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Influence of Computer-Assisted Interactive Instruction on Achievement in English Reading Comprehension among Form Two Secondary School learners in Embakasi Sub-County

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Abstract

The study aimed to explore the effect of interactive learning tools in Computer-Assisted Learning (CAL) on English reading comprehension achievement among learners in Secondary schools in the Embakasi Sub-County, Nairobi, Kenya. The study was based on three main aspects of CAL: educational software applications, interactive multimedia, and virtual learning platforms, to improve learners' engagement and understanding. The study was anchored on Solomon's four-group experimental design and involved 286 Form Two students of four secondary schools. The participants were separated into Experimental Groups (E1 and E2) and Control Groups (C1 and C2). Data collection instruments included pre- and post-test reading comprehension assessments, learner and teacher questionnaires, and interviews with school principals. Statistical analysis using SPSS included descriptive statistics, t-tests, ANOVA, and regression. Findings revealed no significant difference in baseline pre-test scores between E1 and C1 ($p > .05$), confirming group equivalence. However, post-test results showed that learners in the experimental groups, who were exposed to interactive CAL tools, outperformed those in the control groups. ANOVA results were statistically significant ($p = .000$), and Post Hoc analysis confirmed that the difference was due to the intervention. Regression analysis further indicated a strong predictive relationship between interactive tools and learner achievement ($R^2 = 0.6402$; $\beta = 0.119$, $p = 0.014$). The study concludes that interactive CAL tools enhance reading comprehension by providing dynamic, student-centered learning experiences. It recommends integrating CAL tools into English instruction to support diverse learning needs and improve reading outcomes in secondary schools.

Keywords: *Educational Technology, Interactive Learning Tools, Computer-Assisted Learning (CAL), Reading Comprehension Achievement*

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1. Introduction

Interactive learning platforms in Computer-Assisted Learning (CAL) transform instruction by making teaching and learning an interactive process rather than a one-way communication done by the teacher. Such platforms integrate tools such as educational software applications, multimedia content, and virtual learning environments to actively engage learners in constructing knowledge. Hoxhaj (2024) explains that interactive learning platforms in CAL promote experiential learning by allowing students to interact with content, receive immediate

feedback, collaborate with peers and teachers in real time. Further, a study by Bai et al. (2023) reveals that digital interactive learning platforms offer promising solutions for improving reading comprehension outcomes among learners by making learning experiential and participatory for both learners and teachers. In English reading comprehension, these tools enhance understanding by supporting text visualization, fostering vocabulary development, and encouraging inferencing through contextually rich materials. Ganira and Odundo (2023) explain that when learners shift from passive recipients to active participants, they achieve deeper comprehension and improved academic performance. However, research by Kivuva et al. (2023) indicates that in nearly 90% of Kenyan secondary schools, integration of interactive learning tools into English instruction remains underutilized, particularly in public schools, due to limited access to technology and inadequate teacher training.

Integration of digital interactive learning platforms into secondary English instruction aligns with 21st-century pedagogical approaches that emphasize learner-centered, participatory, and technology-driven methods to enhance achievement in English reading comprehension. According to Bechtold (2023), interactive learning in Computer-Assisted Learning (CAL) enhances knowledge acquisition by making the instructional process more engaging, responsive, and learner-focused than traditional, teacher-directed methods. Therefore, learners exposed to digital platforms that simulate real-world reading experiences, such as interactive story maps, animated summaries, and vocabulary games, are more likely to comprehend texts more effectively, retain information longer, and build confidence in navigating complex reading tasks. This observation aligns with findings by Hernández-Sellés et al. (2019), who highlight that meaningful interaction with digital tools significantly improves learners' comprehension skills, motivation, and academic self-efficacy. Despite empirical evidence supporting technology-powered interactive learning as an effective instructional approach for improving learner achievement, Mailo, Odundo, and Ganira (2023) observe that schools continue to treat digital platforms as supplementary rather than integral tools, leading to minimal pedagogical impact, limited learner engagement, and persistently low achievement in English reading comprehension.

