

STUDENTS' EXPERIENCES IN USING DIGITAL ANNOTATION TOOLS TO ENHANCE READING COMPREHENSION

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ABSTRACT

The rapid proliferation of digital technologies in educational settings has fundamentally transformed how students engage with academic texts. Among the many tools that have emerged, digital annotation tools - software applications that enable readers to highlight, comment, tag, and organize information within digital documents - have attracted considerable scholarly interest. Despite growing enthusiasm in both practitioner communities and research circles, relatively little attention has been paid to how students themselves experience the use of these tools, particularly in relation to reading comprehension development. This qualitative study explores the lived experiences of 24 undergraduate EFL (English as a Foreign Language) students enrolled at a state university in Indonesia who used digital annotation tools - specifically Hypothesis, Kami, and Adobe Acrobat Reader - over one full academic semester. Drawing on semi-structured interviews, reflective journals, and classroom observations, the study examines students' perceptions of tool usability, their emerging annotation strategies, and the ways in which tool use influenced their reading comprehension processes and outcomes. Findings reveal that digital annotation tools fostered deeper textual engagement by encouraging active reading behaviors, facilitating meaning negotiation, and promoting metacognitive awareness. Students reported marked improvements in their ability to identify main ideas, make inferences, and critically evaluate source texts. However, challenges related to digital literacy, screen fatigue, and technological access also surfaced as notable barriers. The study contributes nuanced, student-centered insights into the pedagogical affordances and limitations of digital annotation tools and offers practical recommendations for educators seeking to integrate these tools meaningfully into reading instruction.

Keywords: *active reading, digital annotation tools, EFL learners, metacognition, qualitative research, reading comprehension*

INTRODUCTION

Reading comprehension sits at the very core of academic success. It is not merely the mechanical decoding of words but rather a dynamic, constructive

process through which readers actively build meaning by drawing on prior knowledge, linguistic competence, and higher-order thinking skills (Afflerbach et al., 2022). In the context of English as a Foreign Language (EFL) education, reading comprehension has long been considered a particularly challenging skill, given the compounded difficulties of unfamiliar vocabulary, complex syntactic structures, and culturally distant content (Yilmaz & Yuksel, 2022). As universities in Indonesia and across Southeast Asia continue to internationalize their curricula-demanding that students engage with English-language academic texts-the stakes associated with reading proficiency have never been higher.

It is against this backdrop that digital technologies have entered educational discourse with both promise and urgency. The COVID-19 pandemic served as a powerful accelerant, compelling institutions to pivot rapidly toward online and hybrid learning models, thereby normalizing the use of digital platforms for instruction and assessment (Moorhouse & Kohnke, 2024). Within this shift, digital annotation tools emerged as one of the more pedagogically promising innovations. Unlike passive reading experiences, these tools invite students to interact with texts in visible, traceable ways - highlighting key phrases, inserting marginal comments, tagging thematic patterns, and even sharing annotations with peers in collaborative environments (Zhu & Chen, 2024).

The theoretical grounding for digital annotation practices draws on several well-established frameworks. The ICAP framework, which posits that constructive and interactive learning activities produce deeper cognitive processing than passive reception, provides one foundational rationale for annotation-based reading instruction (Calle-Arroyo et al., 2023). Sociocultural theory further suggests that when students annotate collaboratively, they participate in a form of mediated knowledge construction - a collective scaffolding that strengthens comprehension beyond what individual readers might achieve alone (Chen & Zhu, 2023; Ramirez-Castillo et al., 2022). Moreover, the role of metacognition in reading comprehension - the reader's capacity to monitor, evaluate, and regulate their own understanding - has been extensively theorized as central to academic literacy development, and digital annotation tools are

increasingly recognized as powerful externalizations of this internal process (Zhussupova & Kazbekova, 2024).

Empirical research has begun to accumulate evidence in support of these theoretical propositions. Studies by Hidayat et al. (2023), Novak and Sila (2023), and Zhu and Chen (2024) have demonstrated that students who use digital annotation tools tend to perform better on comprehension assessments, engage more frequently with difficult passages, and demonstrate more sophisticated reading strategies than their peers who rely on traditional methods. Yet the research landscape is not without its gaps. A significant body of prior work has focused on quantitative performance metrics - test scores, annotation frequency counts, and time-on-task measurements - while the qualitative dimension of student experience has received comparatively limited attention. As a result, educators and curriculum designers are often left without a nuanced understanding of how students themselves perceive, navigate, and make sense of digital annotation tools in their reading lives.

