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When stories go digital: Designing children's reading for pleasure in digital storybooks

Quando le storie diventano digitali: progettare la lettura per piacere dei bambini nei libri narrativi digitali

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Abstract. This critical literature review examines recent research on the pedagogical, cognitive, and usability dimensions of digital storybooks, with the aim of identifying evidence-based criteria for coherent and engaging narrative design. Drawing on cognitive load and multimedia learning theories, it analyses how personalisation, interactivity, and multimedia features can support comprehension, motivation, and narrative engagement while preserving narrative flow. The review highlights how design choices shape children's reading for pleasure and broader literacy experiences, and discusses the educational potential of digital books as narrative spaces that foster authorship and narrative agency. The article concludes by offering pedagogically informed guidance for teachers and parents on selecting and using digital storybooks in age-appropriate ways.

Keywords: e-storybooks, reading for pleasure, narrative experience, design.

Riassunto. Questo articolo presenta una revisione critica della letteratura recente sulle dimensioni pedagogiche, cognitive e di usabilità dei libri narrativi digitali, con l'obiettivo di individuare criteri fondati su evidenze empiriche per un design narrativo coerente e coinvolgente. Facendo riferimento alla teoria del carico cognitivo e alla teoria dell'apprendimento multimediale, il contributo analizza come personalizzazione, interattività e funzionalità multimediali possano sostenere comprensione, motivazione e coinvolgimento narrativo, preservando il flusso della narrazione. La rassegna mette in luce come le scelte di design influenzino la lettura per piacere e le più ampie esperienze di alfabetizzazione dei bambini, e discute il potenziale educativo dei libri digitali come spazi narrativi capaci di favorire autorialità e agentività narrativa. L'articolo si conclude offrendo indicazioni pedagogicamente fondate per insegnanti e genitori sulla scelta e l'uso dei libri narrativi digitali in forme adeguate all'età.

Parole chiave: libri narrativi digitali, lettura per piacere, esperienza narrativa, design.

INTRODUCTION

Recent international surveys highlight a marked decline in reading for pleasure among children and adolescents (Cremin & Scholes, 2024). In the United Kingdom, the National Literacy Trust reported in 2024, through its Annual Literacy Survey, «by far the lowest level of reading enjoyment» (Clark et al., 2024, p. 2) since monitoring began in 2005, describing the findings as «shocking and dispiriting» (p. 29). The 2025 survey confirmed this trend, expressing particular concern about the rapid decline in reading enjoyment among younger children, given that early positive experiences form the foundation for lifelong reading habits (Clark et al., 2025).

At the same time, a substantial body of research shows that growing up in families rich in book-related cultural stimuli is associated with higher educational outcomes, with effects extending into adulthood (Georgiou & Inoue, 2025). Children exposed early to reading-supportive environments tend to show advantages in language development, reading skills, and motivation (Hayes et al., 2025). Parents' reading habits (Loh & Sun, 2020), access to books in the home (Sikora et al., 2019), and shared reading practices (Noble et al., 2019) are among the strongest predictors of literacy development and sustained interest in reading. Access to books is also associated with more frequent reading and more positive attitudes toward reading (Clark & Poulton, 2011), while parental modelling of reading enjoyment plays a key role in shaping children's motivation (Cremin & McGeown, 2025; OECD, 2021). However, many children still lack early access to high-quality picture books (Cole et al., 2022), and changes in family routines have reduced shared reading practices (Stangeland et al., 2024).

Within this context, digital books are frequently identified as a promising resource for mitigating educational disparities, as they can reduce children's reliance on parental mediation and literacy-related support (Bus et al., 2025; Xu et al., 2022). This potential is particularly salient for children from low-literacy or socioeconomically disadvantaged backgrounds, for whom digital formats may enable meaningful reading experiences even when adult support is limited (Egert et al., 2022; López-Escribano et al., 2021; Liu, 2024). E-books have also been shown to motivate reluctant readers and children with reading difficulties, including in independent reading contexts (Kucirkova et al., 2023; Xu et al., 2022). When well designed and equipped with appropriate scaffolding features, e-books and talking e-books can support reading engagement and early literacy development by enabling autonomous access to narrative content (Dore et al., 2018).

Alongside print books, families now have access to a wide range of digital formats, from e-books and narrative apps to transmedia storytelling, immersive experiences, and AI-mediated compositions, which are reshaping both story forms and the reader's role within the reading experience (Mascia et al., 2026). Early reading experiences increasingly take place through educational apps and e-storybooks (Müller-Brauers et al., 2020; Sari et al., 2019), supported by the growing availability of children's content on mobile devices (Bus et al., 2020). Over the past two decades, these resources have evolved from simple digital replicas of print books into complex multimedia environments combining narration, animation, interactivity, adaptive feedback, and augmented reality (Müller-Brauers et al., 2020; Wang, 2022). Their diffusion has raised expectations regarding their potential to support both reading for pleasure and learning, making digital stories a central topic in educational research (Kucirkova & Kümmerling-Meibauer, 2021; Wu & Amzah, 2023).

Meta-analyses and systematic reviews indicate that e-books grounded in cognitive principles can foster emergent literacy, vocabulary, and comprehension (Bus et al., 2025; Chuang & Jamiat, 2023; Furenes et al., 2021; Liu, 2024; López-Escribano et al., 2021; Savva et al., 2022). However, findings remain mixed: while some digital books enhance motivation and comprehension, others fragment narrative flow or encourage superficial interaction (Bus et al., 2020; Kucirkova, 2017b). Parents similarly express ambivalent attitudes, acknowledging the motivational potential of e-books while voicing concerns about content quality, distraction, and screen exposure, and often preferring print books for shared reading practices (Kucirkova & Flewitt, 2022; Strouse & Ganea, 2017).

Despite their potential, many commercial digital books continue to exhibit shortcomings in content and design. International studies report pedagogical weaknesses (Sari et al., 2019; Meyer et al., 2021) and limited narrative scaffolding comparable to skilled adult support (Furenes et al., 2021). The diversity of digital formats further complicates evaluation and makes it difficult for educators and parents to identify high-quality products (Bus et al., 2020). Standardized design guidelines remain scarce (Çirakoğlu et al., 2022), as do robust evaluative frameworks (Kucirkova, 2017a), while scholars increasingly stress the need for user-centred approaches that actively involve children in the design process (Sylla et al., 2022).

Although research on children's digital books has expanded into a multidisciplinary and methodologically diverse field (Kim & Hassinger-Das, 2019; Kucirkova, 2019), evidence on children's actual reading experiences

with digital narratives remains limited, and empirical studies examining how multimodality and interactivity shape narrative comprehension are still relatively scarce (Schwabe et al., 2022). As a result, much remains unknown about how children experience digital literature and how this medium may contribute to, or even enhance, the pleasures of reading (Kucirkova & Kümmerling-Meibauer, 2021). Against this backdrop, the present article examines how digital narrative books influence children's literary experience. Its aims are twofold: first, to investigate the impact of narrative e-books on story comprehension, attention, engagement, and adult-child interaction; and second, to outline evidence-based principles to inform the design of effective digital narrative books.

1. THEORETICAL FRAMEWORK

1.1 Design principles for digital storybooks

The design of engaging, immersive, and meaningful narrative experiences can draw on several theoretical frameworks that, although not developed specifically for digital storybooks, offer principles and design criteria highly relevant to this context. These include Cognitive Load Theory (Sweller et al., 2019), Dual Coding Theory (Paivio, 1986), Cognitive Theory of Multimedia Learning (Mayer, 2022; 2024), and the Cognitive-Affective Theory of Learning with Media (Moreno & Mayer, 2007). An expanding body of research draws on these perspectives to inform the design of effective e-books and digital narrative experiences (Altun, 2024; Bali et al., 2025; Li & Bus, 2023; Liang et al., 2025).

Cognitive Load Theory (CLT) provides a foundational account of how learning is constrained by the limited capacity of working memory, the cognitive system responsible for the temporary maintenance and manipulation of information required to perform a task (Baddeley et al., 2021). Learning effectiveness depends on both the amount and the nature of the cognitive load imposed on the learner: when demands exceed available resources, overload occurs, undermining efficient processing (Sweller et al., 2019; Sweller, 2020). Narrative comprehension relies heavily on working memory, as readers must continuously construct and update a coherent mental representation by linking information, generating inferences, and integrating new content with prior knowledge (van den Broek & Kendeou, 2022). When reading tasks impose excessive cognitive load – particularly extraneous load caused by suboptimal design – comprehension efficiency declines, leading to weaker narrative understanding and poorer integration of information (Brüggemann et al., 2023; Paas & van Merriënboer, 2020).

