

The Effect of Learning Modalities and Self-Regulated Learning on EFL Learners' Critical Thinking Development

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Abstract—This research investigates the effect of learning modalities (online, blended, face-to-face) on the critical thinking skills of EFL learners, reviewed by their level of self-regulated learning (SRL), and develops conjectures about their interaction. Using a mixed-methods approach with an explanatory sequential design (quantitative: 3x3 factorial; qualitative: case study), it involved 99 fourth-semester learners enrolled in a Critical Reading course. The results revealed significant effects of both SRL level ($F = 16.663, p = 0.000$) and learning modalities ($F = 19.395, p = 0.000$) on critical thinking skills, as well as a significant interaction effect between the two ($F = 3.713, p = 0.008$), indicating that the effect of a learning modality depends on the level of SRL and vice versa. The subsequent qualitative analysis developed nine conjectures to explain this interaction, highlighting how high SRL learners benefit from adaptive independence in online learning, moderate SRL learners require scaffolded critical thinking, and low SRL learners face cognitive fragmentation barriers; how blended learning supports high SRL learners through trans-modality synergy, moderate SRL learners through integrated stimulation, and low SRL learners through adaptive instructional alignment; and how face-to-face learning fosters self-driven criticality in high SRL learners, provides focused stimulation for moderate SRL learners, and is constrained by cognitive discontinuity for low SRL learners. These findings carry significant pedagogical implications for language teaching, highlighting the need for adaptive learning strategies tailored to SRL levels to effectively promote both student autonomy and critical thinking across diverse learning environments.

Index Terms—blended learning, critical thinking, face-to-face learning, online learning, self-regulated learning

I. INTRODUCTION

The landscape of higher education is undergoing a profound transformation driven by rapid technological advancements, shifting pedagogy from passive knowledge transmission to student-centred engagement. This aligns with global demands and national policies, such as the Indonesian Minister of Education, Culture, Research, and Technology Regulation Number 53 of 2023, which mandates flexibility to foster lifelong learning. Such provisions necessitate integrating diverse modalities—face-to-face, online, and blended—to cultivate essential 21st-century skills like critical thinking and adaptability, which are crucial for navigating the digital era (van Laar et al., 2020).

The availability of these modalities presents distinct opportunities and challenges for EFL instruction. Online learning, accelerated by the pandemic, increases accessibility and flexibility, a trend evident at Sultan Ageng Tirtayasa University (Untirta) (Suharsih & Wijayanti, 2021). While digital resources can deepen understanding and produce outcomes comparable to those of traditional methods, the lack of immediate interaction may impede the verbal communication skills necessary for nuanced interpretation of EFL texts (Sari, 2021; Thahir, 2021). Conversely, Blended Learning has emerged to bridge this gap by integrating online autonomy with the depth of face-to-face interaction (Huang et al., 2022). Untirta supports this through its SPADA platform (Agung & Yuliana, 2024). Meanwhile, traditional face-to-face instruction remains vital for immediate feedback, collaborative analysis (Suhirman & Prayogi, 2023), and social engagement (Zhao & Song, 2022).

Despite the availability of these methods, the cultivation of critical thinking—defined as the ability to evaluate arguments and make evidence-based decisions (Ennis, 2011)—remains a challenge. Recent research at Untirta indicates that critical thinking skills among English Language Education students are primarily low to moderate (Rima & Muhyidin, 2023), underscoring the need for pedagogical intervention. The Critical Reading course serves as a pivotal platform for this development, training students to move beyond information acquisition to deep engagement with diverse perspectives

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and complex arguments.

Crucially, the effectiveness of these modalities is likely influenced by Self-Regulated Learning (SRL). SRL refers to an individual's ability to control and adapt their learning processes (Schunk, 2023). It is theorised to moderate the relationship between instructional delivery and skill acquisition; for instance, highly self-regulated EFL learners can better leverage online independence (Lazorak et al., 2021). Research consistently highlights SRL's vital role in enhancing learning effectiveness and fostering critical thinking (Ranjbar et al., 2022; Zeng et al., 2024), yet its specific role in EFL Critical Reading remains underexplored.

While research on individual modalities exists, a comprehensive investigation into the differential effects of online, blended, and face-to-face learning on critical thinking in Critical Reading courses is limited (Ifnaldi et al., 2025). To address these gaps, this study employs a sequential explanatory mixed-methods design to evaluate the effectiveness of these three modalities and SRL levels on EFL learners' critical thinking. Specifically, this research aims to:

1. determine the differential main effects of learning modalities on critical thinking;
2. determine the differential main effects of SRL levels on critical thinking;
3. analyse the interaction effect between instructional delivery and learners' self-regulation capabilities;
4. qualitatively explore the underlying conjectures and specific self-regulation strategies that explain how learners navigate these learning environments to construct meaning.

II. LITERATURE REVIEW

A. Online Learning: Characteristics, Benefits, and Challenges

Online learning is a distance education method that leverages the Internet, enabling teaching and learning without spatial or temporal constraints (Jensen et al., 2022). Online learning encompasses various forms, including virtual interactions via video conferencing and Learning Management Systems (LMS) like Google Classroom, as well as fully online methods without direct physical interaction. Its primary benefits include flexibility in time and place, efficient dissemination of content, and unrestricted access to up-to-date information. Empirical studies indicate that these features can foster a more dynamic interaction between lecturers and students by facilitating real-time feedback and inclusive participation (Yu et al., 2022; Zeinstra et al., 2022). However, online learning also presents significant drawbacks, notably internet connectivity issues, reduced direct communication, a potential decrease in assessment objectivity, and adaptation challenges for students. To mitigate these challenges and standardise the quality of digital instruction, Untirta implemented the SPADA Online Learning System. SPADA is a comprehensive ecosystem designed to foster flexible, interactive learning. By utilising its interactive discussion forums and structured content modules, the platform supports the development of critical thinking and problem-solving skills. At Untirta, the SPADA Online Learning System has been implemented as an advanced platform to foster flexible and interactive learning, thereby promoting the development of critical thinking and problem-solving skills.

