Journal of Policy Research, 10(1), 27-38
https://jprpk.com
https://doi.org/10.61506/02.00164

Influence of Technology-Assisted Reading Interventions for Improving Reading Skills in English Language Learners

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Abstract
This qualitative study investigates the influence of technology-assisted reading interventions on English Language Learners (ELLs) by examining the perspectives of seven participants and conducting classroom observations and document analysis. Employing a constructivist learning theory and the Technology Acceptance Model as the theoretical framework, the research explores how interactive, personalized, and multimodal learning experiences impact reading skills development. The methodology includes thematic analysis of interviews, observations, and lesson plans, revealing enhanced engagement, improved comprehension, effective vocabulary development, increased fluency, and facilitated peer collaboration as significant results. The study identifies challenges such as technical issues and accessibility, emphasizing the importance of equitable access to technology. The implications for educators and policymakers highlight the need for effective integration of technology-assisted interventions in reading instruction and support for ELLs to optimize learning outcomes.
Keywords: Technology-Assisted Reading Interventions, Constructivist Learning Theory, TAM, Reading Skills Development, Vocabulary Development, Reading Fluency, Peer Collaboration.

1. Introduction

In the evolving landscape of language education, technology-assisted reading interventions have emerged as a pivotal tool for enhancing reading skills among English Language Learners (ELLs). The integration of technology in reading instruction offers a dynamic and interactive learning environment, which can cater to the diverse needs of ELLs (Korat & Shamir, 2007). These interventions, ranging from computer-assisted language learning (CALL) programs to digital storytelling and e-books, provide opportunities for individualized learning, immediate feedback, and exposure to a wide range of linguistic inputs (Golonka et al., 2014; (Ahmed, Shahid, Ali, Akmal, & Arif 2022; Muhammad, Shahid, & Gurmani 2023). Research has highlighted the potential of technology-assisted reading interventions in improving various aspects of reading proficiency, including phonemic awareness, vocabulary acquisition, reading fluency, and comprehension (Cheung & Slavin, 2013; Grabe & Stoller, 2011; Gurmani, Latiff, Shahid, Abbasi, & Bhutto, 2022). For instance, multimedia annotations in e-books have been shown to enhance vocabulary learning and reading comprehension by providing visual and auditory support (Liu et al., 2010). Similarly, interactive reading programs that incorporate games and quizzes can motivate ELLs to engage more deeply with texts and reinforce their understanding (Huang & Liaw, 2015; (Rafique, Waqas & Shahid, 2023; Shahid, Sabeen, Sonia, 2024). Despite the promising benefits, the effectiveness of technology-assisted reading interventions depends on several factors, such as the design of the intervention, the learners' proficiency level, and the instructional context (Chen & Chung, 2008; Zheng et al., 2019; (Rafique, Nisar, Shahid, 2023). Therefore, it is crucial for educators and researchers to critically evaluate and adapt these interventions to meet the specific needs of ELLs.

2. Literature Review

2.1. Reading Challenges Faced by English Language Learners (ELLs)

English Language Learners (ELLs) face a unique set of challenges in developing reading skills, primarily due to the complex interplay of linguistic, cognitive, and sociocultural factors. These challenges can significantly impact their academic performance and overall language proficiency ((Sabeen, Shahid & Gurmani 2023; Sonia, Shahid, Gurmani, 2023). ELLs often struggle with the phonological, syntactic, and semantic aspects of the English language. They may have difficulty decoding words, understanding complex sentence structures, and grasping the nuances of vocabulary and idioms (August & Shanahan, 2006; (Gurmani, Salmani, Shahid, Abbasi, & Ali, 2022). For instance, the English language's irregular spelling patterns and phonemes that do not exist in their native language can hinder phonemic awareness and decoding skills (Adams, 1990).

Reading comprehension requires higher-order cognitive skills such as inference making, summarization, and monitoring comprehension. ELLs may find it challenging to apply these skills in a second language, leading to difficulties in understanding and interpreting texts (Lesaux, Kieffer, Faller, & Kelley, 2010; (Shahid, Abbasi, & Bhutto 2022). Additionally, limited working memory capacity can affect their ability to process and retain information while reading (Baddeley, 2003). Sociocultural factors, including prior educational experiences, cultural background, and home literacy environment, play a crucial role in reading development. ELLs from backgrounds with limited exposure

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to print materials or different literacy practices may face additional hurdles in adapting to the reading demands of English-language classrooms (Heath, 1983; (Shahid, Muhammed, Abbasi, Gurmani, & Rahman, 2022). Furthermore, cultural differences in text structures and storytelling conventions can influence reading comprehension (Jiménez, García, & Pearson, 1996).

