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COGNITIVE COMPETENCIES IN DIGITAL ENGLISH READING: A SYSTEMATIC REVIEW

by

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Abstract

The rise of digital devices and content consumption has reshaped reading habits, potentially influencing the development of early reading skills. However, limited research addresses cognitive competencies in digital English reading, which enable readers to process, comprehend, and retain information online. This study aimed to investigate the presence of cognitive competencies in digital English reading materials and the challenges in developing them. A Systematic Literature Review (SLR) was conducted, excluding 47 articles and including 15 based on research criteria. Findings indicate that cognitive competencies—critical thinking, problem-solving, creativity and innovation, situation analysis, decision-making, and pattern recognition—are integrated into English reading materials but require further development in digital contexts. The study also identified challenges in developing cognitive competence, including cognitive load, material, pedagogical design, teacher and student expectations, technology and digital literacy, feedback and assessment, information overload, interdisciplinary and critical thinking skills, and the nature of literacy. Understanding the integration of cognitive competencies into digital resources is crucial for educators and stakeholders, as it aids in optimizing language learning experiences and developing targeted solutions to enhance language learning tools and strategies.

Keywords: *cognitive competencies; digital English reading; systematic review*

Abstrak

Munculnya perangkat digital dan konsumsi konten telah membentuk kembali kebiasaan membaca, yang berpotensi mempengaruhi perkembangan keterampilan membaca awal. Namun, penelitian yang ada masih terbatas pada kompetensi kognitif dalam bacaan bahasa Inggris digital, yang memungkinkan pembaca untuk memproses, memahami, dan menyimpan informasi secara online. Penelitian ini bertujuan untuk menyelidiki keberadaan kompetensi kognitif dalam materi bacaan bahasa Inggris digital dan tantangan dalam mengembangkannya. Tinjauan Literatur Sistematis (SLR) dilakukan dengan mengecualikan 47 artikel dan memasukkan 15 artikel berdasarkan kriteria penelitian. Temuan menunjukkan bahwa meskipun kompetensi kognitif - seperti berpikir kritis, pemecahan masalah, kreativitas dan inovasi, analisis situasi, pengambilan keputusan, dan pengenalan pola - diintegrasikan ke dalam bahan bacaan bahasa Inggris, namun kompetensi tersebut memerlukan

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pengembangan lebih lanjut dalam konteks digital. Studi ini juga mengidentifikasi tantangan dalam mengembangkan kompetensi kognitif, termasuk beban kognitif, materi dan desain pedagogis, harapan guru dan siswa, teknologi dan literasi digital, umpan balik dan penilaian, informasi yang berlebihan, kemampuan berpikir interdisipliner dan kritis, dan sifat literasi. Memahami integrasi kompetensi kognitif ke dalam sumber daya digital sangat penting bagi para pendidik dan pihak terkait, karena hal ini membantu mengoptimalkan pengalaman belajar bahasa dan mengembangkan solusi yang ditargetkan untuk meningkatkan alat dan strategi pembelajaran bahasa.

***Kata Kunci**: kompetensi kognitif; membaca bahasa Inggris digital; tinjauan sistematis*

INTRODUCTION

Employing cognitive skills in digital resources is essential for developing well-rounded and adaptable learners. Several studies have investigated the scientific and pedagogical principles behind developing cognitive competencies in students augmented with innovative technologies. These studies utilize emerging frameworks to assess students' cognitive skills, focus on fostering competencies in engineering students through cognitive technology, and construct cognitive-social-emotional competencies to enhance academic learning (Linares et al., 2005; Chong & Shahrill, 2016; Mingaleva & Vukovic, 2020; Mazagaon, 2023). The extensive exploration of cognitive competence underscores its significance in understanding the development of student's abilities and its interplay with other skill sets.

While several studies have examined the role that cognitive competencies play in students' development, often in conjunction with mathematical, engineering, and cognitive technologies, there remains a significant knowledge gap regarding how these competencies are developed within interdisciplinary frameworks and reading themselves. More precisely, there is a lack of research focused on developing cognitive competencies and other critical skills, such as reading, notably in the context of digital English reading materials. Most existing research focuses on higher education, particularly in engineering or technology-based fields, leaving a gap in exploring cognitive competency in reading skills as general and critical skills required, especially concerning real-world environments and technology learning.

This is essential given the increasing demand for digital literacy as a fundamental element of 21st-century learning. Therefore, this study seeks to bridge the gap by investigating the existence of cognitive competencies and incorporating digital literacy. Understanding this intersection provides insights into how foundational skills can be developed in the educational process, contributing to a broader approach to developing literacy and cognitive competency.

Haleem et al. (2022) explain that these technologies significantly impact education and completely change the learning paradigm. Competence in emotional, social, and cognitive intelligence predicts achievements in professional, managerial, and leadership roles across various sectors of society (Boyatzis, 2008). Although technology is changing the educational paradigm, the competencies needed in the 21st century rely on cognitive abilities. One important manifestation of these abilities is their necessity for efficient management and leadership in the workplace.

Reading skills can be integrated into other language skills and are essential in academic and professional contexts. In academic settings, reading proficiency and literacy skills are closely related, especially in reading fluency, which directly impacts comprehension. Reading fluency also facilitates the correlation between word reading, rapid naming, and reading comprehension (Cadime et al., 2024). In professional contexts, digital literacy has become increasingly valuable, as it enhances a student's appeal to potential employers and strengthens employability in the graduate job market (Morgan et al., 2022).

Improving the reading experience signifies a paradigm shift in how people interact with written content (Gamage et al., 2023). According to this concept, reading is no longer just about decoding words on a page; it is now a dynamic, interactive process made possible by various digital tools and platforms. The emphasis on reading skills also becomes more prominent as technological-based education transcends traditional boundaries, which requires a deep understanding of implementing digital reading materials.