B. Blended Learning: Integration, Components, and Implementation

Blended learning is an educational approach that integrates traditional face-to-face instruction with online learning via digital platforms, offering students the flexibility to learn both in the classroom and independently online (Johler, 2022). By combining the strengths of both modalities, it serves as a natural extension of classroom learning, adapting to individual needs through interactive multimedia. Essential components for its implementation include live events, self-paced learning, collaboration, and assessment, with a focus on integrating direct interaction with independent online study (Al-Othman, 2025).

In the specific context of Critical Reading, this approach offers distinct advantages. Empirical studies indicate that the flexibility of blended learning allows students to process complex texts at their own pace before engaging in synchronous analysis (Boelens et al., 2017). This combination of online preparation and face-to-face debate fosters deeper reflection and increased student participation (Sivakumar et al., 2023). However, challenges such as gaps in digital literacy and inconsistent infrastructure persist (Listyani, 2025). To address these variables, Untirta mandates the use of the SPADA platform for the 2024/2025 course. This design integrates asynchronous modules for independent text analysis with synchronous video conferences and practical sessions, ensuring a comprehensive and supported learning experience.

C. Face-to-Face Learning: Foundations, Advantages, and Limitations

Face-to-Face Learning (FTFL) is a long-established and effective instructional method involving direct interaction between lecturers and students in a structured classroom environment (Gherheş et al., 2021). This method enables lecturers to observe student behaviour, provide personalised and timely feedback, and foster intensive social interaction. FTFL encompasses various types, including lectures, discussions, practical exercises, and group work, with lectures and interactive discussions being the most common. FTFL strategies can be either lecturer-centred (traditional) or student-centred (modern), with the latter aiming to develop students' affective and psychomotor domains (Ni, 2022). The benefits of FTFL include enhanced learning motivation, better comprehension of the material, effective two-way communication, flexibility without internet dependency, direct character assessment, and support for practical activities (Koirewoa et al., 2024). However, FTFL also has drawbacks, including fixed schedules that limit flexibility, challenges with learning

communities and physical presence, reliance on physical resources, uneven learning quality, student dependence on lecturers, time constraints, lack of lecture recordings, and classroom distractions (Juneja et al., 2023).

D. Critical Thinking Skills: Definition, Attributes, and Measurement

Critical thinking is recognised as a fundamental skill in higher education, involving the comprehensive analysis, evaluation, and synthesis of information (Ennis, 2015). To operationalise this concept, this study adopts Robert Ennis’s Taxonomy of Critical Thinking. This framework distinguishes five specific categories of cognitive skills: (1) Elementary Clarification (focusing on a question), (2) Basic Support (judging credibility of sources), (3) Inference (making deductions and inductions), (4) Advanced Clarification (defining terms and assumptions), and (5) Strategies and Tactics (interacting with others). In this research, the five-stage framework serves as the primary measurement tool. The specific indicators within these categories were used to construct the scoring rubric for the Critical Reading tests, enabling a precise evaluation of how the blended learning intervention affected each dimension of students’ analytical abilities.

E. Self-Regulated Learning: Conceptual Framework and Influencing Factors

Self-regulated learning (SRL) refers to an individual’s capacity to actively control and manage their learning process, a concept rooted in Bandura’s social cognitive theory, in which behaviour, personal factors, and the environment reciprocally influence learning (Zimmerman, 2023). This proactive approach involves setting clear goals, planning effective strategies, monitoring progress, and self-evaluating outcomes, emphasising the active role of metacognition, motivation, and behaviour. Factors influencing SRL include individual aspects such as knowledge (declarative, procedural, and conditional), metacognition (planning, organising, and evaluating), and goal-setting; behavioural factors, such as self-observation, self-judgment, and self-reaction, also play a crucial role, alongside environmental factors that shape learning behaviour and create conducive learning atmospheres (Henderson & Cunningham, 2023). This study operationalises SRL using Zimmerman’s (2002) fourteen strategies as primary indicators: self-evaluation, organising, goal-setting/planning, seeking information, monitoring, environmental structuring, self-consequences, rehearsing, seeking assistance, and reviewing records. This framework is used to analyse whether the autonomy in blended learning encourages EFL learners to mobilise these strategies more effectively than in traditional settings.

III. METHODOLOGY

A. Design

This research employed a mixed-methods sequential explanatory design, characterised by the collection of quantitative data followed by qualitative analysis to elaborate on EFL students’ performance (Creswell & Clark, 2017). This sequence leveraged complementary strengths: the quasi-experimental phase provided a robust empirical foundation, while the qualitative phase offered interpretive depth to contextualise statistical findings, including the exploration of outliers or unexpected patterns (Borg & Gall, 1989).

The quantitative phase utilised a 3x3 Factorial Design (Table 1). This specific configuration involves the crossing of two independent variables, each containing three distinct levels, yielding nine possible experimental conditions (Andrade, 2024). The design was selected to address practical constraints that prevented random assignment of individual students; instead, pre-existing intact classes were assigned to treatment groups. This structure enabled the simultaneous examination of the main effects and interaction effects of two independent variables: (1) Learning Modalities (three levels: online, blended, face-to-face) and (2) SRL Level (three levels: high, moderate, low) on the dependent variable, critical thinking skills.