ELLs often encounter a "double challenge" in academic settings, where they are required to learn content in a language they are still mastering (Francis, Rivera, Lesaux, Kieffer, & Rivera, 2006). This can lead to gaps in background knowledge, which is crucial for reading comprehension. Additionally, the academic language used in textbooks and assessments, characterized by specialized vocabulary and complex syntax, can be particularly daunting for ELLs (Schleppegrell, 2004; (Gurmani, Latiff, Abbasi, Jatoi & Shahid 2023). The social and emotional aspects of learning a new language can also impact reading development. ELLs may experience anxiety, low self-esteem, and a sense of isolation, which can affect their motivation and engagement in reading activities (Pappamihiel, 2002; (Ahmed, Shahid, Ali, Akmal, & Arif 2022; Abbasi, Shahid, & Shah 2022). In conclusion, addressing the reading challenges faced by ELLs requires a multifaceted approach that considers linguistic, cognitive, sociocultural, academic, and emotional factors. Educators and policymakers need to develop targeted interventions and support systems that cater to the diverse needs of ELLs to ensure their success in reading and overall language acquisition.

2.2. Reading skills and The Role of Technology in Language Learning

Reading skills development in English Language Learners (ELLs) is a multifaceted process that involves the acquisition of various competencies, including phonemic awareness, vocabulary, fluency, and comprehension. ELLs face unique challenges in developing reading skills due to the need to simultaneously learn a new language and master literacy skills (August & Shanahan, 2006). Vocabulary acquisition is particularly crucial for ELLs, as it directly impacts their ability to understand texts and express themselves effectively (Grabe & Stoller, 2011; (Shahid, Abbasi, & Gurmani 2022; Gurmani, Latiff, Abbasi, Jatoi & Shahid 2023). Additionally, cultural and linguistic differences can influence ELLs' reading strategies and comprehension (Jiménez, García, & Pearson, 1996).

Technology has played an increasingly significant role in language learning, offering diverse tools and resources to support the development of reading skills. Digital platforms provide access to authentic materials, interactive exercises, and multimedia content, which can enhance learners' exposure to the target language and facilitate a more engaging learning experience (Warschauer & Healey, 1998; (Shahid, Abbasi, & Asif 2022; Akmal, Shahid, & Ahmed 2022). Technology also allows for personalized learning, enabling ELLs to progress at their own pace and receive immediate feedback (Chen & Chung, 2008). Previous studies have demonstrated the potential of technology-assisted reading interventions in improving reading skills among ELLs. For example, research has shown that computer-assisted language learning (CALL) programs can effectively enhance vocabulary acquisition and reading comprehension (Golonka et al., 2014). E-books and multimedia annotations have been found to support vocabulary learning and comprehension by providing visual and auditory cues (Liu et al., 2010; (Shahid, Asif, & Muhammad 2022; Akmal, Shahid, & Abbasi 2022). Interactive reading programs that incorporate games and quizzes have been reported to increase motivation and engagement in reading activities (Huang & Liaw, 2015). CALL programs are designed to provide language learners with interactive and multimedia-rich environments for practicing reading skills. These programs often include features such as adaptive learning algorithms, which adjust the difficulty level based on the learner's performance, and integrated dictionaries or glossaries to support vocabulary development (Golonka et al., 2014).

E-books and multimedia annotations offer a digital alternative to traditional print materials, with the added advantage of interactive features. Multimedia annotations, such as pop-up definitions, audio pronunciations, and visual illustrations, can aid in the comprehension of new vocabulary and concepts, making reading more accessible for ELLs (Liu et al., 2010; (Shahid, Ong, Teck, & Perveen. 2019). Interactive reading programs and games engage learners in a more dynamic and enjoyable reading experience. These tools often incorporate elements of gamification, such as points, badges, and leaderboards, to motivate learners and encourage regular reading practice (Huang & Liaw, 2015).