Using technology for reading abilities is to create a dynamic, personalized reading experience not limited to static texts but made possible by the power of digital tools and platforms (Manalu, 2019; Abdulrahaman et al., 2020). This strategy aims to develop a generation of readers who are proficient, critical, and interested in the diverse areas of digital literature while embracing the innovations of the digital age. Technology is not preventing readers from becoming more proficient; in the real sense, the technology's dynamic properties should help readers contribute to their reading abilities. Personalized reading experiences are anticipated to effectively educate a technologically literate generation about each individual's cognitive abilities.

Reading abilities enhanced by technology include multimodal literacy, in which people interact with written texts and various multimedia elements. Images, videos, hyperlinks, and interactive components contribute to a more immersive and comprehensive understanding of the content (Hines, 2014; Mills & Unsworth, 2017). This multimodal approach gives rich experiences in reading activity by making it more informative and engaging. Activities in the classroom have changed towards activities that are more advanced and make students engaged with the materials. The use of technology tools and applications is one activity that is rich with material references.

While the primary goal of reading is to obtain information, it also extends to comprehension, as Neil Anderson highlights (Anderson, 2003). Reading involves more than just skimming words on a page; it also involves fully comprehending what is being said. The ultimate objective of any text, whether a novel, a news article, or a technical manual, is to understand it so that individuals can use it in their daily lives or at jobs. Readers should strive to embed in their minds that reading a book or scrolling through an article is not solely for information but fundamentally for understanding.

Furthermore, personalized and adaptive learning is implemented in classrooms to shape learners' careers, benefiting faculty, institutions, and learners themselves (Kem, 2022). Adaptive learning platforms, which customize reading experiences based on individual proficiency levels, learning preferences, and styles, are also made possible by technology. These platforms customize content using algorithms and offer focused assistance to improve vocabulary growth and comprehension, allowing each learner to receive the support needed in language learning.

The ATC21S framework classifies 21st-century skills into four primary categories: thinking, working, working tools, and ways of living in the world (Binkley et al., 2012). Besides, there is an agreement that 21st-century skills include cognitive abilities such as creativity and innovation, critical thinking, problem-solving, and decision-making (Binkley et al., 2010a). According to the ATC21S (Assessment and Teaching of 21st Century Skills) framework, critical thinking is part of cognitive competence in the Ways of Thinking category. This classification highlights the importance of fostering these abilities to prepare individuals for the professional setting of modern life.

Digital reading includes various online tools to improve English language proficiency. This covers electronic books (e-books), articles published online, interactive multimedia files, and other digital resources meant to aid in improving English language reading skills. The organization of key cognitive competencies and the availability of high-quality data on cognitive competencies hold significant scientific and social relevance. As students engage with digital English reading materials that should be integrated with cognitive competencies, they are encouraged to push their ability to use critical thinking skills. They learn to critically assess information and form well-informed opinions when faced with difficult questions, complex scenarios, or demanding text analysis. It also fosters various cognitive abilities essential for personal, professional, and academic success.

Developing students' cognitive skills, such as problem-solving, situation analysis, critical thinking, and decision-making, is the primary and most important step in this educational system. Incorporating cognitive competencies into learning materials aims to produce immersive, engaging learning environments beyond the simple transmission of knowledge. These resources aim to support learners in acquiring various cognitive competencies necessary for academic success and lifetime learning by stimulating cognitive processes and promoting active engagement.

These cognitive competencies grow and change due to experience, education, and external circumstances. Developing cognitive competencies is essential for success in the classroom and lifelong learning. Threshold competencies include a variety of basic cognitive abilities, such as memory and deductive reasoning. Cognitive competencies encompass skills like pattern recognition and systems thinking (Boyatzis, 2008). It implies this cognitive ability to think critically or analyze data and circumstances in a way that promotes efficient or excellent performance. (Boyatzis, 2008) Furthermore, cognitive intelligence competency refers to the capacity for critical thought, information analysis, and situational analysis that results in outstanding performance. Situation analysis is among the essential cognitive competencies, as well as pattern recognition and systems thinking.

The cognitive processes that comprise critical thinking, such as reasoning, drawing conclusions, self-reflection, the integration of diverse perspectives, and creative thinking, which

encompasses a range of creative thinking styles, including constitutional, global, and local thinking styles, are collectively referred to as cognitive competence (Sun & Hui, 2006). These competencies cover a broad spectrum of cognitive functions and abilities that allow people to comprehend, process, and apply information. It is further connected to technological tools for teaching and boosting students' passion and motivation in courses, which has become increasingly important (Karakoç Öztürk, 2021). With the development of technology, natural human abilities can be replaced, so this cognitive ability becomes a critical ability that has produced efficiency in any field, both in terms of self-impact and social utility. Hence, research in the investigation of learning materials is important so that the integration of cognitive competence remains present and honed in the language learning process.

From these explanations, it is important to integrate cognitive competencies in digital reading English materials as they will be used for academic success and professional settings. Incorporating cognitive competencies into reading materials aims to produce immersive, engaging learning environments that proceed beyond the simple transmission of knowledge. By fostering these competencies, students are prepared to face career challenges. Therefore, investigating the availability of cognitive competencies is critical so that educators and decision-makers can observe the findings and understand the challenges involved.

To explore this further, the following research questions have been formulated based on the theoretical review to investigate the availability of cognitive competencies and the challenges in developing them in scientific articles that have been reviewed based on the criteria specified in this research:

1. How are cognitive competencies available in digital English reading materials?
2. What are the challenges in developing cognitive competencies in digital English reading materials?

