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THE EFFECTIVENESS OF DIGITAL MEDIA-ASSISTED RECIPROCAL TEACHING ON ELEMENTARY STUDENTS' READING COMPREHENSION SKILLS

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Abstract

Traditional instructional methods often fail to develop students' metacognitive and evaluative reading skills, necessitating innovative pedagogical approaches that leverage digital technology to enhance literacy development. This study aimed to evaluate the effectiveness of a digital media-assisted reciprocal learning strategy on fifth-grade elementary students' reading comprehension skills. This study used a quantitative approach with a quasi-experimental method. The study participants consisted of 302 grade V students (aged 10-11 years) from six elementary schools in urban Indonesia. The intervention was conducted over one semester. Data were collected through a Reading Comprehension Test of 30 questions and classroom observations. The analysis included descriptive statistics and ANCOVA to test the main hypothesis. The experimental group showed a significant increase in reading comprehension compared to the control group, sig=0.001<0.05 (Cohen's d = 1.34). The increase was especially seen in the dimensions of metacognitive awareness (Cohen's d = 1.37) and evaluative reading (Cohen's d = 1.32), indicating that the integration of digital media with reciprocal learning strategies effectively improved high-level comprehension skills. Conclusion: Reciprocal learning with the assistance of digital media is an effective approach to improving students' reading comprehension skills. This research has contributed to the utilization of digital technology with reciprocal learning strategies effectively in literacy learning.

Keywords: Reciprocal Learning, Digital Media, Reading Comprehension.

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INTRODUCTION

Traditional instructional methods often fail to develop students' metacognitive and evaluative reading skills, which hinders the development of comprehensive literacy in the digital age (Roshid & Haider, 2024). The need for innovative pedagogical approaches that utilize digital technology is urgent to improve elementary school students' reading comprehension skills, given the complexity of literacy demands in the 21st century (Varas et al., 2023).

Reading comprehension is a fundamental skill that plays a crucial role in students' academic and life success (Ma & Zhao, 2025; Strauss, 2024; Uleanya, 2024). At the primary school level, these skills become increasingly important as students move from "learning to read" to "reading to learn" (Le Roux, 2024; J. Liu, 2015).

However, recent data from PIRLS (Progress in International Reading Literacy Study) shows that Indonesia still ranks low in students' reading literacy skills compared to other countries, with scores that are below the international average of 500 (PIRLS, 2022). This condition is reinforced by the 2022 PISA (Program for International Student Assessment) results, which ranked Indonesia 62nd out of 81 countries in reading literacy with a score of 359, far below the OECD average of 476 (OECD, 2023). These findings reveal a significant gap in Indonesian students' reading comprehension skills and underscore the need for innovative and effective instructional interventions. Preliminary research conducted at an elementary school in Cirebon showed that the majority of fifth-grade students experienced difficulties in understanding reading content, particularly in identifying the main ideas as well as explicit and implicit information within the texts. This aligns with the findings of Marmoah & Poerwanti (2022) who emphasized the importance of managing a literacy culture in elementary schools as a key factor in enhancing students' reading abilities. Furthermore, Pamularsih (2022) found that a conducive school climate positively influences students' reading achievement, highlighting the necessity of a supportive learning environment. Additionally, Anam & Stracke (2016) asserted that effective language learning strategies and students' self-efficacy beliefs play crucial roles in the success of reading comprehension.

The reciprocal teaching approach is effective in improving reading comprehension skills through four main strategies: summarizing, questioning, clarifying, and predicting (Fung et al., 2003; Mafarja et al., 2023; Sparapani et al., 2018). Some previous studies, such as those conducted by Sparapan*i et a*l. (2018) and Tong and McBride (2017), demonstrated the effectiveness of reciprocal learning in conventional contexts. However, as the digital era progresses and the way students interact with texts changes, there is a research gap on how to integrate digital media in reciprocal learning to optimize its impact on students' reading comprehension in this technological era(Elçi, 2024; Kurniaman et al., 2024; van Rooyen & Mihai, 2024).