TABLE 1
FACTORIAL DESIGN 3X3

Factor		Learning Modalities		
		Online (A1)	Blended (A2)	Face to Face (A3)
Self-regulated learning	High (B1)	B1/ A1	B1/ A2	B1/ A3
	Moderate (B2)	B2/ A1	B2/ A2	B2/ A3
	Low (B3)	B3/ A1	B3/ A2	B3/ A3

The qualitative phase employed a case-study approach to develop a substantive theory grounded in an in-depth understanding of the observed phenomena. Data were collected using in-depth semi-structured interviews to capture the learners’ subjective experiences and reasoning processes. Following the data collection, the analysis involved three main stages: Open Coding, Axial Coding (application), and Selective Coding, designed to extract and formulate theoretical constructs from the empirical data (Vollstedt & Rezat, 2019).

B. Participants

Participants comprised 99 fourth-semester undergraduate students in the English Language Education Program at Untirta (2024/2025). Distributed across three intact classes (30–35 students each) undertaking the Critical Reading course, groups were assigned to distinct modalities: Online, Blended, and Face-to-Face, facilitating a 3x3 factorial design. Core objectives and materials remained consistent to ensure comparability, while delivery was adapted to the affordances of

the modality (asynchronous vs. synchronous discussions). Fourth-semester students were selected for their cognitive maturity and the course's curricular relevance. Subsequently, participants for the qualitative phase were purposively sampled based on critical thinking scores and SRL levels to ensure diverse representation.

C. Data Collection Instrument

Critical thinking skills were quantitatively assessed using a Critical Thinking Test administered as a pretest and posttest. Adapted from Ennis's (1985) framework, the instrument consisted of 12 essay-type items designed to evaluate the five specific cognitive dimensions previously outlined. To ensure content validity, the test items were reviewed by three senior lecturers in applied linguistics, and reliability was established with a Cronbach's alpha coefficient of 0.917.

Simultaneously, learners' SRL levels were measured using a comprehensive SRL Questionnaire comprising 55 items. This instrument was developed based on Zimmerman's (1986) self-regulated learning strategies, utilizing a 4-point Likert scale ranging from 'Strongly Agree' to 'Strongly Disagree'. The questionnaire demonstrated strong internal consistency ($\alpha = 0.964$) and was used to categorize learners into high, moderate, and low SRL groups for the factorial design.

To gain a deeper understanding of these quantitative patterns, the study employed a purposive sampling strategy, specifically extreme-case sampling. From the total population, 27 participants were selected to represent the distinct intersections of the 3x3 design. This selection was limited to a small, focused cohort to enable the granular analysis required for a case study approach. Data were collected through semi-structured interviews, with questions adapted from Zimmerman's (1986) SRL interview protocols. The interview guide was designed to probe the specific cognitive conjectures and regulation strategies identified in the quantitative phase.

D. Data Analysis

(a). Quantitative Data Analysis

This research employed a mixed-methods approach, utilizing quantitative analysis to rigorously assess the research problem. Before conducting parametric tests, the fundamental assumptions were verified in SPSS v26. Results from the Kolmogorov-Smirnov and Levene's tests were non-significant ($p \geq 0.05$), confirming that the data met the necessary conditions of normality and homogeneity. A 3x3 between-subject factorial design was subsequently employed to examine the combined effects of learning modalities (online, blended, face-to-face) and SRL levels (high, moderate, low). A Two-way ANOVA was used to analyze main effects and interactions, with Scheffé's post hoc test used to identify specific group differences where significant interactions occurred at the 95% confidence level.

(b). Qualitative Data Analysis

Qualitative data, derived from questionnaires and interviews, were analysed using a case study. This approach aimed to analyse substantive theory through empirical data using focused case studies (Creswell, 2015). The analysis involved three main stages: Open Coding, Axial Coding, and Selective Coding. The initial stage, Open Coding, involved assigning codes to every participant's response from tasks and interviews. These codes were used to identify emerging ideas or concepts related to critical thinking and problem-solving. Following this, Axial Coding involved selecting a core category from the open coding results and linking other categories to it, specifically to describe the relationship between SRL and critical thinking. Key elements considered in axial coding included Causal Condition, Core Category, Context, Intervening Conditions, Strategies, and Consequences (Kendall, 1999). The final stage, Selective Coding, involved a comprehensive theory-building process that integrated and connected the various categories identified during axial coding.

IV. RESULTS AND DISCUSSION

A. Quantitative Findings

Methodological validity was ensured through parallel pre- and post-tests for Critical Thinking and a baseline SRL Questionnaire to stratify participants. Moderate SRL was the predominant category, and assumptions for parametric analysis were confirmed via Kolmogorov-Smirnov and Levene's tests ($p > 0.05$). The Two-way ANOVA (Table 2) revealed significant main effects on N-Gain for both Learning Modalities [$F(2, 90) = 19.395, p = 0.000$] and SRL [$F(2, 90) = 16, p = 0.001$]. Crucially, a significant interaction effect [$F(4, 90) = 3.713, p = 0.008$] indicates that instructional efficacy is contingent on learners' self-regulation, with the model explaining 48.3% of the variance ($R^2 = 0.483$).

