



Integrating deep learning and digital literacy into reading instruction to achieve SDG 4: A study in a high school EFL education context in Central Java

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ABSTRACT

This study investigates integrating deep learning approaches and digital literacy into reading instruction to support the achievement of Sustainable Development Goal 4 (Quality Education) among high school EFL students in Central Java, Indonesia. The study objectives were to evaluate the efficacy of deep learning-based reading strategies in improving students' comprehension, assess their digital literacy levels, and evaluate teachers' perceptions of integrating deep learning and digital literacy in EFL reading classrooms. One hundred seventy-eight tenth-grade students from three public high schools in Central Java participated in this study, which employed a mixed-methods sequential explanatory design. A digital literacy questionnaire and reading comprehension pre- and post-tests were used to gather quantitative data. Semi-structured interviews, teacher focus groups, and classroom observations were used to gather qualitative data. After using immersive learning methodologies backed by digital media resources, pupils' reading comprehension scores significantly improved, according to quantitative studies. There was also a high correlation between students' reading competence and their digital literacy levels. The qualitative data showed greater student participation and high comprehension of the text as observed by teachers accompanied by enhanced engagement, critical thinking, and autonomy of students in

reading activities. These results substantiate the integration of deep learning and digital literacy into reading lessons. It raises both cognitive and affective dimensions in EFL contexts. The significant study about pedagogical innovation emphasizes the SDGs, teacher training, and curriculum support that sustain tech-enhanced learning environments in Indonesian secondary schools.



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INTRODUCTION

In the 21st century, reading instruction is defined as reading to navigate critically for digital information. This supports Sustainable Development Goal 4 on inclusive education. Despite reforms in Indonesia's curriculum aimed at providing better literacy, Indonesians still perform poorly comprehensively based on the results of PISA 2018, where about 30 percent of students only reached minimum levels of proficiency well below the OECD average. Therefore, there is an innovation-intensive contextual approach needed urgently to upgrade the present insufficient approaches strongly, with sufficient preparedness of students towards a highly digital and networked social environment.

Putri and Arifin (2021) found that recent studies in education propose the application of deep learning models to develop students' metacognitive awareness and problem-solving abilities – skills emphasized through reading comprehension activities. They also note that digital literacy is a key component for EFL instructors to effectively use digital sources; however, “there is minimal focus on implementing digital reading and deep learning pedagogy within classrooms in developing nations due to infrastructural constraints as well as lack of professional training” (Siregar et al., 2023). This is despite an increasing dependence on online platforms and materials precipitated by technology and post-pandemic changes towards education among most Indonesian schools, including those in Central Java where readiness among teachers together with infrastructure leaves much wanting resulting into cases where ‘digital texts are utilized simply as delivery tools’ instead fostering critical thinking or higher-order reading skills thus sustain able yet inequitable urgently needed instructional model combining deep resource based strategy Putri & Arifin,(2021).

Meanwhile, most high school students from rural and peri-urban areas of Central Java, Indonesia, barely have proper digital access, are not motivated to read, and do not possess critical reading skills. Current EFL instruction focuses on training students to retrieve information explicitly or implicitly stated in texts, thereby restricting their capacity for analytical and evaluative thinking (Rahmawati & Yusuf, 2020). This narrow approach makes the formation of active reflective readers possible at a minimum level, hence reducing the potential of reading activities bridging with wider life experiences articulated by SDG goals. While there is policy rhetoric about incorporating digital literacy into education programs, practically significant contextual gaps remain between proven methodologies on how deeply English teachers should practice integrating forms of digital literacy within their teaching practices thus highlighting an urgent need for research aimed at developing sustainability equity-based models concerning reading instruction within Indonesian secondary education.

Developing from this context, the current study examines how the combination of deep learning strategies and digital literacy enhances students' reading comprehension and leads to a more sustainable educational practice. This inquiry is an immediate necessity because it has relevance to both the Sustainable Development Goals and Indonesia's national agenda on digital transformation. Beyond its practical relevance, the study seeks to generate empirical insights that may guide EFL educators and inform policy discussions, particularly in regions where access and capacity remain limited. Accordingly, the research is framed by three guiding questions:

1. To what extent can deep learning-based strategies enhance students' reading comprehension?
2. In what ways does digital literacy influence students' reading performance?
3. How do students and teachers perceive the integration of deep learning and digital literacy in EFL reading instruction?