The novelty of this study lies in the comprehensive integration of digital media, including interactive e-books, text visualization applications, digital discussion forums, and online

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collaboration platforms into the four reciprocal learning strategies. Unlike previous studies that only used one type of digital media or applied them partially (Hayashi et al., 2025; Xie & Lin, 2025). This study develops an integrated framework that aligns various digital media with specific stages in reciprocal learning. This approach enables personalized learning that is more adaptive to students' diverse needs and learning styles.

This study aims to (1) analyze the effect of the digital media-assisted reciprocal learning approach on the reading comprehension achievement of grade V students, (2) identify the aspects of reading comprehension most affected by this intervention, and (3) develop an implementation model that can be replicated in the Indonesian learning context. Through a quasi-experimental design with pre-test and post-test in experimental and control groups, this study comprehensively examined the effectiveness of the proposed intervention.

The urgency of this research is supported by three main factors. First, the phenomenon of low reading literacy levels among Indonesian students requires an innovative approach to overcome (Marmoah & Poerwanti, Suharno, 2022). Second, the increasing accessibility of technology in Indonesian schools has not been optimally utilized in literacy learning (Royanto, 2012). Third, the need for a learning model that can bridge the digital divide while improving students' conventional literacy skills in preparation for the literacy demands of the 21st century (Fanani & Kusmaharti, 2018; Hasan et al., 2022; Pamularsih, 2022).

This research makes significant contributions both theoretically and practically. Theoretically, it expands the understanding of the interaction between reciprocal pedagogy and digital technology in the context of reading comprehension learning. Practically, it produces an implementation framework that educators can adapt to integrate digital media into literacy learning without compromising the social and metacognitive aspects that are the main strengths of reciprocal learning. (Liu et al., 2025).

The long-term impacts of this research include improving the quality of reading comprehension learning in Indonesian primary schools, developing a sustainable model of technology integration in literacy, and improving students' readiness to face future digital literacy demands. Furthermore, this research has the potential to contribute to national efforts to improve Indonesia's literacy rankings in international assessments such as PIRLS and PISA while preparing a generation capable of critical and analytical thinking in facing the digital information age.

Theoretical Framework

Reciprocal teaching is an instructional approach designed to improve reading comprehension through structured dialogue between teachers and students (Ma & Zhao, 2025). This approach is based on Vygotsky's theory of social constructivism which emphasizes that learning occurs through social interaction and the important role of scaffolding in the learning process. Vygotsky's concept of Zone of Proximal Development (ZPD) is fundamental to

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reciprocal teaching, where students can achieve higher understanding with help from more skilled individuals before eventually being able to do so independently (Nicholas et al., 2021).

The four main strategies in reciprocal teaching namely predicting, clarifying, questioning, and summarizing are designed to improve reading comprehension through a metacognitive approach (Mafarja et al., 2023). Flavell's theory of metacognition explains the importance of students' awareness and ability to monitor and regulate their own cognitive processes while reading. Reciprocal teaching systematically facilitates the development of metacognitive skills by teaching students to actively monitor their comprehension and apply appropriate strategies when facing difficulties (Moritz & Lysaker, 2018).

In the context of the digital age, the reciprocal teaching model undergoes adaptation to accommodate changes in text characteristics and the way students interact with information (Wenren et al., 2024). The digital literacy theory proposed by Diprossimo et al. (2023) emphasizes that reading in digital environments requires additional skills, including the ability to navigate non-linear texts, evaluate the reliability of sources, and integrate information from multiple media formats. Modern reciprocal teaching integrates these skills to prepare students for the complexity of digital texts.

