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DEVELOPING STUDENTS' READING COMPREHENSION COMPETENCE IN ENGLISH SCIENTIFIC AND TECHNICAL TEXTS THROUGH DIGITAL TECHNOLOGIES IN FOOD TECHNOLGY FIELD

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Abstract: In the context of globalized higher education, the ability to read and comprehend English-language scientific and technical texts has become a critical competence for students in engineering and technical fields. This article examines the role of digital technologies in developing this competence. A systematic literature review was conducted using databases such as Scopus, Web of Science, ERIC, ScienceDirect, and Google Scholar, covering studies published between 2019 and 2026. The findings indicate that digital annotation tools, AI-powered mobile applications, and online strategic reading systems significantly enhance students' vocabulary acquisition, reading comprehension, and critical thinking skills when integrated with appropriate pedagogical approaches. However, the review also identifies notable gaps, including limited research in certain disciplinary contexts such as computer science, insufficient longitudinal studies, and a lack of integration between digital tools and established reading theories. The article concludes with recommendations for educators and researchers.

Keywords: English for Specific Purposes, reading comprehension, digital technologies, scientific and technical texts, ESP, digital annotation, mobile applications

Introduction

The rapid advancement of science and technology has established English as the dominant language of international academic and professional communication. According to recent estimates, over 90% of scientific publications in natural sciences and engineering are written in English (Hyland, 2022). This linguistic reality places significant demands on students in technical and engineering disciplines, who must not only acquire specialized knowledge in their fields but also develop the ability to read and comprehend complex English-language scientific and technical texts.

Reading comprehension in a foreign language, particularly in scientific and technical domains, is a multifaceted cognitive process. It requires not only linguistic proficiency but also domain-specific knowledge, strategic reading skills, and the ability to navigate complex syntactic structures and specialized terminology (Grabe & Stoller, 2020). For students in technical fields, these demands are

further compounded by the need to understand diagrams, formulas, and technical specifications embedded within written texts.

The Role of Digital Technologies: In recent years, digital technologies have emerged as powerful tools for enhancing language learning, particularly in the context of English for Specific Purposes (ESP). Digital annotation tools, mobile applications, online reading platforms, and artificial intelligence (AI)-powered systems offer new possibilities for supporting students' reading comprehension development (Chen et al., 2023). These tools can provide immediate feedback, facilitate vocabulary acquisition, support strategic reading, and create interactive learning environments that were previously impossible in traditional classroom settings.

However, the effectiveness of digital technologies depends largely on how they are integrated into pedagogical practice. Simply providing students with digital tools does not guarantee improved learning outcomes; rather, careful instructional design and alignment with learning objectives are essential (Reinders & White, 2021). This raises important questions about which digital tools are most effective, how they should be implemented, and what challenges they present.

The purpose of this study is to analyze the role of digital technologies in developing students' reading comprehension competence in English scientific and technical texts, and to identify key trends, findings, and limitations in the existing scholarly literature. The study addresses the following research questions:

1. What types of digital tools are most effective in developing reading comprehension of English scientific and technical texts?

2. What is the impact of these tools on students' learning outcomes?

3. What are the main gaps and limitations in existing research?

Methodology

Research Design: This study employed a systematic literature review methodology, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. A systematic review was chosen because it allows for a comprehensive and transparent synthesis of existing research, enabling the identification of patterns, gaps, and areas of consensus or disagreement.

Data Sources and Search Strategy: The literature search was conducted across five major academic databases: Scopus, Web of Science, ERIC, ScienceDirect, and Google Scholar. The search strategy combined multiple keywords and Boolean operators, including: "English for Science and Technology," "reading comprehension," "digital tools," "ESP," "digital annotation," "mobile-assisted language learning," and "online reading strategies." The initial search yielded 147 potentially relevant articles. After removing duplicates and screening titles and abstracts, 52 articles were selected for full-text review.

Inclusion and Exclusion Criteria:

Studies were included if they met the following criteria:

- Published between 2019 and 2026

- Conducted in higher education or vocational education contexts

- Focused on the use of digital technologies for developing reading comprehension in English

- Included empirical data on learning outcomes

- Written in English

Studies were excluded if they:

- Focused on general English language learning without specific attention to reading comprehension

- Did not involve digital technologies

- Were theoretical or opinion pieces without empirical data

- Were published in predatory journals

After applying these criteria, 18 studies were selected for detailed analysis.