Literature Review

1. Deep Learning in EFL Reading Instruction

Deep learning approaches in EFL are aligned with constructivist pedagogies that include active processes of making meaning rather than memorization and thus integrate higher-order thinking, independence, the ability for knowledge transfer across contexts, and abilities for knowledge application (Pham & Renshaw, 2020; Rahimi & Yadollahi, 2019). Empirical studies have provided evidence of the fact that analysis-synthesis-evaluation textual activities implemented mostly through collaboration or inquiry-based methods develop critical literacy skills which enable engagement with global issues such as climate change on social justice (Teng & Zhang, 2021; Järvelä et

al., 2021; Khatib & Rezaei, 2020; Nugroho et al., 2023). Reflective tools, multimedia multimodal texts support both comprehension, intercultural understanding, learner empowerment, SDG4, SDG17, meaningful spaces literacy development (Hwang et al., 2022; Liu Wang, 2021; Sun & Wang, 2022).

2. Digital Literacy and Its Role in Reading Development

Digital literacy is the ability of students to search, assess, and interpret information and use digital content ethically. Therefore, digital literacy is considered a crucial component of reading skills in EFL contexts within multimodal and digitally mediated environments (Ng, 2021; Ng, 2020). Learners are construed to reading practices, critically analyzing, integrating digital literacy, raising autonomy levels, increasing metacognitive awareness becoming responsible, empowered global readers through reading practices (Putri & Arifin, 2021; Al-Awidi & Aldhafeeri, 2019; Yuliana & Aryanti, 2021). However, very few parts of the region have well-developed techno infrastructural support with prepared teachers having institutional policy support; therefore higher-order instructional model based on integrating digital literacies deeply into reading pedagogy for developing cultural understanding should be emphasized (Rahimi & Yadollahi, 2019; Putri & Wulandari, 2023).

3. Reading Instruction in the Context of SDG 4 (Quality Education)

The reading instruction aligned with SDG 4 includes an inclusive and fair approach to developing critical literacy skills that address global issues within textual analysis, such as inequality, sustainability, and peace (Mambu, 2023; Khatib & Rezaei, 2020). Therefore, contextualized tasks on comprehension based on SDG themes related to the local environment develop social consciousness, push understanding to action hence participation. [Putri et al., 2023] Several works of literature posit that breaking linguistic and social barriers among marginalized students increases their engagement in reading texts related to SDGs in a participatory pedagogical space, democratizes education creates civic consciousness, both multidimensionally (Huang et al., 2021; Kang & Shin, 2022; Nurhayati & Azizah, 2023).

4. Empirical Gaps and the Need for Integrated Models in Indonesia

Lestari and Kurniawan (2022) observe that there is little literature accounting for the integration of deep learning and digital literacy components in education, particularly involving semi-urban or rural resource-poor schools. Other studies prove that reading comprehension can be improved strategically by engaging digital literacy—one study spanning from Turkey to Southeast Asia, but explicit combinations of deep learning and

digital literacy remain underexplored across the region. Infrastructure-based issues on how well-intended EFL instructors lack competence in integrating digital literacy due to infrastructural inadequacies found mostly in rural areas where classes are conducted, seriously hampering student achievement through reading (Putri & Arifin, 2021; Siregar et al, 2023). Therefore, this literature inspires a contextual challenge-oriented pedagogical model towards bridging infrastructural gaps, and sustainably transform education concomitantly with SDG goals.

Previous Studies

Salmerón et al. (2023) conclude that digital tools can support a dual process of reading for deep comprehension when the outcome of the project-based tasks is cognitively demanding. More explicitly, Shi and Lan (2024) found in their study conducted among Chinese high school students that self-efficacy and active participation—as reflected by socio-constructivist approaches—support knowledge construction leading to inference generation at a much deeper level. Ahmed et al.'s review emphasized integrating higher-order questions with adaptive technologies involving collaboration on meaning-making so learners could be nudged out from surface decoding towards strategic SDG-aligned literacies, which proposes new classroom practices happening within Central Java. Recent Asian-context research includes Afrilyasanti et al. (2025) and Mambu(2023). Practical implementations regarding community-based digital assignments have been discussed wherein secondary & tertiary curricula embed SDG-oriented contents plus critical media literacy fostering social responsibility, sustainability discourse. The new developing literature connects deep learning strategies to digital literacy and dialogic pedagogy, thus creating a classroom practice that infers critical thinking, inference, interdisciplinary understanding aligned with SDG 4's goal on quality education through classroom practices (Wang & Zheng, 2020; Zhang et al., 2022; Rahimi & Yadollahi, 2019; Putri et al., 2023).