Singer Trakhman et al. (2025) dual-coding theory is also relevant in this framework, which explains that information is processed through interconnected verbal and visual pathways. Digital learning environments that present text with visual support can improve reading comprehension, especially for primary school students who are still developing decoding and comprehension skills. Reciprocal teaching strategies can utilize multimedia features to reinforce conceptual understanding and support different learning styles (Akram & Abdelrady, 2025).

Reading comprehension is also integrated into this theoretical framework, which identifies three key elements in comprehension: the reader, the text, and the activity of reading in a specific sociocultural context. In the digital age, the characteristics of texts have changed significantly, requiring adaptive teaching approaches (Chen et al., 2025). Reciprocal teaching provides a flexible structure to accommodate different types of digital texts while maintaining a focus on developing deep comprehension (Wenren et al., 2024).

This research is also grounded in cognitive load theory, which emphasizes designing instruction mindful of working memory constraints. According to recent studies, segmenting complex learning tasks into smaller units and providing scaffolding effectively manages cognitive load (Sweller, 2024). In reading instruction, reciprocal teaching strategies such as guided prediction, questioning, clarification, and summarization, not only scaffold the comprehension process but also distribute cognitive effort incrementally (Cockerill et al., 2023). By breaking down texts into manageable segments and offering structured support, these strategies are well-suited to the developmental capacities of primary school students, thereby optimizing cognitive resources for deeper learning (Spörer & Schünemann, 2014).

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METHODS

This study used a quantitative approach with a quasi-experimental method to examine the effectiveness of digital media-assisted reciprocal learning strategies on the reading comprehension skills of grade V elementary school students. The quasi-experimental method was chosen due to the impossibility of random assignment in the formal education context. (Creswell & Creswell, 2018). The research design used was a Non-Equivalent Control Group Design with pre-test and post-test measurements, which allows researchers to compare the results of interventions between experimental and control groups without ignoring the initial conditions of the research subjects. (Creswell & Creswell, 2018).

This study was conducted in elementary schools in Cirebon, West Java, Indonesia. The study participants consisted of 302 grade V students (aged 10-11 years) from six elementary schools in urban Cirebon, Indonesia, divided into an experimental group (n=153) and a control group (n=149). The sampling technique used was purposive sampling with the following criteria: (1) availability of digital infrastructure at school, (2) similar socio-economic background, and (3) similar academic achievement profile. To minimize bias, teachers in both groups had equivalent qualifications and teaching experience (at least 5 years of experience).

The intervention was conducted over one semester (16 weeks) with three meetings per week of 60 minutes each. The experimental group received digital media-assisted reciprocal learning that integrated interactive e-books, text visualization applications, digital discussion forums, and online collaboration platforms into four main reciprocal learning strategies: summarizing, questioning, clarifying, and predicting. Meanwhile, the control group received conventional learning using lectures, discussion, and print media as per the standard curriculum.

Reading comprehension ability in this study refers to the reading comprehension taxonomy developed by (Anderson, & Krathwohl, 2001) and modified by Oakhill, Cain., & Elbro (2014) Which includes four dimensions: (1) Literal comprehension, which is the ability to identify explicit information in the text with indicators: recognizing explicit facts, details, and sequence of events; (2) Inferential comprehension, which is the ability to conclude from implicit information with indicators: determining the main idea, making inferences, and recognizing implied cause-effect relationships; (3) Evaluative comprehension, which is the ability to assess and criticize text content with indicators: distinguishing facts and opinions, assessing the accuracy of information, and identifying the author's purpose; and (4) Metacognitive comprehension, which is awareness of one's thinking process with indicators: monitoring comprehension, identifying effective strategies, and evaluating the suitability of strategies with reading objectives.