Because working memory capacity is limited, effective narrative design must focus on reducing unnecessary cognitive demands. Minimising extraneous load allows cognitive resources to be devoted to essential processing and integration with long-term memory. This underscores the importance of avoiding superfluous design elements – such as redundant graphics, disorganised layouts, or unintuitive navigation – that distract attention and impair comprehension. Conversely, well-designed digital storybooks can reduce extraneous load and support more efficient processing (Bali et al., 2025; Li et al., 2023). In electronic books, multimedia and interactive features may increase working memory demands, while in print the absence of supportive cues may require greater adult mediation. In both cases, learning effectiveness depends on the overall cognitive load imposed by the format and the text, particularly given children's limited attentional capacity (Kim & Hassinger-Das, 2019; Richter & Courage, 2017).

While CLT explains why cognitive overload occurs, Dual Coding Theory (DCT) clarifies how information can be processed more efficiently. DCT posits two interconnected processing systems: a verbal system for language and sounds, and a nonverbal system for visual information such as images and animations (Paivio, 1986). Distributing information across these channels can reduce pressure on any single system and support more efficient working memory use. Applied to digital stories, this perspective suggests that coherent integration of verbal and visual information facilitates narrative comprehension. Empirical evidence shows that children understand stories more effectively when text and images are meaningfully coordinated (Verhallen & Bus, 2011). Both print and digital formats can support dual coding; however, in e-books this potential is amplified – or undermined – by the quality and relevance of multimedia features (Kim & Hassinger-Das, 2019).

Building on these premises, the Cognitive Theory of Multimedia Learning (CTML) explains how words and images can be combined to foster meaningful learning in multimedia environments (Mayer, 2021). CTML rests on three core assumptions: dual processing channels, limited working memory capacity, and active cognitive processing. Learning is most effective when learners actively select relevant information, organise it into coherent mental representations, and integrate it with prior knowledge (Mayer, 2024). Research in multimedia learning has identified design principles aimed at reducing extraneous cognitive load and preserving resources for processing intrinsic complexity (Fiorella & Mayer, 2022). Applied to digital books, these principles suggest that multimedia elements are beneficial only when inten-

tionally integrated, carefully calibrated, and narratively coherent. Learning outcomes are generally enhanced when information presented across modalities is overlapping or complementary – for example, when written words are paired with congruent images or spoken narration is supported by text. However, these benefits may also entail cognitive costs. Dividing attention across multiple information sources can generate attentional competition, particularly when information is conveyed through the same sensory modality, potentially undermining comprehension (Liao et al., 2024; Sweller et al., 2019). Consistently, studies on digital book reading show that multimedia enhancements support comprehension only when they are purposefully designed and narratively aligned, whereas superfluous features tend to hinder understanding (Furenes et al., 2021).

Finally, the Cognitive-Affective Theory of Learning with Media (CATLM) extends CTML by incorporating emotional, motivational, and metacognitive dimensions of learning (Moreno & Mayer, 2007). Motivation and affect influence how learners allocate attention and cognitive resources, shaping selection, organisation, and integration processes. Well-designed multimedia environments can foster interest and engagement, helping to offset cognitive demands and support learning-relevant effort. From this perspective, e-books enriched with engaging yet carefully designed multimedia features may sustain children's motivation to read and support deeper engagement with narrative content (Li et al., 2023).

Taken together, these theories provide a coherent framework for designing digital narrative experiences in which multimedia elements support comprehension and engagement without overloading working memory (Fiorella & Mayer, 2022; see Table 1)¹.

1.2 The importance of reading for pleasure

Over the past fifteen years, the work of Teresa Cremin and the Open University research group in the United Kingdom has profoundly influenced educational discourse and practice around reading, foregrounding the central role of reading for pleasure (RfP). Their research has contributed to a reconceptualisation of

reading not merely as a curricular requirement, but as a meaningful, self-directed, and socially situated practice (Cremin & McGeown, 2025).

The concept of reading for pleasure is closely related to reading enjoyment and is described in the literature through a range of partially overlapping terms, including recreational reading, leisure reading, volitional reading, free voluntary reading, independent self-selected reading, and voluntary reading. Despite this terminological diversity, these expressions converge on a shared core meaning: reading undertaken by choice rather than obligation. Reading for pleasure is commonly defined as «reading that we do of our own free will, anticipating the satisfaction that we will get from the act of reading» (Clark & Rumbold, 2006, p. 6), emphasising the intrinsic motivation and enjoyment that characterise this activity.

A substantial body of evidence documents the positive effects of reading for pleasure across both short- and long-term outcomes. In the short term, it is associated with improvements in reading comprehension, vocabulary development, empathy, social skills, and wellbeing; in the long term, it supports the development of confident, skilled readers and contributes to overall academic success (Cremin & Scholes, 2024). Research consistently demonstrates a clear relationship between reading enjoyment, reading motivation, reading frequency, and reading achievement (Hamedi et al., 2020; Hebbeker et al., 2019; Lindorff et al., 2023; Toste et al., 2020; Torppa et al., 2020): children who enjoy reading tend to read more often and in greater volume, which strengthens comprehension skills and, in turn, further enhances reading enjoyment. Over time, sustained engagement with texts also leads readers to encounter increasingly complex material, reinforcing literacy development in a cumulative manner (Toste et al., 2020).

Reading for pleasure also plays a mediating role with respect to gender and socio-economic disparities: high levels of interest and motivation can attenuate the gender gap – where girls typically report higher engagement – and reduce differences between students who are able to cultivate reading practices at home and those from less advantaged backgrounds (OECD, 2021). Indeed, reading enjoyment has been shown to be a stronger predictor of academic success than socio-economic background alone (Clark & Rumbold, 2006).

Notably, research highlights the specific and particularly strong role of narrative reading within this association between reading practices and young people's educational outcomes (Jerrim & Moss, 2019). This may be due to the fact that reading narrative texts typically requires sustained time and perseverance, involves deep cognitive and emotional engagement, and places

¹ Alongside these theoretical frameworks, the Universal Design for Learning (UDL) provides an approach aimed at making narrative experiences more inclusive and accessible by addressing the variability in learners' abilities, cultural backgrounds, experiences, and languages. E-books designed according to UDL facilitate access to narrative content and increase students' motivation and enjoyment. For children with specific educational needs, features such as self-paced reading, content repetition, immediate narrator feedback, dialogic prompts, and motivational scaffolds can support attention and engagement.

Table 1. Adapting the fifteen multimedia learning principles to children's digital storybook design (from Mayer, 2021).

N.	Principle	Description	Adaptation to the e-storybook context
1	Multimedia principle	People learn better from words and pictures than from words alone.	Integrate written text, illustrations, and audio narration to support narrative comprehension and vocabulary development.
2	Coherence principle	People learn better when extraneous material is excluded rather than included.	Exclude decorative animations, sounds, or interactive elements that do not contribute to narrative meaning or comprehension.
3	Signaling principle	People learn better when cues are added that highlight the organization of essential material.	Use subtle visual or auditory cues to guide attention toward key characters, events, or linguistically relevant elements.
4	Redundancy principle	People do not learn better when printed text is added to graphics and narration.	Avoid verbatim duplication of written text and audio narration, except when redundancy serves explicit literacy-support functions.
5	Spatial contiguity principle	People learn better when corresponding words and pictures are presented near rather than far from each other.	Place written text in close proximity to the illustrated elements it refers to.
6	Temporal contiguity principle	People learn better when corresponding words and pictures are presented simultaneously rather than successively.	Synchronize audio narration with the appearance of relevant images or animations.
7	Segmenting principle	People learn better when content is presented in user-paced segments rather than as a continuous unit.	Structure the story into short, user-controlled scenes or pages.
8	Pre-training principle	People learn better when they know the names and characteristics of key concepts in advance.	Introduce characters, settings, or key vocabulary before the narrative unfolds.
9	Modality principle	People learn better from graphics and narration than from graphics and on-screen text.	Favor oral narration combined with images over dense on-screen text, especially for emergent readers.
10	Personalization principle	People learn better when words are presented in a conversational rather than formal style.	Use a warm, engaging, and age-appropriate narrative voice.
11	Voice principle	People learn better when narration is spoken in a friendly human voice rather than a machine voice.	Employ expressive, natural human voices suited to children.
12	Image principle	People do not necessarily learn better when the speaker's image is added to the screen.	Avoid visual representations of narrators that may distract from the story world.
13	Embodiment principle	People learn more deeply when the onscreen instructor displays high rather than low embodiment.	Use expressive character movements and gestures to convey emotions and actions relevant to the narrative.
14	Immersion principle	People do not necessarily learn better in immersive 3D virtual environments than in corresponding 2D presentations.	Limit immersive or highly realistic effects that may disrupt narrative coherence or increase cognitive load.
15	Generative activity principle	People learn better when they are guided to engage in generative learning activities.	Include prompts that encourage prediction, reflection, or meaning-making without interrupting narrative flow.

significant demands on readers' attentional resources. Studies further show that narratives evoke emotions and activate memories that resonate with readers' personal experiences, helping them establish meaningful connections and fostering deeper engagement, which in turn often stimulates further voluntary reading practices (Kuzmičová & Cremin, 2022).

