Reading Comprehension Interventions Using Digital Technologies with Spanish-speaking Population: A Systematic Review

Intervenciones en comprensión de textos mediante tecnologías digitales con población hispanohablante: una revisión sistemática

Intervenções na compreensão de textos por meio de tecnologias digitais em população hispanofalante: uma revisão sistemática

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Abstract: This paper presents a systematic review of empirical studies aimed at improving the reading comprehension of Spanish-speaking students by using digital technologies. We included studies published in the period 2014-2025, conducted with students in primary and secondary education. We located 16 studies that met the inclusion criteria. All of them use technologies designed to support a specific learning objective. Most interventions are structured around introductory and training phases and address cognitive and metacognitive aspects related to reading comprehension. Feedback emerges as a key element, although its characteristics vary across interventions. Overall, most studies report an improvement in reading comprehension after the implementation of the intervention. These trends are discussed in relation to prior research in the field of reading instruction, and future research directions are proposed, highlighting the need for further studies in Latin American contexts.
Keywords: reading; reading comprehension; digital technology; educational technology; education

Resumen: Este trabajo presenta una revisión sistemática de estudios empíricos orientados a mejorar la comprensión de textos de estudiantes hispanohablantes mediante el uso de tecnologías digitales. Se incluyeron estudios publicados en el período 2014-2025, implementados con estudiantes de educación primaria y secundaria. Se localizaron 16 estudios que cumplieron con los criterios de inclusión. En todos los estudios se utilizan tecnologías diseñadas en función de un objetivo de aprendizaje. En forma mayoritaria, las intervenciones se organizan en torno a fases de introducción y de práctica. En las propuestas se abordan aspectos cognitivos y metacognitivos vinculados con la comprensión, y la retroalimentación emerge como un elemento clave, aunque varía según la intervención. La mayoría de los estudios reportan una mejora en la comprensión de textos luego de la implementación de la intervención. Se discuten estas tendencias en relación con investigaciones previas en el campo de la enseñanza de la lectura, y se proponen líneas de investigación futuras, se destaca la necesidad de realizar nuevos estudios en contextos latinoamericanos.
Palabras clave: lectura; comprensión de textos; tecnología digital; tecnología educativa; educación

Resumo: Este trabalho apresenta uma revisão sistemática de estudos empíricos voltados a melhorar a compreensão de textos de estudantes hispanofalantes por meio do uso de tecnologias digitais. Foram incluídos estudos publicados no período de 2014-2025, realizados com estudantes dos ensinos fundamental e médio. Foram localizados 16 estudos que cumpriram os critérios de inclusão. Em todos os estudos, utilizam-se tecnologias desenhadas em função de um objetivo de aprendizagem. De forma majoritária, as intervenções organizam-se em torno das fases de introdução e de prática. Nas propostas, abordam-se aspectos cognitivos e metacognitivos vinculados à compreensão. O feedback emerge como um elemento-chave, embora apresente variações de acordo com a intervenção. A maioria dos estudos referem uma melhoria na compreensão de textos após a implementação da intervenção. Discutem-se essas tendências em relação a pesquisas prévias no campo do ensino da leitura e propõem-se linhas de pesquisa futuras, destacando a necessidade de realizar novos estudos em contextos latino-americanos.
Palavras-chave: leitura; compreensão de textos; tecnologia digital; tecnologia educacional; educação

The inclusion of digital technologies in education has become increasingly central, alongside significant challenges for educational systems. A wide range of reasons—economic, social, cultural, and pedagogical—justify their incorporation into school settings (Pedró, 2011). Within the educational psychology field, it is relevant to analyze how these transformations influence the development of key competencies required for responsible citizenship in a digital society, among which reading and text comprehension stand out (Salmerón & Delgado, 2019).

Digital technologies not only transform the ways people access information, but also the interactions that take place in teaching and learning practices in school settings. This encompasses a range of possibilities: novel uses, enriching uses of already existing spaces, or uses that reproduce usual practices (Coll Salvador et al., 2023). In this regard, technologies enable the implementation of teaching and learning proposals both inside and outside the classroom and appear as an alternative that favors personalization and flexibility of content and activities, enabling more appropriate support for students who experience difficulties (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2023). Nevertheless, their impact is heterogeneous and varies according to the community, the socioeconomic level, the educational level, and the available infrastructure (Organisation for Economic Co-operation and Development [OECD], 2020; UNESCO, 2023).

This scenario has led to a specific field of study: educational technologies. Although defining this term is complex, it refers to the diversity of digital tools and applications that contribute to designing, presenting, or supporting the learning process of certain content (Cheung & Slavin, 2013). It comprises not only devices —mostly connected to the internet (such as mobile phones, computers, and tablets)— but also a wide range of software, platforms, or virtual environments accessed through them.

Over the past decades, several countries in Latin America have sought to advance the "digitalization" of educational practices (OECD, 2020) by integrating digital devices and tools in classrooms, valuing aspects such as attractiveness of content presentation, possibilities for novel interactions, and students' motivation (Ghanbaripour et al., 2024), as well as their potential for collecting and analyzing data on students' performance in technology-mediated tasks (Gros, 2016).

However, the inclusion of technologies in education has generated significant debates and criticisms. This is partly due to inequalities evident in the region regarding technological infrastructure and connectivity (OECD, 2020). In addition, previous research has shown that the effects of educational technologies on certain types of learning are not always positive and, in some cases, may be an obstacle in educational settings (Salmerón & Delgado, 2019). Research in the area shows heterogeneous results and is far from providing conclusive explanations regarding the complexity of digital technology-mediated activities in educational contexts (Coll Salvador et al., 2023).

Within this scenario, examining the changes that digital technologies generate in fundamental skills within the school context, such as reading and text comprehension, is particularly relevant. Understanding a text involves a complex interaction between the reader, the text, and the context in which the reading activity takes place (Snow, 2002), and involves multiple linguistic and cognitive processes (Abusamra et al., 2022). To build a coherent representation of what is read, the reader engages various cognitive and metacognitive processes. Cognitive processes are related to processing and use of textual information and the reader's prior knowledge to construct text meaning, and include, among others, inferences making, vocabulary, and text structure knowledge. Metacognitive processes

are linked to reflection, evaluation, and regulation of one's own reading and allow the reader to adjust their activity according to reading goals when comprehension is hindered (Barreyro, 2020; Cartoceti et al., 2016).