METHOD

Design

This research implemented the Systematic Literature Review (SLR) following the outline guide by Kitchenham and Charters (2007) for identifying, assessing, and interpreting all relevant

research within a specific research question or subject matter. In line with these guidelines, this research investigates the cognitive competencies present in digital English reading materials.

Table 1 includes the population, the factors, and the topic to determine research questions so that the literature search process is not spread over a broader scope.

Table 1. *Criteria and scope*

Criteria	***Scope***
Population	*Empirical studies of the cognitive competencies and challenges in developing it in digital English reading materials.*
Factor (1)	*Empirical studies that examine the presence of cognitive competencies in digital English reading materials.*
Factor (2)	*Empirical studies explore the challenges in developing cognitive competencies in digital English reading materials.*

A systematic literature review takes several inclusion criteria into account. In English, papers from 2019 to 2023 are prioritized, focusing on journal articles, resulting in 62 studies. Each article must address at least one cognitive competence and challenge related to developing cognitive competencies in digital English reading materials.

Some terms attempted to define, propose, describe, or suggest for the researchers in the area of availability of cognitive competencies mentioned in the studies, such as critical thinking, problem-solving, creativity and innovation, situation analysis, decision-making, pattern recognition, and systems thinking and address the challenges in developing the cognitive competencies have to be included in these publications. To ensure a thorough review process, the SLR needs to incorporate specific exclusion guidelines. Although it is important to consider articles from various languages and themes, the review's scope should be limited to those that meet specific requirements. Articles in languages other than English are immediately disqualified from review, as are those from related fields missing the specified keywords.

Following establishing the exclusionary criteria, a shortlisting and review procedure is used to identify the inclusionary requirements. Every manuscript is subjected to a rigorous review process to ensure that it meets the review's requirements, which include relevance to the topic or

research question. Ultimately, only those publications that fulfill the inclusion criteria are selected for further investigation and examination. The following is Table 2, which contains the research questions that formed the basis for selecting suitable papers.

Table 2. *Research questions structure*

Question	***Answer***
How are cognitive competencies available in digital English reading materials?	*Yes/No/Partially of the availability of cognitive competencies in digital English reading materials in the context of academic paper*
What are the challenges in developing cognitive competencies in digital English reading materials?	*There are challenges/There is no challenge in developing cognitive competencies in digital English reading materials in the context of academic papers.*

This research employs an iterative search approach, which involves refined steps to ensure comprehensive data retrieval and analysis. First, the authors conduct an online search using the Google Scholar database, exploring terms such as cognitive competencies included in digital English reading materials and addressing the challenges in developing cognitive competencies in digital English reading materials from 2019 to 2023. The decision to use Google Scholar as a database is based on the researcher's rationale that it provides access to a broader range of perspectives, including smaller or local journals that may not be indexed in reputable databases but still offer substantial and detailed insights. Additionally, Google Scholar frequently links to open-access versions of articles, facilitating broader access to sources. This diversity is particularly valuable for a Systematic Literature Review (SLR), as it ensures a comprehensive overview of the available literature. Second, the authors review and refine the search results by identifying the relevance and pattern. Third, the authors modify the search results by adjusting the search terms and filters. Finally, the authors categorize the academic articles according to the following themes: Ways of Thinking, which includes critical thinking, problem-solving, creativity and innovation, and decision-making; Boyatzis' cognitive competencies, such as situation analysis, pattern recognition, and systems thinking, and challenges, such as cognitive load and competencies, material and pedagogical design, teacher and student expectations, technology and digital literacy, feedback and assessment, information overload, interdisciplinary and critical thinking skills, and the nature of literacy.

The established eligibility and exclusion criteria parameter was designed to verify that the articles chosen met the review framework. Table 3 outlines these criteria.

Table 3. *The eligibility and exclusion criteria*

Criterion	***Eligibility***	***Exclusion***
Literature Type	- *Journal article*	- *Book* - *Book section/chapter* - *Conference Proceedings.*
Scope	- *The availability of cognitive competencies in digital English reading materials (critical thinking, problem-solving, creativity and innovation, situation analysis, decision-making, pattern recognition, and systems thinking).* - *The challenges in developing the cognitive competencies in digital English reading materials (problems or difficulties in developing the cognitive competencies).*	- *It only explains the definition of cognitive competency in general.* - *The study only concentrates on and describes the types of digital reading in general.*
Language used	- *English*	- *Non-English*
Year	- *Between 2019 and 2023*	- *Before 2019*

The search keywords for the academic paper are as follows:

Table 4. Search keywords

Keywords
The availability of cognitive competencies in digital English reading materials (digital reading, digital English reading, critical thinking, critical reading, cognitive demands, cognitive abilities, cognitive competence, information processing, comprehension process, creativity, decision-making, visual processing, process of recognizing patterns).
The challenges in developing the cognitive competencies in digital English reading materials (problems and difficulties in developing the cognitive competencies or improving reading skills; cognitive load, material or pedagogical design, feedback and assessment, information overload, interdisciplinary and critical thinking skills, and the nature of literacy).

Selecting trustworthy and relevant articles is critical to ensure data accuracy and reliability. Search keywords and exclusion criteria are used to narrow the focus of the study. For articles partially included in the evaluation, only relevant information is retrieved for quality assessment; otherwise, they are excluded. This method is essential for obtaining precise results during data extraction. Table 2 shows the questions used in the article selection process.