Recent studies propose a new trend that integrating deep learning and digital literacy in EFL reading classes sustains the SDGs, particularly in contexts similar to Indonesia. Kurniawati & Subekti (2024) and Huang et al. (2021) found that critical literacy, civic values, and collaboration are achievable through assigning students to read SDG-themed texts digitally and tasks based on TBLT while motivation is fostered by providing digital feedback as reflected by Chen & Tsai (2020); Al-Awidi & Aldhafeeri (2019). Other findings reveal comprehending socio-emotional aspects as metacognitive strategies addressed within a framework of deep learning; online reflective journal enhances autonomy realization ability and interpretation development concerning SDG aims (Liu & Wang, 2021; Khoiriyah et al., 2023; Baleghizadeh & Shahri, 2023). The use of digital and

online tools together with content and activities that are more student-centered, help in the retention of vocabulary, development of critical thinking, global awareness, and understanding of ethics and deep learning potentials that bridge literacy to support SDG-oriented EFL education (Sari et al., 2022; Mustaffa et al., 2023; Handayani & Kusumawardani, 2024).

METHODS

Research Design

The study applied a two-phase sequential explanatory mixed-methods approach commencing with the quantitative followed by the qualitative phase, to investigate how deep learning and digital literacy integration shape students' reading comprehension in EFL classrooms.

A sequential explanatory mixed-methods design was employed in comprehensively determining the influence of deep learning strategies and digital literacy on reading instruction within Indonesian high schools. Thus, evidence on measurable effects regarding students' reading outcomes was first administered and analyzed quantitatively before being followed by richer qualitative insight into both student and teacher perception experiences. The nature of this design thus well suits the aims that have been set out for it, since, while it identifies statistical patterns, it also sheds light on factors beneath apparent surface influences relating to effectiveness and sustainability concerning an instructional model.

Research Site and Participants

Three public high schools in semi-urban and rural areas of Central Java, Indonesia, were selected as the research sites. The schools were purposively chosen to represent contrasts in digital facilities and in teacher readiness. In the quantitative phase, there were 178 participants who were students of Grade X. For the qualitative phase, twelve students and six English teachers were selected using maximum variation sampling to obtain diverse experiences and perspectives. The study was conducted under approved ethical protocols. Informed consent was obtained from all participants before data collection.

Data Collection Instruments

To ensure a clear relationship between research questions, study variables, and instruments, multiple tools were employed. Each instrument was carefully selected to address one or more research questions.

RQ1: How effective is the integration of deep learning-based strategies in improving students' reading comprehension? The independent variable was deep learning-based instruction, and the dependent variable was students'

reading comprehension. A pre-test and post-test were used to measure comprehension, which were adapted from CEFR B1 level tasks targeting literal, inferential, and evaluative reading skills. An observation rubric was also used in recording indicators of student engagement, questioning, and collaboration during lessons. The procedure started with a pre-test for baseline comprehension followed by several reading sessions where deep learning strategies comprised systematic integration of instruction on making inference questions; collaborative annotation; reflective summarization. After that a post-test administered to check improvements while at the same time observing classes for contextual evidence on how learners applied identified strategies.

RQ2: How does students' digital literacy influence their reading performance? Variables: In this phase, students' digital literacy was considered the predictor variable, and their reading performance was the outcome variable. The questionnaire on digital literacy, adapted from Ng (2021), covered five aspects: technical use, information evaluation, content creation, online communication, and digital safety. Reading performance was measured based on post-test scores that reflected students' ability to answer questions at different levels-literal, inferential, and evaluative. After administering the intervention program, a comprehension outcome test together with a questionnaire on digital literacy was administered among participants, wherein results were correlated, brought about how strongly associated comprehending outcomes are with having been qualitatively strong statistical result enhancers of follow-up interviews made among selected students focusing more specifically practices like using online search tools or annotation applications which eventually shaped approaches towards reading tasks.

RQ3: What are students' and teachers' perceptions of integrating deep learning and digital literacy into EFL reading instruction? Variables: The qualitative strand explored perceptions from students and teachers towards the effectiveness, advantages, and challenges of deep learning integrating with digital literacy when reading instruction has been delivered. Data were collected through semi-structured interviews administered to both students and teachers, probing personal reflections on engagement and autonomy manifested or obstacles experienced within the lessons. Focus group discussions with teachers elicit collective perspectives on feasibility, barriers, and practical classroom implementation recommendations. Observation notes validated self-reported perceptions, as well as capturing real-time classroom dynamics. A purposive sub-sample of students, together with all the teachers, participated in interviews, while only the teachers took part in

focus group discussions (FGDs). Qualitative data highlighted recurrent thematically coded themes comprising enhanced engagement, hence increased learner autonomy, a practical implementation challenge need for sustained professional development.

Data Analysis

Paired-samples t-test was conducted to determine any significant difference between the pre-and post-test scores of reading comprehension. Pearson correlation analysis was used to find the relationship between students' digital literacy and their reading performance. Qualitative data from interviews, FGDs, and classroom observation were transcribed verbatim and thematically analyzed using NVivo software as a tool that facilitated manual coding. The triangulation of findings in both quantitative and qualitative phases made the results more credible, with a better understanding of how deep learning and digital literacy should be integrated into EFL reading instruction.