The inclusion of technologies produces transformations that encompass the emergence of new modes and formats of reading and the reconfiguration of usual reading practices (Godoy, 2023). In particular, reading on digital media or platforms has specific characteristics linked to the nature of the text and possible interaction formats (Jewitt, 2005). One positively valued aspect related to technologies is the possibility of offering different types of personalized feedback, enabling more adaptive approaches (Salmerón et al., 2024) that enhance each student's metacognitive reflection, a key aspect for improving reading comprehension (Swart et al., 2022). On the other hand, it has been shown that reading in these environments necessarily requires specific medium-related skills: operational, formal, communicative, informational, and strategic skills (Burin, 2020; van Dijk, 2020). However, and most importantly, it also demands general reading comprehension skills (Ripoll, 2023; Saux, 2020).

Over the past decades, research has produced multiple contributions regarding reading comprehension and use of digital technologies. On the one hand, several meta-analyses and systematic reviews have examined empirical studies that underpin teaching of reading comprehension in Spanish (Ripoll & Aguado, 2014; Tonani & Chimenti, 2023). In addition, the impact of reading medium (paper vs. screen) has been studied, indicating superior performance in printed formats, although this effect is moderated by some factors such as text type, device, reading time, or possibilities for self-regulation (Clinton, 2019; Delgado et al., 2018; Singer & Alexander, 2017).

On the other hand, research has examined the effects of digital technologies on reading processes. A classic meta-analysis (Cheung & Slavin, 2012) identified positive —though small—effects of educational technologies, with better results in comprehensive models that combine computer-assisted instruction and traditional teaching, followed by programs designed to complement traditional teaching through individualized, computer-assisted work. Similar findings were reported in reviews focused on reading and writing skills (Fernández Batanero et al., 2021), the use of digital texts (Berkeley et al., 2015), and Intelligent Tutoring Systems (ITS; Atun, 2020; Xu et al., 2019). In the latter case, a relationship between intensity of use and students' comprehension achievements was observed, as well as a much greater positive impact of ITS compared to other educational technologies.

Within Spanish-speaking contexts, available studies reported heterogeneous results. While a meta-analysis on computer programs aimed at improving reading comprehension (Sáciga Palomino, 2017) yielded small and non-significant effects, other recent studies (e.g., Berral Ortiz et al., 2024) highlighted positive effects on specific components of reading and writing following the implementation of programs involving interactive and performance-adaptive proposals.

Despite these advances, important gaps remain. First, most studies focus on English-speaking populations (Atun, 2020; Berkeley et al., 2015; Cheung & Slavin, 2012; Fernández Batanero et al., 2021; Xu et al., 2019), limiting the generalizability of their findings to other contexts due to linguistic and sociocultural differences (Gomes-Koban et al., 2019; Navarro, 2016; Ripoll & Aguado, 2014). In addition, studies often do not sufficiently detail characteristics of the interventions—a crucial aspect for evaluating their specific contributions and, eventually, building knowledge about effective teaching practices (Rijlaarsdam et al., 2017). Finally, as noted by Gomes-Koban et al. (2019), in Spanish-speaking contexts there is a lower availability of evidence-based programs, which reinforces the need for systematic reviews specifically focused on these settings.

In this regard, this study aims to systematically review empirical studies reporting interventions in the Ibero-American context between 2014 and 2025, which use digital technologies as a means of intervention to improve reading comprehension in primary and secondary education. Specifically, the following objectives are pursued: (1) to describe the methodological characteristics of the included studies; (2) to identify and describe the type of technology employed; (3) to analyze the cognitive and metacognitive comprehension processes promoted in the interventions; (4) to identify the structure of the sessions and the feedback mechanisms used; and (5) to analyze the main results obtained.

Method

The systematic literature review was conducted following the guidelines of the PRISMA statement (Page et al., 2021).

Inclusion criteria

It was decided to include empirical studies that met the following criteria:

1. reported intervention proposals implemented in educational settings;
2. were conducted in the Ibero-American context;
3. aimed to improve aspects related to reading comprehension;
4. were developed in primary and secondary education with native Spanish-speaking students (L1) with typical development;
5. included an exhaustive description of an intervention proposal that depends substantially on technology as the main component of its development;
6. included an assessment of participants' performance in comprehension after the intervention (for example, through standardized tests or assessment scales);
7. were published in the period 2014–2025 as a journal article or book chapter.

Studies that did not report implemented and evaluated interventions were excluded, such as exploratory, descriptive, correlational, or confirmatory research that assessed reading comprehension performance using digital technologies but without implementing an instructional program. Studies conducted outside Ibero-America, aimed at speakers of another language or Spanish as a second language (L2), that pursued the improvement of other reading skills than comprehension; interventions aimed at early childhood education students, higher education students, or students without typical development, as well as studies in which the intervention was not exhaustively described, were also excluded. In addition, conference presentations, conference papers, books, undergraduate, masters, and doctoral theses, among others, were excluded.

The search was limited to the last ten years in order to focus on studies that incorporate recent digital technologies, given that substantial changes have occurred in the last decade both in available technologies and in instructional designs that integrate technologies in educational contexts.

Search procedure

The systematic review was conducted in two stages. The main search was carried out during the first week of December 2023, while in September 2025 an update search was performed. On this second occasion, a temporal filter was applied across all databases, restricting the search to the 2023–2025 period. In addition, a further inclusion criterion was applied: (8) the study had not been included in the previous search.

Six databases were selected: Scopus, Web of Science, ERIC, SciELO, LA Referencia, and Dialnet. The search was carried out based on combinations of keywords, using AND and OR operators, organized into three conceptual axes: one related to reading comprehension, another to intervention, and a third linked to digital technologies (Table 1).

Terms for this last axis were selected by conducting a screening of 27 articles related to the topic in order to include as many technology-related terms as possible. A temporal filter was applied to the initial search across all databases. In La Referencia, the first search string was restricted to title field only, whereas in Dialnet a reduced search string was used due to the characteristics of the database. In Scopus and Web of Science, searches were conducted in English using translated versions of the keywords, and results were filtered by country. In ERIC, the search was conducted using thesaurus-based descriptors.