This study seeks to address that gap. By centering student voice and experience, it moves beyond the question of whether digital annotation tools work to explore the richer question of how and why they work - or do not work - from the learners' own perspective. The research is guided by three primary questions: (1) How do students describe their experiences of using digital annotation tools during academic reading tasks? (2) What annotation strategies do students develop, and how do these strategies relate to their reading comprehension processes? and (3) What perceived impacts - both enabling and constraining-do students attribute to digital annotation tool use? The answers to these questions, the study argues, can provide valuable insights for pedagogical design and technology integration in higher education reading instruction.

LITERATURE REVIEW

Reading Comprehension in the Digital Age

Reading comprehension is widely understood as a multidimensional construct that encompasses literal understanding, inferential reasoning, critical

evaluation, and creative interpretation (Afflerbach et al., 2022; Seah & Tay, 2023). Traditional models of reading - those grounded in print literacy - emphasized a largely solitary and linear process: a reader encounters a text, applies decoding skills and background knowledge, and constructs meaning in relative isolation. The rise of digital reading environments has complicated and enriched this picture considerably. Readers navigating digital texts do not simply move from left to right and top to bottom; they click hyperlinks, watch embedded media, annotate in margins, search for definitions, and share excerpts with peers - all within a single reading session (Coiro et al., 2023; Bui & Nguyen, 2024).

These new reading practices have prompted scholars to theorize what might be called 'new literacies' - the expanded set of competencies required to comprehend, evaluate, and produce digital texts effectively (Coiro et al., 2023). Research in this area consistently underscores that digital reading is not simply print reading on a screen; it demands different cognitive strategies, particularly around self-regulation, source evaluation, and information integration across multiple documents (Afflerbach et al., 2022; Bui & Nguyen, 2024). Importantly, studies suggest that these demands can be both supported and complicated by the tools readers use, making the design and pedagogical integration of those tools a matter of considerable practical importance.

Digital Annotation Tools: Definitions and Typology

Digital annotation tools refer broadly to any software or application that allows readers to embed commentary, highlight textual segments, insert tags, draw connections, or otherwise mark up a digital document without altering the source text itself (Zhu & Chen, 2024). They range from relatively simple features built into PDF readers - such as the highlighting and sticky note functions in Adobe Acrobat - to sophisticated web-based platforms like Hypothesis, which supports collaborative social annotation visible to an entire class, or Kami, which integrates seamlessly with Google Workspace and offers a rich array of annotation modes.

Researchers have proposed several typologies to categorize these tools. Earlier scholarship distinguished between private annotations intended for personal use and public annotations designed for social sharing. Building on this

foundation, more recent taxonomies differentiate individual annotation tools (private, non-collaborative), synchronous collaborative annotation tools (where multiple users annotate simultaneously), and asynchronous collaborative annotation tools (where annotations are shared but not in real time) (Ramirez-Castillo et al., 2022). Each type carries distinct pedagogical implications: individual tools may best support reflective, self-regulated reading, while collaborative tools align more closely with sociocultural models of learning and community of practice frameworks, enabling co-construction of meaning through shared textual engagement (Chen & Zhu, 2023; Vandommele et al., 2022).

Theoretical Frameworks Underpinning Annotation-Based Learning

The pedagogical rationale for incorporating digital annotation into reading instruction draws from a constellation of complementary theories. At its foundation lies the ICAP (Interactive, Constructive, Active, Passive) framework, which posits that learning activities can be arranged along a continuum based on the degree of cognitive engagement they demand. Passive activities - watching a lecture, rereading a text - produce the shallowest processing. Active activities - highlighting, underlining - engage attention more meaningfully. Constructive activities - paraphrasing, generating connections, posing questions - require learners to produce outputs that go beyond the given material. Interactive activities - discussing, co-constructing meaning - represent the highest level of engagement. Digital annotation, depending on how it is implemented, can span all four levels of this framework (Calle-Arroyo et al., 2023).