The main instrument used in data collection was the Test of Reading Comprehension adapted from the PIRLS assessment framework and adjusted to the Indonesian context. The Test of Reading Comprehension consists of 30 items that measure the four dimensions of reading comprehension with proportions: literal comprehension (10 items), inferential (10

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items), evaluative (5 items), and metacognitive (5 items). The instrument has been validated through expert judgment (n=5) and pilot testing on 80 grade V students from a school that did not participate in the study, with the result of reliability analysis using Cronbach's Alpha of 0.87 indicating high internal consistency. In addition, to measure students' engagement in digital learning, a Digital Reading Engagement Scale with 15 Likert scale items was used, as well as a Strategy Implementation Observation Sheet to measure teachers' adherence to the intervention protocol.

Data analysis techniques included descriptive and inferential analysis. To test the main hypothesis, Analysis of Covariance (ANCOVA) was used with pre-test scores as covariate to compare the effectiveness of the intervention in experimental and control groups. Effect size was calculated using Cohen's d to determine the magnitude of the intervention impact. Furthermore, multiple regression analysis was conducted to identify the aspects of reading comprehension most affected by the intervention, while repeated measures ANOVA was used to analyze changes in the application of reading strategies over time. To control for potential bias from outside variables, a subgroup analysis based on gender, prior reading achievement, and students' digital literacy level was conducted. All statistical analyses were conducted with the help of SPSS version 28.0 software with a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

Before the implementation of the intervention, the Test of Reading Comprehension went through a comprehensive validation procedure. Content validity was tested through expert judgment involving five experts in language and reading education. Table 1 presents the results of content validity using Aiken's V formula.

Table 1. Results of Content Validity of Reading Comprehension Test

Dimensions	Item	Aiken's V Range	Aiken's V Mean	Interpretation
Literal Comprehension	1-10	0,78-0,92	0,85	High validity
Inferential Comprehension	11-20	0,80-0,93	0,88	High validity
Evaluative Comprehension	21-25	0,76-0,90	0,84	High validity
Metacognitive Comprehension	26-30	0,77-0,89	0,83	High validity
Overall Instrument	1-30	0,76-0,93	0,86	High validity

The reading comprehension test demonstrated strong content validity across dimensions, with Aiken's V coefficients ranging from 0.76 to 0.93, exceeding the minimum acceptable threshold of 0.70 (Aiken, 1985). Reliability analysis of the instrument was conducted through a pilot test involving 80 grade V students from schools that did not participate in the main study. Table 2 presents the results of the reliability analysis using Cronbach's Alpha coefficient.

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Table 2. Results of Reliability Analysis of Reading Comprehension Test

Item Dimensions	Item	Cronbach Alpha (α)	Interpretation
Literal Comprehension	10	0,85	Good reliability
Inferential Comprehension	10	0,83	Good reliability
Evaluative Comprehension	5	0,80	Good reliability
Metacognitive Comprehension	5	0,79	Reliability is acceptable
Overall Instrument	30	0,87	Good reliability

Cronbach's alpha coefficients for all dimensions exceeded 0.70, indicating acceptable to good internal consistency (Taber, 2018). The instrument's overall reliability coefficient of 0.87 showed high internal consistency, confirming the reliability of the reading comprehension test to measure reading comprehension among grade V students.

Descriptive Statistical Analysis

The comparison of pre-test and post-test scores between the experimental and control groups is presented in Table 3.

Table 3. Descriptive Statistics of Pre-test and Post-test Scores

Group	N	Pre-test		Post-test		Mean Increase	95% Confidence Interval for Increase
		M	SD	M	SD		
Experiment	153	62,41	8,32	78,65	7,45	16,24	[14,87, 17,61]
Control	149	61,87	8,56	68,23	8,12	6,36	[5,02, 7,70]

Table 3 shows that the experimental group had a significantly higher mean increase (16.24 points) compared to the control group (6.36 points). Non-overlapping confidence intervals for the mean increase indicate a statistically significant difference in improvement between the two groups.

Inter-Group Comparative Analysis

Analysis of covariance (ANCOVA) was conducted to compare post-test scores between groups by controlling for pre-test scores as a covariate. Analysis of covariance (ANCOVA) was conducted to compare post-test scores between groups while controlling for pre-test scores as a covariate. The results of this analysis are presented in Table 4.

