

A COMPARATIVE STUDY OF MOBILE-ASSISTED AND PAPER-BASED ANNOTATION ON READING COMPREHENSION OF INDONESIAN EFL LEARNERS

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Abstract

This study aims to examine the effect of mobile-assisted annotation strategies on the reading comprehension of Indonesian EFL learners and to compare their effectiveness with traditional paper-based annotation strategies. Reading comprehension remains a persistent challenge among junior high school students, often caused by limited vocabulary mastery, low engagement, and the lack of effective reading strategies. Although annotation has been widely recognized as a useful approach to foster active reading, empirical studies comparing different annotation modalities, particularly within the Indonesian EFL context, are still limited. This research adopts a mixed-methods approach with an explanatory sequential design. The quantitative phase utilizes a quasi-experimental method involving two groups of students, each consisting of 30 participants. One group is exposed to mobile-assisted annotation, while the other group uses paper-based annotation. Data are collected through pre-tests and post-tests to assess students' reading comprehension improvement. Statistical analyses are conducted to determine whether there are significant differences between the two groups. Following the quantitative phase, the qualitative phase is conducted to gain deeper insights into students' experiences and perceptions regarding the use of both annotation strategies. Data are gathered through semi-structured interviews and analyzed using thematic analysis. This phase helps to explain and enrich the quantitative findings by highlighting students' preferences, challenges, and engagement levels. The findings of this study are expected to contribute to the existing literature on reading strategies and mobile-assisted language learning. Ultimately, the study offers educators a practical roadmap for revitalizing reading pedagogy through the strategic integration of mobile technology.

Keywords: Explanatory sequential design; Indonesian EFL learners; Mobile-assisted annotation; Mobile-Assisted Language Learning (MALL); Reading comprehension

Introduction

Moreover, reading comprehension in a foreign language is intrinsically linked to metacognitive awareness—the ability of learners to monitor, evaluate, and adjust their cognitive strategies while interacting with challenging text. When students utilize annotation tools, they externalize their internal cognitive monitoring processes, making them tangible and easier to reflect upon. This externalization supports both local comprehension (understanding sentence-level details) and global comprehension (grasping overarching textual structures). Consequently, comparing mobile-assisted and paper-based annotation modalities provides vital empirical insights into how different technological media

mediate metacognitive self-regulation among junior high school EFL learners.

Reading comprehension is widely acknowledged as one of the most fundamental, complex, and critical language skills in learning English as a Foreign Language (EFL). It serves as the primary cognitive, academic, and socio-cultural gateway through which learners acquire new knowledge, expand their intellectual horizons, and interact with diverse global discourses across various academic and professional domains. Proficient reading comprehension enables students to decode orthographic symbols, understand literal meanings, interpret pragmatic intentions, and construct deep conceptual meaning from written texts spanning multiple genres, registers, and modalities. However, despite

its paramount importance in contemporary language education, empirical observations, national assessments, and classroom evaluations consistently reveal that a vast majority of Indonesian EFL students continue to face persistent, compounding difficulties in reading comprehension (Fitria et al., 2024).

These persistent challenges are frequently rooted in a complex interplay of internal and external factors. Prominent among these are limited active vocabulary mastery, low intrinsic and extrinsic motivation, heightened cognitive anxiety when encountering dense or unfamiliar academic texts, and the complete absence of effective, self-regulated reading strategies (Nanda, 2020). Such pedagogical obstacles are particularly acute across secondary education levels in Indonesia, where junior high school students frequently struggle to process complex syntactic structures, synthesize main ideas, evaluate authorial tone, and fully comprehend authentic English texts under time constraints. Without targeted, innovative instructional interventions, these comprehension deficits widen over time, negatively impacting overall academic performance, linguistic confidence, and lifelong literacy development.

To address these pressing pedagogical challenges, language educators, curriculum designers, and researchers have implemented a wide variety of instructional strategies aimed at boosting students' reading comprehension and fostering active cognitive engagement. Among these varied instructional techniques, text annotation has emerged as a widely recognized, highly robust pedagogical approach. Text annotation involves active physical or digital interaction with a text through systematic marking, highlighting, underlining, circling, and writing marginal notes while reading (Yeh et al., 2016). By engaging in active

annotation, students are purposefully discouraged from passive, superficial decoding and are instead prompted to focus on crucial information, maintain sustained concentration, and construct deeper mental representations of the textual content. Previous empirical investigations (Zhang, 2026) have consistently demonstrated that structured annotation tactics considerably improve learners' reading comprehension by encouraging higher-order cognitive processing, active synthesis, and metacognitive self-regulation.