Table 1

Search terms and operators used in each database

	Scielo / La Referencia	**Dialnet**	**Scopus / Web of Science**	**ERIC**
Reading comprehension	comprensión lectora OR comprensión de textos OR lectura OR competencia lectora	comprensión lectora OR estrategias de lectura	reading comprehension OR reading strategies OR digital reading	reading comprehension OR reading strategies OR digital reading
			AND	
Intervention	intervención OR programa OR efecto	intervención OR programa OR efect*	intervention OR program OR effect*	intervention OR improvement program OR effect*
			AND	
Digital technologies	tecnología OR computadora OR software OR inteligencia OR inteligente OR e-book OR electrónico OR electrónica OR aplicación OR app OR tic OR pantalla	tecnología OR digital OR app OR tic OR tablet OR pantalla.	technology OR digital OR computer OR software OR intelligent* OR e-book OR electronic OR tablet OR app OR ict OR screen OR computer assisted OR virtual platform OR tutoring system	technology OR educational technology OR computer assisted OR software OR intelligent tutoring system OR electronic OR tablet computer.

Once the search was completed, duplicates were detected and an initial selection was made based on title and abstract using Rayyan software (Ouzzani et al., 2016). To this end, all records were screened by the first author; the second author independently screened a randomly assigned 50 % of the records, and the third author screened the remaining 50 %. Consequently, each record was assessed for inclusion by two reviewers. This process was carried out independently by each author, yielding an agreement percentage close to 95 %, with a strong agreement (k = .68). Disagreements were resolved through dialogue. After this initial selection, full texts were read.

Analysis of studies

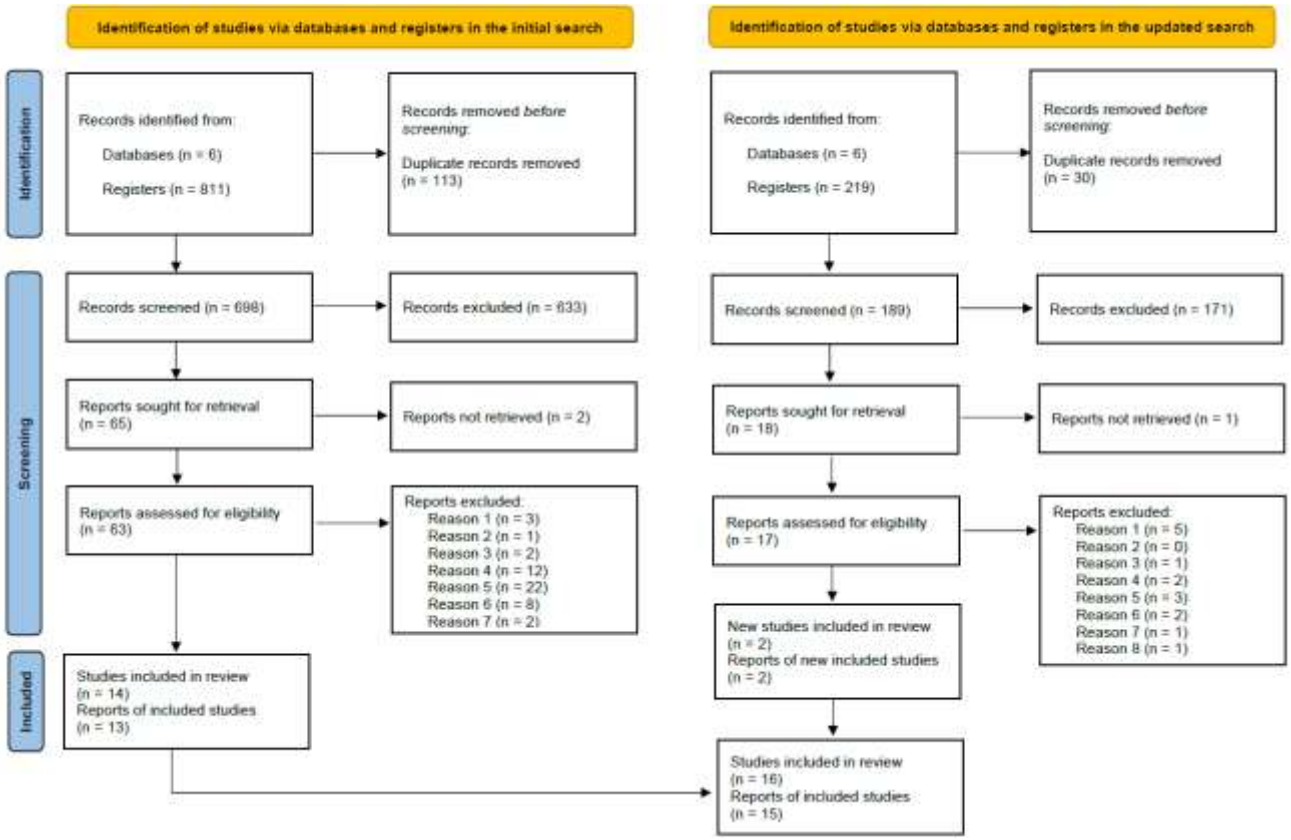
After the final reading and selection of publications that met inclusion criteria, an analysis of the characteristics of intervention proposals was conducted in order to produce a qualitative synthesis (Moher et al., 2009). To this end, a data matrix was constructed in Excel in which, in addition to bibliometric variables of the articles, the following aspects were examined in line with the proposed objectives: methodological design, sample size, main results, type of technology employed, cognitive and metacognitive processes addressed, structure of the sessions, feedback provided during the sessions, and impact of the interventions on reading comprehension.

Results

The initial search yielded a total of 811 records. Following the identification process and the study selection (Figure 1), 13 publications reporting 14 studies were included. The updated search yielded a total of 219 records, from which two studies were included after the screening process (Figure 1), resulting in the final inclusion of 15 publications reporting a total of 16 studies.

Figure 1

PRISMA flow diagram for study selection in both the initial and the updated search



Note. Prepared by the authors based on the PRISMA flow diagram (Page et al., 2021). A single unified diagram is presented in order to comply with editorial criteria and to maintain transparency of the search process at each of its stages.

General characteristics of intervention proposals

Studies were mostly conducted with populations from Spain (*n* = 8), followed by Chile (*n* = 3), Colombia (*n* = 2), Ecuador (*n* = 2), and Peru (*n* = 1) (Table 2). Eleven studies were implemented in primary education, four in secondary education, and one in both educational levels.