1.1 Educational Software

Educational software applications within CAL are instructional tools designed to transform passive reading into an interactive, learner-centered experience by providing learners with platforms to engage with reading comprehension content, collaborate with peers, and actively participate in the learning process. According to Emmanuel, Paul, and Lilian (2022), interactive educational applications positively impact learning outcomes by enhancing learner participation, fostering positive teacher-student relationships, and streamlining knowledge delivery. These platforms enable learners to engage with leveled passages, complete comprehension tasks, receive instant feedback, and track their progress, helping them internalize reading strategies, expand vocabulary, and improve fluency. Bechtold (2023) affirms that interactive educational software, such as ReadTheory and eKitabu, enhances learners' achievement in English reading comprehension through adaptive comprehension tasks, vocabulary support, and performance tracking, thereby enabling learners to develop critical reading strategies and confidence. Notably, the use of interactive educational applications remains uneven, as noted by Mukonyi, Ganira, and Odundo (2024). Schools lack sufficient infrastructure and teacher training to fully harness these tools, which limits impact on reading achievement.

1.2 Multimedia

Multimedia tools in CAL refer to the integration of text, audio, video, animation, and graphics to enrich the learning environment and deepen learner engagement. A study by Bechtold (2023) shows that interactive multimedia creates dynamic, multisensory experiences that promote better understanding of content by catering to diverse learning styles, visual, auditory, and kinesthetic. In English reading comprehension, multimedia enhances learners' ability to decode, interpret, and analyze texts through visual aids, narrated passages, animated story sequences, and contextual vocabulary support. According to Buehl (2023) and Munyao et al. (2022), multimedia learning environments help learners build coherent mental models of textual information by promoting dual-channel processing (verbal and visual), improving comprehension and retention. However, despite the pedagogical value of multimedia, Bekele, Odundo, Mwangi, and Ganira (2025) observe that its integration in Kenyan secondary schools remains limited due to inadequate ICT infrastructure, insufficient teacher training, and limited internet access, hindering the full realization of multimedia's potential to improve reading comprehension outcomes.

1.3 Virtual Learning Platforms

Virtual learning platforms offer flexible, collaborative environments that extend reading comprehension instruction beyond physical classrooms. Shadiev and Yu (2024) highlight that these platforms support both synchronous and asynchronous learning, enabling learners to access materials, share insights, and receive real-time feedback. In the context of secondary education in Kenya, platforms such as Google Classroom, Edmodo, and MwalimuPlus have facilitated digital comprehension activities, peer collaboration, and teacher-guided online assessments. Bai et al. (2023) affirm that virtual learning platforms foster learner autonomy and reflective engagement by offering differentiated access to materials. Similarly, a study by Mudawi and Maslamani (2024) found that well-designed Computer-Assisted Learning environments significantly enhance learner participation, motivation, and comprehension outcomes by supporting intercultural and interactive learning experiences. However, a study by Kivuva, Atwoli, and Waititu (2023) highlights numerous inconsistencies in teacher support and the absence of structured online engagement, which leads learners to experience isolation and reduced motivation. Therefore, while virtual platforms hold great potential to improve reading comprehension, their impact in the Kenyan context is constrained by technological, pedagogical, and systemic barriers.

1.4 Problem Statement

The academic success of secondary school learners in English reading comprehension is critical to overall educational achievement, as this skill underpins understanding of content across all subjects assessed in English. However, over the past five years, there has been a persistent trend of low achievement in this area in the Kenya Certificate of Secondary Education (KCSE) examinations in Embakasi Sub-County. As shown in Table 1.

Table 1: Learner Performance in the English language

2020	2021	2022	2023	2024
Mean	Mean	Mean	Mean	Mean
34.39	37.00	40.37	36.88	35.94

Source: ***Results analysis by QASO Embakasi Sub- County, Nairobi County, Kenya***

Notably, the KNEC report (2023) attributes low performance in English to poor reading comprehension skills among the learners. Despite the availability of qualified teachers and appropriate learning resources, traditional instructional methods, which rely primarily on rote learning and teacher-centered approaches, have proven ineffective at engaging students and addressing diverse learning needs. Such dismal results prompted interest in computer-assisted interactive learning, which offers engaging educational software applications, multimedia, and virtual learning platforms that boost learners' achievement in English reading comprehension.

1.5 Research Objectives

This study was guided by the following specific objectives:

1. To determine the influence of educational software applications on learners' achievement in English reading comprehension.
2. To examine the effect of interactive multimedia on learners' understanding and retention of reading comprehension content.
3. To assess the contribution of virtual learning platforms to learners' engagement and performance in reading comprehension tasks.