1.3 The importance of narrative

In literary theory, communication studies, and psychology, the term *narrativity* is used as an umbrella concept encompassing the set of characteristics that distin-

guish narrative texts from other text types, such as expository, argumentative, or descriptive texts. Narration, however, is not merely an expressive form; rather, it constitutes a fundamental cognitive tool through which human beings make sense of the world and of themselves. As argued by Bruner, life can be understood as a flow of events involving characters, actions, and objects situated within spatio-temporal contexts, in which the self assumes the role of the main protagonist (Bruner, 2004). From this perspective, narrative identity theory, developed within the cognitive sciences, posits that individuals construct their identities in the form of stories. Through an ongoing process of internal reworking, facts and experiences are organised into a coherent autobiographical

narrative that enables individuals to attribute meaning to lived experience. Humans do not simply undergo experiences; rather, they structure and recount them in order to make sense of them. A coherent and meaningful self-narrative is therefore crucial for personal identity and for a sense of self-continuity (Lee et al., 2020).

Within this contribution, the focus is placed on reading for pleasure, with particular attention to narrative engagement, while acknowledging that, in the context of digital books, narratives are often presented in ways that differ from traditional print or illustrated storytelling. Without disregarding the importance of pedagogical reflections on how to promote reading for pleasure in formal educational contexts, the present work foregrounds children's personal and social engagement with narrative in digital books.

As shown by Gottschall and Oatley, the human inclination to create and interpret stories is not merely a learned skill but a deeply rooted feature of our species. From an evolutionary perspective, narratives provide an adaptive advantage by functioning as a kind of simulator that prepares individuals for the complexities of life. Narrative fiction has been described as «an ancient virtual reality technology that specializes in simulating human problems» (Gottschall, 2012, p. 59). Through stories, individuals can explore dilemmas, emotions, and consequences within a safe environment. Narratives thus allow humans to simulate social experiences, learn from past events, and imagine possible futures, enabling them to engage with situations in a vicarious manner. In this sense, immersion in narrative worlds can be understood as a form of experiential learning, with potential implications for real-life understanding and behaviour (Mar & Oatley, 2008).

Narrative provides a privileged context for the development of perspective-taking, empathy, and socio-emotional skills (Kidd & Castano, 2013). In particular, it fosters affective empathy, the ability to feel what another person feels, and Theory of Mind (ToM), understood as the capacity to anticipate and interpret others' perspectives and mental states (Hogan, 2018). Within this framework, identification occurs when readers imaginatively adopt the viewpoint of story characters, experiencing their emotions, sensations, goals, and intentions (Mar & Oatley, 2008). This emotional involvement arises from the mental simulation of narrative events, through which readers internally model characters' experiences and actions (Busselle & Bilandzic, 2009). Engagement with narrative fiction can thus be understood as a form of cognitive and emotional simulation of social experience that enhances perspective-taking and role-taking skills, regardless of medium

or fictionality (Mar & Oatley, 2008). Neurocognitive evidence supports these effects: mechanisms of embodied simulation and mirroring enable readers to mentally simulate actions and emotions described in the text, fostering empathic identification (Gallese & Morelli, 2024), while neuroimaging studies show that narrative reading activates brain regions associated with empathy and theory of mind (Mar, 2011).

2. METHOD

2.1 Research design

This study adopts a structured qualitative literature review design aimed at identifying, selecting, and synthesising research on children's digital storybooks, with particular attention to the relationship between design features and narrative-related outcomes. The review focuses on how formal and interactive characteristics of digital storybooks shape children's comprehension, engagement, reading experience, and adult-child shared reading.

The review combined an exploratory phase and a focused analytical phase. Google Scholar was used initially to map the field, identify recurrent descriptors, thematic clusters, and seminal contributions. Targeted searches were then conducted in major academic databases and publisher archives, including Scopus, Web of Science, ERIC, Taylor & Francis Online, Wiley Online Library, SAGE Journals, Elsevier PsycInfo, Education Research Complete, APA PsycInfo, APA PsycArticles, Medline, PubMed, and related education and social science databases.

The review did not aim at a statistical meta-analysis. Instead, it was designed as a structured qualitative synthesis of a heterogeneous body of literature, making the search, selection, and synthesis procedures as explicit as possible (Grant & Booth, 2009; Snyder, 2019; Baethge et al., 2019). Greater weight was assigned to meta-analyses, systematic reviews, and methodologically rigorous experimental studies, while smaller-scale studies were retained when they offered specific insight into design mechanisms, reading processes, or narrative engagement (OCEBM, 2011).

2.2 Research questions

The review was guided by the following research questions:

- RQ1. Which design features of children's digital storybooks are most frequently associated with differences in narrative comprehension, engagement, and reading pleasure?

- RQ2. How are these features conceptualised and operationalised across the empirical and review literature?
- RQ3. Under which reading conditions, particularly in relation to adult-child interaction and shared reading practices, do digital storybooks appear to support or hinder children's narrative experience?

No formal hypotheses were tested statistically. However, the analysis was guided by two working assumptions derived from the theoretical framework: first, that digital storybooks are more likely to support comprehension and engagement when multimodal and interactive features are congruent with the narrative structure and do not create excessive extraneous cognitive load; second, that the educational value of these features depends on the reading situation, including adult guidance, mode of interaction, and broader contextual conditions.

2.3 Search strategy and eligibility criteria

The search strategy was developed progressively in order to preserve conceptual breadth while delimiting the field. Search terms covered four main areas: digital reading formats and devices; design-related features of children's digital books, such as interactivity, navigation, animation, and multimedia support; relational and experiential dimensions, including shared reading, dialogic reading, and narrative engagement; and outcome variables such as reading comprehension, story comprehension, narrative immersion, and reading engagement. Population terms included child, preschool children, kindergarten, and early primary-school readers. Terms were combined through Boolean operators and applied to titles, abstracts, and keywords.

To complement database searches, open-access repositories, institutional archives, and conference proceedings were also examined when they offered sufficient methodological transparency and direct relevance to the review aims.

Studies were included if they were published between January 2010 and January 2025; focused on children in preschool, kindergarten, or early primary school; addressed digital storybooks and outcomes related to narrative comprehension, engagement, recall or retelling, or adult-child interaction; and provided adequate methodological transparency. Priority was given to meta-analyses, systematic or critical reviews, and experimental or quasi-experimental studies linking design features to narrative-related outcomes.

Studies were excluded if they focused primarily on isolated literacy skills, such as vocabulary acquisition, decoding, or general literacy outcomes, without explic-

it connection to narrative design or reading processes within digital storybooks; if they focused on adolescents or adults; if they addressed digital devices or screen-based activities without a specific focus on digital storybooks; or if they lacked sufficient methodological clarity for analytical comparison.

2.4 Final corpus and analytic dimensions

The search process led to the consultation of 110 records. After screening and eligibility assessment, 32 peer-reviewed studies were retained for the final corpus, including 10 reviews, 15 experimental studies, and 7 quasi-experimental or observational studies. Among the empirical studies, the main subgroups concerned comparisons between print and digital storybooks, comparisons between enhanced and non-enhanced e-books, and studies focusing on specific design features or shared reading conditions.

Cross-study comparison led to the identification of four recurrent analytic dimensions: multimodality, text interactivity, medium affordances, and the reading situation. These dimensions were not imposed a priori, but emerged as the most consistent lenses through which digital storybook design was conceptualised, operationalised, and linked to children's reading processes. The synthesis is therefore presented thematically rather than study by study, and Section 3 is organised around these four dimensions in order to highlight recurrent patterns, convergences, and differences across the selected studies.

3. DESIGN GUIDELINES FOR CHILDREN'S DIGITAL STORYBOOKS

Children's books – whether print, audiobooks, or simple and enhanced e-books – present both external features, immediately perceptible (weight, portability, page-turning mechanisms), and internal features tied to graphic design, degrees of interactivity, and embedded multimedia (Kucirkova, 2017a; Kim & Hassinger-Das, 2019). Reading experiences are also shaped by interface characteristics and by the material affordances of different devices (Mangen & Kuiken, 2014). In digital books and narrative apps, these affordances can be understood along four main dimensions:

- *multimodal text*, integrating dynamic images, sounds, and activities aligned with the storyline;
- *interactive text*, involving the reader's ability to access additional information or receive feedback;
- *the medium*, conceived both in contrast with print and as a set of embodied possibilities and alternative

pathways enabled by the device;

- *the reading situation*, shaped by screen-sharing practices, rereading opportunities, and the influence of prior knowledge.

Each of these dimensions is examined in the following sections.