Across the included studies, there was a tendency toward the use of a quantitative methodological approach with pre- and post-test designs. Seven studies employed a design with one experimental group and one control group (Benavides & Zambrano, 2023; García et al., 2021; Quiroz-Benítez et al., 2023; Salmerón & Llorens, 2019; Serrano et al., 2018; Serrano-Mendizábal et al., 2023; Vidal-Abarca et al., 2014); in two studies, a design with two experimental groups and one control group was used (Guerra & Mellado, 2017; Torres & Medina, 2020); and five studies employed a single-group design (McCarthy et al., 2020; Salmerón et al., 2015; Sánchez & Pascual, 2022; Serrano et al., 2018; Soto et al., 2019). One study adopted a qualitative approach (Pedrozo Castrillo et al., 2021), and another employed a mixed-methods approach, a design-based research with one experimental group and one control group (Tobar-Muñoz et al., 2017).

The interventions reported in the studies varied considerably in terms of total duration and frequency of sessions, ranging from 1 to 50 sessions, each lasting between 15 and 50 minutes (Table 2).

Table 2

Characteristics of the included studies in the systematic review

	Study	Country	Educational level	Design and sample	Used technologies	Duration and frequency of sessions	Main results
1	Benavides and Zambrano (2023)	Ecuador	General Basic Education	Experimental design pre and post 1 EG + 1 CG N = 76 (M_{age} = 11.26; SD = 0.55)	Web-based environment, Video modeling Google Forms	2 sessions	No significant improvement was observed between groups in the selection and problem-solving phase. However, the EG demonstrated greater efficiency than the CG on the posttest.
2	García et al. (2021)	Spain	Primary Education	Pre and post design with random assignment 1 EG + 1 Active CG N = 66 (between 11 and 12 years-old)	Video modeling (Eye-Movements Modeling Examples) CMapTools	4 sessions of 50 minutes each, consecutive days	The EG obtained higher scores than the CG on the posttest, although the instruction effect was small and not statistically significant. Despite the positive effect of EMME on knowledge of the phases involved in constructing concept maps, it did not lead to greater comprehension. No effects of EMME-based instruction were found on integrated document comprehension.
3	Guerra and Mellado (2017)	Chile	Basic Education	Experimental design pre and post 2 EG + 1 CG N = 92 (between 9 and 12 years-old)	*A-Book* (*Assisted-reading book*)	6 sessions of 30 minutes each, 3 per week	Results differed depending on the skill assessed. Regarding inference-making, the adaptive EG showed a significant improvement compared to both the training EG and the CG. The CG outperformed the training EG. No significant effects of condition were found for text structure, with only a non-significant improvement observed in the adaptive EG. For comprehension monitoring, a decline in performance was observed across all conditions.
4	McCarthy et al. (2020)	Chile	Middle Education	Pre and post design1 EG N = 22 (between 14 and 17 years-old; M_{age}: 15; SD = 0.75)	Intelligent Tutoring System (I-START-E)	11 sessions of 1 hour each	Students' comprehension improved significantly on the posttest, resulting in higher-quality self-explanations. No significant correlations were found between reading motivation scales and reading comprehension improvements.

5	Quiroz-Benítez et al. (2023)	Ecuador	General Basic Education	Quasiexperimental design pre and post 1 EG + 1 CG *N* = 34	Facebook	3 weeks, 2 activities per week	Both groups improved their performance on the posttest. In the CG, results indicated a medium level of comprehension, with some changes compared to the pretest: the group maintained a medium level of inferential comprehension, declined from high to medium in literal comprehension, and improved from low to medium in critical comprehension. The EG achieved a high level of reading comprehension on the posttest across all three levels, with the most notable improvement occurring in critical comprehension, which increased from low to high.
6	Pedrozo Castrillo et al. (2021)	Colombia	Primary Basic Education	Qualitative design Action research approach *N* = 18 (between 9 and 11 years-old)	Virtual Learning Object (Educaplay platform)	Not specified	Students strengthened their reading level, showing a consolidation of inferential reading level. In addition, some students progressed toward a critical reading level.
7	Salmerón and Llorens (2019)	Spain	Secondary Education	Pre and post design with random assignment 1 EG + 1 CG *N* = 101 (M_{age} =14.5; *SD* = 0.8)	Video Modeling (*Eye-Movements Modeling Examples*)	3 sessions of 1 hour each, 1 per week	Students in the EG showed a significant improvement compared to the CG. It was expected that EG students would differ from the CG in reading time and navigation patterns. On the posttest, a significant difference in reading time on the main page was found in favor of the EG. However, no significant effects of condition, time, or interaction were found for reading time on relevant and irrelevant pages or for navigation.
8	Salmerón et al. (2015)	Spain	Secondary Education	Within-subjects design 1 EG *N* = 20 (M_{age} = 13.5; *SD* = 1.32)	Video Modeling (*Eye-Movements Modeling Examples*)	1 session of 1 hour and 30 minutes	Results indicate an increase in students' knowledge of digital reading strategies after the intervention. Findings from content analysis and level of student interaction during paired discussions revealed a positive correlation between the quality index and the number of digital reading strategies mentioned by students after the intervention.