2. Literature Review

Empirical studies show that interactive learning tools within Computer-Assisted Learning (CAL) significantly enhance learners' achievement in reading comprehension. Research by Bai et al. (2023) established that digital CAL interventions improved learners' comprehension outcomes by promoting active engagement, immediate feedback, and individualized learning pathways, particularly among learners in resource-constrained settings. Similarly, Hernández-Sellés et al. (2019) found that technology-supported collaborative learning environments enhance both cognitive and affective dimensions of learning, leading to improved comprehension, motivation, and learner autonomy. In the context of multimedia learning, Buehl (2023) and Munyao et al. (2022) emphasize that integrating visual, auditory, and textual elements supports dual-channel processing, enabling learners to construct deeper meaning from texts. These findings suggest that interactive CAL tools play a critical role in transforming reading instruction from passive content delivery to an engaging, learner-centered process that improves comprehension outcomes.

However, despite the demonstrated effectiveness of interactive CAL tools, several studies highlight contextual and implementation challenges that limit their impact, particularly in developing countries. Kivuva et al. (2023) report that the integration of computer-assisted learning in Kenyan secondary schools remains inconsistent due to inadequate ICT infrastructure, limited access to digital devices, and insufficient teacher training. Similarly, Mukonyi et al. (2024) note that learner preparedness and teacher competency significantly influence the successful implementation of digital learning interventions, with gaps in digital literacy undermining potential gains in academic achievement. Mudawi and Maslamani (2024) further argue that without structured pedagogical frameworks and sustained institutional support, virtual learning platforms may fail to achieve their intended outcomes, leading to learner disengagement. Therefore, while existing literature affirms the effectiveness of interactive CAL tools in enhancing reading comprehension, it also underscores the need for systemic support, capacity building, and equitable access to technology to maximize their impact in diverse educational contexts.

2.1 Theoretical review

This study is grounded in Vygotsky's Constructivist Learning Theory as articulated in Mind in Society (1978), which conceptualizes learning as an active, socially mediated process in which knowledge is constructed through interaction with others and with cultural tools. A central construct of the theory is the Zone of Proximal Development (ZPD**),** the range between what learners can achieve independently and what they can accomplish with guided support. Constructivism emphasizes learner engagement, scaffolding, interaction, and gradual internalization of skills, with instructional supports systematically withdrawn as competence increases. Technology, language, and symbolic systems are viewed as mediational tools that facilitate this process, enabling learners to actively make meaning rather than passively receive information.

The theory is directly relevant to this study because interactive learning tools within Computer-Assisted Learning (CAL) function as mediational tools that operationalize constructivist principles in reading comprehension instruction. Educational software applications and virtual platforms provide scaffolded guidance and adaptive support, placing learners within their ZPD by adjusting task difficulty and feedback in response to performance. Interactive multimedia facilitates active engagement and meaning-making by linking visual, auditory, and textual information, supporting vocabulary development, inference-making, and monitoring comprehension. Learner interaction with texts, feedback mechanisms, and self-paced activities promotes metacognitive regulation and learner autonomy, which are critical for deep comprehension. Thus, Constructivist Learning Theory provides a coherent explanatory framework for understanding how interactive CAL tools enhance reading comprehension achievement by supporting individualized scaffolding, engagement, and progressive mastery among secondary school learners.

2.2 Empirical Review

Empirical evidence indicates that interactive learning tools within Computer-Assisted Learning (CAL) significantly improve learners' achievement in reading comprehension. A study by Bai et al. (2023) found that online CAL interventions enhanced reading outcomes by promoting active learner engagement, individualized learning pathways, and immediate feedback mechanisms, particularly among learners in disadvantaged contexts. Similarly, Hernández-Sellés et al. (2019) established that technology-supported collaborative learning environments strengthen both cognitive and affective learning outcomes, leading to improved comprehension, motivation, and learner autonomy. In the area of multimedia learning, Buehl (2023) demonstrated that integrating visual, auditory, and textual elements enhances learners' ability to construct meaning from texts, while Munyao et al. (2022) reported that multimedia-supported instruction improves retention and comprehension by facilitating dual-channel processing. Collectively, these studies affirm that interactive CAL tools transform reading instruction into an engaging, learner-centered process that enhances comprehension achievement.