Metacognitive theory offers another crucial lens. Metacognition - knowledge about one's own thinking processes and the ability to regulate them - has long been identified as a central driver of reading success. Skilled readers differ from struggling readers not primarily in vocabulary size or background knowledge, but in their capacity to monitor comprehension, recognize when understanding breaks down, and deploy repair strategies accordingly (Afflerbach et al., 2022; Zhussupova & Kazbekova, 2024). Digital annotation tools, insofar as they require readers to make explicit the connections and questions they are forming during reading, can serve as an externalization of metacognitive

processes - making private cognitive activity visible, revisable, and teachable.

Sociocultural perspectives add a further dimension by foregrounding the role of social interaction in cognitive development. The concept of the zone of proximal development - the space between what a learner can accomplish independently and what they can achieve with skilled guidance has been productively extended to collaborative annotation contexts. When students annotate shared texts and can see and respond to each other's annotations, they engage in a form of peer scaffolding that can push individual comprehension beyond what solitary reading would produce (Chen & Zhu, 2023; Novak & Sila, 2023).

Empirical Evidence on Digital Annotation and Reading Comprehension

The empirical literature on digital annotation and reading comprehension has grown substantially, with acceleration particularly marked from 2022 onward as digital learning practices became increasingly normalized. Hidayat et al. (2023) conducted a mixed-methods study with undergraduate EFL students in Indonesia who used the Hypothesis social annotation platform for one semester. Quantitative analyses revealed statistically significant improvements in reading comprehension scores, while qualitative data indicated that students valued the ability to see classmates' annotations as a means of calibrating their own understanding. Particularly telling were interview responses in which students described reading as a more 'conversational' experience - a word that speaks directly to the sociocultural dimensions of the tool. Novak and Sila (2023) extended this line of inquiry by examining annotation quality and its relationship to learning outcomes in higher education settings. Their study found that students who engaged in structured annotation activities - guided by instructor-supplied question prompts - performed significantly better on end-of-semester reading assessments than those who annotated freely or superficially. The authors emphasized that annotation depth, not frequency, was the strongest predictor of comprehension gains, a finding with important implications for how annotation assignments are designed.

In EFL contexts specifically, research has highlighted both the promise

and the complexity of digital annotation integration. Wichadee and Pattanapichet (2023) investigated the use of Kami among Thai university students and found that the tool facilitated vocabulary learning alongside comprehension, as students regularly annotated unfamiliar words and their glosses within the text itself. This proximity between annotation and source text - in contrast to the spatial separation involved in looking words up in a separate dictionary - appeared to support better retention of new vocabulary within its contextual frame.

Research focused specifically on Indonesian EFL contexts has been growing steadily. Fithriani and Dewi (2024) examined the effects of AI-assisted digital annotation on academic reading and found that annotation encouraged more frequent engagement with difficult passages, possibly because the social visibility of annotation activity created a mild accountability effect - students were less likely to skip challenging sections when they knew their engagement (or lack thereof) would be visible to their instructor and peers. Similarly, Istiqomah and Nugroho (2022) found that students using digital annotation tools on academic articles reported significantly higher levels of text comprehension self-efficacy than their peers who read without annotation support.

Not all evidence is uniformly positive, however. Gao and Sun (2022) identified patterns in which instructor engagement in annotation activities significantly mediated student learning outcomes, suggesting that annotation tools function most effectively not as autonomous student tools but as pedagogically embedded practices. When instructors actively participated in - or responded to - student annotation threads, the depth and quality of student contributions improved markedly. These findings underscore the need for thoughtful, context-sensitive integration of digital annotation in reading curricula.

RESEARCH METHOD

Research Design

This study adopted an interpretive qualitative research design, grounded in phenomenological principles. Phenomenology is concerned with uncovering the essence of lived experience - with exploring what a particular phenomenon means

to those who have directly encountered it. As Braun and Clarke (2022) emphasize in their articulation of reflexive qualitative methodology, research of this kind foregrounds the researcher's interpretive engagement with participant meaning-making rather than aiming for detached objectivity. The study prioritized depth over breadth, seeking richly textured accounts of experience over statistically generalizable findings.

Participants

Participants were 24 undergraduate students enrolled in an Academic Reading and Writing course at a state university in East Java, Indonesia, during the 2023–2024 academic year. All participants were majoring in English Language Education and were thus highly motivated, if not uniformly proficient, readers of academic English. Purposive sampling was employed, with selection criteria including: enrollment in the target course, willingness to participate in all phases of data collection, and varying levels of prior digital literacy (assessed through a pre-study survey). Ages ranged from 19 to 23 years, with 17 identifying as female and 7 as male - a gender distribution broadly representative of English Education departments in Indonesian universities.