9	Sánchez and Pascual (2022)	Spain	Primary Education	Quasiexperimental design pre and post 1 EG *N* = 153	Digital serious game (Leobien)	50 sessions of 15 minutes each, 5 per week	After program implementation, significant differences were found in comprehension measures, with a medium effect size. A significant increase in academic achievement was also observed, along with a positive correlation between academic grades and comprehension scores. However, it is not possible to conclude that the improvement in academic grades is due to the program.
10	Serrano et al. (2018)	Spain	Primary Education Secondary Education	Pre, post and follow-up design 1 EG *N* = 47	Intelligent Tutoring System (TuinLEC Web)	8 sessions of 45 minutes each, depending on the phase 2 per week	Intervention in the EG appears to improve performance and accuracy in decision-monitoring among students with low comprehension skills, whereas students with good comprehension skills do not seem to benefit from the intervention.
11	Serrano et al. (2018)	Spain	Primary Education	Pre, post and follow-up design with random assignment 1 EG + 1 Active CG *N* = 68	Intelligent Tutoring System (TuinLEC Web)	8 sessions 2 per week	No significant differences were found between EG and CG students' performance from pretest to posttest. However, a significant difference emerged at the follow-up assessment, where the EG showed a significant improvement in performance, while the CG did not differ from previous assessments.
12	Serrano-Mendizábal et al. (2023)	Spain	Primary Education	Experimental design pre and post 1 EG + 1 Active CG *N* = 130 (*M*age = 11.32; *SD* = 0.54)	Intelligent Tutoring System (TuinLEC Web / AutoLEC)	8 sessions of 50 minutes each 2 per week	EG students who used TuinLECweb improved their scores on situation model questions but not on text-based questions, whereas the opposite pattern was observed in the group that used AutoLEC. In addition, training with TuinLECweb was effective for deep comprehension. In both interventions, neither time spent, use of support, nor review of feedback were related to gains in reading learning.
13	Soto et al. (2019)	Chile	Elementary Education	Preexperimental design pre and post 1 EG *N* = 85 (between 10 and 13 years-old)	Educational Technology (COMPRENDE)	6 sessions of 1 hour each 1 per week	Results revealed a statistically significant difference between students with low and high reading performance. Improvements in Lectum performance favored the low-performing group, as their performance increased, while the high-performing group showed a decrease.

14	Tobar-Muñoz et al. (2017)	Colombia	Elementary Education	Design-Based Research Experimental design 1 EG + 1 Active CG N = 51 (between 8 y 12 years-old; M_{age} = 9.61; SD = 1.32)	Augmented-reality digital game	2 weeks	No significant differences were found in posttest scores between students in both groups.
15	Torres and Medina (2020)	Peru	Secondary Education	Quasiexperimental design pre and post 2 EG + 1 CG N = 123	Virtual classroom in a web platform with Virtual Learning Object	5 weeks	Posttest results show a significant improvement in the use of reading strategies in both EGs compared to the CG. No significant differences were observed between the EGs; therefore, the improvement was not associated with the level of interactivity of the Virtual Learning Objects used in the study.
16	Vidal-Abarca et al. (2014)	Spain	Primary Education	Pre and post design with random assignment 1 EG + 1 CG N = 25	Intelligent Tutoring System (TuinLEC Web)	8 sessions of 45 minutes each 2 per week	Results indicate that the EG improved its reading competence compared to the CG, with a medium effect size. Improvements were observed in the subscales of reading comprehension, vocabulary, reading fluency, and inferential skills.

Note. In the Educational level column, the denominations reported in each study were used, according to the educational system of each country. In the Design and sample column, the designs are reported as described in the original studies. When available, participants' age and/or age range were included. A distinction is made between control group (CG) and active control group (Active CG) in order to account for groups in which participants engage in activities, receive sessions, or follow a program with similar tasks to the implemented training in the experimental group (EG).

Type of digital technology used

All studies used technologies designed for educational purposes, which were mainly implemented by using computers.

Many of the studies (*n* = 5) used ITS: I-Start-E (McCarthy et al., 2020), TuinLEC (Vidal-Abarca et al., 2014), TuinLECweb (Serrano et al., 2018; Serrano-Mendizábal et al., 2023), and AutoLEC (Serrano-Mendizábal et al., 2023). ITS are interactive learning environments that use artificial intelligence to adapt to students' skills (Xu et al., 2019). Based on system–student interactions, the system assesses their knowledge, offers feedback, and creates instruction tailored to their performance.

Three studies used video modeling or Eye-movement modeling examples (EMME) (García et al., 2021; Salmerón et al., 2015, Salmerón & Llorens, 2019). This technology consists of an instructional technique that provides a model of a subject's actions related to a given task. It not only allows strategies employed by the subject to be modeled, but also their visual processing and attention to the task (van Gog et al., 2024). Studies that use this technology for reading digital texts emphasize modeling the subject's strategic processing of the information that needs to be prioritized in order to understand the texts. In the study by García et al. (2021), this technology was combined with software for creating concept maps (CmapTools), in line with the aim of applying knowledge derived from the models to construct an explanatory map on a given topic, with an appropriate hierarchical organization of information.

Four studies used websites for their development, in some cases complemented by other digital tools. Soto et al. (2019) employed COMPRENDE, an educational technology that focuses on reading strategies and combines presentation of lessons, activities, and feedback provided by an animated educational agent. Meanwhile, the study by Guerra and Mellado (2017) used an assisted-reading book or A-book. This book is distinctive in that it presents a selection of stories and related questions in digital format, and supports readers through feedback provided during reading. Benavides and Zambrano (2023) developed an intervention through an educational environment supported by a task selection algorithm, designed to promote self-regulation in reading tasks by adjusting activities according to the relationship between mental effort and performance, as reported by each student. To explain how they should rate effort and select tasks, they included video modeling, and then students had to complete reading activities through Google Forms, assigned based on an algorithm that took into account complexity level and support degree (no support, low, or high). Quiroz Benítez et al. (2023) implemented a proposal using Facebook as an educational environment for sharing materials, producing content, and carrying out collaborative activities linked to certain reading tasks, established in advance and based on certain cognitive processes.

Two studies used Virtual Learning Objects (VLO; Pedrozo Castrillo et al., 2021; Torres & Medina, 2020). VLO are characterized as digital resources designed and structured for an educational purpose, which present specific content to students (Cóndor-Herrera et al., 2021). Pedrozo Castrillo et al. (2021) used a platform (educaplay) that allows the design of activities, with the aim of working on reading comprehension. Torres and Medina (2020) employed virtual classrooms on a Learning Management System (LMS) platform. In the classroom, VLOs were presented differently depending on the experimental condition (passive vs limited interactivity).