TABLE 2
TWO-WAY ANOVA MEAN SCORE OF CRITICAL THINKING N-GAIN SCORE

Tests of Between-Subjects Effects					
Dependent Variable: N Gain Critical Thinking					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.462 ^a	8	.058	10.504	.000
Intercept	3.636	1	3.636	660.994	.000
Learning Modalities	.213	2	.107	19.395	.000
Self-Regulated Learning	.183	2	.092	16.663	.000
Learning Modalities * Self-Regulated Learning	.082	4	.020	3.713	.008
Error	.495	90	.006		
Total	4.631	99			
Corrected Total	.957	98			

a. R Squared = .483 (Adjusted R Squared = .437)

(a). *The Effect of Self-Regulated Learning on Learners' Critical Thinking*

To further explore the significant main effect of SRL, post hoc Scheffé tests (Table 3) revealed distinct differences. The comparison between High and Low SRL yielded a statistically significant difference ($p = 0.000$), with High SRL learners achieving a superior N-Gain (Mean Difference = 0.1153). Similarly, High SRL learners significantly outperformed the Moderate group ($p = 0.000$; Mean Difference = 0.0764). However, the difference between Moderate and Low SRL was not statistically significant ($p = 0.090 > 0.05$). Consequently, while High SRL learners demonstrated substantially better gains in critical thinking than both other groups, the performance of Moderate and Low SRL learners remained comparable.

TABLE 3
POST HOC TEST OF SELF-REGULATED LEARNING LEVEL FACTOR

Multiple Comparisons						
Dependent Variable: N_Gain_Critical Thinking						
Scheffe						
(I) Self_Regulated_Learning	(J) Self_Regulated_Learning	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
SRL_High	SRL_Moderate	.0764*	.01859	.000	.0301	.1227
	SRL_Low	.1153*	.01958	.000	.0665	.1640
SRL_Moderate	SRL_High	-.0764*	.01859	.000	-.1227	-.0301
	SRL_Low	.0389	.01749	.090	-.0047	.0824
SRL_Low	SRL_High	-.1153*	.01958	.000	-.1640	-.0665
	SRL_Moderate	-.0389	.01749	.090	-.0824	.0047

Based on observed means.
The error term is Mean Square (Error) = .006.
*. The mean difference is significant at the .05 level.

This study highlights the pivotal role of SRL in fostering critical thinking, particularly within critical reading. The ANOVA results confirm significant differences across SRL groups, corroborating meta-analyses (Broadbent & Poon, 2015) and frameworks that demonstrate that learners who actively monitor their cognitive processes outperform peers. This aligns with Zimmerman's (2002) cyclical phases of forethought, performance, and self-reflection, which are inherent to critical reading and enable High-SRL EFL learners to apply strategies effectively (Russell et al., 2022; Schunk, 2023). While High vs. Moderate distinctions were not always significant, potentially due to a "ceiling effect" or domain knowledge factors (Radovic & Seidel, 2024), the need to tailor instruction to learner autonomy remains clear.

Regarding learning modalities, the analysis powerfully positions Blended Learning as the most effective mode, particularly when combined with high SRL. The superior N-Gain in this group aligns with the 'Community of Inquiry' framework (Garrison & Kanuka, 2024), suggesting a unique synergy where learners utilize online autonomy for preparation and face-to-face sessions for social knowledge construction. In contrast, fully online environments, potentially hindered by 'Transactional Distance', showed less responsiveness to internal SRL variations. Similarly, traditional face-to-face learning yielded lower N-Gain, likely due to a lack of structured independent processing time. Ultimately, these findings confirm that integrating blended instruction with strong self-regulation is key to optimal development of critical thinking.

(b). *The Effect of Learning Modalities on Learners' Critical Thinking*

Post-hoc Scheffe analyses were also conducted to explore the significant main effect of learning modality on N-Gain Critical Thinking. This analysis specifically identified which pairs of learning modalities and SRL exhibited substantial differences in their effect on critical thinking. The results indicate that blended learning significantly outperformed both online and face-to-face learning. Specifically, blended learning resulted in significantly higher N-Gain Critical Thinking scores compared to online learning (Mean Difference = 0.0918, $p < 0.001$). Similarly, blended learning showed substantially greater gains in critical thinking than face-to-face learning (Mean Difference = 0.0871, $p < 0.001$).

In contrast, no statistically significant difference in average N-Gain Critical Thinking scores was found between online and face-to-face learning (Mean Difference = -0.0046, Sig. = 0.969, $p > 0.05$). This indicates that, within the context of this study, the effectiveness of online and face-to-face learning in fostering gains in critical thinking was comparable.

TABLE 4
POST HOC TEST ON LEARNING MODALITIES FACTOR

Multiple Comparisons Dependent Variable: N_Gain_Critical Thinking Scheffe						
(I) Learning Modalities	(J) Learning Modalities	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Online	Blended	-.0918*	.01786	.000	-.1362	-.0473
	Face to face	-.0046	.01845	.969	-.0506	.0413
Blended	Online	.0918*	.01786	.000	.0473	.1362
	Face to face	.0871*	.01858	.000	.0409	.1334
Face to face	Online	.0046	.01845	.969	-.0413	.0506
	Blended	-.0871*	.01858	.000	-.1334	-.0409

Based on observed means.
The error term is Mean Square (Error) = .006.
*. The mean difference is significant at the .05 level.

This research confirms a significant effect of learning modalities on critical thinking ($p = 0.000$). Post-hoc Scheffé analysis (Table 4) revealed that blended learning significantly outperformed both online (mean difference = 0.0918, $p < 0.001$) and face-to-face instruction (mean difference = 0.0871, $p < 0.001$), while no significant difference was found between online and face-to-face learning ($p = 0.969$). The superiority of blended learning aligns with the Community of Inquiry framework (Akyol et al., 2009; Garrison & Vaughan, 2007) and recent studies (Amenduni & Ligorio, 2022; Teng et al., 2024), attributing its success to the integration of flexibility, interaction, and cognitive presence. In contrast, the comparable but lower effectiveness of online and face-to-face modes stems from their respective limitations: online learning heavily demands high SRL, while lecture-heavy face-to-face settings often fail to foster the deep, active reflection required for critical thinking, particularly for students with low SRL (Lim et al., 2020).