Table 4. ANCOVA Results for Inter-Group Comparisons on Post-test Scores

Source	JK	db	KR	F	p	ηp^2
Pre-test (Kovariat)	4281,34	1	4281,34	87,53	<0,001	0,23
Group	5499,87	1	5499,87	112,46	<0,001	0,27
Error	14622,43	299	48,90			
Total	1582684,00	302				

Note. JK = Sum of Squares; db = degrees of freedom; KR = Mean Square; ηp^2 = partial eta square.

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The ANCOVA results showed a significant effect of the intervention on reading comprehension ($F(1, 299) = 112.46$, $p < 0.001$, $\eta p^2 = 0.27$). The effect size (Cohen's $d = 1.34$) indicated a large practical significance of the intervention, exceeding Cohen's benchmark of 0.80 for a large effect.

Reading Comprehension Dimension Analysis

To evaluate the impact of the intervention on the different dimensions of reading comprehension, separate ANCOVAs were conducted, as presented in Table 5, with pre-test scores used as covariates for each dimension.

Table 5. Comparison of Reading Comprehension Dimensions between Groups

Dimension	Experimental Group		Control Group		F (1, 299)	p	Cohen's d
	Pretest	Posttest	Pretest	Postest			
Literal	68,23	82,41	67,92	75,18	46,23	<0,001	0,86
Inferential	61,34	78,92	60,89	67,43	89,74	<0,001	1,29
Evaluative	58,65	76,18	57,98	63,45	102,56	<0,001	1,32
Metacognitive	54,21	73,27	53,76	61,15	118,35	<0,001	1,37

The intervention had significant positive effects on all dimensions of reading comprehension, with the largest effect observed on metacognitive comprehension ($d = 1.37$), followed by evaluative comprehension ($d = 1.32$), inferential comprehension ($d = 1.29$), and literal comprehension ($d = 0.86$). This pattern suggests that digital-assisted reciprocal learning is particularly effective for improving higher-order reading comprehension skills.

Analysis of Reading Strategy Implementation

A repeated measures analysis of variance was conducted to analyze changes in reading strategy implementation over time as measured by the Strategy Implementation Observation Sheet. Results showed a significant increase in strategy use in the experimental group ($F(3,456) = 78.35$, $p < 0.001$, $\eta p^2 = 0.34$).

Table 6. Implementation of Reciprocal Strategy in Experimental Group

Strategy	Week 1	Week 5	Week 10	Week 16	F	p	ηp^2
Summarizing	41,2	57,6	68,4	75,8	63,42	<0,001	0,29
Questioning	38,5	54,3	65,7	73,2	59,85	<0,001	0,28
Clarifying	35,7	52,8	67,5	78,0	84,62	<0,001	0,36
Predicting	36,8	50,9	64,8	75,5	71,29	<0,001	0,32
Overall Implementation	38,1	53,9	66,6	75,6	78,35	<0,001	0,34

Table 6 shows the progressive improvement in the implementation of the four reciprocal learning strategies throughout the intervention period. The clarifying strategy showed the

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greatest improvement (42.3 percentage points), followed by predicting (38.7 percentage points), summarizing (34.6 percentage points), and questioning (34.7 percentage points).

Subgroup analysis was performed to explore whether the intervention had varying effects based on gender, prior reading achievement, and digital literacy level. This analysis aimed to identify potential differences in outcomes among these distinct groups.