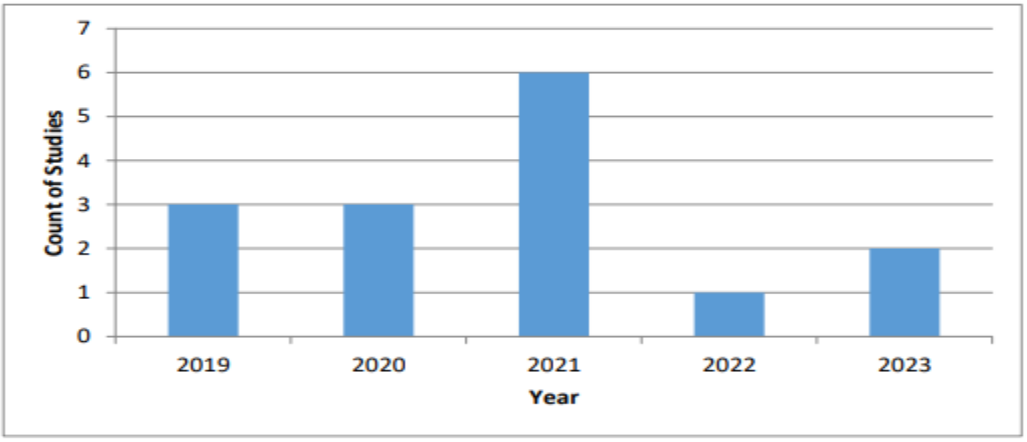
RESULT AND DISCUSSION

Result

The research findings are separated into two categories to address the two research questions. The following results relate to the availability of cognitive competencies in digital English reading materials and the challenges in developing these competencies.

Availability of cognitive competencies

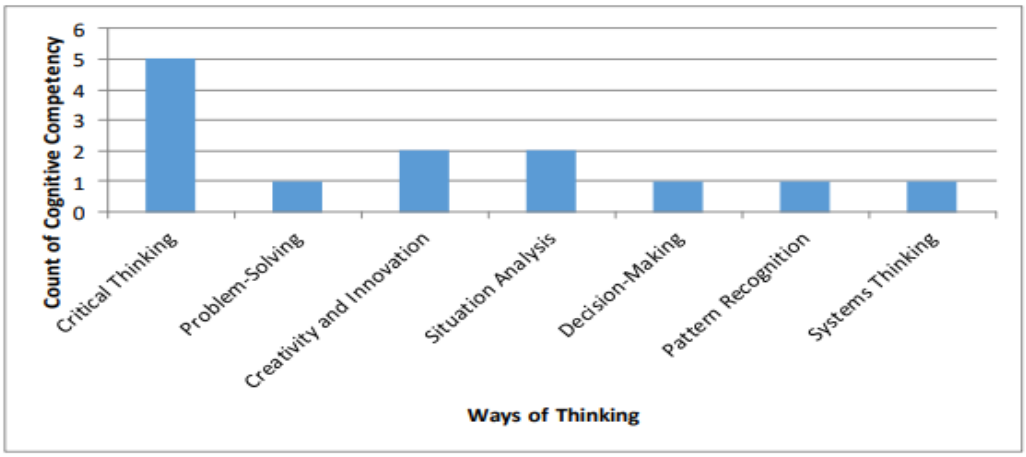
Graphics 1 presents the findings of the first research question regarding the availability of cognitive competencies in digital English reading materials, followed by a discussion on this topic. The cognitive competencies in Table 6 include critical thinking, problem-solving, creativity and innovation, decision-making (Binkley et al., 2010), situation analysis, pattern recognition, and systems thinking (Boyatzis, 2008).



Graphics 1. *Availability of cognitive competencies by year*

Graphics 2 shows the exploration of cognitive competencies across various studies from 2019 to 2023, emphasizing their role in digital reading and learning contexts. Several authors highlight specific competencies such as decision-making and visual processing (Pardede, 2019), creativity (Anggraeni & Pentury, 2020), and critical thinking alongside academic self-efficacy (Mhlongo et al., 2023). Others focus on comprehension and active cognitive engagement, such as building cognitive maps (Yu et al., 2022) and using digital tools to develop additional skills and dispositions (Yamaç & Öztürk, 2019). Coiro (2020) underscores multidimensional processing skills like memory, self-regulation, and critical evaluation. Interactive approaches, such as multimedia

(Fitrawati et al., 2023) and digital comics (Damopolii et al., 2021), enhance cognitive learning outcomes. While some studies remain silent on specific competencies, the data underscores the diversity and evolving nature of cognitive skill development in digital education.



Graphics 2. *Cognitive competencies breakdown by ways of thinking*

The data in Graphics 2 highlights how different cognitive competencies are interconnected with distinct ways of thinking. Critical thinking is one key competency connected to academic achievement, self-efficacy, and a deep engagement with information. Attending to, remembering, tracking, assessing, integrating, and synthesizing information are all part of this engagement. Additionally, it has been demonstrated that using dynamic reading materials and interactive multimedia increases student motivation and interaction while promoting the growth of logical and cognitive abilities, particularly critical thinking. The significance of the comprehension process within the larger Ways of Thinking category is further supported by the fact that it is closely linked to situation analysis and, crucially, critical thinking.

Decision-making and problem-solving have connections, especially when it comes to digital texts. These texts' cognitive demands call for both visual processing and decision-making abilities. This implies that students must be able to make decisions and decipher visual cues to navigate and comprehend digital information. This link emphasizes how crucial effective decision-making and visual literacy are in a digital learning environment.

