person reliability coefficient was 0.81, indicating stable item-difficulty estimates and adequate discrimination among students with varying levels of reading ability. Therefore, the value of 0.99 should not be interpreted as contradictory to the Rasch reliability coefficients, as these indices assess different aspects of measurement quality. Therefore, the coefficient was interpreted as evidence of strong score consistency rather than as an indication of measurement error.

The reading test consisted of five passages with ten questions following each passage. The questions were: main idea (e.g., what is the main idea of the passage?), specific information (e.g., According to the passage, Silent Spring is primarily), inferences (e.g., It can be inferred from the passage that in 1952, Carson's book *Under the Sea Wind*), vocabulary questions (e.g., the word "heading" in line 24 is closest in meaning to), and unstated detailed questions (e.g., The skills of all the following could be considered examples of labor, as defined in the passage, EXCEPT). For each correctly answered item, a score of 1 was given, while for each incorrectly answered item, a score of 0 was given. The following are the item indicators.

Table 2. Item indicators of the reading comprehension instrument

Variable	Indicators	Items
Reading comprehension	Main Idea	1, 12, 23, 28, 33, 43
	Vocabulary in Context	2, 3, 6, 7, 9, 13, 17, 24, 30, 39, 41, 45, 46, 47, 49
	Inferences	5, 35, 36, 44, 48
	Specific Information	4, 8, 11, 14, 15, 16, 18, 19, 21, 22, 25, 26, 29, 34, 40, 42
	Unstated Detailed Questions	10, 20, 27, 31, 32, 37, 38, 50

Research Procedures

The Institutional Review Board (IRB) of the Faculty of Teacher Training and Education at Universitas Bandar Lampung authorized the study. 72 participants (senior high school students) provided informed consent, signifying their agreement to participate in the study. Then we spent one session briefing the students on how to complete the questionnaire and the EFL reading comprehension task. Any issues related to the data collection were discussed and solved during that session with both the teacher and the students.

Data Collection

Data collection in this study was conducted systematically to obtain accurate and reliable information on students' metacognitive awareness and English as a Foreign Language (EFL) reading

comprehension. The procedures were designed to ensure ethical compliance, clarity of instruction, and consistency across participants. Prior to data collection, institutional approval was obtained, and informed consent was secured from all participating students to ensure voluntary participation and confidentiality.

The data were collected at a single point in time in accordance with the cross-sectional research design. Online data collection was selected to facilitate efficient administration and to ensure that all participants completed the instruments under similar conditions. Students were provided with clear instructions on how to complete each instrument, and they were given sufficient time to respond to the questionnaires and the reading comprehension test. Any technical or procedural issues that arose during the process addressed immediately to minimize response error

Two types of instruments were used to gather the data: self-report questionnaires and an English reading comprehension test. The questionnaires were administered first to capture students' metacognitive awareness without being influenced by test performance. The reading comprehension test was administered subsequently to assess students' actual reading ability across different cognitive processes. All responses were collected electronically and securely stored for further analysis.

Data Analysis

The Quest program was used to perform a Rasch analysis. The purpose of the Rasch analysis was to investigate the relationship between students' achievement in EFL reading comprehension and item difficulty. Next, in SPSS 25, the correlation among the variables was analyzed using Pearson's Product-Moment Correlation (Puth et al., 2014), and a One-Way MANOVA was performed to examine differences in students' metacognitive awareness by gender (Zhu et al., 2022). Finally, the structural relationship between the MAI subscales and English reading comprehension was analyzed using PLS-SEM (Hair et al., 2019).

RESULT AND DISCUSSION

The Type of Metacognitive Awareness That Students Demonstrate Well

Surprisingly, all the cognitive processes in EFL reading comprehension have insignificant correlations with all metacognitive awareness subscales. All the subscales of metacognitive knowledge/knowledge of cognition (declarative knowledge, procedural knowledge, and conditional knowledge) have a significant correlation with all aspects of metacognitive regulation/regulation of cognition (planning, monitoring, information management, debugging skills, and evaluation). As shown in Figure 2, among the reading comprehension cognitive processes, students performed better on guessing vocabulary in context than on the other processes ($M = 7.70$, $SD = 1.60$). At the same time, students had a high average in declarative knowledge ($M = 17.66$, $SD = 5.91$) and conditional knowledge ($M = 11.87$, $SD = 3.13$). On the other hand, in terms of metacognitive regulation/regulation of cognition, students demonstrated a high average level of knowledge across all subscales except debugging skills ($M = 11.95$, $SD = 4.57$). In summary, the students' metacognitive awareness is above average in almost every aspect.