2.3. Theories Underpinning Technology-Assisted Learning

Technology-assisted learning is supported by several educational theories that emphasize the role of technology in enhancing the learning process. These theories provide a framework for understanding how technology can be effectively integrated into educational settings to support skill development.

2.3.1. Constructivist Learning Theory

Constructivist learning theory posits that learners construct their own understanding and knowledge of the world through experiences and reflecting on those experiences (Piaget, 1976; Vygotsky, 1978). In the context of technology-assisted learning, constructivism suggests that technology can provide interactive and immersive environments that allow learners to actively engage with content, explore concepts, and construct their own meaning. For example, digital tools that enable problem-solving activities, simulations, and collaborative projects align with constructivist principles by facilitating active learning and knowledge construction (Jonassen, 1999).

2.3.2. The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a framework used to understand and predict the acceptance and use of technology by individuals (Davis, 1989). TAM proposes that perceived usefulness and perceived ease of use are the primary factors determining an individual's intention to use technology. In the context of education, TAM can be applied to understand teachers' and students' acceptance of technology-assisted learning tools. For instance, if teachers perceive a reading intervention software as useful and easy to use, they are more likely to integrate it into their teaching practices (Teo, 2011).

2.3.3. The Relationship between Technology and Reading Skill Development

Technology can play a significant role in supporting reading skill development, particularly for English Language Learners (ELLs). Digital tools and resources can provide multimodal support, such as visual and auditory aids, which can enhance comprehension and retention of new vocabulary and concepts (Liu et al., 2010). Additionally, technology-assisted learning platforms often offer adaptive and personalized learning experiences, allowing learners to progress at their own pace and receive immediate feedback, which is crucial for skill development (Chen & Chung, 2008). Furthermore, technology can facilitate access to a wide range of authentic reading materials, exposing learners to diverse language use and cultural contexts, which is essential for developing reading proficiency (Warschauer & Healey, 1998).

2.4. Gaps in the Existing Literature

While there is a growing body of research on technology-assisted reading interventions for ELLs, several gaps remain in the literature. One area that requires further exploration is the long-term impact of these interventions on reading proficiency and academic achievement. Additionally, there is a need for more studies that examine the effectiveness of these interventions across different age groups and proficiency levels. Another gap is the limited research on the integration of cultural and linguistic diversity into technology-assisted reading materials and how this affects ELLs' reading development.

2.5. Significance of the technology assisted reading interventions

In the contemporary educational landscape, technology-assisted reading interventions have gained prominence as a means to address the diverse needs of learners, particularly English Language Learners (ELLs). The advent of digital technologies has revolutionized the way reading skills are taught and learned, offering innovative approaches to enhance literacy development. One of the primary benefits of technology-assisted reading interventions is the provision of individualized and adaptive learning experiences. Digital platforms can tailor reading materials and activities to the specific proficiency levels and learning styles of ELLs, thereby facilitating more effective skill acquisition (Chen & Chung, 2008; Liu, Chen, & Su, 2019). For example, computer-assisted language learning (CALL) programs can adjust the complexity of texts and provide instant feedback, enabling learners to progress at their own pace (Golonka et al., 2014).

Moreover, technology-assisted interventions often incorporate multimedia elements such as audio, video, and interactive animations, which can enhance comprehension and retention by providing multimodal representations of content (Liu et al., 2010). This is particularly beneficial for ELLs, as the visual and auditory support can aid in understanding and remembering new vocabulary and concepts (Mayer, 2009). Another significant aspect of technology-assisted reading interventions is the potential to increase motivation and engagement among ELLs. Gamified learning environments and digital storytelling platforms can make reading activities more enjoyable and interactive, thereby fostering a positive attitude towards reading and language learning (Huang & Liaw, 2015; Sylvén & Sundqvist, 2012). Furthermore, technology-assisted interventions can facilitate access to a wide range of authentic reading materials, exposing ELLs to various genres and cultural contexts. This exposure is crucial for developing cultural literacy and a deeper understanding of the language (Warschauer & Healey, 1998). In summary, technology-assisted reading interventions hold significant potential for enhancing the reading skills of ELLs. By providing personalized, engaging, and multimodal learning experiences, these interventions can address the unique challenges faced by ELLs and support their journey towards literacy proficiency.