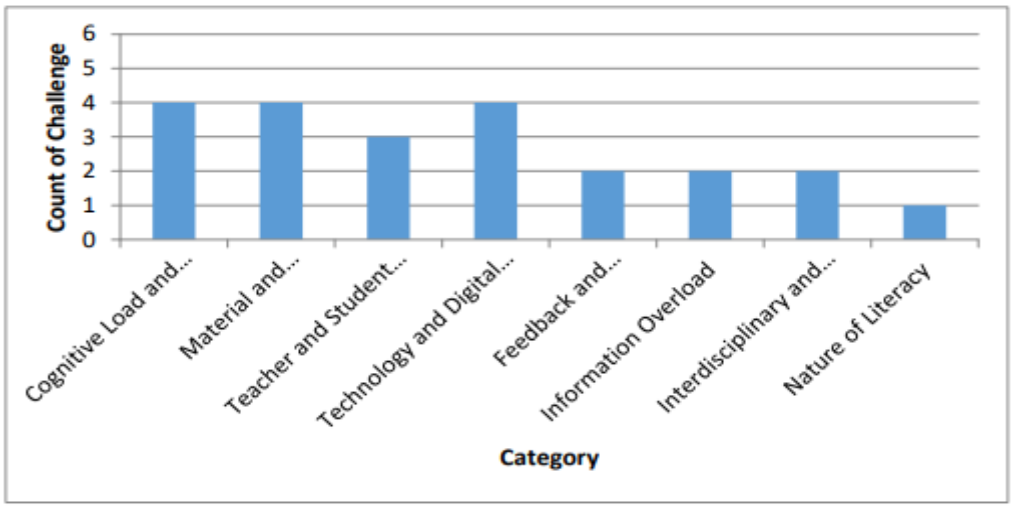
Cognitive competencies are closely tied to creativity, innovation, and critical thinking, with digital comics playing a role in enhancing cognitive learning outcomes. Using images in

comics stimulates creativity and supports cognitive growth by fostering active meaning-construction processes. Moreover, creating a cognitive map of the text emphasizes the situation analysis closely linked to comprehension and critical thinking, highlighting the importance of analytical abilities in understanding complex situations.

Graphics 3 concludes by discussing pattern recognition and how it relates to self-directed learning in digital settings. It highlights the significance of metacognition, awareness, and self-regulation in digital learning by implying that autonomous learning in these settings cultivates the ability to identify patterns in learning behaviors. However, the study cited in the table did not associate systems thinking with any particular cognitive competency.

Challenges in developing cognitive competencies in digital English reading materials

The following table presents the findings for the second research question, highlighting the challenges in developing cognitive competencies. The categorized challenges include cognitive load and competencies, material and pedagogical design, teacher and student expectations, technology and digital literacy, feedback and assessment, information overload, interdisciplinary and critical thinking skills, and the nature of literacy. The category was created through an analysis aimed at grouping similar items and concepts identified in the journal articles, which helped organize and better understand the challenges presented in the results.



Graphics 3. *Challenges in developing cognitive competencies by category*

The data in Graphics 3 points out some significant challenges to the growth of cognitive abilities. "Cognitive Load and Competencies," a notable category, draws attention to problems consisting of cognitive overload, its troubling impact on reading comprehension, the difficulty of integrating digital technology, and the difficulty of developing efficient digital toolboxes. These ideas highlight how crucial it is to create learning activities that reduce unnecessary cognitive load and offer precise instructions on using digital resources. The challenges posed by advanced digital tools and the creation of a "digital toolbox" point to the necessity of more user-friendly interfaces and focused instruction on the efficient use of technology for education.

Another notable category is "Material and Pedagogical Design," which highlights issues with a lack of personalized resources, the intricacy of interactive e-book designs, the requirement for ingenuity when creating picture book applications that use digital storytelling techniques, and the incompatibility of technology and pedagogy. These difficulties highlight the necessity of relevant, high-quality learning resources adapted to meet individual learning requirements. Digital learning materials must also be pedagogically sound and easy for technology to support rather than undermine learning objectives. The focus on creativity in picture book app development suggests new strategies are required to get younger students interested in digital media.

Significant issues are also raised by "Teacher and Student Expectations," such as the disparity between what teachers expect and what students do, the necessity of helping teachers become more creative, and the significance of preparing students for Industry 4.0's demands for flexibility and ongoing learning. These difficulties show how important it is for educators to incorporate technology into the classroom successfully and how important it is to provide professional development opportunities that encourage creativity and an awareness of the demands of the contemporary workplace. Students must be prepared for the quickly changing landscape of Industry 4.0 by being given the technical know-how, flexibility, and capacity for lifelong learning necessary to succeed in a changing environment.

Further challenges are identified within the "Technology and Digital Literacy categories," which encompass the lack of digital literacy promotion, technology inequality, difficulty keeping pace with technological advancements, and the integration of ICT skills. These challenges

highlight the significance of addressing the digital divide, encouraging digital literacy among educators, and offering continual training to guarantee that teachers are proficient with emerging technologies. The effective use of technology for teaching and learning is just as important as simply utilizing it.

Other categories include "Interdisciplinary and Critical Thinking Skills," which emphasizes the need to foster interdisciplinary competencies and strengthen critical thinking; "Information Overload," which addresses the problems of information overload and its consequences as a result of rapid technological advancements; "Feedback and Assessment," which highlights the deficiency of feedback and effective assessment strategies; and, lastly, "Nature of Literacy," which highlights the difficulty of defining and understanding the changing nature of literacy itself. These areas highlight the significance of giving students insightful feedback, creating suitable evaluation techniques for online learning environments, controlling the wealth of online information, encouraging critical thinking and interdisciplinary approaches, and adjusting to the evolving definitions of literacy in the digital age.

Discussion

Researchers have generally discussed and described cognitive abilities in academic discourse, primarily focusing on mathematics, engineering, and cognitive technologies. However, the presence of cognitive competencies within English reading, particularly in digital English reading materials, has not been explicitly explored and has been lacking in previous research. Despite this gap, this review indicates that particular cognitive abilities are present in digital English reading materials. The studies selected after the inclusion process revealed these materials' integration of critical thinking, problem-solving, creativity and innovation, situation analysis, decision-making, and pattern recognition. Studies focus on providing more support for the idea that individualized instruction or multimedia helps students learn independently, decreases cognitive load, and increases motivation, which could benefit cognitive development.