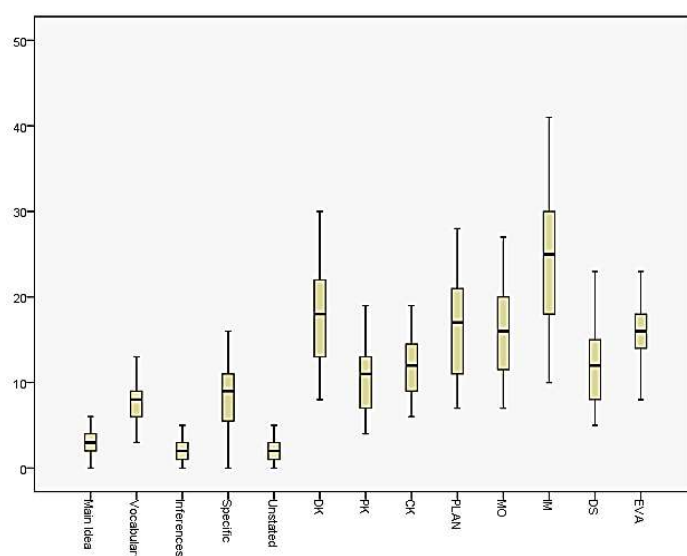


Figure 2. Distribution of scores across reading comprehension and metacognitive awareness dimension

The Type of Cognitive Process in EFL Reading That Students Were Able to Process The Most

The primary purpose of the EFL reading test was to evaluate students' reading comprehension and the types of cognitive processes they were most able to engage in. The test was essential to estimate the ability parameters and item difficulty levels of the tests. Rasch analysis of the Quest program was used to determine the distribution between student achievement and item difficulty levels (Figure 3). Figure 3 depicts students' reading comprehension performance on

the left and item difficulty levels on the right. The person-item map reveals that students performed poorly on unstated, detailed questions (questions 10 and 31). In addition, they found the vocabulary-in-context questions (items 2 and 3) to be the simplest. With the rest of the items, students demonstrated that the main idea, inferences, and specific information were neither too difficult nor too easy. The Rasch analysis confirmed the correlation analysis result that guessing vocabulary in context seems to be the cognitive process in which students perform best.