3.1 Affordances of multimodality

The meaning-making potential of a storybook or picturebook can be understood in terms of semiotic affordances, namely the expressive possibilities offered by the modes involved in meaning construction. Digital narratives retain key conventions of traditional storytelling while extending them through the coordinated interplay of multiple semiotic modes, giving rise to multimodal ensembles – integrated configurations of resources that jointly produce meaning. From this perspective, multimodality is not a simple juxtaposition of codes, but a process of orchestration in which modes interact in semiotic harmony. Multimodal reading therefore requires readers to process information across distinct semiotic systems, each characterised by specific affordances and constraints (Kress, 2010). Meaning does not reside in any single mode; rather, it emerges from the relationships among modes, generating a semantic richness that exceeds the sum of individual components. Well-designed digital picture books exemplify this process by integrating verbal narration and images in complementary ways, thereby enriching the textual experience and supporting deeper story comprehension (Bus et al., 2020; Müller-Brauers et al., 2020).

Animations can strengthen the narrative by highlighting relevant details, introducing dialogue, or extending character actions (Bus & Anstadt, 2021; Li et al., 2023). Such features can guide attention to key information, enhance immersion (Sun et al., 2022), and facilitate the integration of visuals and narration (Christ et al., 2019; Furenes et al., 2021; Yeari et al., 2024). They may also clarify implicit meanings, supporting inferences about causal relations and characters' emotions, thoughts, and goals (Yeari et al., 2024), thereby improving comprehension and recall (Altun, 2021; Korat et al., 2022a). Animations that illustrate key narrative actions can support lexical and narrative comprehension more effectively than static visuals, contributing in particular to expressive vocabulary development (Korat et al., 2022a; Sun et al., 2019).

Digital features such as integrated supports, multimodal elements, animations, zooming functions, and interactive dictionaries can enhance the appeal of stories by making them more stimulating and engaging

(Li & Bus, 2023). These features have been shown to increase children's attention, participation, enjoyment, and active involvement in meaning-making processes (Richter & Courage, 2017; Strouse & Ganea, 2017). At the same time, children also report appreciating e-books even in the absence of such enhancements (Son et al., 2020; Richter & Courage, 2017). In particular, self-narrated books with integrated read-aloud functions appear especially attractive to young readers, supporting both engagement and accessibility (Dore et al., 2018). Moreover, e-books that include exploratory or creative opportunities may foster intrinsic motivation, while personalised and collaborative formats that support co-creation between children and caregivers can further enhance positive engagement with texts (Kucirkova, 2017b).

However, the benefits of multimedia are not guaranteed. Digital picture books often include rich multimedia elements that attract attention and interest, yet meta-analyses report only modest and inconsistent effects on comprehension (Chuang & Jamiat, 2023; Savva et al., 2022). Redundant or overly dense multimedia can distract children and undermine understanding (Bali et al., 2023; López-Escribano et al., 2021). When e-stories contain too many features, managing them while following the storyline can overload working memory and disrupt comprehension (Altun, 2021; Ma et al., 2024). Excessive multimedia density may also fragment narrative continuity and create temporal mismatches that impede integration and memory. Animations, in particular, may introduce an additional layer of problem-solving, challenging preschoolers who are still developing the skills required to integrate complex information (Liang et al., 2025).

Coherence is therefore crucial. Animations that are aligned with narrative progression support processing (Li et al., 2023; Müller-Brauers et al., 2020), whereas decorative embellishments – the so-called «bells and whistles» – can undermine comprehension (Bus et al., 2015; Li & Bus, 2023). A recent meta-analysis on non-independent readers showed that printed books outperformed minimally enhanced digital books in comprehension, whereas no differences emerged when digital enrichments were coherent with the narrative (Furenes et al., 2021).

Temporal synchronisation across modes is equally important. According to the temporal contiguity principle, presenting verbal and visual information simultaneously supports meaning-making and reduces cognitive load, while spatial contiguity recommends placing text near the relevant image. When visuals and words appear together, with text synchronised to audio narration, children are better able to maintain focus and narrative coherence (Long et al., 2018). Coordinating audio with

Table 2. Multimedia design principles for children's digital storybooks.

Category	Design principle	References
Multimedia integration	Integrate words, images, and narration to support meaning-making	Fiorella & Mayer, 2022; Bus et al., 2020; Li & Bus, 2023
Coherence	Remove non-essential elements that increase cognitive load	Bus et al., 2015; Sweller et al., 2019; Altun, 2021; Bali et al., 2023; Son & Butcher, 2024
Signaling	Guide attention to relevant information	Christ et al., 2019; Yeari et al., 2024
Spatial – temporal contiguity	Align text, images, and narration in space and time	Long et al., 2018; Liu et al., 2022
Semiotic orchestration	Coordinate multiple modes without redundancy	Kress, 2010; Kucirkova, 2017a
Meaningful enrichment	Use animations, sounds, and music to clarify narrative content	Bus & Anstadt, 2021; Li et al., 2023; Furenes et al., 2021; Altun, 2024
Avoid redundancy	Avoid unnecessary overlap between text, audio, and animation	Bus et al., 2015; López-Escribano et al., 2021; Ma et al., 2024; Sweller, 2020

visuals is essential for keeping attention aligned with the unfolding story, a condition that appears more easily achieved with automated than with user-controlled features (Liu et al., 2022).

Audio elements such as sounds and music add a further layer of complexity. When appropriately integrated, they can enhance attention, convey emotional tone, and foster empathic engagement (Altun, 2024). However, they may also overload the auditory channel and hinder language processing, particularly for younger children and for those with language difficulties (Sari et al., 2019).

Despite these challenges, multimedia features can be particularly supportive for children with limited background knowledge – a major predictor of comprehension (Wexler, 2025). Picture books often contain vocabulary and syntactic structures that go beyond everyday exposure (Montag et al., 2015), and well-designed multimedia can provide parallel nonverbal representations that help children follow the storyline despite linguistic demands (Bus et al., 2015).

Finally, the balance between multimedia and interactivity emerges as a critical design issue. E-books that include multimedia elements such as audio, music, and animations often outperform print books in terms of vocabulary and comprehension, but this advantage tends to disappear when interactive features are added. Children understand stories better in multimedia-only e-books than in hybrid versions that combine multimedia and interactivity (Liang et al., 2025), underscoring the need for careful calibration of design features (see Table 2).

3.2 Affordances of interactivity

Reading is inherently interactive, as readers actively construct meaning through cognitive, emotional, senso-

ry, and embodied resources (Rosenblatt, 1978). However, interactivity takes different forms in print and digital narratives. Digital storybooks can extend engagement through animations, sound effects, and features such as audio narration, highlighting, hotspots, feedback, and creative tools, potentially “bringing stories to life” (Kucirkova & Flewitt, 2022). The extent to which these affordances support narrative coherence and comprehension, however, varies widely².

Early generations of story apps often embedded playful interactions weakly connected to the storyline, frequently undermining literacy goals (Bus et al., 2021). Although more recent designs increasingly prioritise narrative-relevant interactivity, legacy features such as hotspots remain widespread despite limited evidence of effectiveness (Bus et al., 2025). Empirical findings therefore remain mixed. Some studies report benefits for comprehension and knowledge acquisition (Bali et al., 2023; Son et al., 2020), and interactive apps may guide attention more effectively than static e-books or print texts (Korat et al., 2022b; Sun et al., 2019). When carefully designed, questions and hotspots can highlight essential information, activate prior knowledge, scaffold inference and provide clarification (Bus & Anstadt, 2021).

At the same time, these benefits are highly contingent on design quality. Poorly aligned or excessive interactivity can distract from the storyline, increase cognitive load, and impair comprehension and recall (Bus et

² A well-known example illustrates this distinction. *The Fantastic Flying Books of Mr. Morris Lessmore*, though aesthetically sophisticated, includes playful activities only loosely tied to the narrative, which can divert attention from the story. In contrast, *The Prank in the Forest* integrates coherent exploratory features – such as letting children insert their own emotional selfies into the characters – making the story more personally meaningful and reinforcing both immersion and the links between text and images (see Vackova et al., 2023).

al., 2021; Furenes et al., 2021; Ma et al., 2024; Son & Butcher, 2024). The type and function of interactivity are therefore critical. Hotspots are beneficial only when narratively coherent and explicitly tied to learning goals (Christ et al., 2019; Li & Bus, 2023; Korat et al., 2022b), while personalisation and well-aligned exploratory tools may foster deeper engagement (Abdelhadi, 2020; Kucirkova, 2017b). Unstructured interaction, by contrast, often increases distraction.

Recent evidence clarifies this ambivalence by showing that enjoyment mediates the relationship between cognitive load and reading outcomes. Cai et al. (2024) show that reading achievement is maximised when cognitive load is perceived as manageable and optimally challenging, whereas both overload and underload reduce enjoyment and performance. Interactivity thus supports comprehension only when cognitive demands are balanced with narrative pleasure.