A study discussing the involvement of digital tools in enhancing or influencing cognitive abilities explains that personalized electronic reading lessons can reduce cognitive load (Liman Kaban & Karadeniz, 2021). Another study states that electronic learning requires students to learn

independently to develop cognitive abilities (K. et al., 2019). Fitrawati et al. (2023) added that direct interaction with critical reading materials using interactive multimedia can increase student motivation, encourage peer interaction, and develop logical thinking and cognitive abilities. As a type of reading material, comics can be used as digital content in learning to optimize cognitive learning outcomes. Damopolii et al. (2021) found that comic images help students build cognitive abilities. These studies demonstrate how various digital reading resources and tools, including multimedia, comics, and personalized lessons, make students more motivated, independent, and cognitively skilled.

The availability of cognitive abilities is also a process that can vary based on the terms defined by the researcher, as explained by Yamaç and Öztürk (2019) about the comprehension process, which is part of cognitive competence that brings out skills and strategies through the development of students' digital skills by using various technological tools and applications. Meanwhile, Yu et al. (2022)) noted that cognitive competence is found through the active meaning construction process by building a cognitive map of a text. This suggests that researchers have different definitions and interpretations of cognitive competence concerning digital reading and learning processes.

Coiro, (2020) outlines five distinct cognitive processes that may impact an individual's comprehension of digital spaces. These processes include paying attention to and remembering information, monitoring and controlling one's comprehension, analyzing it critically for various goals, integrating and synthesizing it, and processing it deeply. Comprehending the five cognitive processes that Coiro (2020) identifies provides a foundational structure for enhancing comprehension in digital environments. Several challenges must be investigated to develop these cognitive competencies in digital English reading materials effectively.

Researchers encounter various challenges in this objective, affecting the ability to foster these cognitive processes. For instance, discrepancies between teachers' expectations regarding strategy use and the actual actions of students can lead to a disconnect that inhibits effective cognitive engagement. Furthermore, reading comprehension may be reduced by the additional cognitive load that digital formats impose, making it challenging for students to fully engage in the cognitive processes meant to improve their understanding. Additionally, these difficulties are

made more difficult by the possibility of cognitive overload, which further complicates the learning process (Reiber-Kuijpers et al., 2021; Pardede, 2019; Fitrawati et al., 2023). These issues imply that supporting cognitive processes in a digital learning environment demands thoughtful consideration of how misplaced expectations and cognitive load affect students' learning. In order to maximize the benefits of digital learning, researchers need to address these obstacles.

Several key processes are involved in developing cognitive abilities, such as creating a digital toolbox, designing an interactive e-book with engaging and compelling interactive elements, and developing picture book apps. These tasks require technical expertise and the involvement of competent designers to enhance story comprehension (Anggraeni & Pentury, 2020; Karakoç Öztürk, 2021; Furenes et al., 2021). Another challenge is fostering teachers' creativity (Damopolii et al., 2021). To fully elevate students' cognitive skills, teachers must be actively involved in the process and possess strong technical and design skills alongside creativity.

Potential challenges were also noted by Yamaç and Öztürk (2019), including technology inequality, information overload, keeping pace with technology advancements, promoting digital literacy, balancing technology and pedagogy, and implementing effective assessment strategies. It can be inferred that tremendous cognitive effort leads to a more substantial mental construction of text meaning (Yu et al., 2022). Several key points were highlighted, such as integrating ICT skills, reinforcing critical thinking, promoting interdisciplinary competencies, and preparing students for Industry 4.0 (Ridho et al., 2021). The difficulties mentioned include technology-related, the requirement for more in-depth cognitive interaction with digital texts, and the acquisition of skills required for upcoming industries. This data indicates that in order to promote and encourage digital literacy and cognitive development effectively, these barriers must be addressed.

In addition to the challenges, some inhibiting factors of e-learning can be a challenge in developing cognitive competence, such as technical problems, poor internet connection, challenges to keep students motivated, and lack of learning independence in students (K. et al., 2019b). One of the outcomes of technology-enabled activities is the habit of 'scrolling,' which presents a challenge. While scrolling is necessary for accessing multimodal texts in digital tools, studies show that students perform poorly on digital tests (Støle et al., 2020). If this is the case,

digital reading materials should be used further to develop proficient cognitive abilities such as reading comprehension.

These challenges that arise in developing cognitive abilities have several ways of overcoming them, as in the study by Liman Kaban and Karadeniz (2021), that providing customized materials reduces cognitive load, provides feedback, and meets student needs. Digital transformation has led to the establishment of new and innovative teaching and learning methods. Students should be equipped to utilize smart gadgets to enhance their reading, learning, comprehension, and focus. However, as technology develops rapidly, it is becoming increasingly difficult to define and understand literacy as it involves interacting with multimedia, online sources, and social media. These changes impact research, policy, and practice (Mhlongo et al., 2023; Coiro, 2020). This occurs in the classroom, where teachers must adjust to new teaching strategies. Updates to educational standards are necessary due to the impact on policy, and researchers are researching how digital literacy is defined and assessed in a technological environment that is changing quickly.

These changes in practice, policy, and research are related to the development of cognitive competencies. Integrating cognitive competencies, including creativity, problem-solving, and critical thinking, becomes crucial as teachers adjust to new teaching pedagogies. While academic research focuses on how these cognitive skills are effectively developed in a digital context, policy updates may reflect the need to promote these competencies within the curriculum. Understanding how digital tools improve cognitive abilities will shape future educational practices. This has the potential to ensure that students are prepared to succeed in the digital world, especially in professional settings.