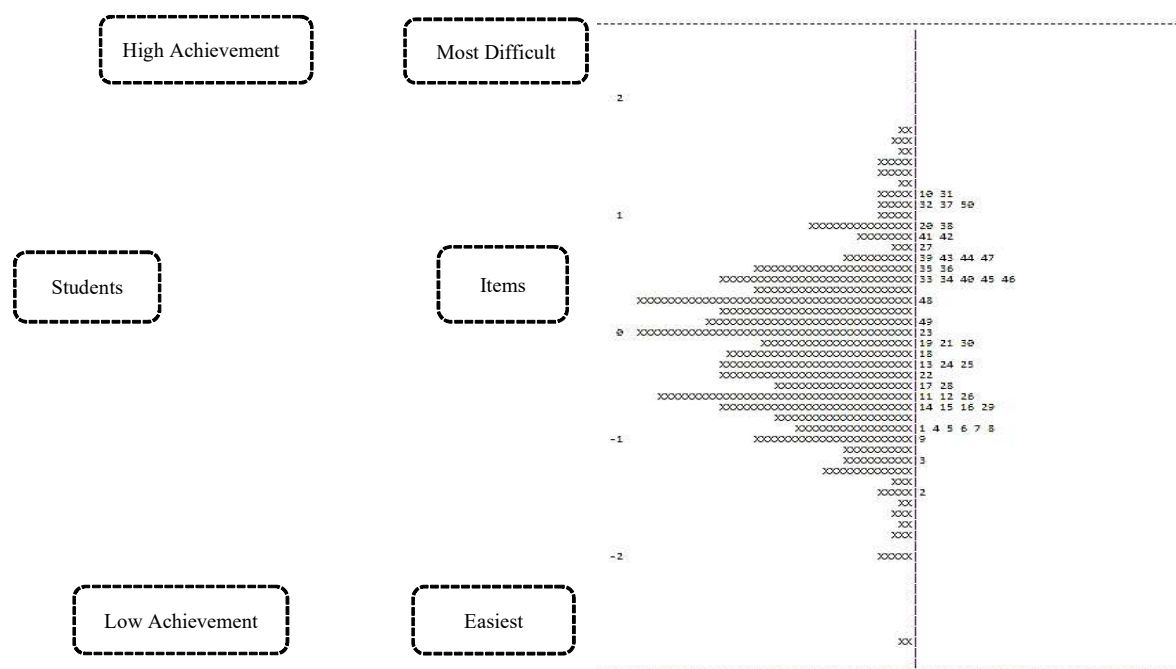


Figure 3. Person-item map indicating persons' ability levels and item difficulties on the same scale (each x represents 0.1 case)

The Level of Reliability and Validity of The Reading Comprehension Test

The mean values (logits) for items and persons were 32.2 and 23.0, respectively. All of these values had positive standardized deviation values. This indicates that the data obtained from the sample demonstrate that students possess a strong capacity to comprehend written text (Polat et al., 2022). Based on the data presented in

Table 3, the reliabilities of both the item and person are considered acceptable. Furthermore, the internal consistency reliability ratings for both items and individuals were determined to exceed 0.80 when evaluated using Cronbach's alpha (KR-20). The test items included in the study demonstrated a commendable level of reliability. (Ismail, Jimam, Dapar, & Ahmad, 2020).

Table 3. Reliability and fit statistics of the test

Construct	Students	
	Items	Persons
Number	50	71
Mean	32.2	23.0
Standard Deviation	10.7	7.4
Reliability (Cronbach's alpha)	0.86	0.81
Separation	2.47	2.05
MNSQ (infit)	1.00	1.00
MNSQ (outfit)	1.01	1.01
ZSTD (infit)	-0.1	0.0
ZSTD (outfit)	0.0	0.1
Chi-squared (X2)	4126.04	
df	3381	

RQ1: Are There Significant Differences In Students' Metacognitive Awareness By Gender?

A One-Way MANOVA test was conducted to determine differences in students' metacognitive awareness across gender. The

results revealed a statistically significant difference across all subscales of metacognitive awareness (Table 4); see also Figure 4.

Consequently, the alternative hypothesis (Hypothesis 1) was supported, and we concluded that there were statistically significant differences

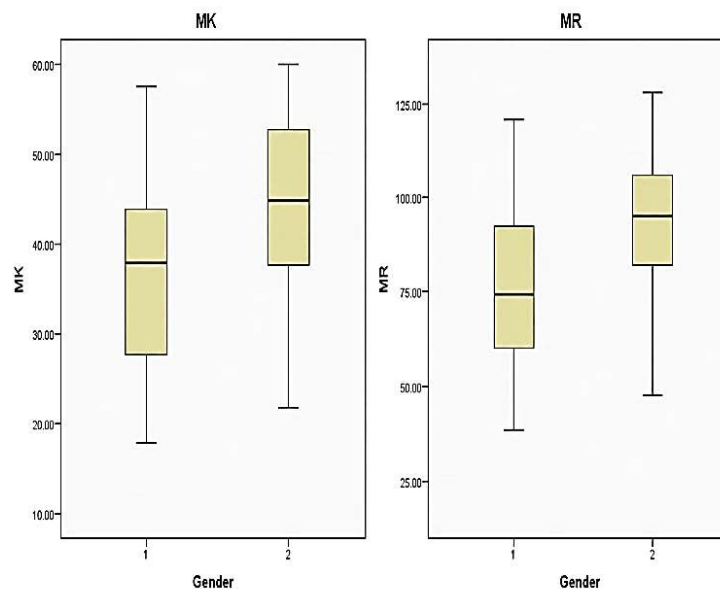


Figure 4. Gender differences in metacognitive awareness. Note: MNSQ: standardized mean square; ZSTD: z-standardized score; df: degrees of freedom

in students' levels of metacognitive awareness (declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, information management, debugging skills, and evaluation) across genders. *Female students*

outperformed male students in all the subscales of metacognitive awareness. The partial eta squared (ζ^2) results of each variable showed a moderate effect size (Table 4).