These dynamics are particularly consequential for young children, whose attentional resources are limited. Unaligned hotspots and game-like elements are especially disruptive when stories are unfamiliar (Furenes et al., 2021; Long et al., 2018). A mismatch between narrative content and interactivity elevates cognitive load, fragments processing, and weakens encoding, retelling, and comprehension (Lim et al., 2021). Conversely, close alignment between narrative and interaction lowers the cognitive cost of shifting between modes (Chuang & Jamiat, 2023).

Accordingly, scholars stress the need to calibrate interactivity to children's developmental level and expertise (Bali et al., 2023; Vackova et al., 2023). The expertise-reversal principle shows that supports helpful for novices may become redundant or counterproductive for more advanced readers, as unnecessary guidance increases cognitive load (Kalyuga, 2007). Interactivity should therefore offer appropriate "opportunities for action" aligned with readers' skills and competences (Colombo & Landoni, 2014; see Table 3)³.

In recreational reading, optimal engagement occurs when readers «lose themselves in a book», becoming so absorbed that time fades from awareness (Green, 2021). This experience closely resembles the concept of flow⁴ (Csikszentmihalyi, 2008) and overlaps with relat-

ed constructs such as «narrative absorption», «narrative immersion», «narrative presence», and «narrative transportation» (Hakemulder et al., 2017). Flow not only enhances reading pleasure but also supports presence, identification, suspense, cognitive involvement, and comprehension (Thissen et al., 2021). In digital storybooks, read-aloud narration and well-integrated multimedia features may further increase transportation and help children regulate pacing in line with their processing speed (Bus & Anstadt, 2021; Colombo & Landoni, 2014).

Narrative engagement depends on emotional immersion, aesthetic appreciation, and empathic alignment with characters through identification and perspective-taking (Busselle & Bilandzic, 2009; Mar & Oatley, 2008). According to Busselle and Bilandzic, immersion relies on mental simulation of narrative events and collapses when inconsistencies or violations of the fictional world's logic disrupt this process. Interactive stories should therefore avoid elements that conflict with narrative coherence or users' world knowledge.

Unlike multimedia elements synchronised with narrative progression, interactive functions are user-controlled and may diverge from the storyline, increasing cognitive load. Interactive narratives must therefore negotiate the "narrative paradox" between authorial control and user agency. While agency can enhance engagement, excessive or poorly structured control may undermine coherence and immersion: unpredictable navigation, frequent task-switching, and even narrative-relevant prompts can interrupt cognitive flow (Bus et al., 2021; Bus et al., 2025). By contrast, accessible interfaces, narrative-driven interaction, and segmented, learner-controlled pacing support both comprehension and immersion, in line with the segmenting principle (Bus & Anstadt, 2021).

3.3 Affordances of the medium

Recent syntheses comparing print and digital reading show that the medium can influence comprehension and consistently report a «screen inferiority effect» for complex informational texts: under comparable conditions, comprehension is typically higher on paper. This pattern emerges across ages, educational levels, and languages, and is particularly pronounced among novice

³ A recent study on beginning readers found that comprehension of narrative and informational texts was higher in digital reading and among children with stronger word-reading skills. Comprehension was lower for less skilled readers in the digital condition but became comparable across digital and print formats as word-reading ability increased; children with more advanced decoding skills showed no disadvantage when reading on screen rather than on paper (Florit et al., 2023).

⁴ Flow is a mental state of deep enjoyment and intense involvement in an activity, during which most attentional resources are focused on its execution. It is marked by total immersion, heightened concentration,

a sense of control, reduced self-awareness, and an altered perception of time. Flow arises when challenge and skill are balanced, goals are clear, feedback is immediate, and the activity is autotelic-intrinsically rewarding and able to sustain internal motivation.

Table 3. Interactivity design principles for children's digital storybooks.

Category	Design principle	References
Meaningful interaction	Use interactions that enhance comprehension and direct attention to key information	Kucirkova, 2018; Vackova et al., 2023; Bus et al., 2015
Narrative congruence	Ensure hotspots, animations, and prompts align strictly with the storyline	Bus et al., 2025; Lim et al., 2021; Christ et al., 2019
Scaffolding – clarification	Provide contextual guidance, activate prior knowledge, and offer clarifying information	Bus & Anstadt, 2021; Revelle et al., 2019
Developmental calibration	Adjust the amount and type of interactivity to children's attentional and cognitive capacities	Bali et al., 2023; Furenes et al., 2021; Chuang & Jamiat, 2023
Flow support	Maintain smooth pacing, minimise task switching, and avoid interruptions that break immersion	Bus et al., 2020, 2025; Thissen et al., 2021
User control	Allow children to regulate pacing to reduce cognitive load	Colombo & Landoni, 2014; Vackova et al., 2023; Son et al., 2020

readers, in time-limited tasks, and especially for expository texts (see Nardi, 2026).

This print advantage, however, does not extend to narrative texts. Studies generally report no disadvantage for narrative comprehension in digital formats (Delgado & Salmerón, 2021; Schwabe et al., 2022). Narratives appear to mitigate many of the typical drawbacks associated with screen reading because they provide setting, plot, thematic continuity, and emotional structure, resulting in greater cohesion, concreteness, and lower cognitive demands (Mar et al., 2021). Evidence suggests that narrative structure constitutes a particularly effective format for human information processing: information embedded in stories is remembered more accurately and for longer periods (Lee et al., 2020). In narratives, a greater number of connective markers and stronger temporal cohesion, along with their emotional dimension, foster deeper engagement and more accurate information processing (Hamedí et al., 2020). By contrast, informational texts rely more heavily on specialised vocabulary, abstraction, and prior knowledge, making them cognitively demanding (Hebert et al., 2016; Lorch, 2017).

These genre differences help explain why narrative reading often yields higher comprehension than expository reading (Mar et al., 2021). From a cognitive and experiential perspective, narratives tend to activate an “aesthetic” mode of reading rather than the “efferent” mode typical of informational texts (Rosenblatt, 1978). Narrative comprehension involves tracking plot development, identifying characters, generating inferences, and integrating information across the story. Meaning emerges through an active, constructive process shaped by the interaction between text, reader, context, and medium. A sufficient degree of narrativity supports fluent comprehension, facilitates transportation into the story world, and elicits emotional responses that pro-

mote deeper engagement and more elaborative processing (Hamedí et al., 2020). Immersion, in turn, reduces awareness of the reading medium and encourages a content-focused reading mode, helping to explain why narratives are less sensitive to medium effects (Schwabe et al., 2021).

At the same time, this immersive potential is also what digital technologies are most likely to disrupt. Narrative immersion typically entails a temporary suspension of awareness of both the external world and the material support of reading (Mangen & Kuiken, 2014). Screen-based reading, by contrast, may promote a form of “distracted immersivity”, whereby interaction with the device repeatedly interrupts narrative flow and increases awareness of the medium itself. This effect is further amplified in mobile reading contexts, where reading often takes place on the move and in short, fragmented sessions, undermining the continuity of the narrative experience (Kuzmičová et al., 2020). In such cases, readers may “use” books rather than read them (Baron, 2021), and “lose themselves in the device” rather than in the narrative. Research suggests that rich interfaces do not necessarily enhance engagement; rather, reduced and well-regulated interaction can better support narrative transportation (Mangen & Kuiken, 2014). Effective digital design must therefore balance engagement and unobtrusiveness, allowing for limited, manageable distractions from which readers can easily re-enter the narrative flow (see Table 4).

Despite these challenges, research on e-books and narrative skill development generally reports positive effects (Furenes et al., 2021). Recent syntheses even point to a moderate digital advantage, though outcomes vary as a function of design quality, type of multimedia enhancement, and children's prior skills and experience with digital devices (Liang et al., 2025).

Table 4. Medium-related design principles for digital storybook reading.

Category	Design principle	References
Screen vs. paper	Consider reduced tactile and spatial cues when reading on screens, which may affect orientation and absorption.	Mangen & Kuiken, 2014; Baron, 2021
Cognitive load	Minimise visual and interactive complexity to avoid overload, especially in informational texts.	Furenes et al., 2021; Schwabe et al., 2022
Genre effect	Use narrative structure to compensate for digital constraints, as narrative cohesion supports comprehension on screens.	Delgado & Salmerón, 2021; Schwabe et al., 2021; Mar et al., 2021
Immersion – absorption	Support uninterrupted immersion by limiting distractions that pull attention toward the device rather than the story.	Mangen & Kuiken, 2014; Kuzmičová et al., 2020
Interface transparency	Ensure the interface remains unobtrusive, avoiding excessive features that disrupt focus and narrative flow.	Baron, 2021; Bus et al., 2021; Mangen & Kuiken, 2014
Attentional focus	Reduce commands, menus, and interactive prompts that fragment attention and weaken narrative engagement.	Schwabe et al., 2022; Ma et al., 2024; Bus et al., 2020
Reader-device relation	Design to reduce “distracted immersion,” helping readers stay with the story rather than with the device.	Baron, 2021; Kuzmičová et al., 2020

While much of the literature has focused on cognitive outcomes, experiential dimensions such as emotional involvement and social engagement have only recently received systematic attention (Schwabe et al., 2021). Reviews that include these dimensions confirm that reading narratives on screen does not impair comprehension relative to print, highlighting the importance of genre and design in shaping digital reading experiences (Schwabe et al., 2022).