Five studies included in this review (Reiber-Kuijpers et al., 2021; Karakoç Öztürk, 2021; Støle et al., 2020; Liman Kaban & Karadeniz, 2021; and Furenes et al., 2021)—addressed the challenges of developing cognitive skills but did not integrate them into the materials. Understanding how cognitive competencies are integrated into digital resources is essential for optimizing language learning and identifying obstacles. By identifying these challenges, potential solutions can be proposed to fill gaps and maximize resource development for future use. This emphasizes the importance of more research on integrating cognitive competencies into digital content. It is vital

to comprehend the barriers to this integration, including pedagogical approaches, technological constraints, or design limitations.

CONCLUSION AND SUGGESTION

This research underscores that cognitive competencies are part of critical thinking and involve individuals' mental processes and abilities to think, learn, and solve problems. By imparting cognitive skills to digital English reading materials, it can provide students with an engaging and dynamic learning experience beyond conventional methods, equipping them for the cognitive demands of the 21st century. This research has identified an understanding of the landscape surrounding the availability of cognitive competencies in digital English reading materials and the challenges that must be addressed for effective development. This implies the significance of teaching English as a foreign language (EFL) to students to help them acquire the digital literacy skills necessary to meet the demands of a digital society and strong reading abilities that enable them to process, comprehend, and retain information efficiently.

The research concludes that cognitive competencies within digital English reading materials include critical thinking, problem-solving, creativity and innovation, situation analysis, decision-making, and pattern recognition. Additionally, cognitive competencies are involved in terms of improving cognitive abilities through the use of digital learning tools. However, the research reveals that fully integrating cognitive competencies into digital reading materials is still in development.

Managing cognitive load, creating appropriate materials, integrating digital tools into pedagogy, meeting teacher and student expectations, advancing digital literacy, and improving assessment techniques are some challenges to developing these competencies. Future research should concentrate on experimental studies to evaluate the successful integration of cognitive competencies in various educational contexts to address these issues. Educators and stakeholders should work together to develop well-designed digital materials that encourage interdisciplinary thinking and critical literacy skills to ensure that students are adequately prepared for the multifaceted nature of the digital world.

Limitation

This study's limitations should be acknowledged despite its valuable insights. Although cognitive competencies are identified, their application in specific educational contexts is not fully explored, and detailed strategies for incorporating them into digital reading materials are also not provided. The reliance on a Systematic Literature Review (SLR) limits the findings to existing data, potentially overlooking emerging trends or unrecorded practical applications. Experimental or mixed-method approaches could yield more profound insights, and action research involving educators and students in iterative cycles could help refine strategies for integrating cognitive competencies effectively.

Implication

Based on the research findings, the implications can be drawn in the following explanation. Policymakers should encourage professional development initiatives that improve teachers' proficiency with digital resources and cognitive-based reading strategies. Reading materials should include personalized and interactive components that encourage critical thinking and problem-solving to address cognitive load concerns. Given the need to integrate various definitions of cognitive competencies in digital reading contexts, the study also highlights the necessity of a thorough theoretical framework. For future research, conducting experimental studies is strongly recommended to evaluate the effectiveness of integrating cognitive competencies into digital reading materials and their impact on learning outcomes.

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APPENDICES

Availability of cognitive competencies

No.	Authors	Availability of Cognitive Competencies	Year
1.	Manon Reiber-Kuijpers, Marijke Kral, Paulien Meijer	-	2021
2.	Parlindungan Pardede	Cognitive demands in the structure of digital texts include two cognitive competencies: decision-making and visual processing.	2019
3.	Anastasia Dewi Anggraeni, Helda Jolanda Pentury	Cognitive competencies discussed elements of creativity.	2020
4.	Ayşegül Liman Kaban, Sirin Karadeniz	-	2021
5.	Ahmet Yamaç, Ergün Öztürk	The comprehension process, part of the cognitive competencies in the internet environment discussed in this study, gives rise to additional skills, strategies, and dispositions by developing students' digital skills using various technological tools and applications.	2019
6.	Başak Karakoç Öztürk	-	2021
7.	Jie Yu, Xing Zhou, Xiaoming Yang, Jie Hu	Cognitive competence is covered through an active meaning construction process by building a cognitive map of the text.	2022
8.	Kassymova G. K., Duisenbayeva Sh. S., Adilbayeva U. B., Khalenova A. R., Kosherbayeva A. N., Triyono M. B., Sangilbayev O. S.	In general, cognitive competencies discuss that electronic learning requires students to learn independently and allows them to develop cognitive competence.	2019
9.	Hildegunn Støle, Anne Mangen, Knut Schwippert	-	2020
10.	Siyabonga Mhlongo, Khanyisile Mbatha,	The specific cognitive competencies discussed in this research are critical thinking, academic self-efficacy,	2023

	Boitumelo Ramatsetse, Reuben Dlamini	and academic achievement.	
11.	Julie Coiro	Attending to and remembering information, monitoring and self-regulating those in understanding, critically evaluating information for multiple purposes, integrating and synthesizing information, and processing information deeply.	2020
12.	Fitrawati, Hermawati Syarif, M. Zaim, David D. Perrodin	The immersion process with dynamic reading material through interactive multimedia boosts student motivation, encourages student interaction, and allows students to develop the required logical and cognitive competencies.	2023
13.	Insar Damopolii, Theresia Lumembang, Genç Osman İlhan	Digital comics as digital reading materials applied in the learning process provide optimal results to improve students' cognitive learning outcomes. Images in the comics help students build their cognitive abilities.	2021
14.	Shofwan Ridho, Sri Wardani, Sigit Saptono	The product developed is effectively used to improve critical thinking skills.	2021
15.	May Irene Furenes, Natalia Kucirkova, Adriana G. Bus	-	2021