Table 4. Results for One-Way MANOVA for all dependent variables (Declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, information management, debugging skills, evaluation)

Source	Wilks' Λ	F	Hypothesis df	Error df	Sig.	η^2
Gender	0.74	2.72	8.000	70	0.01	0.25

Note. The p-value was significant < 0.05

Evaluation of The Measurements Model

PLS-SEM (Partial Least Squares Structural Equation Modeling) was utilized to analyze our data. The loading factors, internal reliability, convergent validity, and discriminant validity were evaluated to develop a reflective measurement model (Hair et al., 2019). An outer loading greater than 0.70 is recommended, and 0.4 or higher is acceptable (Kwong, 2013). Outer loadings greater than 0.70 are generally recommended. In contrast, values of 0.40 or higher may still be retained, particularly in exploratory research and when the indicator contributes to the construct's theoretical content validity (Kwong, 2013). In the present study, although the Conditional Knowledge loading (0.463) was below the recommended threshold of 0.70, it exceeded the minimum acceptable criterion of 0.40. Furthermore, removing this indicator would have reduced the conceptual coverage of metacognitive knowledge because declarative, procedural, and conditional knowledge collectively represent the theoretical dimensions proposed by Schraw & Dennison (1994). Hair et al. (2019) also suggest that indicators with loadings between 0.40 and 0.70 may be retained when their removal does not

substantially improve composite reliability or average variance extracted (AVE). When Conditional Knowledge was removed from the model, the increases in Composite Reliability and AVE were marginal and did not substantively improve measurement quality. Therefore, the indicator was retained to preserve theoretical completeness. Since the construct demonstrated acceptable composite reliability and convergent validity, the indicator was retained in the measurement model. The data revealed that outer loadings satisfied the criterion, as indicated by outer loading values (see Table 5) ranging from 0.463 to 0.944. Then, using the Composite Reliability (CR), we evaluated the model's internal consistency. The value range between 0.6 and 0.7 is acceptable for exploratory research, and the range between 0.7 and 0.9 is acceptable (Hair et al., 2019). The CR values (0.600-1.000) indicated that our model met the criteria for internal consistency. The Average Variance Extracted (AVE) was used to assess convergent validity. The cut-off value for AVE, according to Hair et al. (2019), should be $e^2 \geq 0.50$. The AVE ranges from 0.645 to 0.737. Consequently, our model met the criterion for convergent validity (see Table 5).

Table 5. Measurement model

Constructs	Subscales	loadings	Alpha	CR	AVE
Metacognitive knowledge/knowledge of cognition			0.827	0.600	0.645
	DK	0.913			
	PK	0.942			
	CK	0.463			
Metacognitive regulation/regulation of cognition			0.911	1.000	0.737
	PLAN	0.882			
	MO	0.944			

	IM	0.886			
	DS	0.825			
	EVA	0.741			
Reading comprehension			0.900	0.913	0.712
	INF	0.867			
	MI	0.845			
	SPE	0.842			
	UNS	0.841			
	VO	0.822			

Note: MI = Main Idea, VO = Vocabulary in Context, INF = Inferences, SPE = Specific Information, UNS = Unstated Detailed, DK = Declarative Knowledge, PK = Procedural Knowledge, CK = Conditional Knowledge, PLAN = Planning, MO = Monitoring, IM = Information Management, DS = Debugging Skills, EVA = Evaluation

In the final step, the Heterotrait-Monotrait ratio (HTMT) was computed to assess discriminant validity. Hair et al. (2019) recommend a threshold value, such as 0.85, when the constructs are conceptually more distinct, and a lower value when conservatism is desired. All HTMT coefficient values were less than 0.85, as shown in Table 6. This indicates that all our model constructs satisfied the discriminant validity criteria. Overall, our constructs met the criteria for internal reliability, convergent validity, and discriminant validity in the evaluation of the reflective model.

Table 6. Discriminant validity HTMT

	MK	MR	RC
MK			
MR	0.819		
RC	0.304	0.177	

Note: *MK* = Metacognitive knowledge/knowledge of cognition, *MR* = Metacognitive regulation/regulation of cognition, *RC* = Reading Comprehension.