However, despite the proven effectiveness of interactive CAL tools, several empirical studies highlight contextual challenges that limit their successful implementation, particularly in developing countries. Kivuva et al. (2023) found that the integration of computer-assisted learning in Kenyan secondary schools remains inconsistent due to inadequate ICT infrastructure, limited access to digital devices, and insufficient teacher training, which negatively affects learner outcomes. In a related study, Mukonyi et al. (2024) established that

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both learner preparedness and teacher competency significantly influence the effectiveness of CAL, with gaps in digital literacy constraining its impact on academic achievement. Furthermore, Mudawi and Maslamani (2024) observed that although virtual learning platforms enhance learner engagement and flexibility, the absence of structured pedagogical support can reduce learner motivation and participation. These findings suggest that while interactive CAL tools have strong potential to improve reading comprehension, their effectiveness depends on adequate infrastructure, teacher capacity, and well-designed instructional frameworks, thereby highlighting the need for further research in specific contexts such as Embakasi Sub-County.

2.3 Conceptual Framework

Figure 2.1 presents a conceptual framework demonstrating the relationship between interactive CAL learning tools (educational software, multimedia, and virtual platforms) and achievement in English reading comprehension. The independent variable**,** interactive CAL tools, influences the dependent variable, learner achievement in reading comprehension. Learner engagement, teacher expertise, and access to technology are also presented as intervening factors, as they influence how learners interact with and benefit from CAL, thereby enhancing their achievement in English reading comprehension.