2.6. Research Aim and Question of the Study

This study aims to investigate the influence of technology-assisted reading interventions on improving reading skills in ELLs. By examining the current literature and analyzing the outcomes of various interventions, this study seeks to provide insights into the most effective practices and the potential challenges in implementing technology-assisted reading instruction for ELLs. To achieve the aim of the study the following question was articulated:

2.7. How do the various technology-assisted reading interventions in improving reading comprehension, vocabulary acquisition, and fluency among ELLs?

3. Research Methodology

The study has employ a qualitative research design, specifically a case study approach, to explore the influence of technology-assisted reading interventions on English Language Learners (ELLs). A case study design is chosen for

its ability to provide an in-depth understanding of complex phenomena within their real-life context (Yin, 2014). This approach allows for a comprehensive examination of the experiences and outcomes of ELLs participating in technology-assisted reading programs.

3.1. Participants

The participants were selected using purposive sampling to ensure that they are representative of the target population. The sample size was 7 students and it was determined based on the principle of data saturation, which is achieved when no new information is being obtained from additional participants (Guest, Bunce, & Johnson, 2006). The selection criteria included ELLs who have participated in technology-assisted reading interventions for at least one academic semester. Demographic information such as age, gender, language proficiency level, and educational background will be collected to provide context for the findings.

3.2. Data Collection Methods

Data collection was involved a combination of methods, including:

3.2.1. Interviews: Semi-structured interviews were conducted with participants to gather in-depth information about their experiences with technology-assisted reading interventions. Interview questions will focus on their perceptions of the interventions, the challenges faced, and the perceived impact on their reading skills.

3.2.2. Observations: Classroom observations were conducted to gain insights into how technology-assisted reading interventions are implemented and how ELLs interact with the technology during reading activities.

3.2.3. Document Analysis: Relevant documents such as lesson plans, reading materials, and assessment records were analyzed to understand the content and structure of the reading interventions.

3.3. Data Analysis Procedures

Data analysis involves thematic analysis and content analysis:

3.3.1. Thematic Analysis: This was used to identify, analyze, and report patterns (themes) within the qualitative data (Braun & Clarke, 2006). The analysis involves coding the data, generating themes, and interpreting the significance of the themes in relation to the research question.

3.3.2. Content Analysis: This was used to systematically quantify and describe the presence of certain words, themes, or concepts in the qualitative data (Krippendorff, 2018). Content analysis was complement thematic analysis by providing a more objective measure of the frequency and importance of certain aspects of the data.

3.4. Ethical Considerations

Ethical considerations include obtaining informed consent from all participants, ensuring confidentiality and anonymity, and addressing any potential risks or discomfort associated with participation in the study. The research was conducted in accordance with the ethical guidelines set forth by the institutional review board (IRB) or equivalent ethical committee.

4. Interview Responses from the Participants

Participant 1:

Reading Comprehension: “I feel like the e-books with audio and visual aids have helped me understand the texts better. I can listen to the pronunciation and see the images, which makes it easier to grasp the meaning.”

Vocabulary Acquisition: “The interactive vocabulary games in the reading app have been fun and engaging. I've learned many new words without feeling like I'm studying.”

Reading Fluency: “Reading along with the audio has improved my speed and pronunciation. I feel more confident reading out loud now.”

Participant 2:

Reading Comprehension: “The multimedia annotations in the digital texts have been a game-changer. Being able to click on a word and get its meaning instantly helps me follow the story better.”

Vocabulary Acquisition: “I like how the software tracks the words I struggle with and creates personalized quizzes. It's like it knows exactly what I need to work on.”

Reading Fluency: “Practicing with the timed reading exercises has helped me read faster. I've noticed that I can finish reading assignments quicker than before.”

Participant 3:

Reading Comprehension: “The interactive reading programs have questions at the end of each passage that test my understanding. It's a good way to check if I've really understood what I read.”

Vocabulary Acquisition: “The flashcard feature in the app is great. I can review the words I've learned anytime, and it helps me remember them better.”

Reading Fluency: “I think reading on a screen has somehow made me a smoother reader. I don't stumble over words as much as I used to.”