Evaluation of The Structural Equation Modeling

RQ2: Does a structural relationship exist between metacognitive knowledge/knowledge of cognition and metacognitive regulation/regulation of cognition with English reading comprehension scores?

Figure 5 describes the result of the evaluation of the structural equation modeling.

Metacognitive knowledge/knowledge of cognition positively predicted EFL reading comprehension ($\hat{\alpha} = 0.679$, $p < .001$), whereas metacognitive regulation/regulation of cognition showed a negative and non-significant relationship ($\hat{\alpha} = -0.389$, $p = .082$). This finding suggests that knowledge about reading strategies, including when and how to use them, is more influential than the mere regulation of those strategies. According to Schraw and Dennison (1994), metacognitive knowledge serves as the foundation for effective strategy use. In the Indonesian EFL context, where students have limited exposure to English outside the classroom, learners with stronger metacognitive knowledge may be better equipped to deal with vocabulary and comprehension challenges. In contrast, higher levels of reported metacognitive regulation may reflect students' attempts to cope with reading difficulties rather than effective strategic behavior. Therefore, metacognitive knowledge appears to be a more important predictor of EFL reading comprehension than metacognitive regulation. First, we evaluated the coefficient of determination. The result showed that EFL reading comprehension was explained by the metacognitive awareness subscales, with an R^2 of 0.173 (17.3%).

For the next step, we evaluated the significance and relevance of the path coefficient from metacognitive awareness subscales to EFL reading comprehension. Metacognitive knowledge/knowledge of cognition positively

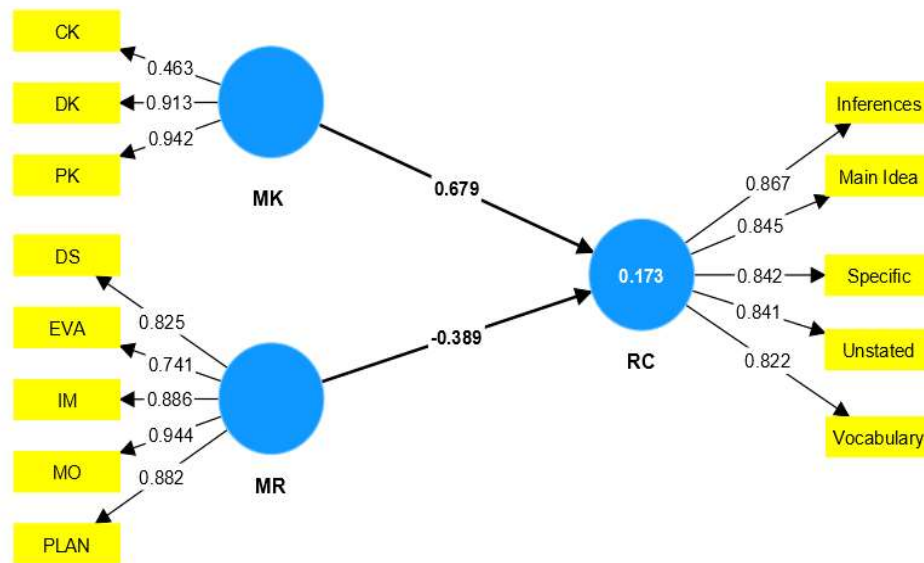


Figure 5. The result of structural equation modeling. Note: MK = Metacognitive knowledge/knowledge of cognition, MR = Metacognitive regulation/regulation of cognition, RC = Reading Comprehension, DK = Declarative Knowledge, PK = Procedural Knowledge, CK = Conditional Knowledge, PLAN = Planning, MO = Monitoring, IM = Information Management, DS = Debugging Skills, EVA = Evaluation

predicted EFL reading comprehension ($\beta = 0.679$, $p < 0.001$). Metacognitive regulation/regulation of cognition negatively predicted EFL reading comprehension (beta = -0.389 ; $p < 0.082$). Metacognitive regulation/regulation of cognition negatively predicted EFL reading comprehension ($\hat{\alpha} = -0.389$, $p = .082$). Although this finding was not statistically significant, it presents an interesting pattern that warrants further consideration. One possible explanation is that students with lower reading proficiency tend to engage in more frequent regulatory activities, such as rereading, monitoring, and checking their understanding, because they encounter greater difficulties during reading. In this case, higher levels of metacognitive regulation may reflect compensatory efforts rather than effective strategy use. This interpretation is consistent with theories of self-regulated learning, which suggest that struggling learners often allocate more cognitive resources to monitoring and problem-solving when comprehension breaks down. However, without sufficient metacognitive