3.4 Affordances of the reading situation

For young children, reading typically takes place either as an adult-mediated activity or as exploratory, self-directed engagement, and both forms are now increasingly enacted in digital contexts (Kim & Hassinger-Das, 2019). Children may independently access narrated e-books, while shared print-reading practices are progressively migrating to electronic books enriched with touch-activated feedback (Nardi, 2016). Despite these shifts, shared reading with caregivers remains one of the most effective strategies for fostering emergent literacy and is associated with well-documented long-term developmental benefits (Noble et al., 2019).

A robust body of experimental research shows that caregiver–child interaction during reading is a key determinant of learning outcomes. Caregivers employ a range of strategies – including reading verbatim, expanding or personalising the text, and inventing storylines – and dialogic reading practices actively guide children’s meaning-making. Through communicative attunement and sustained shared thinking, adults modulate gestures, tone, and language in response to children’s cues. Questions, comments, and references to text and images draw

attention to salient information, clarify challenging passages, and connect narrative events to prior knowledge, thereby supporting comprehension, attention, and inferential skills (Müller-Brauers et al., 2020).

E-books can partially extend this scaffolding. Multimedia features may function as «electronic scaffolds» (McKenna, 1998), facilitating comprehension and vocabulary even in the absence of an adult (Furenes et al., 2021). In this sense, digital devices can act as mediational tools when interactions remain within the child’s zone of proximal development and are responsive to the child’s cues (Vygotskij, 1978). Some e-books include read-to-me functions that allow independent access (Dore et al., 2018), while others rely on parental mediation or hybrid narration. Self-directed reading gives children control over pacing, whereas system-controlled narration proceeds automatically. Certain digital books attempt to simulate dialogic dynamics through parasocial interactions with on-screen characters (Vackova et al., 2023), and interactive questions placed at key narrative points can emulate adult mediation and directly engage children (Revelle et al., 2019).

Evidence suggests that the most effective digital books integrate interactivity seamlessly with the narrative. Meta-analytic findings show that interactive affordances can enhance comprehension in ways comparable to adult scaffolding (Bus et al., 2015; see Table 5)). Some books incorporate interaction “blocks” that require children to perform the same action as the protagonist for the story to continue, improving comprehension and memory (Bus & Anstadt, 2021; Son et al., 2020). Mirroring characters’ actions may also foster perspective-taking and identification, further supporting narrative engagement (Bus et al., 2021; Zhao & Unsworth, 2017).

Table 5. Reading situation design principles for shared and independent digital storybook reading.

Category	Design principle	References
Shared reading	Support adult-child meaning-making through dialogue, questions, and references to text and images.	Noble et al., 2019; Strouse & Ganea, 2017
Scaffolding	Provide explanatory feedback, clarifications, and prompts that guide comprehension.	Furenes et al., 2021; Dore et al., 2018
Electronic scaffolds	Use multimedia features (e.g., narration, highlighting) as supports when adult mediation is limited.	McKenna, 1998; Furenes et al., 2021; Bus et al., 2015
Independent access	Allow children to read autonomously through read-to-me functions or user-controlled pacing.	Dore et al., 2018; Xu et al., 2022
Dialogic dynamics	Use embedded questions or parasocial interactions to emulate adult guidance.	Vackova et al., 2023; Revelle et al., 2019; Xu et al., 2022
Narrative-aligned interactivity	Integrate interactions that advance the storyline and deepen comprehension.	Bus et al., 2025; Bus et al., 2015; Lim et al., 2021
Embodied engagement	Encourage actions that mirror characters' behaviour to support identification and memory.	Bus & Anstadt, 2021; Son et al., 2020; Bus et al., 2021; Zhao & Unsworth, 2017; Gallese & Morelli, 2024
Hybrid adult-ebook mediation	Combine adult mediation with digital affordances to enhance comprehension, dialogue, and narrative processing	Nardi, 2016; Egert et al., 2022; Savva et al., 2022; Chuang & Jamiat, 2023

Reading aloud is inherently multisensory. In shared print reading, adults combine words and images with intonation, vocal effects, gestures, and embodied actions, such as knocking on the table to mimic a door or humming a fanfare. These interactions reinforce comprehension by engaging auditory, visual, and bodily modalities. Print books are typically used for social and relational purposes, fostering dialogue, shared attention, and rich communicative exchanges. By contrast, e-books are more often used primarily as entertainment tools, a pattern associated with fewer communicative interactions and reduced relational warmth and affective attunement (Yuill & Martin, 2016). Studies consistently show that print books elicit richer and more frequent adult-child dialogue than digital books (Strouse & Ganea, 2017; Munzer et al., 2019). During e-book reading, the adult's role often diminishes (López-Escribano et al., 2021), and comprehension support and dialogic exchanges become less frequent. Adults reading print books more often adopt meaning-oriented strategies, whereas digital reading prompts procedural comments such as «click here» or «turn the page» (Munzer et al., 2019). Highly enhanced e-books – especially those with features unrelated to the narrative – further reduce story-related talk and increase device-focused comments, leading to lower engagement and weaker comprehension (Nardi, 2016; Munzer et al., 2019).

Overall, evidence indicates that adult-supported e-book reading offers more benefits than independent use. The combination of adult mediation and digital affordances constitutes a particularly powerful asset (Egert et al., 2022; Korat et al., 2022a; Zhao & Un-

worth, 2017). The «e-book-plus-adult» configuration appears especially advantageous (Nardi, 2016), and recent meta-analytic evidence confirms that benefits increase when adults actively mediate interactive features (Chuang & Jamiat, 2023). In some cases, adult-supported digital reading even surpasses adult-supported print reading in its effects on comprehension (Savva et al., 2022).

Parental mediation is therefore decisive for supporting children's comprehension during e-book reading. When adults accompany digital reading with explanations, questions, and comments, children show improved understanding of plot structure, better integration of text and images, and more advanced interpretive strategies (Dore et al., 2018; Strouse et al., 2023). Well-designed hotspots can promote joint attention, highlight central themes, and encourage discussion, whereas poorly aligned ones risk diverting attention toward peripheral elements (Abdelhadi, 2020). Embedded questions should guide interpretation and prompt reflection, and immediate feedback should signal that the child's input has narrative consequences. When advanced e-book features are well designed, coherently integrated with the narrative, and aligned with instructional goals, they can support emotional and cognitive engagement at levels comparable to shared print reading and facilitate text comprehension (Clinton-Lisell et al., 2024). Ultimately, digital books that provide clear visual cues and narrative-aligned interactivity can sustain high-quality shared reading and dialogic exchanges comparable to those elicited by print (Liang et al., 2025; Strouse et al., 2023).

4. DISCUSSION

The narrative experience offered by children's digital books is not a by-product of technology but the outcome of deliberate design decisions. Choices such as the pacing of animations or the placement of hotspots shape how children construct meaning, sustain attention, and experience immersion. Multimedia and interactivity can enrich storytelling only when they are narratively coherent; otherwise, they risk disrupting comprehension and engagement. Accordingly, learning outcomes depend less on the mere presence of enhancements than on their quality and alignment with principles from multimedia learning, dual coding, and cognitive load theory (Bus et al., 2020; Mayer, 2021; Chuang & Jamiat, 2023).

Across studies, a recurring finding is that “more” is not necessarily “better.” A higher number of animations does not automatically improve comprehension or enjoyment. Evidence instead supports a calibrated approach in which a limited set of narratively relevant animations highlights key story events and is adjusted to text complexity and readers' skill levels; excessive or decorative animation can fragment attention and increase cognitive load, especially in more complex narratives (Son & Butcher, 2024). In this sense, effectiveness lies in narrative function rather than multimedia density.

More broadly, the literature converges on a core principle: e-books work best when narrative content, multimedia, and interactivity are integrated as a single coherent system (Bus et al., 2015; Chuang & Jamiat, 2023; Liang et al., 2025). Interactivity is most supportive when it scaffolds inference-making and narrative processing rather than operating as a parallel activity (Kucirkova, 2018). Likewise, multimedia features are beneficial when they function as embedded supports – narratively relevant illustrations, animations, sound effects, and music; temporal alignment between text, audio, and images; and restrictions of animation to essential story elements (Mayer, 2021; Long et al., 2018; Bus & Anstadt, 2021; Li et al., 2023). Conversely, seductive details, irrelevant visuals, incongruent audio, or mismatched emotional tone undermine comprehension by increasing extraneous load and breaking immersion (Schwabe et al., 2021, 2022; Chuang & Jamiat, 2023). Designers therefore need to evaluate whether each interactive element genuinely advances narrative understanding or primarily introduces extraneous stimulation (Liang et al., 2025).