Table 7. Subgroup Analysis of Intervention Effects

Subgroup	n	Pre-test	Post-test	Post-test Corrected*	F	p	ηp^2
Gender					F(1,151) = 2,18	0,140	0,01
Male	78	61,87	77,92	78,05			
Female	75	62,97	79,42	79,29			
Initial Reading Achievement					F(2, 150) = 14,23	<0,001	0,16
Low (≤55)	47	51,34	72,68	80,21			
Medium (56-70)	62	63,45	79,74	78,26			
High (≥71)	44	73,56	83,82	75,42			
Digital Literacy Level					F(2, 150) = 9,47	<0,001	0,11
Low	38	60,76	73,58	74,7			
Medium	75	62,35	78,92	78,8			
High	40	64,21	82,86	81,12			

Observations of the implementation of digital media-assisted reciprocal learning strategies in the experimental group showed significant progress throughout the intervention period. Observations were conducted at four time points: week 4, week 8, week 12, and week 16, using the Strategy Implementation Observation Sheet. The following are the main findings from the observations.

Table 8. Reciprocal Learning Strategy Implementation Score

Strategy	Week 4	Week 8	Week 12	Week 16	*F*	*p*-value
Summarizing	2,6 ± 0,7	3,4 ± 0,6	3,9 ± 0,5	4,3 ± 0,4	38,27	<0,001
Questioning	2,3 ± 0,8	3,2 ± 0,7	3,7 ± 0,6	4,1 ± 0,5	42,15	<0,001
Clarifying	2,4 ± 0,7	3,0 ± 0,6	3,6 ± 0,5	4,2 ± 0,4	45,83	<0,001
Predicting	2,1 ± 0,9	2,8 ± 0,8	3,5 ± 0,6	4,0 ± 0,5	49,26	<0,001
Total Score	2,4 ± 0,7	3,1 ± 0,6	3,7 ± 0,5	4,2 ± 0,4	43,72	<0,001

Notes: Scores are on a scale of 1-5 (1=Very Poor, 2=Deficient, 3=Sufficient, 4=Good, 5=Excellent); A p-value of <0.05 indicates a significant difference.

The results of repeated measures ANOVA analysis showed significant improvement in the application of all reciprocal learning strategies from week 4 to week 16. The predicting strategy showed the most substantial improvement ($F=49.26$, $p<0.001$), followed by clarifying ($F=45.83$, $p<0.001$), questioning ($F=42.15$, $p<0.001$), and summarizing ($F=38.27$, $p<0.001$).

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Observations also revealed positive developments in group dynamics and digital interactions. At the beginning of the intervention, interactions between students in the digital collaboration platform tended to be limited and dominated by a few students. As time progressed, participation became more evenly distributed with more students actively involved in online discussions and collaboration. By week 16, most groups demonstrated the ability to distribute roles (summarizer, questioner, clarifier, predictor) effectively, and role rotation was smooth. Communication within the digital collaboration platform became more structured and task-focused and showed higher levels of metacognitive reflection.

Observations also recorded significant progress in teachers' adaptation to the integration of digital technology in reciprocal learning. At the beginning of the intervention, teachers tended to experience difficulties in managing the technical aspects of the digital platforms used and often spent significant time addressing technical issues. By the middle of the intervention, teachers showed increased confidence in using various digital platforms and started to develop effective strategies to integrate technology in learning without compromising pedagogical aspects. By week 16, teachers demonstrate the ability to flexibly switch between different digital platforms as per learning needs, provide appropriate scaffolding for technology use, and facilitate metacognitive discussions on how technology can support students' reading strategies.

Discussion

The findings of this study provide strong evidence of the effectiveness of digital-assisted reciprocal learning strategies in improving elementary school students' reading comprehension. The significant increase in the experimental group's reading comprehension scores ($M = 78.65$, $SD = 7.45$) compared to the control group ($M = 68.23$, $SD = 8.12$) with a large effect size (Cohen's $d = 1.34$) emphasizes the strong impact of this integrated approach.