knowledge regarding which strategies to use and when to apply them, these regulatory efforts may not lead to successful comprehension. In the Indonesian EFL context, where students often have limited exposure to English texts outside the classroom, regulatory behaviors may be activated in response to linguistic challenges such as unfamiliar vocabulary and complex sentence structures. Consequently, greater metacognitive regulation may signal reading difficulty rather than reading success, which could explain the negative relationship observed in the present study. The outcomes of structural equation modeling evaluations are summarized in Table 7.

The path regression analysis among the above variables showed that metacognitive knowledge (knowledge of cognition) predicted students' EFL reading comprehension better than cognitive regulation.

This study examined the effect of gender on differences in metacognitive awareness among students and the impact of metacognitive knowledge (knowledge of cognition) on EFL

Table 7. Hypothesis testing

Hypothesis path	Std Beta	t-value	p-value	Results
Metacognitive knowledge/knowledge of cognition->EFL Reading Comprehension	0.679	2.439	0.001	supported
Metacognitive regulation/regulation of cognition->EFL Reading Comprehension	- 0.389	1.175	0.082	Not supported

reading comprehension. In terms of metacognitive awareness, female students outperformed male students. In addition, metacognitive knowledge (knowledge of cognition) is more strongly associated with EFL reading comprehension than metacognitive regulation (regulation of cognition). These results support the notion that there are gender differences in metacognitive knowledge/knowledge of cognition and provide evidence of a contradictory relationship between metacognitive knowledge/knowledge of cognition and metacognitive regulation/regulation of cognition, as well as students' achievement, particularly in EFL reading comprehension.

According to this study's findings, responding to detailed, unstated questions appeared to be the most difficult cognitive process in EFL reading comprehension tasks. Conversely, it was simpler to determine the meaning of words from context. The findings of this study are essential for determining which reading tasks would most effectively leverage students' metacognitive awareness in EFL reading comprehension. When responding to the unstated, detailed questions, students most likely activated their metacognitive knowledge (knowledge of cognition) and applied the necessary regulation to solve the problem. Additionally, students' high average metacognitive awareness was expected to positively influence their EFL reading comprehension. The lack of a significant correlation between the metacognitive awareness subscales and the EFL reading comprehension subscales prompted some skepticism regarding our second and third hypotheses. However, useful information on the

significance of metacognitive awareness in EFL reading was found.

The findings of this study supported our first hypothesis that female students are more metacognitively aware of their learning. This study confirmed previous findings that gender influences differences in students' metacognitive awareness (Abdelrahman, 2020; Köse & Güneş, 2021). Female students reported higher levels of metacognitive awareness, suggesting that they were more conscious of potential challenges and the strategies needed to address them during reading comprehension tasks. Students inevitably become accustomed to using a set of procedural knowledge in reading strategies. The more they use various reading strategies, the better they are able to decide which strategies are appropriate for solving specific reading comprehension challenges. Moreover, according to Anggia & Habók (2023), EFL students also struggle with linguistics knowledge relatively to L1 and ESL students. Therefore, mastering reading comprehension strategies is an important element to support successful comprehension. On the other hand, the findings of this study rebut several former investigations that firmly stated that gender has no impact on metacognitive awareness (Baba & Aydogmus, 2021; Chen, 2015; Sheorey & Mokhtari, 2001; Taki & Soleimani, 2012). Like the present study, these studies only involved small numbers of participants. Although involving a larger number of participants is recommended for such a study, the current study's findings offer a new perspective: a small number of participants can differ significantly in metacognitive awareness by gender.