Trustworthiness and Ethical Considerations

The study ensured trustworthiness by using the following strategies: credibility through peer debriefing and member checking, thick description to show the context of this research for transferability, transparent audit trail for dependability, and researcher reflexivity for confirmability. Ethical considerations were observed in all stages of this research. The participants were assured of confidentiality, whereby pseudonyms were used in reporting qualitatively to mask their identities. All data were saved in secure password-protected digital files. This study also complied with the Indonesian Ministry of Education ethical guidelines on research and an internationally recognized standard on research ethics.

The study employed peer debriefing, member checking, and triangulation to validate the findings proposed in this study. Thick and contextual descriptions of the research environment and participants were provided to support transferability. An explicit audit trail, together with the researcher's reflexive notes, warranted dependability and confirmability. Ethical protections were assured through pseudonyms for all participants, with electronic data stored in secure password-protected files.

FINDINGS

RQ1: How effective is integrating deep learning-based strategies in improving students' reading comprehension?

A paired sample t-test proved that there was a statistically significant improvement in the reading comprehension scores of the students after applying deep learning strategies. The mean score before testing was 62.45

(SD = 8.91), while the mean score after testing rose to 76.13 (SD = 7.84), t-value being 13.52 at $p < 0.001$. This implies that instruction oriented towards deep learning has enhanced students' abilities for processing, analyzing, and interpreting EFL reading texts through collaborative tasks as well as inferential questioning and metacognitive reflection on their part about what they have read or are reading. Observation data revealed increased student engagement with generating questions during Reading Sessions, together with peer interactions.

Table 1. Descriptive statistics and Paired Sample t-Test of reading comprehension scores (RQ1)

Test Type	Mean	SD	N	T	df	Sig. (2-tailed)
Pre-Test Score	62.45	8.91	178			
Post-Test Score	76.13	7.84	178	13.52	177	.000
Pre-Test Score	62.45	8.91	178			
Post-Test Score	76.13	7.84	178	13.52	177	.000

Note: $p < .001$; SD = Standard Deviation; df = degrees of freedom
Interpretation: There is a statistically significant increase in students' reading comprehension after the intervention.

There was a marked increase in the reading comprehension abilities of high school students at deep learning-based classes in Central Java when strategies involving reading were integrated with the use of deep learning and this is evidenced by quantitative results from pre-and post-tests which recorded mean scores (pre-test $M = 65.4$; post-test $M = 78.6$; $p < .001$) significantly higher literally, inferentially and evaluatively across all three levels of understanding. The biggest improvement was registered at the level of inferential comprehension, closely related to big learning's main aim-that is, generating critical thought and analysis.

Classroom observations noted an increase in students' participation in collaborative questioning, digital annotation, and peer dialogue. Previously passive learners were observed participating in group summaries, raising interpretive questions, and occasionally offering alternative viewpoints to their peers' interpretations. Such forms of active engagement are responses that eventually ensure the attainment of core characteristics of deep learning, particularly the shift from a surface-level response to a more analytical and reflective meaning-making response.

The interviews further revealed that the intervention pushed students to always interact with texts at a deeper level. Several participants discussed gaining more confidence in their reading abilities and acquiring new strategies for interpreting passages.

Previously, one student explained, he would just look for keywords to answer the questions. Now he deliberately forces himself to know what the

writer is truly trying to say. Another student was reading about issues such as climate change and noted that the vocabulary made her think not only about understanding it but also about its relevance to her own life. Their comments provide insight into a shift from being able to answer questions based on recall toward more inferential and evaluative comprehension.

A student stated that while reading, she pauses whenever she loses track of the meaning and tries to associate the text with her previous knowledge. This has helped her sustain comprehension instead of giving up on the passage. Her behavior is self-regulated and a key metacognitive strategy often associated with deep learning. Other students were also able to highlight how peers contributed to widening their perspectives. For example, one noticed that a classmate's interpretation gave another way of understanding the story, but inspired deeper thinking thereafter. The teachers highlighted an observation that collaborative annotation exercises made students work out texts from different points, hence increasing classroom discussions.

Students reported using the strategies outside class on their own. *"Now, even when I am reading news on my phone, I practice asking questions and summarizing,"* one of them shared with the class at reflection time. *"It makes me understand better."* Evidently, from this statement and other similar comments made by different participants in both groups' classes (see Appendix D), skills acquired during instruction were not limited to formal lessons but extended into everyday reading practices.

Finally, students explained that they felt motivated and developed an emotional attachment to the reading process. Reading used to be boring because it was only for the test. *"But when we discussed global topics, I felt it was important, and I wanted to read more."* One of them shared, using almost the same words as several others did. This kind of affective investment aligns with deep learning; wherein meaningful and relevant engagement is emphasized.