Crucially, a significant interaction effect was observed between learning modality and SRL ($F = 3.713$, $p = 0.008$), indicating that effectiveness is contingent upon student self-regulation. In online environments, N-Gain consistently declines with lower SRL, reflecting a heavy reliance on self-management (Dai et al., 2023; Jin et al., 2023). Conversely, blended learning proves most effective for high SRL learners, who achieve the highest gains by strategically integrating both modalities (Lee, 2024). Meanwhile, face-to-face instruction resulted in moderate N-Gain across all levels, appearing significantly less sensitive to SRL variations than the other modalities.

(c). Interaction Effect of Self-Regulated Learning and Learning Modalities on Learners' Critical Thinking

The results of the two-way ANOVA revealed a statistically significant interaction effect between the learning modality and learners' SRL levels on their critical thinking abilities. The significance level ($p < 0.05$) for this interaction term indicates that the effect of a particular learning modality on critical thinking outcomes varies by the learner's level of self-regulation. Conversely, the effect of a student's SRL level on their critical thinking was contingent upon the learning modality they experienced. This finding suggests that the effectiveness of a given learning modality was not uniform across all levels of student self-regulation.

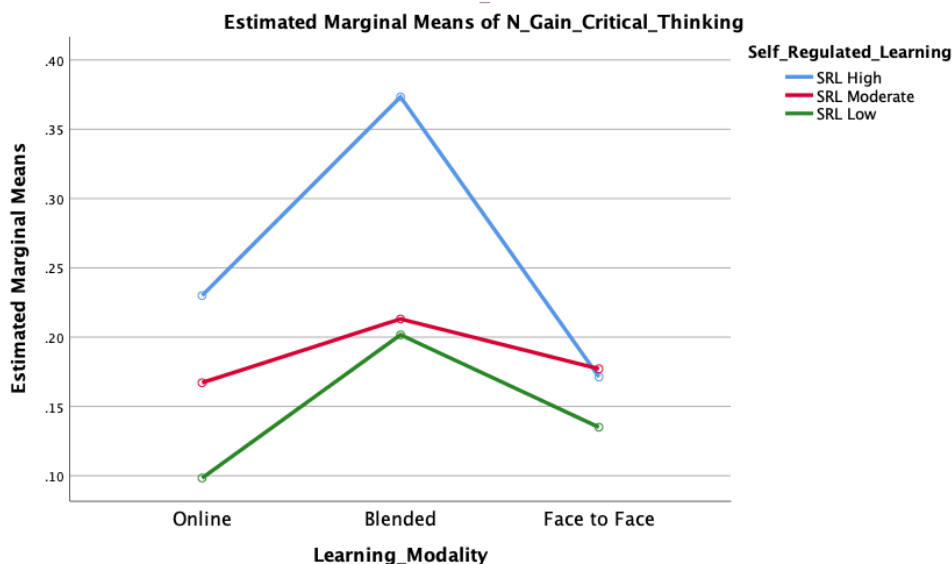


Figure 1. Interaction Effect of Self-Regulated Learning and Learning Modalities on Learners' Critical Thinking Skills

Figure 1 illustrates a disordinal interaction ($p = 0.008$), confirming that instructional effectiveness is contingent upon learners' SRL capacity. The overall model demonstrated a strong fit ($R^2 = 0.483$), explaining 48.3% of the variance in critical thinking scores. Scheffé post hoc analysis revealed that Blended Learning was superior, particularly for High SRL learners, who significantly outperformed their High SRL Online counterparts (Mean Diff = -0.1433 , $p = 0.044$). This advantage was even more pronounced against Moderate (Mean Diff = -0.2062 , $p < 0.001$) and Low SRL Online learners (Mean Diff = -0.2750 , $p < 0.001$). Conversely, within the online modality, SRL levels did not significantly differentiate gains, nor were significant differences found between Online and Face-to-Face groups across any levels ($p > 0.05$).

Blended Learning emerged as the most effective approach, particularly for High SRL EFL learners, who achieved a peak N-Gain of approximately 0.37. While scores decreased for Blended-Moderate (0.21) and Blended-Low (0.20) groups, they remained competitive. In contrast, Online Learning exhibited a sharp decline correlated with SRL capabilities, dropping from 0.17 (Moderate) to a nadir of 0.10 (Low), confirming heavy dependence on self-management. Face-to-Face instruction showed moderate stability, with a slight anomaly: Moderate SRL learners (0.18) marginally outperformed High SRL students (0.17), followed by Low SRL (0.14). Ultimately, while Face-to-Face and Online modes showed similar improvement levels, both fell short of the superior performance achieved by the Blended-High combination.

These interaction patterns provide strong empirical support for Adaptive Learning models (Dagunduro et al., 2024; du Plooy et al., 2024) and underscore the importance of instructional design that actively facilitates self-regulation (Vrieling et al., 2018). The efficacy of blended learning across levels suggests it successfully balances support and autonomy (Cao et al., 2024; Müller et al., 2023). Conversely, the evident challenges in fully online settings and the suboptimal performance in traditional contexts highlight the need for differentiated interventions (Jin et al., 2023; Prasse et al., 2024). Educators should therefore prioritize blended models and implement initial diagnostic SRL assessments to tailor strategies, ultimately optimizing gains in critical thinking in the Critical Reading course.