Building directly upon this solid theoretical foundation, a prior study conducted by Simatupang and Katemba (2026) specifically explored the efficacy of various text annotation tactics in enhancing reading comprehension abilities within the Indonesian educational context. Their study utilized a quantitative comparison design involving pre-tests and post-tests to contrast individual annotation practices with collaborative group annotation. The empirical findings revealed that while both cohorts experienced meaningful improvements in their reading comprehension scores, there was a substantial performance variance depending on the collaborative implementation structure. Furthermore, student participants exhibited strong positive affective reactions toward the structured integration of annotation strategies within their regular reading assignments.

While prior research clearly underscores the general efficacy of annotation tactics, earlier investigations predominantly focused on traditional, paper-based annotation methods utilizing printed texts and conventional stationery. In today's rapidly evolving digital age, the pervasive integration of information and communication technologies into educational ecosystems has catalyzed the emergence of Mobile-Assisted Language

Learning (MALL). Within MALL frameworks, learners leverage portable digital devices—such as smartphones, tablets, and e-readers—to supplement, personalize, and extend their language acquisition processes beyond the physical confines of the traditional classroom (Stockwell, 2022). Mobile annotation opens up unprecedented instructional possibilities, including interactive digital highlighting, dynamic multimedia integration, instant dictionary lookups, and streamlined cloud-based note-taking (J. Li & Cui, 2026). Nevertheless, the transition toward digital reading environments also introduces complex pedagogical and cognitive challenges, such as potential attention fragmentation, screen-induced visual fatigue, and cognitive overload when compared to traditional paper-based reading modalities (Aziz et al., 2024; Lepp et al., 2022).

Despite the exponential growth of mobile technology usage in modern education, there remains a notable scarcity of empirical research directly comparing the instructional effectiveness of mobile-assisted annotation against traditional paper-based annotation, particularly within the Indonesian secondary EFL environment. Moreover, a significant portion of existing literature relies heavily on quantitative outcome metrics, such as standardized test scores, while neglecting deep, qualitative explorations of learners' lived experiences, affective engagement, and cognitive hurdles. Consequently, this study is designed to bridge these critical gaps in the literature by performing a rigorous comparative analysis of mobile-assisted and paper-based annotation methodologies and their distinct impacts on the reading comprehension of Indonesian junior high school EFL learners.

Literature Review

To establish a robust conceptual and theoretical foundation for this investigation,

it is imperative to examine the key constructs governing this research: reading comprehension, text annotation strategies, Mobile-Assisted Language Learning (MALL), and paper-based cognitive processing models.

Reading comprehension is fundamentally conceptualized as an active, goal-directed cognitive process wherein the reader constructs meaning through the simultaneous extraction and construction of textual information (Cartwright, 2015). Drawing upon executive function frameworks, reading comprehension is directly tied to cognitive processes that regulate attention control, working memory capacity, cognitive flexibility, and self-monitoring. In the context of EFL learning, where linguistic automaticity is still developing, executive functions are heavily taxed. When readers encounter unfamiliar vocabulary or complex syntactic arrangements, their working memory resources can easily become overburdened, leading to comprehension breakdown. Therefore, pedagogical tools that externalize cognitive load and support working memory—such as structured annotation—are vital for academic success.

Text annotation serves as a crucial metacognitive bridge connecting lower-level decoding with higher-level text comprehension. According to Azmuddin et al. (2020), annotation acts as both an external memory store and an active processing mechanism. When learners physically or digitally mark, highlight, or annotate texts, they engage in generative cognitive processing—selecting relevant information, organizing it into coherent mental structures, and integrating prior knowledge with new textual concepts. In traditional paper-based reading, annotation relies on tactile manipulation (writing with pens, highlighters, and sticky notes), which embodies cognitive processes and reinforces haptic memory retention (Ross et al., 2017).