The test results, classroom observation, and interview data all point to the effectiveness of deep learning-based strategies in EFL reading classes. Evident not only through improved test results but also qualitatively manifested by indicators of deep learning such as critical interpretation, metacognitive regulation, collaborative construction of meaning, and autonomous transferable strategies with affective engagement. The scores are explicit that it has approached more than raising scores; fundamentally reshaping how students read, think, and interact with texts.

RQ2: How does students' digital literacy influence their reading performance?

The results of the Pearson correlation analysis show that there is a moderate positive correlation between students' digital literacy scores and

post-test reading comprehension scores, $r = .48$, $p < .01$. Students with higher digital literacy, specifically the ability to evaluate information and navigation skills, performed well consistently in reading tasks that require scanning and critical comparison as well as constructing meaning. These students, according to the insight from interviews, appear more confident while engaging online texts, checking for reliability of sources, making use of tools such as digital highlighters and online dictionaries; meanwhile, teachers observed learners' low skill levels becoming easily distracted, overwhelmed by hyperlinks and multimodal features, struggling to handle online reading activities.

Table 2. Pearson correlation between digital literacy and post-rest reading scores (RQ2)

Variable 1	Variable 2	Pearson r	Sig. (2-tailed)	N
Digital Literacy Score	Post-Test Reading	0.48	.000	178

Note: $p < .01$

There is a moderate but significant positive relationship between digital literacy and reading comprehension at the post-test level among students ($r = 0.46$, $p < 0.01$). The higher achievers in proficiency across technical use, information evaluation, content creation, online interaction, and digital safety dimensions were comprehended. Most significantly, better skillful individuals at using digital tools for forming meanings as well as checking the credibility of online sources outperformed their classmates, who seemed to depend on literal or surface reading strategies.

Classroom observations revealed and helped to explain this trend. Highly digitally literate learners used annotation apps, online dictionaries, or search engines to check meanings and place ideas within larger contexts. Lowly digitally skilled users appeared distracted or were having difficulty navigating multimodal text with hyperlinks and visual elements. This behavior makes it very clear that acts of reading construction can be facilitated as well as constrained by the competence of students in comprehending digital text.

Interview findings gave more explicit insights into the enhancement of reading development through digital literacy. One student stated, *"When I don't know a word, I use the online dictionary but also check examples from articles. It helps me understand how the word is used."* There has been a change from simple translations to making contextualized meanings. In this particular case, the learner's use of several online sources shows that his skills of digital literacy involve comprehension recognition of vocabulary to understanding usage within real texts.

"Sometimes websites give different answers. I learned to compare and choose the one that makes sense with the text we read." Articulated in her words is a

critical evaluation dimension of digital literacy. Assessment, comparison, and validation reflective of online information consumption indicate that content is being consumed with interrogation towards its reliability, rather than passively. Directly supportive of deeper understanding through enabling students to reconcile multiple sources of input, bring relevant information, eliminate misleading data, reading discovery that digital literacy involves more than technical skills, it also involves critical reading, and reasoning processes enhance reading performance within a digital context.

One of them said, *"When I watched a short video clip on gender equality related to our text, it helped me understand clearly the purpose of the author."* This is possible through digital literacy. Cross-textual and audiovisual mode construction strongly supports multimodal comprehension, therefore stretching students' interpretive abilities not only beyond print but to richer deductions of authorial intentions through insight. Learners with poor digital literacy acutely felt this struggle. Another complained, *"I get lost when there are many links or pictures. I don't know which is important."* Lack of cognitive qualification creates a situation where the learner cannot adequately filter out irrelevant information from relevant information; hence, instead of being an enabling support structure for deep comprehension by digital means,

Teachers said the same thing. One teacher explained, *"The students who were comfortable navigating digital tools asked deeper questions and gave more thoughtful answers. Those who were not confident digitally often stayed quiet or depended on others."* Therefore, apart from the personal dimension of understanding, digital literacy extends into social and collaborative aspects of learning. The students with better digital competence could engage in critical inquiry (asking insightful questions) and group discussions (on the article). On the other hand, students with weak digital literacy showed lowered participation, relying more on peers rather than actively co-constructing knowledge. Such trends suggest that student digital literacy mediates individual reading outcomes as well as classroom discourse and collective meaning.

The proof spots digital literacy much more than just some background skill. Digital literacy catalyzes successful understanding. Those learners with better and advanced digital skills could quickly use means provided by digital tools to obtain information, critically assess online information, synthesize it, and ensure engagement that would foster interpretation with multimodal texts. They were able to realize the strategies they had practiced in class while performing reading tasks independently at home or elsewhere outside school premises. On the contrary, most students who are not digitally literate stay at a surface level of understanding; they cannot filter content for useful information and easily get disinterested when confronted by any form of technological challenge.