B. Qualitative Findings

To address the fourth objective regarding underlying success mechanisms, an in-depth qualitative analysis employed open and axial coding to formulate selective conjectures for each SRL-modality combination. The resulting axial coding diagram (Figure 2) visually maps the intricate framework connecting causal conditions, strategies, and consequences. These findings complement the quantitative analysis by providing nuanced explanations of how EFL learners with varying SRL levels engage with different learning environments to develop critical thinking.

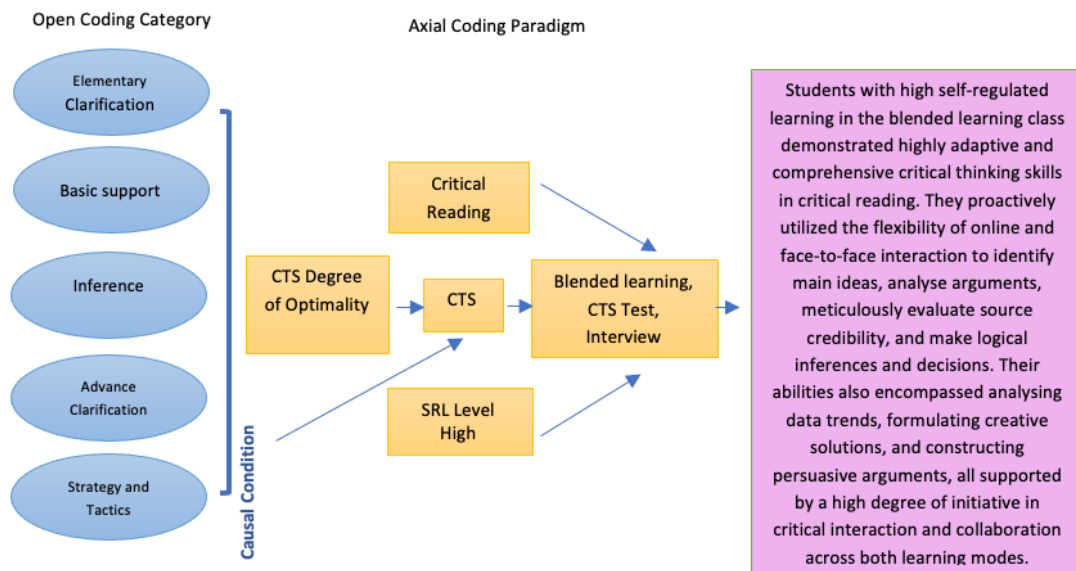


Figure 2. Axial Coding Diagram Illustrating the Relationship Between Learners With High Self-Regulated Learning (SRL) and Critical Thinking Skill in Blended-Learning

(a). High Self-Regulated Learning and Online Learning: Adaptive Independence

This conjecture asserts that high SRL EFL learners possess the essential foundational skills to thrive in the independent demands of online learning environments. Qualitative data indicate that their “adaptive independence”, where self-management and proactivity enable them to consciously and systematically utilize digital features and resources to sharpen their critical thinking abilities. These students efficiently focus on questions, accurately and comprehensively analyse arguments from varied online texts, and proactively seek clarification independently. They are also highly discerning in evaluating the credibility of online sources through cross-checking, capable of analysing digital data trends, and making logical and holistic deductive and inductive inferences. Even in the online context, they demonstrate creative

thinking in seeking alternative solutions, constructing persuasive arguments, and actively engaging in digital collaborations.

These findings align with the view that self-regulated learners possess metacognitive, motivational, and behavioural capabilities to achieve their learning goals (Brenner, 2022). Given the minimal external structure in EFL learning, this capacity becomes crucial. Highly SRL learners can apply effective planning, monitoring, and self-reflection strategies to navigate the vast amount of online information, identify key points, and critically evaluate the information they encounter. Self-regulated learning is a strong predictor of success in online learning, largely due to the self-paced, self-directed nature of the environment (Broadbent, 2017). The independence fostered by high self-regulated learning facilitates the complex process of online critical reading, where readers must actively interpret, analyse, and evaluate information without constant direct guidance.

(b). Moderate Self-Regulated Learning and Online Learning: Scaffolded Critical Thinking

This conjecture highlights that while moderate SRL EFL learners possess a sufficient base of self-regulatory skills (Wood et al., 2009), the development of their critical thinking abilities in online environments heavily relies on adaptive support and clear structure. The data suggest that their essential thinking abilities are reasonably developed, but their consistency and independent initiative fluctuate, necessitating external stimuli. These students can focus on questions about online English texts, primarily structured ones, but require more time for complex text analysis and explicitly analyze when they struggle to interpret their readings. They exhibit inductive-inductive or inductive-direct connections, but lack rigor, stating limitations. Creative thinking and persuasive argument construction are more frequent when explicitly prompted, and participation in online interactions is contingent on this.

These findings align with the scaffolding perspective in learning (Wood et al., 2009), which emphasizes the importance of temporary support to help learners navigate their zone of proximal development. Moderate SRL EFL learners are at a point where they possess basic capacity but require guidance and structure to consistently apply critical thinking strategies in a demanding online environment. Effective e-learning design often recommends features that support self-regulated learning, such as self-monitoring tools, clear instructions, and targeted feedback (Bozkurt & Sharma, 2021; Huang et al., 2022). In an online EFL critical reading class, this could involve providing guiding questions for critical reading, templates for argument analysis, or actively moderated discussion forums to stimulate deeper engagement and reflection. Without this adaptive support, learners with moderate SRL may not fully optimize their potential for critical thinking in online learning environments.