Cognitive competencies breakdown

No.	Ways of Thinking	Cognitive Competency
1.	Critical Thinking	- Critical thinking, academic self-efficacy, and academic achievement. - Attending to and remembering information, monitoring and self-regulating those in understanding, critically evaluating information for multiple purposes, integrating and synthesizing information, and processing information deeply. - The immersion process with dynamic reading material through interactive multimedia boosts student motivation, encourages student interaction, and allows students to develop the required logical and cognitive competencies. - The product developed is effectively used to improve critical thinking skills. - The comprehension process is associated with many

		competencies, particularly situation analysis and critical thinking, which are part of the Ways of Thinking Category.
2.	Problem-Solving	- Cognitive demands in the structure of digital texts include two cognitive competencies: decision-making and visual processing.
3.	Creativity and Innovation	- Cognitive competencies discussed elements of creativity. - Digital comics, as digital reading materials applied in the learning process, provide optimal results to improve students' cognitive learning outcomes. Images in the comics help students build their cognitive abilities.
4.	Situation Analysis	- Cognitive competence is covered through an active meaning construction process by building a cognitive map of the text. - The comprehension process is associated with several competencies, particularly situation analysis and critical thinking, which are part of the Ways of Thinking Category.
5.	Decision-Making	- Cognitive demands in the structure of digital texts include two cognitive competencies: decision-making and visual processing.
6.	Pattern Recognition	- Electronic learning requires students to learn independently and allows them to develop cognitive competence. This point suggests self-directed learning and the capacity to recognize patterns in learning behaviors.
7.	Systems Thinking	- The previously mentioned study did not identify any particular cognitive competency.

Challenges in developing cognitive competencies

No.	Authors	Challenges in Developing Cognitive Competencies	Year
1.	Manon Reiber-Kuijpers, Marijke Kral, Paulien Meijer	There are discrepancies in teachers' expectations regarding strategies and students' actions.	2021
2.	Parlindungan Pardede	There is a supplementary cognitive load that sequentially reduces reading comprehension performance.	2019
3.	Anastasia Dewi Anggraeni, Helda Jolanda Pentury	The challenge in developing cognitive competence is making the digital toolbox, as described in this study, an integral part of the English program, particularly	2020

		in the reading program.	
4.	Ayşegül Liman Kaban, Sirin Karadeniz	Cognitive load is a challenge in electronic reading lessons.	2021
5.	Ahmet Yamaç, Ergün Öztürk	Potential challenges include: - Technology inequality - Information overload - Keeping up with technology - Promoting digital literacy - Balancing technology and pedagogy - Implementing effective assessment strategies	2019
6.	Başak Karakoç Öztürk	The challenge is that designing an interactive e-book with engaging and compelling interactive elements can be complicated.	2021
7.	Jie Yu, Xing Zhou, Xiaoming Yang, Jie Hu	The mental construction of text meaning may require more cognitive effort.	2022
8.	Kassymova G. K., Duisenbayeva Sh. S., Adilbayeva U. B., Khalenova A. R., Kosherbayeva A. N., Triyono M. B., Sangilbayev O. S.	Several inhibiting factors of e-learning can be a challenge in developing cognitive competence, such as technical problems, poor internet connection, challenges to keeping students motivated, and lack of learning independence in students.	2019
9.	Hildegunn Støle, Anne Mangen, Knut Schwippert	Complex cognitive skills such as reading comprehension should be further developed in digital reading materials because "scrolling" is a challenge on digital devices.	2020
10.	Siyabonga Mhlongo, Khanyisile Mbatha, Boitumelo Ramatsetse, Reuben Dlamini	Awareness of pedagogical understanding in education is the key to overcoming the challenges of integrating digital technology and the internet.	2023
11.	Julie Coiro	The rapid evolution of technology makes it difficult to establish and comprehend the nature of literacy and the potential consequences of these adjustments for practice, policy, and research.	2020
12.	Fitrawati, Hermawati Syarif, M. Zaim, David D. Perrodin	If multimedia components are not well planned, they can cause cognitive overload. Controlling the quantity and complexity of interactive features is essential to prevent students from becoming overwhelmed and unable to concentrate on critical reading.	2023
13.	Insar Damopolii,	The challenge in developing cognitive competence	2021

	Theresia Lumembang, Genç Osman İlhan	lies in developing the creative sense in teachers.	
14.	Shofwan Ridho, Sri Wardani, Sigit Saptono	The challenges of developing cognitive competence highlighted several points, including integrating ICT skills, reinforcing critical thinking, promoting interdisciplinary competencies, and preparing students for the continuous growth of learning and adaptability in Industry 4.0.	2021
15.	May Irene Furenes, Natalia Kucirkova, Adriana G. Bus	It takes not only an author and illustrator to create picture book apps with new digital storytelling techniques but also skilled designers who are creative in figuring out how to help children and stimulate their interest in what will happen while they read it.	2021

Challenges breakdown

No.	Category	Challenge
1.	Cognitive Load and Competencies	- Cognitive overload - Additional cognitive load lowering reading comprehension - Complex cognitive skills in integrating digital technology - Developing cognitive competencies in making a digital toolbox
2.	Material and Pedagogical Design	- Lack of customized materials - Complex design of interactive e-books - Creativity in creating picture book apps with digital storytelling techniques for children - No balance between technology and pedagogy
3.	Teacher and Student Expectations	- Discrepancies between teachers' expectations and students' actions - Developing a creative sense in teachers - Preparing students for continuous learning and adaptability in Industry 4.0
4.	Technology and Digital Literacy	- Lack of digital literacy promotion - Technology inequality - Difficulty in staying current with technology - Integration of ICT skills

5.	Feedback and Assessment	- Lack of feedback - No effective assessment strategies
6.	Information Overload	- Information overload - Implications for due to rapid technological advances
7.	Interdisciplinary and Critical Thinking Skills	- Reinforcing critical thinking - Promoting interdisciplinary competencies
8.	Nature of Literacy	- Defining and comprehending the nature of literacy