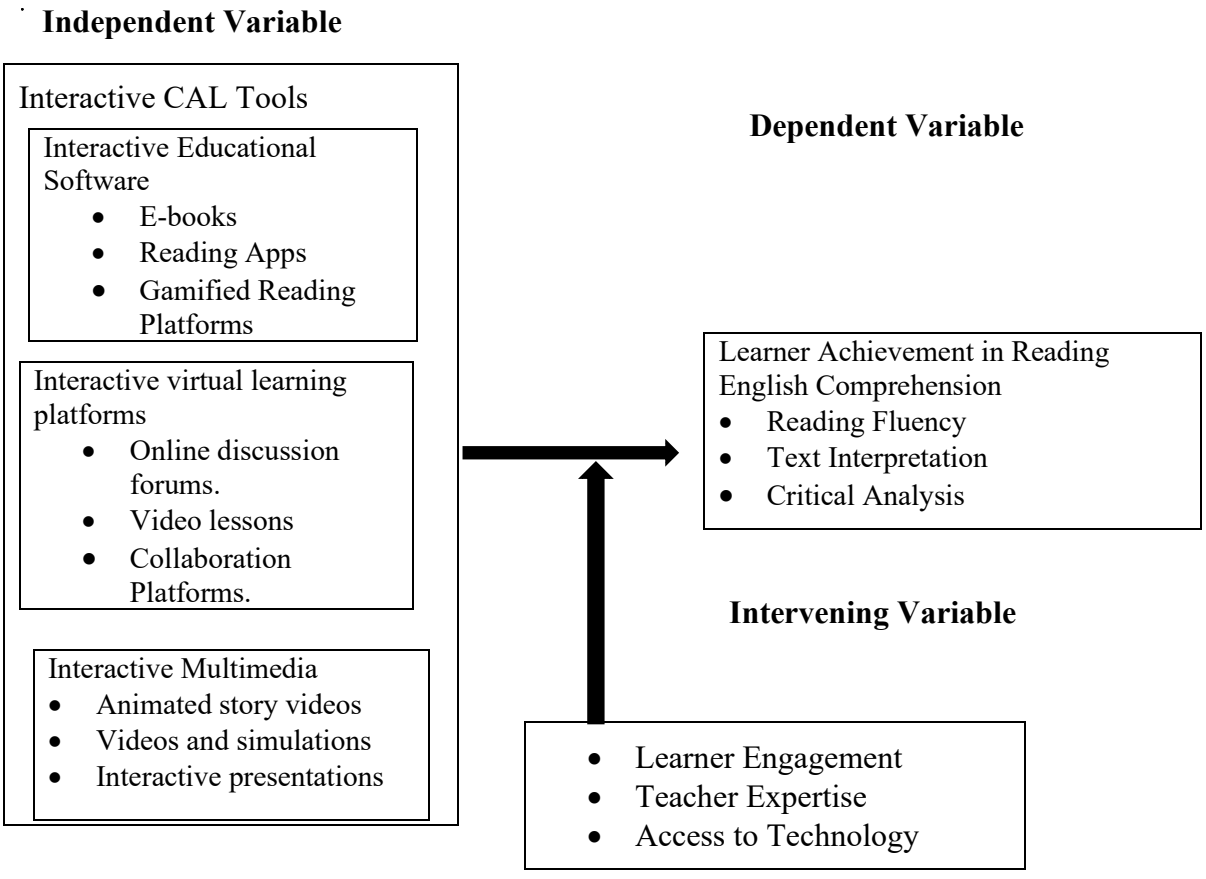

Figure 1: Conceptual Framework

3. Methodology

Solomon's four-group experimental design was used to control for pre-test sensitization effects and strengthen internal validity. Conducted in Embakasi Sub-County, Nairobi County, the study targeted 9 public secondary schools, comprising 1,890 Form Two learners, 16 English teachers, and 9 school principals. Four schools were purposively selected based on accessibility and the availability of basic ICT infrastructure. A sample of 286 Form Two learners was drawn and assigned to two experimental groups (E1 and E2) and two control groups (C1 and C2). Learners in the experimental groups were exposed to interactive learning tools embedded in Computer-Assisted Learning (CAL), including educational software applications, interactive multimedia, and virtual learning platforms, over a three-week intervention period, while the control groups continued with conventional teacher-centered reading instruction. Pre-tests were administered to E1 and C1, and post-tests to all four groups, to determine the effect of the intervention on reading comprehension achievement.

Data were collected using reading comprehension achievement tests, questionnaires for learners and teachers, interview schedules for school principals, and classroom observation checklists to capture both quantitative outcomes and implementation fidelity. The comprehension tests assessed learners' literal, inferential, and evaluative reading skills, while the questionnaires elicited perceptions of engagement, motivation, and instructional effectiveness. Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize learner performance and respondent perceptions, while inferential statistics were employed to analyze the relationship between interactive computer-assisted learning and achievement in English reading comprehension. Specifically, independent-samples t-tests were used to establish pre-test equivalence between groups; one-way Analysis of Variance (ANOVA) was used to determine differences in post-test achievement across the four groups; and multiple linear regression analysis was conducted to examine the predictive contribution of interactive CAL tools to learners' reading comprehension achievement.

4. Results and Discussion

This study examined the influence of interactive learning tools within Computer-Assisted Learning (CAL) on Form Two learners' achievement in English reading comprehension in Embakasi Sub-County. Data analysis was conducted in line with study objectives and presented using descriptive and inferential statistics.

4.1 Baseline Equivalence of Learners' Reading Comprehension Achievement

A descriptive analysis of pre-test scores was conducted to assess whether the experimental and control groups were comparable prior to the intervention. The results showed no statistically significant difference in the pre-test mean scores between the experimental and control groups ($p > .05$), confirming baseline equivalence. This indicated that learners across all groups had similar reading comprehension abilities before exposure to interactive CAL tools, thereby validating the use of post-test comparisons to assess the intervention's effect.

Independent samples t-test results showed no significant difference between the groups ($t = 0.67$, $p = .50$).

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Table 2: T-Test for Control Group 1 and Experimental Group 1

Pre-test scores	*Levene's Test for Equality of Variances*		*T-test for Equality of Means*	
	F	**Sig.**	**T**	**Df**
Equal variances assumed	1.427	.235	0.894	141
Equal variances not assumed			0.894	132.217

4.2 Influence of Interactive CAL Tools on Reading Comprehension Achievement

To determine the effect of interactive CAL tools on learners' reading comprehension achievement, post-test scores were analyzed descriptively and inferentially. The results indicated that learners exposed to interactive CAL tools achieved substantially higher mean scores than those who received regular instruction.

The descriptive statistics clearly show that learners in both experimental groups outperformed their counterparts in the control groups. To establish whether these differences were statistically significant, a one-way ANOVA was conducted.

Table 3: One-Way ANOVA Results for Post-test Scores Table 4.1: Post-tests-ANOVA

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	1324.781	3	441.594	27.536	.000
Within Groups	4522.376	282	16.037		
Total	**5847.157**	**285**			

The ANOVA results revealed a statistically significant difference in post-test scores among the four groups, $F(3,156) = 11.47$, $p < .001$. This indicates that exposure to interactive CAL tools significantly improved learners' reading comprehension achievement.