(c). Low Self-Regulated Learning and Online Learning: Cognitive Fragmentation

This conjecture demonstrates that the fundamental limitations in self-regulation among low-SRL EFL learners lead to “cognitive fragmentation” in an independent online environment. Qualitative data indicate that they struggle to focus on questions, often reading English texts superficially and being easily distracted. The understanding of analysis readability is minimal, and the analysis of online data is very superficial. Decisions tend to be impulsive, deductive-inductive reasoning is weak, and generalizations are often unwarranted. Difficulty defining terms and distinguishing concepts is also significant. Creative thinking is minimal, arguments are weak and incoherent, and participation in online interactions is passive.

This phenomenon aligns with findings that, without the intrinsic ability to manage time, self-motivate, or apply effective learning strategies, an online environment that demands autonomy becomes a barrier to learning (Pedrotti & Nistor, 2019). Cognitive Load Theory can explain this phenomenon: when low SRL learners are faced with complex online critical reading tasks without adequate scaffolding, the intrinsic and extraneous cognitive load becomes too high, making it difficult for them to process information and develop critical thinking skills (Hartson & Pyla, 2012). Limitations in self-regulated learning fundamentally hinder their ability to engage critically with the material, underscoring a need for significantly greater, structured, and proactive external support to lay a foundation for critical thinking.

(d). High Self-Regulated Learning and Blended Learning: Trans-Modality Critical Thinking Synergy

This conjecture asserts that High-SRL EFL learners strategically leverage blended learning to create a “trans-modality synergy” that optimizes critical thinking by proactively integrating the distinct advantages of both modes. Qualitative data reveal that they efficiently synthesize online resources with face-to-face clarifications to enhance argument analysis and systematically verify the credibility of sources. Their engagement is characterized by insightful questioning in class, followed by independent exploration in online forums. Consequently, they demonstrate strong deductive-inductive reasoning, creative thinking, and the ability to construct persuasive arguments, actively maintaining critical collaboration across both environments.

These findings align with the Community of Inquiry (CoI) framework, which emphasizes the maximization of cognitive, social, and teaching presence (Garrison & Vaughan, 2007). High-SRL EFL learners are ideal candidates for this model, as they demonstrate initiative to independently foster cognitive presence in online environments while leveraging face-to-face sessions to enhance social presence and deep interaction. By effectively combining online flexibility with the direct support of in-person learning, these students capitalize on the strengths of both modalities to achieve superior outcomes in the development of critical thinking (Lim & Yeo, 2021).

(e). Moderate Self-Regulated Learning and Blended Learning: Integrated Critical Stimulation

This conjecture suggests that moderate SRL EFL learners benefit greatly from “integrated critical stimulation” in blended learning to optimize the development of their critical thinking. Data indicate that integrating online and face-to-face modes fosters critical engagement, although their independent initiative and depth of analysis often depend on external triggers. They can focus questions on texts, guided by discussion, and analyse explicit arguments. They actively ask questions in face-to-face sessions and utilize online forums, though they are less proactive in seeking answers independently. Class discussions help them understand the criteria for evaluating sources, analyse complex data, and enrich their decision-making perspectives. Deductive-inductive reasoning develops with group discussion. They can define terms and distinguish concepts with face-to-face interaction. Creative initiatives are sparked by brainstorming, and logical arguments are developed through face-to-face debates or presentations. Interaction participation is active when collaborative tasks are assigned.

These findings are consistent with the notion that blended methods can provide flexible, adaptive scaffolding for learners who require it (Wilson, 2016). For moderate SRL EFL learners, face-to-face activities provide opportunities for direct guidance, immediate feedback, and social interaction that can trigger their critical thinking. At the same time, the online component guides them to practice independence, access additional resources, and reflect on the material without the pressure of time. In a Blended Learning method, this combination can overcome the weaknesses of single-mode learning, allowing instructors to provide appropriate support at the right time. An effective blended learning design can help students with moderate self-regulated learning internalize self-regulation and critical thinking strategies through repeated exposure and systematic feedback, thereby promoting significant improvement.

(f). Low Self-Regulated Learning and Blended Learning: Adaptive Instructional Alignment

This conjecture asserts that for low SRL EFL learners, blended learning necessitates “adaptive instructional alignment”. Fundamental limitations within this group lead to a heavy reliance on external support despite the availability of face-to-face interaction. Qualitative data reveal they struggle to optimize either modality due to a lack of initiative, requiring explicit direction to focus or analyze arguments. Specific observed deficits include passive questioning, minimal understanding of source credibility, and superficial observation of data without instructor interpretation. Furthermore, decision-making tends to be impulsive, while deductive and inductive reasoning, as well as creative thinking, remain weak, leading to passive participation in which concepts are not distinguished even after repeated explanations.

Although quantitative analysis suggests blended methods outperform pure face-to-face learning for this group, qualitative findings confirm that low self-regulation remains a significant impediment. These learners require highly intensive, personalized scaffolding; mere physical presence does not equate to active engagement without continuous prompting. This aligns with Van Laer and Elen (2017), who note that novice learners require highly structured instruction rather than the self-discovery approach often assumed in blended models. Consequently, the “self-directed” component poses a specific challenge, necessitating proactive pedagogical interventions to address SRL limitations before critical thinking strategies can be effectively internalized.