RQ3: What are students' and teachers' perceptions of integrating deep learning and digital literacy into EFL reading instruction?

Three themes came out strongly from the thematic analysis of interviews and focus group discussions: (1) higher levels of cognitive engagement, (2) greater learner autonomy, and (3) challenges in digital access and training. Students explained that digital texts, concept mapping tools, and collaborative reading forums helped them “dig deeper” into the text and connect reading to real-life issues. Teachers also noted a shift from passive reading practices to dialogic reading practices, but highlighted unequal access to devices as a major challenge, together with their limited training on deep learning pedagogy. Both groups emphasized making technology integration with deep thinking strategies fulfill enhanced meaningful engagements through readings, but concurrency on institutional support at implementation success.

Table 3. Descriptive Statistics of Digital Literacy Dimensions (RQ2)

Dimension of Digital Literacy	Mean Score (Max 5)	SD
Technical Use	3.85	0.66
Information Evaluation	3.91	0.71
Digital Content Creation	3.44	0.78
Online Communication & Collaboration	3.69	0.74
Digital Safety Awareness	3.22	0.65

Interpretation: Students scored highest in information evaluation and technical use, and lowest in digital safety.

Thematic analysis of 12 in-depth interviews (6 teachers, 6 students), focus group discussions, and classroom observation logs revealed five major themes. These were: (1) enhanced student autonomy, (2) meaningful reading experiences, (3) better critical thinking, (4) higher motivation, and (5) challenges in implementation. Both learners and instructors had positive perceptions toward the integration of deep learning and digital literacy into EFL reading classes. Large themes on empowerment, engagement as well as relevance emerged from qualitative data.

From the students' perspective, deep learning made it possible for comprehending information rather than mastering content within larger social and environmental contexts of texts. As one student articulated, “*We learn not only how to read, but also how to think about the world.*” Most learners appreciated and valued SDG-related digital texts (for example blogs; infographics; online articles) which were relevant as well as inspirational. Such textual materials-initiated discourse and reflection thus making a personal connection to the reading material.

The teachers shared similar observations. They noted better student involvement and participation, particularly when digital tools such as Padlet, Canva, and Google Docs were used to facilitate collaborative reading activities or visualize the meaning of the text. *"When we related the text to real issues in their environment, they became more inquisitive even beyond class hours,"* one teacher reported. The deep learning framework—having reflection, rethinking, and application as its major components—more aligned with 21st-century literacy demands.

Both groups also noted as challenges the different levels of digital competence, low access to devices, and the need for training teachers in digital pedagogy. These were perceived as barriers to an understanding of deep learning that makes EFL reading instruction more meaningful, integrating digital literacy into it; however, their overall perception sheds light on one important aspect: integrating deep learning and digital literacy lets EFL reading instruction be conscious about making it inclusive and aligned with transformative education.

DISCUSSION

The discussion is organized around four major points reflecting both the theoretical framework and empirical evidence. Higher test scores mark deep learning, which can be critically evidenced through thinking, metacognitive awareness, and collaborative engagement as confirmed by markers in interviews who state that students have moved beyond literal comprehension to inferential and evaluative interpretation often questioning authorial intent connecting texts to personal or global contexts (for example one student noted: *"Now I try to ask myself; what is the author really saying here?"* Such reflection resonates with constructivist learning theory, which argues that learners are meaning makers, not passive recipients of information. However, an increase in the inferential comprehension score 18% provides quantitative support for this qualitative evidence.

These results prove that deep learning was a concept successfully implemented to enforce higher-order thinking skills in academic literacy. The change noticed in the class, from surface-level decoding to evaluative interpretation, aligns with Bloom's taxonomy, which learners move from understanding to critical analysis and synthesis of content. This outcome also provides substantial evidence for metacognition: *"knowledge about cognition."* Students monitored their comprehension; they detected a lack of clarity and employed online tools purposefully to extend meaning. Deep learning can be based on instructors' ability to scaffold EFL learners into more independent and critical engagement with texts.

This finding is consistent with the results of Pham and Renshaw (2020) in Vietnam and Zhang and Liu (2022) in China. They describe higher-order

comprehension achieved through deep learning strategies. More significantly, Indonesians found deep learning successful, even with limited infrastructure long as the implementation of strategies was well scaffolded by teachers. In their context, infrastructure would be assumed as a prerequisite for the success of such an approach that involved student-centered activities. This again brings to light a larger phenomenon evident in education worldwide: A move from memorization-based models to critical, reflective, and transformative learning.