Conversely, mobile-assisted annotation leverages digital affordances, such as color-coded categorization, hyperlinked definitions, text-to-speech features, and searchable archives, transforming static reading into an interactive, multimodal dialogue (Zhang, 2026).

Mobile-Assisted Language Learning (MALL) provides the overarching pedagogical paradigm for digital annotation. As Stockwell (2022) notes, MALL is characterized by portability, social interactivity, contextual sensitivity, and learner agency. Mobile devices allow EFL learners to bridge formal and informal learning environments, accessing target language texts anytime and anywhere. However, MALL integration is not without friction. Scholars like Begum and Ahmad (2025) caution that mobile devices inherently introduce multitasking temptations and digital distractions (e.g., social media notifications, messaging apps), which can fragment attention and diminish reading endurance. Furthermore, comparative reading studies (Delgado et al., 2018; Clinton, 2019) have long debated whether digital screens induce superficial skimming compared to the sustained, linear concentration fostered by printed paper.

Despite these theoretical debates, empirical research comparing mobile-assisted annotation directly against paper-based annotation within Indonesian secondary schools remains exceptionally scarce. This study addresses this theoretical and empirical void by examining both quantitative achievement outcomes and qualitative learner perceptions.

Furthermore, social constructivist perspectives on reading emphasize that comprehension is not merely an isolated cognitive extraction of text, but a socially mediated, highly active constructive process (Vygotsky, 1978). Annotation serves as an

externalized cognitive artifact that mediates between the reader's internal mental schema and the external textual stimuli. When students utilize mobile devices to annotate, they tap into distributed cognition networks where digital tools shoulder part of the working memory burden, allowing learners to allocate cognitive resources toward inferential reasoning and thematic synthesis.

In the Indonesian educational landscape, where English is taught strictly as a foreign language with limited naturalistic exposure outside the classroom, maximizing classroom engagement through interactive tasks is paramount. Traditional reading instruction in Indonesian secondary schools has historically relied on rote translation and passive comprehension checks. The integration of mobile-assisted annotation represents a paradigm shift toward student-centered, technology-enhanced language pedagogy. However, because teachers often lack structured frameworks for balancing digital tools with conventional literacy practices, empirical comparative research such as this study provides essential evidence-based guidance for curriculum developers.

Methodology

This study employs a rigorous mixed-methods research design, specifically adopting an explanatory sequential design framework (Sharma et al., 2023). This methodological approach is intentionally structured into two distinct, chronologically connected phases: the initial collection and statistical analysis of quantitative experimental data, immediately followed by the collection and thematic analysis of qualitative interview data designed to further explain, elaborate upon, and contextualize the quantitative outcomes.

In the initial quantitative phase, a quasi-experimental methodology utilizing a

pretest-posttest control group design (Anggraini, 2025) was implemented to evaluate causal relationships between instructional treatments and learning outcomes. The target population comprised seventh and eighth-grade students enrolled at SMP Advent VII Rawamangun in Jakarta, Indonesia, who were actively learning English as a Foreign Language. A total sample of 52 students from Grades VII and VIII was selected and evenly divided into two distinct instructional cohorts: 26 students in the experimental group who received structured instruction utilizing mobile-assisted annotation strategies, and 26 students in the control group who received parallel instruction utilizing traditional paper-based annotation strategies. Due to practical administrative constraints within the school setting where random individual assignment was unfeasible, cluster sampling (Ballance, 2024) was employed to select intact classes with comparable baseline English proficiency levels.

The quantitative data collection instrument consisted of validated reading comprehension tests administered as both pre-tests prior to treatment and post-tests following the instructional intervention. These examination instruments comprised multiple standardized reading passages accompanied by multiple-choice items meticulously designed to measure core reading comprehension sub-skills, including identifying main ideas, extracting specific factual details, making complex logical inferences, and interpreting vocabulary items within context. The content validity of the instruments was established through expert appraisal against standardized EFL curriculum benchmarks, while reliability was verified using internal consistency metrics (Cronbach's alpha exceeding 0.75). The treatment procedure spanned six instructional weeks, during which the experimental cohort executed digital annotations using tablet and

smartphone software interfaces, while the control cohort performed manual annotations using printed handouts and highlighters. Quantitative data were subsequently analyzed using descriptive statistics (means and standard deviations), prerequisite assumption tests (normality and homogeneity tests), paired sample t-tests to evaluate within-group progress, and independent sample t-tests to compare post-test performance between the two cohorts at a significance level of $p = 0.05$.