(g). High Self-Regulated Learning and Face-to-Face Learning: The Self-Driven Criticality

This conjecture posits that the initiative and intellectual independence of High-SRL EFL learners enable them to optimize critical thinking in face-to-face settings. Qualitative data indicate they actively shape discussions and extend understanding beyond classroom structures. Key behaviours include dissecting argument structures, posing challenging inquiries, and meticulously verifying the credibility of sources in English texts. Their reasoning is accurate, allowing them to question limitations, demonstrate creative thinking, and construct persuasive arguments. Consequently, they actively drive face-to-face interactions, initiating debates and facilitating in-depth collaboration.

These findings align with Self-Determination Theory (Ryan & Deci, 2020), describing these learners as active, autonomous learners who maximize the interactive potential of face-to-face EFL environments. Rather than merely absorbing information, they actively test understanding and challenge ideas through dialogue. Since critical thinking is a social and collaborative process (Liyanage et al., 2021), High-SRL learners leverage these interactions to hone skills beyond the explicit curriculum. By bringing a critical disposition to the classroom, they transform the face-to-face environment into an arena for sharpening their intellect.

(h). Moderate Self-Regulated Learning and Face-to-Face Learning: Focused Critical Thinking Stimulation

This conjecture suggests that while Moderate SRL learners possess basic self-regulation, their face-to-face critical thinking relies heavily on external structure, masking a lack of independent initiative. Engagement tends to be reactive and analysis superficial without direct guidance, limiting learners to safe boundaries rather than deep exploration of English texts. These findings align with Vygotsky’s Zone of Proximal Development (Iqbal, 2015), indicating that while scaffolding is necessary, non-adaptive support can constrain growth. Furthermore, consistent with Bandura’s (1986) social cognitive theory, a lack of motivation to actively extend observed behaviours prevents these learners from achieving the level of optimization seen in High SRL peers, as traditional EFL methods often fail to foster the autonomy required for advanced critical thinking.

(i). Low Self-Regulated Learning and Face-to-Face Learning: Cognitive Discontinuity

This conjecture asserts that fundamental limitations in self-regulation led to “Cognitive Discontinuity” among Low SRL EFL learners in face-to-face settings. Qualitative analysis indicates struggles with managing learning processes, manifesting as superficial reading of English texts, distraction, and passive participation. Argument analysis remains minimal and often incoherent, requiring step-by-step guidance. Furthermore, these learners avoid complex challenges, accept information uncritically, and exhibit impulsive decision-making, with weak deductive and inductive reasoning. Consequently, collaborative contributions are limited, marked by weak argumentation and a lack of constructive solutions.

These findings align with Cognitive Load Theory (Sweller, 2024), suggesting that the cognitive demands of face-to-face EFL environments are overwhelming for this group. Both extraneous and intrinsic loads hinder effective processing (Ouwehand et al., 2025), as the lack of metacognitive ability prevents independent knowledge building. It is emphasized that self-regulation is key to learning interactions; thus, without highly structured, explicit scaffolding, standard face-to-face methods become barriers to learning. This underscores the critical need for personalized interventions to stabilize essential thinking skills.

V. CONCLUSION

A. Conclusion

This research demonstrates the significant interactive effects of Self-Regulated Learning (SRL) and learning modalities on EFL learners’ critical thinking in Critical Reading. Quantitatively, higher SRL learners consistently outperformed their peers, while blended learning emerged as the superior modality. Crucially, a statistically significant interaction effect confirmed that instructional effectiveness is contingent upon EFL learners’ self-regulation capacity. The qualitative phase deepened these insights through selective conjectures, revealing how specific SRL mechanisms facilitate or hinder engagement across different environments. These findings corroborate the quantitative results and underscore the need for tailored instructional design, concluding that fostering critical thinking in EFL contexts requires integrating pedagogical approaches with individual students’ characteristics.

B. Implications

This research significantly enriches the theoretical understanding of how SRL and learning modalities interact within EFL education. It confirms SRL as a fundamental catalyst for critical thinking in critical reading, offering empirical evidence that its effectiveness is contingent on EFL learners’ characteristics rather than on a single universal mode. This supports adaptive learning frameworks and calls for instructional designs that explicitly integrate student self-regulation. Furthermore, the study contributes to blended learning literature by demonstrating its unique adaptability to various SRL levels, making it optimal for development through synergistic online and face-to-face interactions. In practice, these findings urge EFL curriculum designers and institutions to prioritize SRL development by adopting adaptive blended models that offer flexibility for high-SRL learners while providing structured scaffolding for moderate- and low-SRL learners. Diagnostic assessments are identified as crucial for tailoring this support. Consequently, EFL Critical Reading instructors should differentiate their pedagogy based on these diagnostics, explicitly teaching both critical thinking and self-regulation strategies. Ultimately, learners are encouraged to proactively develop their SRL skills to optimize their growth in critical thinking within these flexible environments.

C. Limitations and Future Directions

Several limitations are acknowledged. First, the single-institution setting restricts generalizability to broader EFL populations. Second, the self-developed SRL instrument relies on self-report, which creates potential for bias. Third, internal variations within modalities—such as interaction quality or structure—were not fully captured. Fourth, qualitative validity requires further cross-checking by a second coder. Finally, standard critical thinking metrics (post-test/N-Gain) may not fully capture the multidimensional complexity of thinking skills in a foreign language.

Future studies should employ longitudinal designs to track EFL learners’ development over time and to test specific pedagogical interventions for SRL. Since the current model explains 48.3% of the variance, future research must investigate the remaining 51.7% by exploring variables such as intrinsic motivation, emotional intelligence, and prior knowledge in EFL contexts. Additionally, researchers should aim for greater demographic diversity among EFL learners and develop more sensitive, context-specific instruments.

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