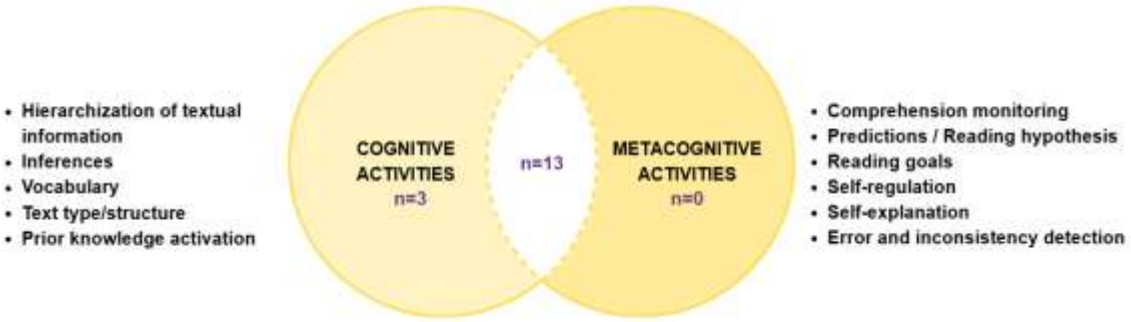
Finally, two studies adopted a game-based learning framework (Sánchez & Pascual, 2022; Tobar-Muñoz et al., 2017). Sánchez and Pascual (2022) implemented a digital serious game developed on an educational web platform (supertics). Unlike “conventional” games, serious games are designed with the primary goal of serving as educational tools, taking advantage of the affordances and benefits offered by games (e.g., their appeal in terms of fun) while subordinating these features to a secondary role (Calvo-Ferrer, 2018). In turn, Tobar-Muñoz et al. (2017) adopted a novel approach by combining an augmented reality digital game with storybook reading. In this way, the augmented reality game unfolded as the images accompanying the pages of the book were viewed using a tablet.

Cognitive and metacognitive aspects of reading comprehension

Except for Quiroz-Benítez et al. (2023), Sánchez and Pascual (2022), and Pedrozo-Castrillo et al. (2021), most studies aimed to address both cognitive and metacognitive aspects related to reading comprehension, even when the focus was primarily on one dimension or the other (Figure 2).

Figure 2

Activities predominantly implemented in the studies reviewed



Source. Prepared by the authors, based on Tonani and Chimenti (2023).

In the reviewed studies, the most frequent tasks were those related to metacognitive processes, which require assessing or monitoring one's own comprehension (García et al., 2021; Guerra & Mellado, 2017; McCarthy et al., 2020; Salmerón et al., 2015; Salmerón & Llorens, 2019; Serrano et al., 2018; Serrano-Mendizábal et al., 2023; Soto et al., 2019; Torres & Medina, 2020; Vidal-Abarca et al., 2014). The second most frequent tasks were cognitive activities linked to hierarchization of textual information, mainly related to the identification of main ideas (Benavides & Zambrano, 2023; McCarthy et al., 2020; Quiroz-Benítez et al., 2023; Sánchez & Pascual, 2022), the use of graphic organizers (García et al., 2021; Quiroz-Benítez et al., 2023), or the preparation of summaries of the read texts (Soto et al., 2019). Thirdly, there were cognitive activities that promote generation of inferences to connect two pieces of information or link the information presented in the text with prior knowledge (Benavides & Zambrano, 2023; Guerra & Mellado, 2017; McCarthy et al., 2020; Pedrozo Castrillo et al., 2021; Quiroz-Benítez et al., 2023; Sánchez & Pascual, 2022; Soto et al., 2019; Tobar-Muñoz et al., 2017; Torres & Medina, 2020). Fourth, tasks related to self-regulation were proposed (Benavides & Zambrano, 2023; García et al., 2021; Salmerón & Llorens, 2019; Serrano et al., 2018; Serrano-Mendizábal et al., 2023; Vidal-Abarca et al., 2014) as a metacognitive activity that is not only key to strategic reading—particularly of texts on screens— but also constitutes a fundamental component of autonomous learning, which is positively valued in virtual environments, where students are required to take on a more active role in regulating their own performance.

To a lesser extent, metacognitive activities linked to the formulation of hypotheses or predictions for reading (Benavides & Zambrano, 2023; Salmerón et al., 2015; Soto et al., 2019; Torres & Medina, 2020), establishment of reading goals (Salmerón et al., 2015; Salmerón & Llorens, 2019; Serrano et al., 2018; Vidal-Abarca et al., 2014), and development of self-explanations (García et al., 2021; McCarthy et al., 2020) are also reported.

Structure of the sessions

Most intervention proposals (n=10) were implemented as complementary spaces to regular lessons, without the intention of being directly integrated into curricular content. In addition, they were organized following a defined structure established prior to implementation. Thirteen proposals implemented an individual work format, where each student works with their own device. To a lesser extent, some proposals (García et al., 2021; Pedrozo Castrillo et al., 2021; Salmerón et al., 2015) employed pair work, emphasizing the potential of interaction and discussion among students for learning.

A large number of studies adopted a phase-based structure (McCarthy et al. 2020; Salmerón & Llorens, 2019; Salmerón et al., 2015; Serrano et al., 2018; Serrano-Mendizábal et al., 2023; Soto et al., 2019; Vidal-Abarca et al., 2014) or blocks-based structure (García et al., 2021; Guerra & Mellado, 2017), alternating moments of instruction or teaching with moments of practice or training. In these cases, the initial phase or block was dedicated to explicitly introducing a certain process or skill related to reading comprehension, based on a resource available in the program or an explanation by the researcher or teacher. This introduction could be presented with or without other multimodal elements (e.g., images, graphics, or videos). Students were then presented with a practice or training section, focused on

working on strategies or skills explained in the previous instance. In the study by McCarthy et al. (2020), two sections were enabled: guided practice and open practice environment. In addition to the instruction and training phases, some studies (Salmerón et al., 2015; Salmerón & Llorens, 2019) included a third phase of reflection on the content presented in the previous phases and/or on the students' responses to the tasks, with the aim of encouraging students to evaluate their own performance and identify areas for improvement.

Benavides and Zambrano (2023) proposed an introductory stage, but aimed at explaining the sequence of the intervention proposal rather than teaching a specific strategy or skill. In this study, the intervention structure depends on the students' performance, as the tasks they must solve are assigned using an algorithm based on their assessment of mental effort. This results in the resolution of reading tasks with different levels of complexity and support.

In other studies, sessions were organized according to reading-related moments: before, during, and after reading (Pedrozo Castrillo et al., 2021; Torres & Medina, 2020). In these cases, prior to reading, anticipation of the text's content and activation of prior knowledge were encouraged. Time was then devoted to reading the text, and finally, after reading, activities related to comprehension were carried out.

Some studies organized the intervention sequence around a game-based dynamic. Sánchez and Pascual (2022) used a game with scheduled sessions, in which a text was read and various related activities were carried out; whereas in the intervention proposed by Tobar-Muñoz et al. (2017), reading serves as an introduction to a challenge or goal that the student must solve, either through an in-game action or by answering to a question.