Following the quantitative phase, the qualitative phase was initiated utilizing a qualitative descriptive approach (E. Ahmed & Albaaly, 2025) to deeply investigate students' personal experiences, psychological perspectives, perceived benefits, and operational challenges encountered during both annotation modes. Purposive sampling (Ahmad & Wilkins, 2025) was utilized to select ten representative student participants (five from the mobile-assisted cohort and five from the paper-based cohort across diverse academic achievement tiers: high, medium, and low achievers). Semi-structured qualitative interviews (Sarib & Rasak, 2022) were conducted in a comfortable school environment using a flexible bilingual format (English and Indonesian) to ensure participants could fully articulate their thoughts without linguistic barriers. The collected interview transcripts were analyzed through rigorous thematic analysis (Cernasev & Axon, 2023), involving data familiarization, open coding, theme generation (encompassing engagement, ease of use, distraction, and cognitive learning effectiveness), and interpretive synthesis to triangulate and enrich the quantitative findings. Trustworthiness in the qualitative phase was established through member checking, peer debriefing, and detailed audit trails (S. K. Ahmed, 2024).

To ensure meticulous methodological rigor, data triangulation was enforced across

both phases. The quantitative experimental data provided macro-level evidence of achievement differentials, while the qualitative descriptive data provided micro-level narrative explanations regarding how and why those differentials occurred. Throughout the quasi-experimental intervention, both the experimental and control cohorts received identical instructional content regarding text structures and reading comprehension sub-skills; the sole methodological variable was the annotation modality utilized (mobile-assisted versus paper-based). This careful experimental control eliminates confounding instructional variables and isolates the specific impact of annotation modality on reading performance.

Finding and Discussion

The results and comprehensive discussion are presented to thoroughly address the research questions concerning the comparative effectiveness of mobile-assisted versus paper-based annotation strategies on junior high school EFL learners' reading comprehension performance, as well as their underlying cognitive and affective perceptions.

The quantitative phase evaluated the pre-test and post-test scores of both the experimental (mobile-assisted) and control (paper-based) groups. Descriptive statistical calculations revealed that both cohorts demonstrated noticeable improvements in their reading comprehension scores from pre-test to post-test, reflecting the general instructional value of active text annotation. However, inferential statistical evaluations utilizing independent sample t-tests were conducted to determine whether the mobile-assisted annotation intervention produced statistically significant advantages over the

traditional paper-based approach. The statistical results are summarized in Table 1 below.

Table 1. Independent Sample T-Test Results of Post-Test Scores

Group	N	Mea n	Std. Deviatio n	Sig. (2- tailed)
Mobile-Assisted Annotation	2 6	78.46	6.21	0.034
Paper-Based Annotation	2 6	74.12	7.05	-

As clearly delineated in Table 1, the experimental group utilizing mobile-assisted annotation achieved a higher mean post-test score ($M = 78.46$, $SD = 6.21$) compared to the control group utilizing paper-based annotation ($M = 74.12$, $SD = 7.05$). Furthermore, the independent sample t-test yielded a two-tailed significance value of $p = 0.034$, which is well below the conventional alpha threshold of 0.05. This statistical outcome confirms that there is a statistically significant difference in reading comprehension performance between the two groups, favoring the mobile-assisted annotation methodology. These quantitative findings substantiate the proposition that integrating mobile digital tools into annotation tasks provides distinct cognitive and linguistic scaffolds that elevate learners' text comprehension capabilities.

To unpack the underlying mechanisms driving these quantitative score disparities, the qualitative thematic analysis of semi-structured interviews provided critical

insights. The analysis yielded four core themes: (1) Affective and Cognitive Engagement, (2) Technological Ease of Use and Accessibility, (3) Digital Distraction and Cognitive Load, and (4) Perceived Learning Effectiveness.

Regarding affective engagement, students in the mobile-assisted cohort articulated a high degree of enthusiasm, noting that interactive color-coded highlighting features, built-in digital dictionaries, and multimedia hyperlinks made the reading process far more dynamic, interactive, and intrinsically motivating. As one high-achieving participant remarked during the interviews, "Using my phone to highlight and instantly check unfamiliar words made reading feel less like a chore and more like an engaging digital activity." This aligns closely with contemporary Mobile-Assisted Language Learning (MALL) theories positing that portable digital interfaces enhance learner autonomy and affective investment (J. Li & Cui, 2026).