Narrative coherence also depends on structural and interface choices. Story progression should remain predominantly linear and segmentable, with features that support event tracking and allow children to regulate

pacing (Chuang & Jamiat, 2023). Motivational elements appear most effective when they reinforce story engagement rather than compete with it through game-like mechanics (Mangen & Kuiken, 2014). From this perspective, the goal is to support flow and sustained narrative absorption, minimising task switching and interruptions that pull attention away from the story world (Colombo & Landoni, 2014; Thissen et al., 2021).

Taken together, available evidence suggests that digital reading does not disadvantage narrative comprehension and, when enhancements are carefully calibrated, may even support it. High-quality digital books combine narrative and educational value, meaningful multimodality, well-regulated interactivity, and targeted personalisation, avoiding one-size-fits-all solutions (Kucirkova, 2018; Vackova et al., 2023). Concrete design features illustrate how this can be achieved: dictionary tools are most effective when brief, visually linked, and embedded without interrupting narrative flow (Furenes et al., 2021); hotspots follow the same logic, hindering comprehension when irrelevant but supporting learning when they direct attention to key events or vocabulary (Christ et al., 2019; Lim et al., 2021; Bus et al., 2025). By contrast, games and non-narrative interactivity often reduce comprehension by inducing task switching and should be included only when narratively justified (Bus et al., 2021; Furenes et al., 2021; Ma et al., 2024; Son & Butcher, 2024). Interface design should therefore be treated as an integral part of the narrative experience: visually appealing, but unobtrusive and oriented toward immersion rather than distraction.

For these reasons, developing high-quality digital books benefits from collaboration among designers, child-development specialists, and digital literacy experts, and from interdisciplinary exchange across cognitive science, pedagogy, and media studies (Dore et al., 2018; Meyer et al., 2021; Egert et al., 2022; Kucirkova & Kümmerling-Meibauer, 2021). Moving beyond commercial strategies that prioritise attention-grabbing features, evidence-based design remains essential to ensure that digital storybooks offer narrative experiences that are inclusive, coherent, and educationally meaningful (Kucirkova, 2018).

5. LIMITATIONS AND FUTURE DIRECTIONS

This review has some limitations. First, because of the heterogeneity of digital formats, study designs, and outcome measures, it was conceived as a qualitative synthesis rather than as a statistical meta-analysis. The conclusions should therefore be read as evidence-informed

patterns rather than as effect-size estimates. Second, key constructs such as interactivity, engagement, and narrative comprehension are not operationalised consistently across studies, which limits direct comparability. The design principles proposed here should therefore be understood as empirically grounded guidelines rather than universally generalisable prescriptions.

These limitations also indicate directions for future research. As previously argued (Bus et al., 2025), studies should move beyond treating digital books as a homogeneous category and examine more closely the specific functionalities and design configurations that distinguish them. Research should also extend beyond cognitive outcomes to address experiential dimensions more systematically, including affective involvement, social interaction, and children's sense of narrative agency (Schwabe et al., 2021). In this respect, recent developments in artificial intelligence open new possibilities for adaptive scaffolding through personalised prompts, explanations, tutoring, and narrative extensions tailored to children's age and interests, while conversational agents may support dialogic reading by fostering inference-making and reflective engagement in ways comparable to adult mediation (Chen et al., 2025; Ratner et al., 2025). Future studies should therefore examine how AI-driven personalisation can be integrated into narrative apps in ethically and pedagogically sound ways, while preserving the integrity of the storytelling experience.

6. CONCLUSION

This article concludes that children's digital storybooks can support reading for pleasure only when narrative design is addressed as a pedagogical and experiential issue rather than as a technological enhancement in itself. Across cognitive load theory, dual coding, multimedia learning, and cognitive-affective perspectives, the evidence converges on a clear principle: comprehension, motivation, and immersion depend primarily on the narrative coherence and functional integration of multimedia features, not on their quantity. Digital elements are effective when they act as embedded supports for meaning-making, but they undermine narrative experience when they introduce competing sources of stimulation that fragment attention and disrupt flow. The review further indicates that medium effects are strongly genre-dependent. While complex informational texts are more susceptible to screen-related disadvantages, narrative texts are comparatively resilient, as narrative structure provides emotional engagement, cohesion, and a cognitively efficient format for processing and memory.

However, this resilience is fragile and can be compromised by poorly regulated interactivity, non-linear navigation, or interfaces that foreground the device over the story. Finally, the findings underscore that reading outcomes are shaped not only by interface design but also by reading context: shared reading remains central to emergent literacy, and adult mediation plays a critical role in amplifying the benefits of digital affordances, particularly when adults scaffold children's engagement with interactive features.

REFERENCES

- Abdelhadi, S. M. (2020). Responses to hotspots during parent-child shared reading of eBook. *International Journal of Child-Computer Interaction*, 23–24, Article 100164. <https://doi.org/10.1016/j.ijcci.2019.100164>
- Altun, D. (2021). Twice upon a mind: Preschoolers' narrative processing of electronic and printed stories. *Early Childhood Education Journal*, 49(2), 349–359. <https://doi.org/10.1007/s10643-020-01079-9>
- Altun, D. (2024). The effects of e-stories on preschoolers' narrative comprehension, retelling and reading attitudes among poor and good comprehenders. *Journal of Early Childhood Literacy*, 24, 471–504. <https://doi.org/10.1177/14687984221079010>
- Baddeley, A. D., Hitch, G. J., & Allen, R. J. (2021). A multicomponent model of working memory. In R. H. Logie, V. Camos, & N. Cowan (Eds.), *Working memory: State of the science*. Oxford University Press.
- Baethge, C., Goldbeck-Wood, S., & Mertens, S. (2019). SANRA – a scale for the quality assessment of narrative review articles. *Research Integrity and Peer Review*, 4, Article 5. <https://doi.org/10.1186/s41073-019-0064-8>
- Bali, C., Matuz-Budai, T., Arato, N., Labadi, B., & Zsido, A. N. (2023). Executive attention modulates the facilitating effect of electronic storybooks on information encoding in preschoolers. *Heliyon*, 9(1). <https://doi.org/10.1016/j.heliyon.2023.e12899>
- Bali, C., Várkonyi, G., Szabó, M., & Zsidó, A. N. (2025). The impact of visual cues on reducing cognitive load in interactive storybooks for children. *Journal of Experimental Child Psychology*, 260, 106320. <https://doi.org/10.1016/j.jecp.2025.106320>
- Baron, N. S. (2021). *How we read now: Strategic choices for print, screen, and audio*. Oxford University Press.
- Brüggemann, T., Ludewig, U., Lorenz, R., & McElvany, N. (2023). Effects of mode and medium in reading comprehension tests on cognitive load. *Computers*