Effectiveness on Multiple Dimensions of Comprehension

An important finding in this study was the differential impact of the intervention on all four dimensions of reading comprehension. Although the intervention resulted in significant improvements in all dimensions, the largest effects were observed on metacognitive comprehension ($d = 1.37$) and evaluative comprehension ($d = 1.32$), followed by inferential comprehension ($d = 1.29$) and literal comprehension ($d = 0.86$). This pattern is in line with the theoretical framework suggesting that reciprocal learning specifically improves higher-order reading skills (Spörer et al., 2009; Wenren et al., 2024) and extends these findings by showing that digital enhancement further amplifies this effect.

The stronger impact of the intervention on higher-order reading skills can be attributed to the reciprocal learning design, which encourages students to actively engage with the text through questioning, clarifying, and predicting strategies(Arifannisya & Asnawi, 2024; Mafarja et al., 2023). The addition of digital tools seems to have enhanced this process by providing multimodal engagement opportunities that support the development of metacognitive

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awareness during reading. (Kanniainen et al., 2021). Interactive e-books with annotation capabilities, digital mind mapping tools, and collaborative platforms are likely to create multiple entry points for students to practice higher-order thinking skills while processing texts. (Leu et al., 2015).

Progressive Development of Strategy Implementation

A longitudinal analysis of strategy implementation showed a clear developmental trajectory throughout the intervention period. Initially, students had difficulty with all four strategies, particularly prediction (M = 2.1, SD = 0.9) and questioning (M = 2.3, SD = 0.8). However, by the end of the intervention, students showed substantial improvement in all strategies, with clarification showing particularly strong growth (from M = 2.4, SD = 0.7 to M = 4.2, SD = 0.4).

This progressive development reflects the gradual internalization of metacognitive strategies, consistent with Vygotsky (1978) The concept of the zone of proximal development and the gradual transfer of responsibility from teacher to student. Qualitative observations support this interpretation, documenting the evolution from simple strategy application (e.g., highlighting words) to sophisticated integration of various digital tools and more complex cognitive processing (e.g., creating structured summaries integrating color-coded highlighting and digital annotation).

The progressive improvement in strategy implementation also suggests that digitally-assisted reciprocal learning is not simply a temporary intervention but a sustainable approach that leads to the use of increasingly sophisticated strategies over time. This finding addresses concerns about the sustainability of digital interventions raised by previous researchers. (Gebremeskel et al., 2024; Jafarian & Kramer, 2025).

Differential Effects on Student Subgroups

Subgroup analysis provided important insights into the differential effects of the intervention. The absence of significant gender differences ($F(1,151) = 2.18$, $p = 0.140$, $\eta p^2 = 0.01$) suggests that digitally-assisted reciprocal learning provides equal benefits for boys and girls, in contrast to some previous studies showing gender disparities in digital learning environments. (Rahimi & Sevilla-Pavón, 2024; Wei et al., 2023).

More striking were the differential effects by initial reading achievement and digital literacy level. The intervention showed the strongest benefit for readers with low initial achievement (corrected post-test M = 80.21), followed by average readers (M = 78.26) and high-achieving readers (M = 75.42), with substantial effect sizes ($\eta p^2 = 0.16$). This pattern suggests that digitally-assisted reciprocal learning can be an effective approach to narrowing the achievement gap, consistent with findings from another study of scaffolded comprehension instruction. (Reutebuch et al., 2015).

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Similarly, a significant interaction between intervention and digital literacy level (ηp^2 = 0.11) indicated that while students with intermediate and high digital literacy benefited substantially from the intervention, those with low digital literacy showed more modest improvements. This finding underscores the importance of addressing digital literacy as a prerequisite for maximizing the benefits of technology-assisted reading interventions. (Gath et al., 2025; Wexler et al., 2022).

Pedagogical Integration of Technology

Observational data revealed a progressive development in the integration of digital technology throughout the intervention. Initially, both teachers and students engaged with digital tools in a limited and often superficial manner. However, by the conclusion of the intervention, evidence showed more sophisticated integration where technology functioned as a cognitive tool rather than merely a delivery medium. This progression aligns with Puentedura (2010) SAMR (Substitution, Augmentation, Modification, Redefinition) model, which conceptualizes technology integration moving from substitution toward redefinition of learning tasks, enabling activities that were previously inconceivable (Blundell et al., 2022). Similar findings by Priante & Tsekouras (2025) emphasize that effective technology integration in classrooms transitions from basic usage to innovative, transformative applications that support higher-order thinking and learner autonomy.