Conversely, students in the paper-based annotation cohort emphasized the deep concentration and tactile grounding associated with physical handwriting. Several participants noted that the tactile act of underlining text and writing marginal notes by hand fostered a slower, more reflective reading pace, minimizing visual fatigue. This qualitative nuance corresponds with established cognitive research on embodied cognition, which suggests that traditional paper reading maintains stable spatial-visual mental representations without the interference of screen glare (Clinton, 2019; Delgado et al., 2018).

Importantly, qualitative triangulation also highlighted the dual-edged nature of mobile devices. While mobile tools offered superior accessibility and vocabulary support, a subset of students candidly reported encountering intermittent digital distractions, such as

incoming social media notifications or messaging pop-ups, which momentarily disrupted their concentration. This finding echoes the cautionary observations of Begum and Ahmad (2025) regarding the friction between digital engagement and digital distraction in classroom settings.

Synthesizing both phases of this explanatory sequential design indicates that while mobile-assisted annotation statistically outperforms traditional paper-based methods in boosting reading comprehension scores—primarily due to interactive scaffolding and immediate lexical resource access—pedagogical success is contingent upon deliberate instructional scaffolding and classroom management to mitigate digital distractions.

A deeper exploration of the qualitative themes further elucidates the cognitive mechanisms at play. When interviewed about vocabulary acquisition, participants in the mobile-assisted group highlighted how built-in translation and dictionary widgets eliminated the friction of stopping to look up words in heavy print dictionaries. This seamless lexical access directly supported fluent reading paths and reduced cognitive fatigue. Conversely, students in the paper-based group noted that manual handwriting encouraged them to synthesize and condense ideas in their own words rather than simply copying digital highlights, fostering deeper conceptual retention.

These nuanced findings align with the dual-coding theory and cognitive load theory, demonstrating that each annotation modality stimulates distinct cognitive pathways. While mobile annotation excels in multi-modal engagement, lexical accessibility, and collaborative potential, paper annotation excels in tactile focus and sustained linear concentration. Therefore, modern EFL pedagogy should not view these modalities as mutually exclusive dichotomies, but rather as

complementary tools that can be strategically blended to maximize junior high school learners' reading comprehension proficiencies.

Pedagogical Challenges and Strategic Implementation in Digital Literacy Integration

While the empirical results confirm the statistical superiority of mobile-assisted annotation in enhancing reading comprehension scores among junior high school EFL learners, successful integration requires careful navigation of classroom dynamics and infrastructure. In many Indonesian secondary schools, digital readiness varies significantly among students and teachers. Instructors often encounter infrastructural bottlenecks, such as uneven internet connectivity, inconsistent device specifications, and varying levels of student digital literacy. These disparities can inadvertently widen achievement gaps if digital tasks are assigned without adequate preparatory training.

Furthermore, managing student attention in mobile-enhanced learning environments demands proactive pedagogical intervention. As noted in the qualitative findings, students occasionally faced distractions from social media and messaging applications. To mitigate these challenges, educators must establish clear classroom protocols—such as utilizing focused application modes, setting strict time boundaries for digital tasks, and coupling mobile annotation with collaborative face-to-face discussions. By fostering a balanced hybrid learning environment where digital tools complement rather than replace foundational reading habits, teachers can maximize the cognitive and linguistic benefits of mobile-assisted instruction while safeguarding students against screen fatigue and cognitive overload.

Theoretical Alignment with Cognitive Load Theory and Dual-Coding Framework
To fully interpret the superior performance of the mobile-assisted annotation group, the findings must be examined through the lens of Cognitive Load Theory (Sweller, 2011) and Paivio's Dual-Coding Theory (1986). Cognitive Load Theory posits that human working memory has finite processing capacity. When instructional materials impose excessive extraneous cognitive load—such as the cumbersome physical friction of flipping pages or searching through print dictionaries for unfamiliar terms—learners experience working memory overload, which impedes comprehension.