Instrumentation and Data Collection

Data were gathered through three instruments over one full semester (± 16 weeks). Semi-structured interviews were held with each participant at three points, beginning, midpoint, and end, each lasting 45–60 minutes in Indonesian or English, recorded and transcribed verbatim. Weekly reflective journals, submitted via the university LMS, prompted students to reflect on their annotation strategies and reading experiences, simultaneously functioning as a metacognitive practice. Eight non-participant classroom observations were also conducted, with field notes written immediately after each session to reduce recall bias.

Data Analysis

All data were analyzed using reflexive thematic analysis (Braun & Clarke, 2022), proceeding through six phases from initial familiarization to final analysis. Member checking with eight participants confirmed thematic representativeness, with two contributing additional perspectives that further enriched the

interpretation. Credibility was reinforced through a researcher reflexivity journal and triangulation across three data sources, treating both convergence and divergence as analytically meaningful. Participant quotations are presented throughout the findings to preserve authenticity of voice.

FINDINGS AND DISCUSSION

Analysis of the combined dataset - comprising 72 interview transcripts (3 per participant), 24 sets of weekly reflective journals totaling approximately 380 individual entries, and 8 observational field note records - yielded four overarching themes: (1) Transformation of Reading Habits and Engagement; (2) Development of Metacognitive Strategies; (3) Collaborative Knowledge Construction through Shared Annotation; and (4) Challenges and Limitations Encountered. These themes are elaborated below, with extensive reference to participant voices and relevant theoretical literature.

Theme 1: Transformation of Reading Habits and Engagement

Perhaps the most pervasive finding across all three data sources was students' reporting of a fundamental shift in how they approached academic reading once they began using digital annotation tools. At baseline - that is, before systematic tool use began - the majority of participants described their reading practices in terms that suggested passivity and surface-level processing. One student, Rizqi (pseudonym, age 21), articulated a perspective that was widely shared among peers: 'Before, I would just read the words and try to memorize the meaning. If I didn't understand something, I skipped it. I thought if I kept reading, it would become clear later, but it rarely did.' Another participant, Farah (age 20), was similarly candid: 'I used to highlight a lot on paper - almost everything - and then when I came back to study, nothing was useful because I didn't know why I had highlighted things.'

By the midpoint of the semester, however, participants consistently described reading as a more purposeful and interactive process. The annotation tools appeared to serve as cognitive prompts - a kind of external scaffold that reminded students to pause, reflect, and respond rather than simply absorb. As

Dimas (age 22) explained in his mid-semester journal entry: 'When I know I have to write a comment or a question in Hypothesis, I pay attention completely differently. I am reading to say something, not just reading to finish.' This shift from reading-as-task-completion to reading-as-dialogue represents precisely the kind of constructive and interactive engagement that annotation-based learning frameworks predict (Calle-Arroyo et al., 2023), and its emergence here - not from instructor coercion but from students' own internalized sense of purpose - suggests that tool design can meaningfully influence reading dispositions.

Observational data corroborated these self-reports. During reading sessions in which Hypothesis was the assigned platform, students who had initially appeared distracted or disengaged - glancing at phones, flipping through pages without apparent focus - were observed to spend substantially longer with individual textual segments, frequently pausing to type annotations before continuing. On multiple occasions, annotation activity visibly preceded re-reading: students would write a comment, then scroll back to an earlier passage to verify a connection they had just noticed - a behavior consistent with what reading researchers describe as elaborative interrogation, a strategy known to support deeper comprehension processing (Permana et al., 2024).

The transformation was not experienced uniformly, however. Students with lower initial digital literacy levels - particularly those less comfortable with touch-typing on laptops - sometimes found the mechanics of annotation distracting in the early weeks. Aisyah (age 19) noted in her week-three journal: 'I spent more time figuring out how to make the comment box work than actually thinking about the reading. It felt like I was fighting the technology instead of using it.' This experience underscores a well-documented phenomenon in educational technology research: the cognitive load associated with tool operation can, at least initially, compete with the cognitive resources available for the primary learning task (Bui & Nguyen, 2024; Ramirez-Castillo et al., 2022). Critically, however, Aisyah's later reflections - gathered at the end-of-semester interview - suggested that this initial burden had substantially diminished once tool operation became routine: 'By week seven or eight, I stopped thinking about

how to use Kami. It was like typing a message - automatic. Then my brain was free to actually think about what I was reading.'