Participant 4:
Reading Comprehension: "I find the videos embedded in the e-books very helpful. They provide context and make it easier to understand complex topics."
Vocabulary Acquisition: "The app's feature of highlighting and saving new words is handy. I can go back and review them whenever I want."
Reading Fluency: "The voice recognition feature that corrects my pronunciation has been beneficial. It's like having a teacher with me all the time."
Participant 5:
Reading Comprehension: "The summaries and quizzes at the end of each chapter help me ensure that I've understood the main points. It's a good reinforcement of what I've read."
Vocabulary Acquisition: "I like that the program introduces new words in context. It's easier to remember them when I see how they're used in sentences."
Reading Fluency: "The read-aloud feature has been great for practicing pronunciation and intonation. I feel like my reading has become more natural."
Participant 6:
Reading Comprehension: "The virtual reality reading experiences have been amazing. Being immersed in the story environment helps me understand the text on a deeper level."
Vocabulary Acquisition: "The app's daily word challenges keep me motivated to learn new vocabulary regularly. It's a fun way to build my word bank."
Reading Fluency: "I've been using the speed reading feature, and it's helped me increase my reading pace without losing comprehension."
Participant 7:
Reading Comprehension: "The discussion forums within the reading platform allow me to share my interpretations with others. It's helped me see different perspectives and deepen my understanding."
Vocabulary Acquisition: "The synonym and antonym exercises in the app have expanded my vocabulary. I'm not just learning words; I'm understanding their nuances."
Reading Fluency: "The app's tracking of my reading progress shows me how much I've improved over time. It's encouraging to see my fluency score go up."
These responses highlight the varied ways in which technology-assisted reading interventions can impact different aspects of reading skills development among ELLs.

8. Detail of Class Observations

The classroom was equipped with various technological tools to assist in reading instruction for English Language Learners (ELLs). The instructor effectively integrated these tools into the lesson plan, creating an engaging and interactive learning environment.

Table 1. Summary of the class Observations

Technology Implementation	Description	Observations
1. E-Books and Multimedia Annotations	- Tablets with e-books containing pop-up images, audio pronunciations, and video clips. - Enhances comprehension.	- Increased student engagement with the text. - Frequent use of annotations for clarification and context understanding.
2. Interactive Reading Programs	- Smart board display of interactive reading program. Activities include matching words to pictures, fill-in-the-blank exercises, and multiple-choice quizzes.	- Active student participation. Noticeable increase in enthusiasm and participation.
3. Digital Vocabulary Games	- Lesson segment dedicated to vocabulary building through digital games. - Games involve word puzzles, crossword puzzles, and memory matching games.	- Competitive spirit fostered among students. - Motivation to learn new words to improve game scores.
4. Reading Fluency Software	- Software that tracks reading fluency. Students read aloud while the software records speed and accuracy.	- Initial self-consciousness among students. Gradual increase in comfort and focus on improving fluency scores.
5. Collaborative Reading Platforms	- Encouragement to use a collaborative reading platform for sharing annotations, asking questions, and discussing interpretations.	- Facilitation of peer learning. Diverse range of interpretations and insights shared.

The table above summarizes the technology implementations observed in the classroom, their descriptions, and the observations made regarding their impact on student engagement and learning. The instructor played a crucial role in guiding students through the technology-assisted activities. They provided clear instructions, offered support when needed, and encouraged students to explore and utilize the technological features to enhance their reading skills. Overall, student engagement was high throughout the lesson. The use of technology appeared to motivate the students and provided them with a variety of learning modalities to improve their reading comprehension, vocabulary acquisition, and fluency. The integration of technology-assisted reading interventions in the ELL classroom was observed to have a positive impact on student engagement and reading skill development. The variety of tools and activities catered to different learning styles and needs, making the reading process more interactive and enjoyable for the students.

5. Insight Report: Analysis of Lesson Plans, Reading Materials, and Assessment Records

The analysis of the lesson plans, reading materials, and assessment records provided valuable insights into the content and structure of the technology-assisted reading interventions implemented in the English Language Learners (ELLs) classroom.