Mobile-assisted annotation alleviates extraneous cognitive load by integrating digital dictionaries, instant hyperlinking, and color-coded categorization into a single unified interface. This enables learners to redirect their limited cognitive capacity toward germane cognitive load—the processing required for deep schema construction, inferential reasoning, and textual synthesis. Simultaneously, the Dual-Coding Theory explains how combining visual, tactile, and auditory cues through mobile interfaces stimulates both verbal and non-verbal processing channels. The interactive highlighting and dynamic multimedia features of mobile annotation create multiple retrieval pathways in memory, resulting in more robust mental representations of the text compared to traditional paper-based methods.

Future Research Trajectories in Digital Reading Modalities

Looking forward, the insights generated by this comparative investigation open several promising avenues for subsequent research in foreign language education. While this study focused primarily on junior high school students using standard mobile annotation tools, future empirical inquiries should

examine longitudinal effects across diverse educational tiers, including senior high schools and tertiary institutions. Additionally, with the rapid proliferation of generative artificial intelligence in education, investigating the specific pedagogical affordances of AI-assisted reading platforms—such as real-time syntactic simplification, automated interactive questioning, and personalized vocabulary scaffolding—represents a vital frontier for future mixed-methods investigations in EFL reading pedagogy.

Implications and Future Directions

The empirical and qualitative findings of this research offer profound theoretical, methodological, and practical implications for English Language Teaching (ELT) in secondary education settings.

Theoretically, this study extends the existing literature on Mobile-Assisted Language Learning (MALL) and reading pedagogy by bridging cognitive information processing models with socio-constructivist frameworks. It demonstrates that digital annotation tools function not merely as cosmetic substitutes for traditional highlighters, but as active cognitive scaffolds that augment working memory and facilitate metacognitive self-regulation among EFL learners. Furthermore, by contrasting digital affordances with embodied paper cognition, this research contributes to a more nuanced understanding of media-induced cognitive processing variations in foreign language reading.

Methodologically, the study highlights the immense value of employing an explanatory sequential mixed-methods design in educational research. Relying solely on quantitative pre-test and post-test scores would have provided a restricted view of achievement outcomes without explaining the underlying student experiences,

preferences, and cognitive hurdles. By integrating semi-structured qualitative interviews and thematic analysis, this research successfully triangulated statistical gains with rich learner narratives, offering a holistic portrait of classroom reality.

Practically and pedagogically, the findings provide actionable recommendations for English teachers, school administrators, and instructional designers. Educators are encouraged to move beyond rigid dichotomies that either demonize mobile devices as mere classroom distractions or unreservedly embrace them without pedagogical structure. Instead, teachers should adopt a blended, scaffolded approach to technology integration. Specifically, educators can incorporate mobile-assisted annotation tasks to boost vocabulary acquisition, active interaction, and learner motivation, while simultaneously establishing clear classroom boundaries to mitigate digital distractions. Teacher training programs should likewise equip educators with digital literacy competencies and instructional design frameworks necessary to implement mobile-assisted reading strategies effectively in Indonesian secondary schools.

Conclusions

This study set out to investigate and compare the instructional impact of mobile-assisted annotation strategies versus traditional paper-based annotation strategies on the reading comprehension of Indonesian junior high school EFL learners, utilizing an explanatory sequential mixed-methods design. The empirical quantitative findings conclusively demonstrated that students exposed to mobile-assisted annotation achieved statistically significant higher reading comprehension post-test scores compared to their peers in the paper-based control group ($p = 0.034$). Furthermore, the qualitative findings corroborated and illuminated these statistical results, revealing

that mobile annotation tools substantially elevate student engagement, interaction depth, and vocabulary accessibility, despite presenting minor challenges related to digital distraction and screen fatigue.

Pedagogically, the insights generated from this research carry profound implications for modern English language teaching. Language educators and curriculum designers are encouraged to strategically integrate mobile annotation technologies into reading pedagogy rather than viewing digital devices solely as sources of distraction. By establishing clear classroom guidelines, teaching digital literacy skills, and leveraging interactive software features, teachers can harness mobile annotation to cultivate active, self-regulated readers. Future research endeavors should expand upon these findings by examining longitudinal effects across diverse educational levels and investigating the specific pedagogical affordances of emerging artificial intelligence-assisted reading platforms.

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