Theme 2: Development of Metacognitive Strategies

A second major theme concerned the relationship between digital annotation and metacognitive development - the growth of students' capacity to monitor, evaluate, and regulate their own reading comprehension processes. This theme emerged strongly from the reflective journal data, where students had the most unmediated opportunity to describe their inner cognitive experiences.

Across journals, a distinctive pattern was visible: students who had initially described their reading in purely output-focused terms - 'I understood the text' or 'I found the main idea' - progressively shifted toward more process-oriented, evaluative language. By the final weeks of the semester, it was common to find entries in which students explicitly tracked the evolution of their understanding across a reading session, noting moments of confusion, attempted strategies, and eventual resolution. Nadia (age 21) provided one of the most vivid illustrations of this development: 'In the beginning I always thought I understood everything I read. But when I started writing annotations, I realized how many times I was confused without knowing I was confused. Now I notice when something doesn't quite fit together, and I write a question mark or a question - and sometimes I answer it myself by reading further, and sometimes I ask in the Hypothesis thread.'

This account captures what reading researchers have termed comprehension monitoring - a metacognitive skill in which readers actively assess whether they have understood what they have read, rather than proceeding on the assumption that reading equals comprehension (Zhussupova & Kazbekova, 2024). The fact that Nadia arrived at this capacity not through direct instruction in metacognition but through the reflective demands of annotation activity suggests that well-designed tools can function as indirect scaffolds for strategic reading development.

Students also described using annotation as a strategy for organizing and synthesizing information across longer texts - a skill closely linked to the

inferential and integrative dimensions of reading comprehension (Seah & Tay, 2023). Hendra (age 23) explained: 'I use different colors in Kami for different kinds of information. Yellow is for main ideas, blue is for evidence, and pink is for things I disagree with or want to question. When I finish the article, I just look at the colors and I can reconstruct the whole argument in my head. Before I had this system, I could read an article and then struggle to explain what it was actually arguing.' This color-coding strategy - self-developed rather than instructor-mandated - reflects a constructive engagement with text that goes well beyond recall and approaches the kind of critical reading that academic contexts demand.

Importantly, several participants reported that annotation practices began to influence their reading even in contexts where no digital tool was available. Arif (age 22) noted: 'Now when I read printed articles, I automatically think in the annotation way - I mentally make comments and questions, even if I can't write them. The habit of thinking that way has stayed.' This observation is particularly significant because it suggests that digital annotation tools may serve not only as immediate comprehension aids but as platforms for cultivating transferable reading strategies - a finding with important implications for how educators conceptualize the role of technology in literacy development (Afflerbach et al., 2022; Lim & Toh, 2022).

Theme 3: Collaborative Knowledge Construction through Shared Annotation

The social dimension of annotation - particularly as enabled by Hypothesis - emerged as one of the most powerful and consistently reported aspects of students' experiences. This theme resonated strongly with sociocultural theories of learning, and students themselves often articulated its logic in terms that, while not theoretical in vocabulary, were theoretically precise in substance.

Students described the experience of encountering peers' annotations as genuinely illuminating - as offering perspectives they would not have arrived at independently. Sari (age 20) reflected: 'When I read by myself, I only understand through my own eyes. But when I open Hypothesis and see what my classmates

commented, sometimes I think - oh, they saw something completely different in the same paragraph. I have to go back and read again to see it from their angle. And often, when I do that, I understand more.' This experience - of using another reader's interpretation as a lens for re-reading - describes a form of perspective-taking that is deeply consonant with collaborative learning theory and that is particularly difficult to achieve through traditional individual reading assignments. Beyond individual interpretation, students also described instances in which annotation threads evolved into mini-discussions that collectively resolved comprehension difficulties none of them could have overcome alone. Bayu (age 21) recounted a specific episode: 'There was a paragraph in one article about discourse analysis - very difficult, very technical. I wrote a comment saying I didn't understand the main point. Then two other people replied, and each one added something. By the time I read all three comments, the meaning was clear. None of us explained it fully alone, but together we did.' This collaborative sense-making process exemplifies the dialogic function of annotation - what researchers have described as the discursive co-construction of textual meaning (Chen & Zhu, 2023) - and represents one of the clearest practical manifestations of zone of proximal development dynamics in a digital learning context (Vandommele et al., 2022).