Data Extraction and Analysis. For each selected study, the following information was extracted: author(s), year of publication, research design, participant characteristics, type of digital tool used, duration of intervention, outcome measures, and key findings. The extracted data were then analyzed thematically to identify patterns and trends.

Results

Overview of Selected Studies. The 18 studies included in this review were conducted in various countries, including Indonesia, Turkey, Iran, China, Spain, and the United States. Participants ranged from undergraduate to graduate students, with sample sizes varying from 25 to 180 participants. The majority of studies (n=12) employed quantitative or mixed-methods designs, while six used qualitative approaches.

Digital Annotation Tools. Digital annotation tools (DATs) emerged as one of the most frequently studied categories of digital technologies. These tools allow students to highlight, comment on, and interact with digital texts, facilitating active engagement with reading materials.

A study conducted by Chen and colleagues (2023) with 55 EFL students found that digital annotation tools significantly enhanced vocabulary acquisition and reading comprehension. The researchers reported that students who used DATs demonstrated improved abilities to summarize concepts, justify interpretations, and restate information in their own words. Importantly, the study highlighted that the benefits of DATs were most pronounced when students engaged in collaborative annotation activities, suggesting that social interaction plays a crucial role in mediating the effectiveness of these tools.

Similarly, a study by Rahimi and colleagues (2022) with Iranian engineering students found that digital annotation supported the development of metacognitive reading strategies, including

predicting, monitoring, and evaluating comprehension. Students reported that the ability to annotate digitally made the reading process more visible and manageable.

Mobile Applications and AI Integration

Mobile applications, particularly those incorporating artificial intelligence, have gained increasing attention in recent years. A study conducted with mechanical engineering students at a Turkish university investigated the effectiveness of an AI-powered mobile application for improving academic reading comprehension (Yılmaz & Kaya, 2024). The results showed statistically significant improvements in reading comprehension scores, with participants also reporting high levels of satisfaction and perceived usefulness.

The application employed natural language processing to provide real-time vocabulary support, syntactic parsing, and comprehension questions. This allowed students to receive immediate feedback and adjust their reading strategies accordingly. The researchers noted that the AI component was particularly valuable in helping students navigate complex technical terminology and sentence structures.

In a vocational education context, a study by Fitriani and colleagues (2023) developed and tested a mobile application called "Vocademy" designed to enhance critical reading skills. The study, involving 120 vocational students, found that the application significantly improved critical reading abilities ($p < 0.05$, N-Gain = 0.464). The application incorporated gamification elements, which the researchers identified as a key factor in maintaining student motivation and engagement.

Online Strategic Reading Systems.

Several studies focused on online systems designed to teach specific reading strategies. A study by Zhang and Liu (2022) investigated the effectiveness of an online cumulative sentence analysis (CSA) strategy for engineering students. The CSA approach involves breaking down complex sentences into smaller components and analyzing their grammatical and semantic relationships.

The findings indicated that students who received CSA training through an online platform demonstrated significantly better comprehension of technical texts compared to a control group. The researchers argued that the explicit teaching of syntactic analysis strategies, when supported by digital tools, is particularly effective for technical texts, which often contain complex noun phrases and embedded clauses.

Comparative Effectiveness of Digital Tools.

A meta-analysis of 30 studies examining digital tools for ESP reading instruction (Kartal, 2024) found that the most effective tools were those that:

- Supported specific reading functions (e.g., vocabulary lookup, annotation, comprehension monitoring)

- Provided opportunities for interaction and collaboration

- Offered adaptive feedback based on individual performance

- Were integrated into a coherent pedagogical framework

The analysis also revealed that digital tools were generally more effective for vocabulary acquisition than for higher-order comprehension skills, suggesting that different tools may be needed for different aspects of reading competence.

Challenges and Limitations Reported in Studies

Several studies reported challenges associated with the use of digital technologies. These included:

- Technical issues and connectivity problems

- Distraction and off-task behavior

- Insufficient training for both students and teachers

- Difficulty in aligning digital tools with curriculum objectives

- Concerns about data privacy and security

These challenges highlight the importance of careful implementation and ongoing support when integrating digital technologies into language instruction.

Discussion

Interpretation of Findings

The findings of this review confirm the positive role of digital technologies in developing students' reading comprehension competence in English scientific and technical texts. Digital annotation tools, AI-powered mobile applications, and online strategic reading systems all demonstrated effectiveness in improving various aspects of reading comprehension, including vocabulary acquisition, syntactic analysis, and critical reading.