Finally, in the study by Quiroz-Benítez et al. (2023), the intervention proposal was organized according to reading tasks to be completed, which, in turn, aimed to promote a specific strategy to which students had to respond on a social network, sometimes individually and sometimes collaboratively.

Feedback provided during the sessions

In nine of the studies analyzed, feedback is an important element of the intervention, although its implementation varies according to the design of each proposal.

In the study by Guerra and Mellado (2017), feedback varied depending on the experimental condition: experimental groups received explanatory feedback, in which, regardless of each participant's performance, an explanation of the correct answer was provided, indicating the relevant and accurate information. In contrast, the control group was only informed whether the answer was correct or incorrect.

In some studies, students received feedback at specific phases of the intervention. For example, Salmerón and Llorens (2019) and Salmerón et al. (2015) introduced feedback during the reflection phase. Information was provided about strategies displayed in the EMMEs (experimental group) or in the written cases (control group) in order for students to reflect on their performance.

Meanwhile, in the studies by McCarthy et al. (2020), Serrano et al. (2018), Serrano-Mendizabal et al. (2023), and Vidal-Abarca et al. (2014), feedback was used at training phase and appeared after students had answered the question. In the study by McCarthy et al. (2020), the system assigned a score to students' responses (from 0 to 3 points) and provided information on how to improve self-explanation. In the other three studies, feedback was presented in different ways. First, the correct answer was indicated; then, the information relevant to the question was highlighted in the text; and finally, students received adapted written feedback based on time spent, strategies used, and support tools used. Serrano-Mendizabal et al. (2023) also used another program (AutoLEC) which, although similar to TuinLEC Web format, differed in terms of the feedback provided, as it only indicated whether the student's answer was correct or not.

Finally, in the study by Soto et al. (2019), feedback was provided with a metacognitive purpose: to encourage students to detect errors and adjust and calibrate their reading. Thus, during the training phase, explanatory feedback was used with the purpose of encouraging students to reflect on their performance. The feedback was aimed at identifying whether the content used was the most appropriate and also at identifying inconsistencies in some texts.

Effects of the interventions on reading comprehension

In order to assess reading comprehension performance, eight of the studies used standardized measures, such as Lectum (Riffo et al., 2011; used in McCarthy et al., 2020; Soto et al., 2019), Comprehension Strategies Test (Vidal-Abarca et al., 2007; used in García et al., 2021; Vidal-Abarca et al., 2014), Comprehension Processes Test (Martínez et al., 2008; used in Serrano et al., 2018), ECOMPLEC (León et al., 2012; used in Serrano-Mendizábal et al., 2023) or the Reading Efficiency Test (Salmerón et al., 2015). In addition, instruments specifically designed for the studies were employed, generally adopting a format consisting of reading a text and answering questions about it (Benavides & Zambrano, 2023; García et al., 2021; Guerra & Mellado, 2017; Pedrozo Castrillo et al., 2021; Salmerón & Llorens, 2019; Serrano et al., 2018; Tobar-Muñoz et al., 2017; Torres & Medina, 2020) or instruments used in similar studies to measure comprehension levels (Quiroz-Benítez et al., 2023). In some cases, performance was evaluated by calculating the scores obtained in an activity carried out through the technology used (Guerra & Mellado, 2017; Sánchez & Pascual, 2022; Serrano et al., 2018; Serrano-Mendizábal et al., 2023). In addition, some studies incorporated other measures to analyze dimensions such as motivation (McCarthy et al., 2020; Tobar-Muñoz et al., 2017) or students' perceptions (McCarthy et al., 2020; Soto et al., 2019; Vidal-Abarca et al., 2014).

Regarding the assessment moment, post-test was administered immediately after the intervention. Only two studies included follow-up measures to assess the stability of the effects two weeks after the intervention (Serrano et al., 2018).

As shown in the results synthesis in Table 2, improvements in reading comprehension performance were generally reported (McCarthy et al., 2020; Pedrozo Castrillo et al., 2021; Quiroz-Benítez et al., 2023; Salmerón et al., 2015; Salmerón & Llorens, 2019; Sánchez & Pascual, 2022; Serrano et al., 2018; Serrano-Mendizabal et al., 2023; Torres & Medina, 2020; Vidal-Abarca et al., 2014). Some studies reported specific improvements: for example, in the case of Serrano et al. (2018), improvements in comprehension were greater for low-performing students. Torres and Medina (2020) reported a significant improvement in both experimental groups compared to the control group, although there were no significant differences based on the experimental condition (passive and limited interactivity). However, some studies reported specific aspects in which improvements were not significant after the intervention, such as integrated comprehension (García et al., 2021), the strategy of activating prior knowledge (Salmerón et al., 2015), or school grades (Sánchez & Pascual, 2022). Finally, certain studies found no significant improvements in students' reading comprehension (Benavides & Zambrano, 2023; Guerra & Mellado, 2017; Tobar-Muñoz et al., 2017).

Discussion

The purpose of this study was to systematically review intervention proposals aimed at improving reading comprehension using technology, implemented with Spanish-speaking primary and secondary school students in the Ibero-American context. The analysis of the selected dimensions allows outlining several trends and projecting future lines of research on this topic.

First, and in general terms, although the studies present a variety of formats, they all use some type of educational technology designed in accordance with a learning purpose. This is significant considering the importance of focusing on the learning outcomes that interventions are intended to promote, rather than solely on the digital technologies used (UNESCO, 2023).

Regarding the type of technologies employed, the studies reviewed exhibit considerable heterogeneity. Intelligent Tutoring Systems (ITS) are most frequently used, yielding positive results for improving reading comprehension. This is consistent with previous research (Atun, 2020; Xu et al., 2019) which has pointed out the capacity of these systems to improve students' performance on complex tasks such as reading comprehension by adapting activities to students' individual needs. However, the implementation of interventions using these technologies can be difficult in certain Latin American contexts, where there is still great inequality in access to resources and availability of infrastructure. Less frequently, the reviewed studies employ techniques such as EMMEs, which produce positive effects by modeling certain digital reading strategies. To a lesser extent, studies implemented other types of proposals such as e-books, digital games, or social networks.