However, the collaborative dimension also surfaced complications. A minority of students expressed discomfort with the public visibility of their annotations, particularly in the early weeks when they were less confident about their interpretations. Yulia (age 19) admitted: 'At the beginning I was scared to write anything wrong in Hypothesis. Everyone could see it. So I waited to see what others wrote first, and then added something safe - something I was sure about.' This tendency toward strategic silence - performing comprehension rather than risking the exposure of confusion - represents a notable limitation of social annotation in contexts where learners lack psychological safety. It suggests that the pedagogical effectiveness of collaborative annotation tools is not merely a function of the technology itself but depends heavily on the classroom culture within which it is embedded.

Theme 4: Challenges and Limitations

No account of students' digital annotation experiences would be complete without an honest reckoning with the challenges they encountered. Several categories of difficulty were consistently identified across data sources, and these limitations deserve serious analytical attention rather than perfunctory acknowledgment. The most frequently cited challenge was screen fatigue. In a context where students were already spending significant portions of their academic and social lives in front of screens, the addition of extended digital reading sessions was experienced by many as physically taxing. Mega (age 20) wrote in her week-ten journal: 'By the time I get to the third reading assignment on the screen, my eyes feel tired and my mind is slower. I know I am not reading as carefully as I did with the first one. The annotations I write near the end of the session are shorter and less thoughtful.' This testimony points to an important interaction effect: the cognitive benefits of annotation may be contingent on physical reading conditions that are not always achievable in students' lives, particularly for those without dedicated, comfortable study environments.

Technological access and reliability constituted a second category of challenge. While all participants had smartphones, not all had reliable laptop access or stable internet connections - prerequisites for the smooth functioning of platforms like Hypothesis. Several students in the study lived in areas with intermittent connectivity, and annotation data was lost on at least four reported occasions when connection drops interrupted the saving process. These experiences, while not universal, introduce an important equity consideration: digital annotation tools, however pedagogically sound their design, can inadvertently disadvantage students who lack the material conditions required for reliable technology use (Permana et al., 2024; Bui & Nguyen, 2024). A third challenge - perhaps the most pedagogically interesting - concerned annotation quality and the risk of surface-level engagement. Several students described a tendency, particularly when under time pressure, to annotate in ways that looked engaged without requiring genuine cognitive effort. Rizqi, whose early reflections had emphasized reading passivity, was notably self-critical on this point at the

end-of-semester interview: 'Sometimes I would highlight everything just to show I read it. Or I would copy a phrase from the text into the comment box and write it slightly differently - like I was saying something, but I wasn't really adding any thought.' This kind of performative annotation - extensively documented in recent social annotation research (Gao & Sun, 2022; Novak & Sila, 2023) - suggests that the mere presence of annotation tools cannot guarantee deep reading. Pedagogical framing, instructor feedback, and explicit strategy instruction may all be necessary to ensure that annotation serves comprehension rather than substituting for it.

Student-Reported Outcomes: Comprehension Performance and Self-Efficacy

When students were invited to reflect directly on how their reading comprehension had developed over the semester, the responses were striking in their specificity and consistency. Rather than offering vague impressions of general improvement, participants tended to articulate discrete changes in their comprehension capabilities - changes they could illustrate with concrete examples from their reading experiences. Improvements in the ability to identify main ideas and distinguish them from supporting details were among the most commonly reported gains. Putri (age 21) explained: 'Before, when someone asked me what an article was about, I would summarize everything - every paragraph. I couldn't tell which ideas were central and which were just examples. Now I can look at my yellow highlights and see the skeleton of the argument immediately.' This kind of structural comprehension - understanding the organizational logic of an academic text, not just its content - is a sophisticated skill that many EFL students struggle to develop even after years of language instruction (Yilmaz & Yuksel, 2022). That several participants described concrete improvements in this area within a single semester of tool use is noteworthy. Inferential comprehension - the capacity to read between the lines, to understand implications that are not stated explicitly — was also frequently cited as an area of development. Farah reflected: 'I used to only understand what the writer actually wrote. If they didn't say it directly, I missed it. But now I write questions in my annotations - like, why is the author mentioning this? What are they suggesting about this? - and that habit of asking forces me to look for the deeper meaning.' The inferential dimension of