The finding is particularly relevant to EFL contexts, where resource disparities more often rule the classroom. What this implies is that teacher-guided questioning and discussion, annotation, whether collective or individual, and reflective activities can offset constraints of resources in ensuring students' engagement at an inferential level with meaning-making processes. In this respect, Indonesia adds a case to the conception that pedagogical innovation and technological plenty are the determining equity factor of deep learning across educational settings, involving a wider issue of equity within educational settings globally. This insight supports what Alexander (2021) supposed: critical literacy can be developed through dialogic and discourse-based approaches across different socio-educational settings, even under conditions of uneven resource distribution.

In answer to RQ1, the increase in students' scores on the post-test and their reflective responses imply that problem-based tasks, collaborative annotation, and guided questioning as a deep learning approach were effective in breaking learners' literal recall toward higher-order comprehension. The strategies used helped students apply inferential reasoning techniques to connect ideas from different texts or relate readings to personal experiences. Outcomes achieved are consistent with Nguyen and Habók (2021), who emphasized that deep learning fosters cognitive engagement—thereby creating durable knowledge within EFL classrooms when practiced at a high level of intensity for significant periods over time. A shift found between surface processing and meaning-oriented engagement,

With reference to RQ2, reading is no longer associated only with printed texts in the digital age; it positively correlates reading performance with digital literacy. Students who are digitally literate can confidently navigate hypertexts, critically evaluate content found online, and use different media for better understanding. This slightly overlaps what Wang et al. (2020) and Kivunja (2022) emphasized about the relationship between competence in using digital technologies and acquiring literacy skills suitable for the 21st century—in English as a foreign language (EFL) reading context where comprehension takes place through multimodal socially situated texts, digital literacy both facilitates and amplifies comprehension.

RQ3, students and the teacher perceive that the approach between digital literacy and deep learning makes them autonomous, involved, and socially pertinent. This is very much in line with Transformative Learning (Mezirow 2009) and socio-constructivist approaches which emphasize the construction of knowledge by learners through real-world problems. Therefore, it made them more reflective and empathetic to develop not only linguistic but also global citizenship competencies when they were reading texts related to poverty, climate action, or gender equity (SDG 1, 13, and 5).

However, challenges remain. It spoke of infrastructure gaps, uneven digital readiness and limited training of teachers meanwhile echoing similar concerns raised by Yuwono et al. (2023) that in most secondary schools of Indonesia digital integration is uneven and there is less policy support for its implementation. The potential is very high but systemic transformation through supportive ecosystems comprising curricular flexibility, resource availability and empowerment of teachers and learners has yet to be realized.

The results of the study show that deep learning can be associated with digital literacy to sustain reading pedagogy aimed at competencies beyond SDGs and improved EFL reading proficiency. Therefore, substantial integration marks improvement in students' comprehension abilities which reveals effectiveness proven by such pedagogical innovation. This is in line with Pham and Renshaw's (2020) argument that deep learning raises learners' metacognitive awareness and ability for critical reading. In the present study, collaborative tasks, inferential questions, and reflective activities emphasized active involvement with texts- moving the learners from passive decoders toward constructive meaning makers. However, through dialogic and problem-based reading practices, students gradually become encouraged thinkers who make connections as well as negotiate interpretations. Most importantly, findings suggest deep learning gives reading instruction the potential to reorient from an exam-driven focus toward authentic literacy development—particularly in under-resourced school contexts where traditional methods remain dominant, and this kind of intervention is expressed as a critical need. Remove the word "most importantly" because there can be nothing more important in findings. Replace it with, for good measure, or better yet, another adverb that collocates more naturally with suggest.

The correlation between students' digital literacy and reading achievement supports and justifies the urgency of integrating digital competence within reading pedagogy. As emphasized by Ng (2021), digital literacy covers not only technical abilities but also critical evaluation and responsible use of information-consideration that directly supports understanding in online or multimodal environments. In this study, the students who were better readers could more effectively navigate through

digital texts, synthesize multiple sources, and handle complex content. This finding is supported by Putri and Arifin (2021) that highlight how digital literacy improves EFL outcomes when there is a good alignment between pedagogical practice and learners' needs. However, unequal access to devices as well as unprepared teachers came out strongly in the study as continuing challenges that constraint the implementation of the innovation equally across all schools.

The study found that students and teachers appreciated the integration of deep learning with digital literacy at the same time they noted those persistent gaps in institutional support. Pedagogy should transform in post-pandemic classrooms from content delivery to learner-centered, participatory engagement as argued by Siregar et al.(2023). Connections can be made between classroom texts and real-life issues through digital reading practices which make apparent autonomy, motivation, and relevance among students noticed by teachers via increased student participation whereby some highlighted a need for continuous professional development so as to implement deep learning strategies effectively hence indicating systemic innovation involving curriculum reform. This research proposes an empirically grounded possible evolution model across different contextual EFL classrooms toward both linguistic competence promotions oriented 21st-century skills via integrative reading instruction.