Post-hoc analysis using Tukey's Honestly Significant Difference (HSD) test was conducted to identify the source of the differences.

Table 4: Tukey Post-Hoc Comparison of Group Mean Scores

Comparison	**Mean Difference**	**p-value**
E1 vs C1	15.2	< .001
E1 vs C2	15.9	< .001
E2 vs C1	16.3	< .001
E2 vs C2	17.0	< .001
E1 vs E2	-1.1	> .05
C1 vs C2	0.7	> .05

The post-hoc results confirm that both experimental groups performed significantly better than the control groups, while no statistically significant differences were observed within experimental or control groups.

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4.3 Predictive Contribution of Interactive CAL Tools to Reading Achievement

To determine the extent to which interactive CAL tools predicted learners' reading comprehension achievement, a regression analysis was conducted. The results showed a strong positive relationship between CAL tools and reading achievement.

Table 5: Regression Analysis of Interactive CAL Tools and Reading Achievement

Model	R	R^2	Adjusted R^2	Std. Error
1	0.800	0.6402	0.636	5.87

The regression model was statistically significant, indicating that interactive CAL tools accounted for 64.02% of the variance in learners' reading comprehension achievement. This finding suggests that features such as interactivity, immediate feedback, and multimedia support substantially enhanced learners' comprehension performance.

4.4 Learner and Teacher Perceptions of Interactive CAL Tools

Qualitative data from learner questionnaires and teacher interviews provided further insights into how interactive CAL tools influenced learning outcomes. Learners reported increased motivation, engagement, and confidence during reading lessons, noting that interactive tasks made reading more enjoyable and easier to understand. Teachers observed improved participation, sustained learner attention, and greater instructional efficiency, particularly due to immediate feedback and interactive content delivery.

However, both teachers and principals highlighted challenges related to limited digital infrastructure, unreliable internet connectivity, and insufficient teacher training.

Table 6: Reported Challenges in CAL Implementation

Challenge	Frequency
Inadequate devices	High
Unreliable internet	High
Limited teacher training	Moderate
Power interruptions	Moderate

These challenges limited consistent implementation of interactive CAL tools and underscore the need for systemic support.

Findings of this study demonstrate that interactive learning tools within CAL significantly enhance learners' reading comprehension achievement. Improved performance of experimental groups supports constructivist principles advanced by Vygotsky (1978), which emphasize active engagement, interaction, and scaffolded learning. The results align with El-Qirem et al. (2022) and Bechtold (2023), who found that interactive applications enhance comprehension through learner engagement and immediate feedback. Similarly, Bai et al. (2023) and Mudawi and Maslamani (2024) affirm that virtual learning environments foster reflective learning and learner motivation.

Overall, the study confirms that interactive CAL tools offer effective, learner-centered instructional strategies for improving reading comprehension, though their sustainability depends on addressing infrastructural and capacity-related challenges.

5. Conclusion

This study demonstrates that the integration of interactive learning tools within Computer-Assisted Learning (CAL) significantly enhances learners' achievement in English reading comprehension among Form Two students in Embakasi Sub-County. Using a rigorous Solomon four-group experimental design, the findings confirmed that improvements in learner performance were directly attributable to the intervention, with experimental groups consistently outperforming control groups. Interactive CAL tools, particularly educational software, multimedia resources, and virtual learning platforms, not only improved comprehension outcomes but also fostered greater learner engagement, motivation, and confidence, reinforcing constructivist principles of active and scaffolded learning. Moreover, the strong predictive relationship between CAL tools and reading achievement underscores their instructional effectiveness and relevance in contemporary pedagogy. However, the study also identifies persistent challenges, including inadequate digital infrastructure, limited internet access, and insufficient teacher training, which hinder optimal implementation. Overall, the findings provide compelling evidence that embedding interactive CAL tools into English instruction offers a transformative, learner-centered approach to improving reading comprehension, provided that systemic and institutional barriers are adequately addressed.

6. Recommendations

i. To Policymakers: The Ministry of Education should prioritize the integration of interactive learning technologies in secondary English curricula and allocate funds for digital infrastructure.
ii. For Practice: Teachers should adopt interactive CAL tools to complement traditional methods and promote learner-centered instruction.
iii. For Further Research: Future studies should explore the long-term impact of interactive CAL tools on other English language skills such as writing, listening, and speaking.

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