comprehension is particularly crucial for academic reading, where authors frequently assume background knowledge, deploy hedged language, and organize arguments through implication as much as explicit statement (Seah & Tay, 2023; Zhussupova & Kazbekova, 2024). Critical evaluation of sources - a competency central to academic literacy and increasingly recognized as a core component of digital reading skill (Coiro et al., 2023) - was a third area in which students described growth. Aldi (age 22) reflected: 'Hypothesis changed how I read research articles. Now I don't just accept everything the author says. I write questions like — is this evidence strong enough? Is this a fair interpretation? Who are they leaving out? Before, I would never have dared to question a published article. Now I think that questioning is my job as a reader.' This shift from reading as reception to reading as critique is one of the most transformative developments that reading educators aspire to foster, and its appearance here - attributed explicitly by students to the reflective demands of annotation - speaks to the pedagogical potential of these tools when thoughtfully implemented.

Comparative Reflections on Tool-Specific Experiences

Students' experiences varied not only across individuals but also across the three tools used in the study, and these tool-specific differences carry implications for educators making decisions about technology integration. Hypothesis was most frequently described as transformative but also most cognitively demanding. Its social annotation architecture was experienced as both its greatest strength and its most significant source of social anxiety. Students valued seeing others' interpretations but sometimes found the public accountability it created to be inhibiting, particularly in the early weeks. As confidence grew, however, the collaborative dimension became increasingly valued.

Kami was described as more comfortable and more immediately practical - partly because its integration with students' existing Google Classroom workflow reduced the technical barriers to entry, and partly because its range of annotation modes (including voice notes) accommodated different learner preferences and working styles. Students who found typing cumbersome or who preferred oral processing found the voice note feature particularly useful. Yusuf

(age 22) noted: 'When I record a voice note about a difficult paragraph, I hear my own confusion - I hear the point where my explanation breaks down - and that helps me figure out exactly what I don't understand. It is like explaining to someone else, but the someone else is future me.'

Adobe Acrobat Reader, meanwhile, was generally experienced as the most limited of the three tools - adequate for basic highlighting and brief notes but lacking the collaborative and organizational features that students came to value in the purpose-built platforms. Its primary utility was as a fallback when connectivity issues made cloud-based tools unreliable. Several students noted that their experience with Hypothesis and Kami had raised their expectations for annotation tools generally, rendering Acrobat's simpler toolset feel insufficient by comparison - a finding that suggests annotation tool choice may be consequential in ways that educators do not always anticipate.

CONCLUSION

Summary of Key Findings

This study set out to explore how undergraduate EFL students in Indonesia experienced the use of digital annotation tools across an academic semester, with particular attention to the impact of those tools on reading comprehension processes and outcomes. The findings, drawn from a rich multi-source qualitative dataset, paint a nuanced and largely affirming picture. Digital annotation tools — when integrated thoughtfully into reading instruction — have the capacity to transform passive reading into active, purposeful engagement; to cultivate metacognitive awareness and strategic reading behaviors; to facilitate collaborative meaning-making that extends individual comprehension; and to develop the higher-order reading skills — inferential reasoning, critical evaluation, structural analysis — that academic contexts demand.

At the same time, the study demonstrates that these outcomes are neither automatic nor universal. Tool adoption entails cognitive costs that must be managed, particularly in the initial phases of use. Social annotation creates productive accountability but can also generate inhibiting anxiety. Annotation

quality is not guaranteed by annotation quantity, and educators who deploy these tools without explicit strategy instruction may find that students engage in performative rather than genuinely constructive annotation. Technological access and physical comfort conditions further mediate the degree to which the potential of these tools is realized in practice.

Theoretical Contributions

This study contributes to theoretical understanding in several respects. First, it provides qualitative empirical support for the applicability of ICAP-aligned frameworks in digital reading contexts, demonstrating that annotation activity can serve as a vehicle for constructive and interactive engagement with text — not merely active engagement (Calle-Arroyo et al., 2023). Second, it enriches the literature on metacognition and reading by showing how an external tool can serve as a scaffold for the development of internal comprehension-monitoring strategies, in ways that may ultimately transfer to non-annotated reading contexts (Zhussupova & Kazbekova, 2024). Third, it advances the application of sociocultural theory to digital annotation by documenting the specific mechanisms — perspective-taking, dialogic sense-making, collaborative resolution of comprehension difficulties — through which social annotation facilitates learning (Chen & Zhu, 2023).

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