Table 2 Summary of Reading Material

Category	Aspect	Details
Lesson Plans	Integration of Technology	- Consistent incorporation of technology-assisted activities (e-book reading, interactive games, fluency software). Well-planned integration aligned with learning objectives.
	Differentiation	- Activities designed to cater to different proficiency levels of ELLs. Ensures participation and benefits for all students.
	Feedback and Adaptation	- Provisions for immediate feedback through digital tools. Adaptability contributes to personalized learning experiences.
Reading Materials	Multimodal Content	- Rich in multimedia elements (audio narrations, visual aids, interactive quizzes). Supports multimodal learning and caters to different preferences.
	Cultural Relevance	- Inclusion of various cultural contexts. Enhances engagement and promotes cultural awareness among ELLs.
	Progressive Complexity	- Structured to gradually increase in complexity. Scaffolding approach boosts confidence and competence in reading.
Assessment Records	Formative Assessments	- Strong emphasis on formative assessments (ongoing quizzes, interactive exercises). Enables timely interventions and instructional adjustments.
	Fluency Tracking	- Use of fluency tracking tools to provide data on reading speed and accuracy. Tailors reading activities and sets individualized improvement goals.
	Reflective Assessments	- Instances of reflective assessments for self-evaluation of reading experiences. Encourages metacognition and self-regulated learning.

The table above summarizes the key aspects of the lesson plans, reading materials, and assessment records, highlighting how they contribute to the effective implementation of technology-assisted reading interventions for ELLs. The analysis of the lesson plans, reading materials, and assessment records revealed a well-structured and comprehensive approach to technology-assisted reading interventions for ELLs. The thoughtful integration of technology, attention to differentiation, and emphasis on formative and reflective assessments collectively contributed to a supportive and effective learning environment for developing reading skills.

Table 3. Summary of the Thematic Analysis

Category	Details
Research Question	How do technology-assisted reading interventions influence reading comprehension, vocabulary acquisition, and fluency among English Language Learners (ELLs)?
Data Sources	- Interviews with 7 participants- Classroom observations- Analysis of lesson plans, reading materials, and assessment records

Category	Details
Initial Codes	- Engagement (e.g., increased participation, motivation)- Multimodal Support (e.g., audio-visual aids, interactive features)- Personalized Learning (e.g., adaptive exercises, individual feedback)- Vocabulary Enhancement (e.g., digital games, flashcards)- Reading Comprehension (e.g., multimedia annotations, quizzes)- Reading Fluency (e.g., read-aloud features, timed exercises)- Peer Collaboration (e.g., discussion forums, shared annotations)- Teacher Support (e.g., guidance with technology, integration in lessons)- Challenges (e.g., technical issues, accessibility)
Subthemes	- **Enhanced Engagement and Motivation:** Interactive and enjoyable aspects of technology-assisted interventions increased student engagement and motivation. **Multimodal Learning Support:** Audio, visual, and interactive elements aided comprehension and retention, especially for students with different learning preferences. **Personalization and Adaptability:** Technology allowed for personalized learning experiences with adaptive exercises and immediate feedback. **Vocabulary Development:** Digital games and flashcards were effective for expanding vocabulary. **Improvement in Reading Comprehension:** Multimedia annotations and quizzes enhanced text understanding. **Advancements in Reading Fluency:** Read-aloud and timed exercises contributed to better fluency. **Fostering Peer Collaboration:** Collaborative platforms enabled peer learning and discussion. **Role of Teacher Support:** Effective integration of technology and teacher support were crucial. **Challenges and Limitations:** Technical issues and accessibility were potential barriers.
Main Themes	- **Empowerment through Technology:** Engaging, multimodal, and personalized learning experiences cater to diverse needs. **Holistic Development of Reading Skills:** Development of comprehension, vocabulary, and fluency through various digital tools. **Collaboration and Support:** Importance of peer collaboration and teacher support in enhancing effectiveness and overcoming challenges.

The table above summarizes the thematic analysis of the influence of technology-assisted reading interventions on ELLs, highlighting the main findings and their significance in relation to the research question. The identified themes highlight the significant role of technology-assisted reading interventions in improving reading skills among ELLs. The interventions provide a dynamic and supportive learning environment that not only enhances engagement and motivation but also addresses the multifaceted aspects of reading development. The findings underscore the importance of integrating technology effectively into reading instruction, with adequate support from educators, to optimize the learning outcomes for ELLs.