The next set of findings supported the second hypothesis that metacognitive knowledge (knowledge of cognition) is positively associated with EFL reading comprehension. Most of the previous studies reviewed on the potential association between metacognitive awareness and EFL reading comprehension concurred that both variables are inseparable (Al-Mekhlafi, 2018; Alkhateeb et al., 2021; Khellab). However, in this study, a distinction was made between metacognitive knowledge (knowledge of cognition) and metacognitive regulation (regulation of cognition). Aspects of metacognitive regulation/regulation of cognition, such as planning, monitoring, and evaluation, are commonly used terminologies by scholars to indicate the presence of metacognitive awareness of EFL learners. In mainstream metacognitive reading strategy instruments, metacognitive knowledge (knowledge of cognition) received no attention. Most of the instruments employed metacognitive regulation/regulation-of-cognition principles in the form of global strategy, support strategy, problem-solving, planning, monitoring, and evaluation. The findings of this study emphasized the important role of metacognitive knowledge (knowledge of cognition) in EFL reading comprehension.

Vice versa, the findings of this study did not support our third hypothesis that metacognitive regulation/regulation of cognition is expected to be positively associated with EFL reading comprehension (Fisher, 2021; Muhid et al., 2020). Metacognitive regulation/regulation of cognition is the process by which an individual plans the necessary steps to solve academic problems and is believed to be positively correlated with academic achievement, including reading comprehension (Raes et al., 2016). According to Schraw and Dennison (1994), knowledge of cognition and regulation of cognition simultaneously construct metacognitive awareness. However, the findings of this study

showed that the two domains could be contradictory with respect to EFL reading comprehension. A study by Stephanou and Mpiontini (2017) confirmed that metacognitive knowledge and metacognitive regulation have predictive power for the development of learning style. In their study, they found that metacognitive regulation is a more powerful predictor of learning style than metacognitive knowledge.

■ CONCLUSION

This research revealed that metacognitive knowledge is positively associated with EFL reading comprehension. It demonstrated that metacognitive knowledge was a significant positive predictor of EFL reading comprehension, whereas metacognitive regulation showed a negative and non-significant relationship. This finding represents a notable contribution to the literature, as it suggests that knowing when, why, and how to apply reading strategies may be more important than merely regulating those strategies during reading. The results also revealed that unstated-detail questions were the most challenging aspect of reading comprehension, while vocabulary-in-context questions were the easiest. Furthermore, female students exhibited higher levels of metacognitive awareness than male students. The paradoxical relationship between metacognitive regulation and reading comprehension suggests that students with lower reading proficiency may engage in more regulatory activities as a compensatory response to comprehension difficulties. These findings contribute to a more nuanced understanding of metacognitive awareness in Indonesian EFL contexts and highlight the importance of strengthening students' metacognitive knowledge as a foundation for effective reading performance.

Students' reading ability appears to be positively associated with their metacognitive knowledge, including declarative, procedural, and conditional knowledge. However, because the

structural model treated metacognitive knowledge as a single latent construct, no conclusion can be drawn about the relative contribution of each component. Knowledge of reading strategies necessitates a well-informed self-regulatory approach; students' self-regulation will not be present. In relation to this, the results of this study also indicated that students' metacognitive regulation is negatively associated with their EFL reading comprehension. It may indicate a gap between metacognitive knowledge and regulation. It is an opportunity for EFL reading instructors to fill the gap by consistently providing their students with reading experience. After mastering metacognitive knowledge, particularly procedural knowledge, students must train themselves to become more metacognitively regulated to overcome difficulties they encounter in EFL reading comprehension. This study then illustrated how to verify the person-item map in EFL reading comprehension and investigated which aspects of metacognitive awareness students possess. Modern EFL reading instructors must always administer a diagnostic test of reading comprehension and metacognitive awareness prior to instruction. Having this information prior to the teaching-learning process will allow instructors to focus on the cognitive and metacognitive aspects that students need to strengthen.

■ DECLARATION OF GENERATIVE AI USAGE IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used generative artificial intelligence (AI) tools, including ChatGPT (OpenAI), to assist with language refinement, grammar checking, and improving the text's clarity and readability. The AI tool was used solely to support the writing process and did not contribute to the study design, data collection, data analysis, interpretation of results, or the formulation of scientific conclusions. All AI-generated

suggestions were carefully reviewed, verified, and edited by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the content presented in this manuscript.