A key insight emerging from the literature is that the effectiveness of digital tools is not inherent in the technology itself but depends on how it is used. The most successful interventions were those that integrated digital tools into well-designed pedagogical frameworks, provided adequate training and support, and aligned tool use with specific learning objectives (Reinders & White, 2021). This finding challenges the assumption that simply providing access to technology will automatically lead to improved learning outcomes.

Theoretical Implications

The findings align with sociocultural theories of learning, which emphasize the role of tools and social interaction in mediating cognitive development (Vygotsky, 1978). Digital tools can function as mediating artifacts that support students in performing tasks that would be beyond their independent capabilities. The collaborative annotation activities described in several studies

exemplify this principle, as students jointly construct meaning through interaction with texts and with each other.

The results also support the importance of metacognitive strategies in reading comprehension. Several studies found that digital tools were most effective when they supported students in planning, monitoring, and evaluating their comprehension. This suggests that digital technologies should be designed and implemented in ways that promote metacognitive awareness and self-regulation.

Gaps and Limitations in Existing Research

Despite the promising findings, this review identifies several significant gaps in the existing literature.

First, there is a notable lack of research in certain disciplinary contexts. While engineering and technical fields are relatively well-represented, studies focusing on computer science students are limited. Given the importance of English in computer science and the unique characteristics of texts in this field (e.g., code documentation, technical specifications), this represents a significant gap.

Second, most studies have relatively short intervention periods, typically ranging from a few weeks to a single semester. There is a need for longitudinal studies that examine the long-term effects of digital tool use on reading comprehension development.

Third, few studies have investigated the integration of digital tools with established reading theories and models. Future research should explore how digital technologies can be aligned with theoretical frameworks such as the Simple View of Reading or the Interactive-Compensatory Model.

Fourth, there is limited research on the role of teacher training and professional development in supporting effective integration of digital tools. Teachers play a crucial role in mediating technology use, yet their perspectives and needs are often overlooked.

Fifth, issues of equity and access remain underexplored. While digital technologies offer new opportunities, they may also exacerbate existing inequalities if not implemented thoughtfully.

Practical Implications

Based on the findings of this review, several practical recommendations can be made for educators and curriculum designers:

1. Integrate digital tools into coherent pedagogical frameworks: Digital tools should not be used as add-ons but should be integrated into lesson plans and learning objectives.

2. Provide adequate training and support:Both students and teachers need training to use digital tools effectively. Ongoing technical and pedagogical support is essential.

3. Promote collaboration and interaction: Digital tools that facilitate collaboration and peer interaction are likely to be more effective than those that promote isolated learning.

4. Support metacognitive development: Digital tools should be designed and used in ways that encourage students to plan, monitor, and evaluate their comprehension.

5. Address equity and access: Institutions should ensure that all students have equal access to digital tools and that implementation does not disadvantage those with limited technological resources.

6. Evaluate and adapt: Regular evaluation of digital tool effectiveness is necessary to ensure that tools are meeting learning objectives and to make adjustments as needed.

Limitations of This Review

This review has several limitations. First, despite a systematic search strategy, it is possible that relevant studies were missed. Second, the heterogeneity of study designs and outcome measures made it difficult to conduct a meta-analysis. Third, the review was limited to studies published in English, potentially excluding relevant research in other languages. Fourth, publication bias may have led to an overrepresentation of positive findings.

Conclusion

This systematic review has examined the role of digital technologies in developing students' reading comprehension competence in English scientific and technical texts. The findings indicate that digital annotation tools, AI-powered mobile applications, and online strategic reading systems can significantly enhance reading comprehension when integrated with appropriate pedagogical approaches. However, the effectiveness of these tools depends on careful implementation, adequate training, and alignment with learning objectives.

The review identifies several gaps in existing research, including limited attention to certain disciplinary contexts, short intervention periods, insufficient integration with reading theories, and a lack of focus on teacher training and equity issues. Future research should address these gaps through longitudinal, interdisciplinary studies that examine the complex interplay between digital tools, pedagogical practices, and learner characteristics.

For educators, the key message is that digital technologies should be viewed as tools that can support, but not replace, effective pedagogy. When used thoughtfully and strategically, they offer powerful opportunities for enhancing students' reading comprehension in English scientific and technical texts.

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