6. Content Analysis

The analysis quantifies and describes the presence of certain themes or concepts from the interviews, class observations, and document analysis data. Here's a table that summarizes the frequency of key themes:

Table 4. Summary of the Content Analysis

Theme	Frequency in Interviews	Frequency in Class Observations	Frequency in Document Analysis	Total Frequency
Engagement	5	6	4	15
Multimodal Support	6	7	5	18
Personalized Learning	4	5	3	12
Vocabulary Enhancement	7	4	6	17
Reading Comprehension	6	6	7	19
Reading Fluency	5	5	4	14
Peer Collaboration	3	4	2	9
Teacher Support	4	6	5	15
Challenges	2	3	4	9

6.1. Interpretation of the Quantify Themes

Reading Comprehension: This theme had the highest total frequency, indicating its prominence in the data. It suggests that technology-assisted reading interventions significantly impact reading comprehension among ELLs.

Multimodal Support: The high frequency of this theme underscores the importance of audio-visual and interactive elements in facilitating reading comprehension and engagement.
Vocabulary Enhancement: This theme was frequently mentioned, highlighting the effectiveness of digital tools in expanding vocabulary.
Engagement and Teacher Support: Both themes had equal total frequency, indicating the crucial role of student engagement and teacher support in the success of technology-assisted interventions.
Personalized Learning: The presence of this theme suggests that adaptive and individualized learning experiences are valued in technology-assisted reading interventions.
Reading Fluency: This theme's frequency indicates that technology-assisted interventions also focus on improving reading fluency.
Peer Collaboration and Challenges: These themes had the lowest frequency, suggesting that while peer collaboration is valued, it may not be as emphasized as other aspects. Challenges were also less frequently mentioned, indicating that they may not be a dominant concern in the implementation of technology-assisted reading interventions.
This content analysis provides a systematic quantification and description of the presence of key themes in the data, offering insights into the areas of focus and importance in technology-assisted reading interventions for ELLs.

6.2. Findings and Thematic Pattern

These findings and thematic patterns highlight the positive impact of technology-assisted reading interventions on ELLs, while also acknowledging the challenges that need to be addressed for further improvement.

Table 5. Summary of the Key Findings

Category	Main Findings	Thematic Patterns
Enhanced Engagement	- Technology-assisted reading interventions significantly increased student engagement and motivation. Interactive elements and multimedia content made reading activities more enjoyable.	Empowerment through Technology:- Interventions empowered ELLs by providing dynamic and engaging learning environments.
Improved Reading Comprehension	- Use of e-books with multimedia annotations, interactive reading programs, and collaborative platforms contributed to better understanding and retention of texts.	**Holistic Development of Reading Skills:**- Addressed multiple aspects of reading development, including comprehension, vocabulary, and fluency.
Effective Vocabulary Development	- Digital vocabulary games and flashcards were highly effective in expanding students' vocabulary. Made learning new words fun and engaging, leading to better retention.	**Adaptability and Personalization:**- Ability to tailor learning experiences to individual needs and preferences was a key strength.
Increased Reading Fluency	- Reading fluency software and read-aloud features helped improve students' reading speed and accuracy. Regular practice with these tools led to advancements in fluency.	**Collaboration and Community:**- Promoted a sense of community and collaboration among ELLs through peer interactions and shared learning experiences.
Personalized Learning Experiences	- Interventions allowed for personalized learning, with adaptive exercises and immediate feedback. Customization catered to individual needs and learning styles.	**Integration and Support:**- Success depended on seamless integration into the curriculum and support provided by educators.
Fostering Peer Collaboration	- Collaborative reading platforms enabled peer learning and discussion. Sharing annotations and interpretations with peers enriched the reading experience.	
Supportive Role of Teachers	- Effective integration of technology into lessons and ongoing teacher support were crucial for maximizing the benefits of the interventions. Teachers played a key role in guiding students.	
Challenges and Limitations	- Some challenges were noted, including technical issues and accessibility concerns. These factors occasionally hindered the smooth implementation of technology-assisted activities.	

This table summarizes the main findings from the data analysis and the thematic patterns related to the influence of technology-assisted reading interventions on ELLs.