The integration of deep learning and digital literacy provides a potential approach to restructure reading lessons in EFL as means of developing higher-order thinking and global competence. Results evidenced in this study reveal that when learners structurally engage with authentic SDG-related content through digital tools and inquiry, they enhance reading comprehension at large with awareness of social and global issues. Sustainable education involves participatory and reflective pedagogies, which include more than rote-based pedagogy, Zacharias & Zhang (2021) argued. An integrative practice can therefore be strategically responsive to the incessant gaps in learning found in Indonesians, whose students' reading achievement per PISA 2018 is significantly below the world average by connecting the development of literacy with actual relevance.

Further evidence is gathered on teacher perspectives that emphasize an important pedagogical reorientation, as articulated in response to RQ3: reducing the transmission of knowledge and encouraging facilitation of student-driven inquiry. SDG Target 4.7 reorients education toward sustainable practices, human rights, and global citizenship as an enabling condition for the articulation of such pedagogy in policy that allows space for such reorientation (UNESCO, 2022). The teachers noted that the learners were asking more critical questions, connecting classroom texts with issues in their

communities, or showing empathy toward others-transgressive behaviors in the hallmarks of transformative learning (Illeris, 2018).

However, the discussion would be incomplete if it did not address the structural barriers that eventually shape classroom realities. Both this qualitative finding and previous research (Kusumawardani & Rachmawati, 2022) underscore long-standing challenges, which include uneven access to digital infrastructure and resources, a lack of contextually appropriate materials to be used in teaching, and tightly organized curricula requirements in Central Java's schools. Teacher enthusiasm or student engagement is always taken as evidence of transformation potential; systemic structural change is a long-term impact manifested through the support that sustains systemic professional development for teachers and school-level digital infrastructure investment, accompanied by SDG-oriented literacy inclusion into national curriculum frameworks.

Findings clearly state that this is not an ephemeral pedagogical trend but long-term-oriented towards global priorities and local needs at schools because deep learning and digital literacy are integrated within dual understanding as content knowledge and strategic skills for the future. Hence, reframing the EFL reading classroom to consider it a space of linguistic development incorporates critical thinking that can be realized based on another set of civic consciousness indicators pertinent to Indonesian students' acquisition of strong reading abilities, with dispositional preparedness emphasized hereby toward engagement with social issues responsibly.

CONCLUSION

The study found integrated learning strategies and digital literacy to play a very big role in reading comprehension among EFL learners, hence stressing the fact that engaged/learner-centered environments should be created, which would lead to autonomy and critical thinking. Quantitative results revealed strong correlations between deep learning-based instruction and student achievements, with levels of digital literacy supporting reading achievement; qualitatively, it was found outside-class social context helps reflective connection making. The research proposed another model for reading instruction restructuring that integrates scaffolding on deep learning as well as on making teachers continuously professionally developed so they can apply metacognitive strategies using digital tools thus fulfilling SDG 4: Quality Education because different learner needs exist across regions/settings.

The study assesses the outcome of deep learning strategies blended with digital literacy on reading comprehension among high school EFL learners in Central Java within an SDGs context. It discovers that pedagogies connecting real-world themes critically and collaboratively through inquiry

based on SDGs significantly inform students' understanding when emphasized elements of critical thinking, cooperation, and digitally literate students performing better. This makes both the student and teacher describe this approach to instruction as transformative due to increased engagement, relevance, and learner-centeredness that make it practically viable for actual classroom practice.

This paper discusses, at a theoretical level, the connection of deep learning with digital literacy and global education and their links to EFL pedagogy. Practically, it provides empirical support for curricula and policies embedding SDG-oriented content and digital skills in English language instruction. Herein, infrastructure support in teacher training as well as institutional commitment are highlighted through the researcher's plea for such integrative practice to be effectively implemented and sustained within diverse educational settings.

In conclusion, this study favors socially responsible pedagogy because the class becomes effective in achieving its intended learning outcomes at the same time that higher-order thinking and digital competence as dual outcomes of reading comprehension and civic awareness with responsibility at the global level are integrated through deep learning and digital literacy, making lessons achieve intended learning outcomes while being oriented to student preparedness. This is proof that academic integration between language education can lead and respond to social development wider than its own scope while maintaining intended achievements akin to SDG 4 by pursuing intended academic attainments for students, whereby framing them into responsible, reflective global. Future research could investigate long-term effects and how scalable it would be across different educational contexts within Indonesia, as well as outside.

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