Regarding the structure of the sessions, a trend observed across the reviewed studies is the organization into instruction phases and training phases. Thus, at first, a strategy or process is explicitly taught or modeled, and then, in the training phases, opportunities are provided to exercise the targeted

processes. This finding is relevant as it aligns with other research in the reading instruction field, which argues that guided, structured, and explicit instruction is essential for promoting reading comprehension (Kamil et al., 2008; Meneses et al., 2022; National Reading Panel, 2000; Ripoll & Aguado, 2014). In particular, in the reviewed studies, technologies are positioned as a means of providing modeling and practice opportunities for students, with varying student autonomy degrees.

Likewise, in line with previous reviews (Berkeley et al., 2015; Ripoll & Aguado, 2014; Sáciga Palomino, 2017; Tonani & Chimenti, 2023), the most frequent tasks are those related to monitoring comprehension, hierarchizing textual information, and making inferences. These activities are linked to cognitive and metacognitive aspects that are crucial for constructing meaning from written texts and, at the same time, reflect an approach that views these general or "traditional" processes of reading comprehension as unavoidable in technology-mediated reading (Ripoll, 2023).

Most of the reviewed studies are implemented in the context of complementary teaching programs. With regard to instructional dynamics, in line with previous research that focuses specifically on improving reading processes through technology (Cheung & Slavin, 2012; Fernández Batanero et al., 2021), individualized student work is generally favored. A minority of studies adopt a pair-work approach, emphasizing the potential of peer interaction in supporting certain learning processes.

Another trend that emerges from the analysis is the use of different types of feedback as a fundamental element in interventions to promote different metacognitive processes, such as students self-assessment, self-reflection, or self-regulation, which, in line with previous studies (Swart et al., 2022), is key to improving comprehension performance.

Taken together, these trends are consistent with findings from research on the reading comprehension instruction field, while also highlighting specific aspects related to the use of technology. In particular, the possibility of offering specific, goal-oriented feedback is one of the main advantages of digital environments (Salmerón et al., 2024) and can be a key aspect in the design of technology-mediated intervention proposals. However, they also raise the challenge of integrating the use of technologies into classroom dynamics, within the framework of regular tasks, group discussions, and entire courses.

Beyond the identified trends and the contributions discussed, the review also reveals a recurring issue in empirical studies reporting instructional programs, namely the lack of information regarding their characteristics and critical design decisions (Rijlaarsdam et al., 2017). Although a detailed analysis of this point exceeds the scope of this study, it is noteworthy that most of the studies excluded during the selection process—particularly during the full-text reading stage (Figure 1)—were due to the absence of an exhaustive description of the interventions. Providing a detailed account of the instructional proposal and reporting on the results of its implementation are two fundamental aspects for the construction of knowledge about effective teaching practices. Addressing these aspects in future research would enable the comparison of similar experiences and the adoption of certain intervention formats according to contextual particularities and available technological resources.

Specifically, with regard to knowledge construction in the educational technology field, another relevant issue concerns the variety of terminology referring to different technologies. Even when an exhaustive review of the existing literature is conducted, as in the present study, this diversity may lead to difficulties in the systematic search for research on the topic and reflects a lack of consolidation of a shared terminological framework. However, part of this heterogeneity is inherent to the field and is related to the constant proliferation of new technologies (García Aretio, 2020).

Finally, certain aspects that limit the generalizability of the results of this review must be considered. One important point is that half of the studies included were conducted in Spain, while a smaller number were carried out in Latin American countries such as Chile, Colombia, Ecuador, and Peru. Latin American contexts are marked by significant socioeconomic inequalities that hinder access to technological devices and by a lack of investment in equipment and infrastructure in schools (OECD, 2020). In this regard, the fact that interventions in Latin America are comparatively less frequent highlights the need to expand research in these countries to ensure that interventions are contextually appropriate. On the other hand, although methodological heterogeneity allows for different approaches to the study of educational technologies in the reading field, it also makes it difficult to directly compare results. Even among studies that use a quantitative pre-post test design, sample sizes and intervention modalities (frequency and duration) vary widely. In addition, although most studies included a control group (passive or active), a significant number of studies do not include this methodological safeguard.

Moreover, most studies did not include follow-up measures, therefore, while short-term effects on reading comprehension are reported, no claims can be made regarding the stability of these learning outcomes over time.

This systematic review is also not free from risk of bias. In particular, two issues regarding inclusion criteria must be noted. On the one hand, criterion 6, which requires studies to include an assessment of comprehension performance after the intervention, may have limited the inclusion of other studies that, despite not meeting this criterion, are valuable for the development of research on the subject. Literacy is a focus of interest for multiple disciplines that draw on different theoretical and methodological approaches. In view of this, future research could adjust the inclusion criteria to address the vast heterogeneity or direct the search according to specific disciplinary interests and discussions. Second, it is worth mentioning a consideration related to the time period selected (2014-2025). Although this decision, based on the results, allowed the inclusion of a broad set of studies in a research area that is still consolidating, it also involves a certain arbitrariness. Limiting the review to studies from the last five years could help focus on more current technologies. In future research, it may even be interesting to focus on the use of specific technologies, such as artificial intelligence. Finally, to avoid possible publication bias effects, future reviews could complement the results by searching for additional studies using other methods (Page et al., 2021), such as consulting experts in the field, tracking relevant citations in identified studies, and using institutional repositories or search engines such as Google Scholar.

Systematic reviews not only allow us to analyze how a field has been researched but also help define future research directions or areas that require more in-depth investigation (Manchado Garabito et al., 2009; Page et al., 2021). Based on the analysis presented, some possible lines of research stand out for further study in the area. On the one hand, in future research, it would be interesting to investigate more thoroughly the specific impact of different digital technologies based on their particular characteristics and modes of implementation. Likewise, it is important to investigate in depth the effects of different types of feedback on reading comprehension performance. Finally, it is important to continue analyzing both the dynamics of exchange that arise when technology is included in educational settings and the specific characteristics of intervention proposals that, through technology, aim to promote not only comprehension skills but also the learning of the content of a specific subject.

By offering a systematization of empirical studies that have used digital technologies to improve reading comprehension in Spanish-speaking students, this review can contribute to the design of well-founded and meaningful educational interventions. This constitutes an opportunity to continue advancing in the effective integration of technology in education.

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