■ REFERENCES

- Abdelrahman, R. M. (2020). Metacognitive awareness and academic motivation and their impact on academic achievement of Ajman University students. *Heliyon*, 6(9), e04192.
- Al-Mekhlafi, A. M. (2018). EFL learners' metacognitive awareness of reading strategies. *International Journal of Instruction*, 11(2), 297–308.
- Alkhateeb, H. M., Abushihab, E. F., Alkhateeb, R. H., & Alkhateeb, B. H. (2021). Reading Strategies Used by Undergraduate University General Education Courses for Students in US And Qatar. *Reading Psychology*, 42(6), 663–679.
- Anggia, H., & Habók, A. (2023). Textual complexity adjustments to the English reading comprehension test for undergraduate EFL students. *Heliyon*.
- Baba Öztürk, M., & Aydogmus, M. (2021). Relational assessment of metacognitive reading strategies and reading motivation. *International Journal of Progressive Education*, 17(1), 357–375.
- Chen, L. W. C. (2015). Taiwanese EFL learners' perceived use of online reading strategies. *IAFOR Journal of Education*, 3(2), 68–80.
- Deliany, Z., & Cahyono, B. Y. (2020). Metacognitive reading strategies awareness and metacognitive reading strategies use of EFL university students across gender. *Studies in English Language and Education*, 7(2), 421–437.
- Fisher, D. (2021). The relationships between metacognition and reading strategies: The

- case of English-majored students at a private university in Vietnam. *European Journal of Educational Research*, 11(1), 69–81.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.
- Ismail, N. E., Jimam, N. S., Dapar, M. L. P., & Ahmad, S. (2020). Validation and reliability of healthcare workers' knowledge, attitude, and practice instrument for uncomplicated malaria by Rasch measurement model. *Frontiers in Pharmacology*, 10, 1–8.
- Khellab, F., Demirel, Ö., & Mohammadzadeh, B. (2022). Effect of teaching metacognitive reading strategies on reading comprehension of engineering students. *SAGE Open*, 12(4), 1–19.
- Khreisat, M. N. (2022). Investigating metacognitive reading strategy awareness of Saudi tertiary students: Comparisons of gender, reading ability and year level. *3L: Language, Linguistics, Literature*, 28(2), 122–139.
- Köse, N., & Güne°, F. (2021). Undergraduate students' use of metacognitive strategies while reading and the relationship between strategy use and reading comprehension skills. *Journal of Education and Learning*, 10(2), 99.
- Kwong, K. (2013). Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. *Marketing Bulletin*, 24(1), 1–32.
- Muhid, A., Amalia, E. R., Hilaliyah, H., Budiana, N., & Wajdi, M. B. N. (2020). The effect of metacognitive strategies implementation on students' reading comprehension achievement. *International Journal of Instruction*, 13(2), 847–862.
- Polat, M., Turhan, N. S., & Toraman, Ç. (2022). Comparison of classical test theory vs. multi-facet Rasch theory. *Pegem Editim ve Öğretim Dergisi*, 12(2), 213–225.
- Puth, M. T., Neuhäuser, M., & Ruxton, G. D. (2014). Effective use of Pearson's product-moment correlation coefficient. *Animal Behaviour*, 93, 183–189.
- Raes, A., Schellens, T., De Wever, B., & Benoit, D. F. (2016). Promoting metacognitive regulation through collaborative problem solving on the web: When scripting does not work. *Computers in Human Behavior*, 58, 325–342.
- Rogers, B. (2007). *The complete guide to the TOEFL test*.
- Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19, 460–475.
- Shorey, R., & Mokhtari, K. (2001). Differences in the metacognitive awareness of reading strategies among native and non-native readers. *System*, 29(4), 431–449.
- Stephanou, G., & Mpiontini, M.-H. (2017). Metacognitive knowledge and metacognitive regulation in self-regulatory learning style. *Psychology*, 8(12), 1941–1975.
- Taki, S., & Soleimani, G. H. (2012). Online reading strategy use and gender differences: The case of Iranian EFL learners. *Mediterranean Journal of Social Sciences*, 3(2), 173–184.
- Villanueva, J. M. (2022). Language profile, metacognitive reading strategies, and reading comprehension performance among college students. *Cogent Education*, 9(1).
- Zhu, T., Zhang, J. T., & Cheng, M. Y. (2022). One-way MANOVA for functional data via Lawley–Hotelling trace test. *Journal of Multivariate Analysis*, 192, 105095.
- Zoghi, M., Mustapha, R., & Maasum, T. N. R. B. T. M. (2010). Collaborative strategic reading with university EFL learners. *Journal of College Reading and Learning*, 41(1), 67–94.