The trajectory of teacher development was critical, evolving from technical troubleshooting to strategic pedagogical integration of digital tools. This echoes findings by Kiyanfar et al. (2025), who assert that successful digitally assisted reciprocal teaching demands sustained professional development that enhances both technical competencies and pedagogical integration skills. Consistently, Wang et al., (2025) and Hrastinski (2021) demonstrated that intensive professional learning and institutional support accelerate teachers' adoption of innovative digital practices, improving student engagement, collaboration, and reflective learning.

The study's findings contribute to existing theoretical frameworks in multiple ways. Firstly, they extend Mafarja et al. (2023) reciprocal teaching model by illustrating how digital tools can augment each of the four reciprocal strategies. Digital highlighting and annotation tools enhance summarization, online discussion forums facilitate questioning, multimedia resources support clarification, and interactive features enable more sophisticated prediction activities. This aligns with contemporary research emphasizing multimodal digital resources as catalysts for active reading comprehension (Aly et al., 2024; Rahmawati & Abduh, 2023; Yi-Ming Kao et al., 2025).

Secondly, the results deepen understanding of new literacies in the digital era. Diprossimo et al. (2023) and Løkken et al. (2025) highlight how traditional comprehension strategies must be adapted and enriched within digital contexts. The significant improvements observed across

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multiple comprehension dimensions suggest that digitally supported reciprocal teaching can bridge conventional literacy practices with the multimodal, interactive literacies essential for navigating digital environments (Habók et al., 2024; Puspita et al., 2023; Rico-Juan et al., 2024).

Finally, these findings reinforce the sociocultural perspective on literacy development (Nicholas et al., 2021), demonstrating how digital tools facilitate collaborative meaning-making and social knowledge construction via shared annotation, online discussions, and co-constructed predictions (Florit et al., 2025). The evolution of group dynamics observed during the intervention reflects how technology enhances the social dimensions of reading comprehension development, a phenomenon also supported by Vargas et al. (2024) and Diprossimo et al. (2023).

Despite these robust findings, several limitations warrant consideration. Firstly, although the intervention duration of 16 weeks exceeds many comparable studies, the long-term sustainability of observed effects remains unclear. Secondly, the research context characterized by relatively ample resources may limit the generalizability of results to under-resourced educational settings. Thirdly, while initial digital literacy levels were controlled, the nuanced interactions between specific digital literacy competencies and reciprocal teaching strategies were not fully explored.

Future research should address these gaps through longitudinal designs that monitor the persistence of learning gains, implementation studies across diverse educational contexts, and detailed investigations of the interplay between discrete digital competencies and comprehension strategies. Moreover, comparative studies exploring varied approaches to technology integration within reciprocal teaching frameworks would help identify the most effective pedagogical and technological combinations.

CONCLUSION

This study provides strong evidence that digitally assisted reciprocal teaching is an effective pedagogical strategy for enhancing elementary students' reading comprehension, particularly in developing higher-order cognitive skills such as summarizing, questioning, clarifying, and predicting. The integration of digital media was found to support not only comprehension outcomes but also to foster student engagement, collaboration, and autonomy within a digitally mediated learning environment. These findings have significant theoretical and practical implications.

The study contributes to the growing body of literature on digital literacy and instructional innovation by offering empirical support for the pedagogical potential of digital reciprocal teaching. Future research is recommended to adopt longitudinal designs to examine the sustainability of learning gains, explore implementation across diverse educational contexts, and investigate the nuanced interaction between specific digital skills and comprehension strategies.

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