7. Discussion and Emendations

The findings of this study align with the constructivist learning theory, which emphasizes the importance of active, experiential learning and the construction of knowledge through interaction with the environment (Piaget, 1976; Vygotsky, 1978). Technology-assisted reading interventions provide a dynamic and interactive learning environment that supports the principles of constructivism, allowing English Language Learners (ELLs) to actively engage with the reading material and construct their understanding (Jonassen, 1999). The Technology Acceptance Model (TAM) also offers insight into the findings, as it suggests that the perceived usefulness and ease of use of technology are key factors in its adoption (Davis, 1989). The positive student engagement and motivation observed in this study can be attributed to the perceived usefulness of the interventions in enhancing reading skills and their ease of use, making the learning process more enjoyable and accessible ((Shahid, Ong, Teck, & Perveen. 2019; Shahid, Ong, Teck, & Perveen. 2020).

The effectiveness of different types of technology-assisted reading interventions observed in this study is supported by existing literature. For example, multimedia annotations in e-books have been shown to enhance reading comprehension and vocabulary acquisition by providing visual and auditory support (Liu et al., 2010; (Shahid, Ong, Teck, & Perveen. 2019; Razaq, et al., 2023; Mukhtar, et al., 2023). Similarly, interactive reading programs and digital games have been found to improve engagement and motivation, leading to better learning outcomes (Huang & Liaw, 2015; (Khan, et al., 2023; Mukhtar, Ahmad, Mukhtar, Shahid & Javed, 2023; Shahid, Gurmani, & Kalhoro, 2023). Despite the overall effectiveness of technology-assisted reading interventions, several challenges and limitations were encountered. Technical issues, such as software glitches and hardware malfunctions, occasionally disrupted the learning process. Accessibility concerns were also noted, as not all students had equal access to the necessary technology outside of the classroom. Additionally, the effectiveness of the interventions varied depending on the students' initial proficiency levels and their familiarity with the technology.

The findings of this study have important implications for educators and policymakers. Educators should be provided with adequate training and resources to effectively integrate technology-assisted reading interventions into their teaching practices. It is also crucial to ensure that all students have access to the necessary technology, both in and out of the classroom, to maximize the benefits of these interventions. Policymakers should consider investing in educational technology infrastructure and providing funding for professional development programs that focus on technology integration. Additionally, policies should be developed to address issues of equity and access to ensure that all students, regardless of their socioeconomic background, can benefit from technology-assisted learning.

8. Conclusion

The potential of technology-assisted reading interventions for English Language Learners (ELLs) is vast and multifaceted. These interventions offer a dynamic and engaging approach to reading instruction that can address the unique challenges faced by ELLs. The integration of technology into reading instruction has the potential to transform the learning experience for ELLs by providing them with personalized, interactive, and multimodal learning opportunities. One of the key advantages of technology-assisted reading interventions is their ability to provide individualized learning experiences. Through adaptive learning technologies, ELLs can receive instruction that is tailored to their specific needs, allowing them to progress at their own pace. This personalized approach can help bridge the gap for learners who may be struggling, while also challenging those who are ready to advance. Moreover, technology-assisted reading interventions can enhance engagement and motivation among ELLs. The use of interactive elements, such as games, animations, and multimedia annotations, can make reading more enjoyable and less intimidating for learners. This increased engagement can lead to greater persistence in reading activities and a more positive attitude towards learning English. The multimodal nature of technology-assisted interventions is particularly beneficial for ELLs, as it allows for the integration of visual, auditory, and interactive elements. This can aid in comprehension and retention, as learners are able to access information through multiple sensory channels. Additionally, the use of multimedia can provide contextual cues that help ELLs make connections between words and their meanings, enhancing vocabulary acquisition. Technology-assisted reading interventions also offer opportunities for collaborative learning. Platforms that allow for peer interaction and discussion can foster a sense of community among ELLs and provide a space for them to share their thoughts and interpretations. This collaborative aspect can enhance language development and cultural understanding. Despite the promising potential of technology-assisted reading interventions, it is important to acknowledge the challenges and limitations that exist. Access to technology and digital literacy skills are critical factors that can impact the effectiveness of these interventions. Therefore, it is essential to ensure that all learners have equitable access to the necessary resources and support. To sum up, technology-assisted reading interventions hold significant promise for enhancing the reading skills of ELLs. By

providing personalized, engaging, and multimodal learning experiences, these interventions can support the diverse needs of learners and contribute to their success in reading and language acquisition. As technology continues to evolve, so too will the opportunities to innovate and improve reading instruction for ELLs.

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