- & *Education*, 192, 104649. <https://doi.org/10.1016/j.compedu.2022.104649>
- Bruner, J. (2004). Life as a narrative. *Social Research*, 71(3), 691–710. <https://doi.org/10.1353/sor.2004.0045>
- Bus, A. G., & Anstadt, R. (2021). Toward digital picture books for a new generation of emergent readers. *AERA Open*, 7. <https://doi.org/10.1177/23328584211063874>
- Bus, A. G., Kucirkova, N., Ten Braak, D., & Ciesielska, M. (2025). Which interactive features in children's digital picture books promote reading comprehension? A meta-analysis. *Early Education and Development*. <https://doi.org/10.1080/10409289.2025.2571978>
- Bus, A. G., Neuman, S. B., & Roskos, K. (2020). Screens, apps, and digital books for young children: The promise of multimedia. *AERA Open*, 6(1). <https://doi.org/10.1177/2332858420901494>
- Bus, A. G., Roskos, K., & Burstein, K. (2021). Promising interactive functions in digital storybooks for young children. In K. J. Rohlfing & C. Müller-Brauers (Eds.), *International perspectives on digital media and early literacy: The impact of digital devices on learning, language acquisition and social interaction* (pp. 7-26). Routledge.
- Bus, A. G., Takacs, Z. K., & Kegel, C. A. T. (2015). Affordances and limitations of electronic storybooks for young children's emergent literacy. *Developmental Review*, 35, 79–97. <https://doi.org/10.1016/j.dr.2014.12.004>
- Busselle, R., & Bilandzic, H. (2009). Measuring narrative engagement. *Media Psychology*, 12(4), 321–347. <https://doi.org/10.1080/15213260903287259>
- Cai, Y., Peng, X., & Ge, Q. (2024). The tango between perceived cognitive load and enjoyment of reading in determining reading achievement. *Reading and Writing: An Interdisciplinary Journal*, 38(7), 1853–1873. <https://doi.org/10.1007/s11145-024-10580-1>
- Chen, J., Tang, M., Lu, Y., Yao, B., Fan, E., Ma, X., Xu, Y., Wang, D., Sun, Y., & He, L. (2025). *Characterizing LLM-empowered personalized story reading and interaction for children: Insights from multi-stakeholder perspectives*. In *Proceedings of the CHI Conference on Human Factors in Computing Systems (CHI '25)* (pp. 1-24). Association for Computing Machinery.
- Christ, T., Wang, X. C., Chiu, M. M., & Cho, H. (2019). Kindergartener's meaning making with multimodal app books: The relations amongst reader characteristics, app book characteristics, and comprehension outcomes. *Early Childhood Research Quarterly*, 47, 357–372. <https://doi.org/10.1016/j.ecresq.2019.01.003>
- Chuang, C., & Jamiat, N. (2023). A systematic review on the effectiveness of children's interactive reading applications for promoting their emergent literacy in the multimedia context. *Contemporary Educational Technology*, 15(2), ep412. <https://doi.org/10.30935/cedtech/12941>
- Çırakoğlu, N., Toksoy, S. E., & Reisoğlu, İ. (2022). Designing, developing, and evaluating an interactive e-book based on the Predict-Observe-Explain (POE) method. *Journal of Formative Design in Learning*, 6(2), 95–112. <https://doi.org/10.1007/s41686-022-00071-3>
- Clark, C., Picton, I., Cole, A., & Oram, N. (2024). *Children and young people's reading in 2024*. National Literacy Trust.
- Clark, C., Picton, I., & Cole, A. (2025). *Children and young people's reading in 2025*. National Literacy Trust.
- Clark, C., & Poulton, L. (2011). *Book ownership and its relation to reading enjoyment, attitudes, behaviour and attainment*. National Literacy Trust.
- Clark, C., & Rumbold, K. (2006). *Reading for pleasure: A research overview*. National Literacy Trust.
- Clinton-Lisell, V., Strouse, G., & Langowski, A. M. (2024). Children's engagement during shared reading of ebooks and paper books: A systematic review. *International Journal of Child-Computer Interaction*, 39, 100632. <https://doi.org/10.1016/j.ijcci.2023.100632>
- Cole, A., Brown, A., Clark, C., & Picton, I. (2022). *Children and young people's reading engagement in 2022: Continuing insight into the impact of the COVID-19 pandemic on reading*. National Literacy Trust.
- Colombo, L., & Landoni, M. (2014). A diary study of children's user experience with ebooks using flow theory as a framework. In *Interaction Design and Children* (ACM International Conference Proceedings, pp. 135-144). <https://doi.org/10.1145/2593968.2593978>
- Cremin, T., & McGeown, S. (2025). *Reading for Pleasure: International Perspectives*. Routledge.
- Cremin, T., & Scholes, L. (2024). Reading for pleasure: Scrutinising the evidence base – benefits, tensions and recommendations. *Language and Education*, 38(4), 537-559. <https://doi.org/10.1080/09500782.2024.2324948>
- Csikszentmihalyi, M. (2008). *Flow: The psychology of optimal experience*. Harper Perennial.
- Delgado, P., & Salmerón, L. (2021). The inattentive on-screen reading: Reading medium affects attention and reading comprehension under time pressure. *Learning and Instruction*, 71, 101396. <https://doi.org/10.1016/j.learninstruc.2020.101396>
- Dore, R. A., Hassinger-Das, B., Brezack, N., Valladares, T. L., Paller, A., Vu, L., et al. (2018). The parent advan-

- tage in fostering children's e-book comprehension. *Early Childhood Research Quarterly*, 44, 24–33. <https://doi.org/10.1016/j.ecresq.2018.02.002>
- Egert, F., Cordes, A.-K., & Hartig, F. (2022). Can e-books foster child language? Meta-analysis on the effectiveness of e-book interventions in early childhood education and care. *Educational Research Review*, 37. <https://doi.org/10.1016/j.edurev.2022.100472>
- Fiorella, L., & Mayer, R. E. (2022). *The Cambridge handbook of multimedia learning*. Cambridge University Press.
- Florit, E., De Carli, P., Lavelli, M., & Mason, L. (2023). Digital reading in beginner readers: Advantage or disadvantage for comprehension of narrative and informational linear texts? *Journal of Computer Assisted Learning*, 39, 432–444. <https://doi.org/10.1111/jcal.12754>
- Furenes, M. I., Kucirkova, N., & Bus, A. G. (2021). A comparison of children's reading on paper versus screen: A meta-analysis. *Review of Educational Research*, 91(4), 483–517. <https://doi.org/10.3102/0034654321998074>
- Gallese, V., & Morelli, U. (2024). *Cosa significa essere umani? Corpo, cervello e relazione per vivere nel presente*. Raffaello Cortina Editore.
- Georgiou, G., & Inoue, T. (Eds.). (2025). *Home literacy environment and literacy acquisition: Evidence from different languages and contexts*. Springer.
- Gottschall, J. (2012). *The Storytelling Animal: How Stories Make Us Human*. Houghton Mifflin Harcourt.
- Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal*, 26(2), 91–108. <https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Green, M. C. (2021). Transportation into narrative worlds. In L. B. Frank & P. Falzone (Eds.), *Entertainment-education behind the scenes* (pp. 87–101). Springer International Publishing.
- Hakemulder, F., Kuijpers, M. M., Tan, E. S., Bálint, K., & Doicaru, M. M. (2017). *Narrative absorption*. John Benjamins Publishing Company.
- Hamedi, S. M., Pishghadam, R., & Fadardi, J. S. (2020). The contribution of reading emotions to reading comprehension: The mediating effect of reading engagement using a structural equation modeling approach. *Educational Research for Policy and Practice*, 19(2), 211–238. <https://doi.org/10.1007/s10671-019-09256-3>
- Hayes, C., Murnan, R., & Bequette, S. (2025). Family, culture, and literacy: Unlocking the power of home for early literacy achievement. *Early Childhood Education Journal*. <https://doi.org/10.1007/s10643-025-01986-9>
- Hebbecke, K., Förster, N., & Souvignier, E. (2019). Reciprocal effects between reading achievement and intrinsic and extrinsic reading motivation. *Scientific Studies of Reading*, 23(5), 419–436. <https://doi.org/10.1080/10888438.2019.1598413>
- Hebert, M., Bohaty, J. J., Nelson, J. R., & Brown, J. (2016). The effect of text structure instruction on expository reading comprehension: A meta-analysis. *Journal of Educational Psychology*, 108(5), 609–629. <https://doi.org/10.1037/edu0000082>
- Hogan, P. C. (2018). *Literature and emotion*. Routledge.
- Jerrim, J., & Moss, G. (2019). The link between fiction and teenagers' reading skills: International evidence from the OECD PISA study. *British Educational Research Journal*, 45(1), 181–200. <https://doi.org/10.1002/berj.3498>
- Kalyuga, S. (2007). Expertise reversal effect and its implications for learner-tailored instruction. *Educational Psychology Review*, 19, 509–539. <https://doi.org/10.1007/s10648-007-9054-3>
- Kidd, D. C., & Castano, E. (2013). Reading literary fiction improves theory of mind. *Science*, 342(6156), 377–380. <https://doi.org/10.1126/science.1239918>
- Kim, J. E., & Hassinger-Das, B. (2019). *Reading in the digital age: Young children's experiences with e-books: International studies with e-books in diverse contexts*. Springer.
- Korat, O., Atishkin, S., & Segal-Drori, O. (2022a). Vocabulary enrichment using an e-book with and without kindergarten teacher's support among LSES children. *Early Child Development and Care*, 192(9), 1384–1401. <https://doi.org/10.1080/03004430.2021.1885391>
- Korat, O., Tourgeman, M., & Segal-Drori, O. (2022b). E-book reading in kindergarten and story comprehension support. *Reading and Writing*, 35(1), 155–175. <https://doi.org/10.1007/s11145-021-10175-0>
- Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication*. Routledge.
- Kucirkova, N. (2017a). An integrative framework for studying, designing and conceptualising interactivity in children's digital books. *British Educational Research Journal*, 43(6), 1168–1185. <https://doi.org/10.1002/berj.3317>
- Kucirkova, N. (2017b). Digital personalization in early childhood: Impact on childhood learning and development. *Computers in Human Behavior*, 70, 369–377. <https://doi.org/10.5040/9781474290838>
- Kucirkova, N. (2018). *How and why to read and create digital children's books: A guide for primary practitioners*. UCL Press.

- Kucirkova, N. (2019). Children's reading with digital books: Past moving quickly to the future. *Child Development Perspectives*, 13(4), 208–214. <https://doi.org/10.1111/cdep.12339>
- Kucirkova, N., & Flewitt, R. (2022). Understanding parents' conflicting beliefs about children's digital book reading. *Journal of Early Childhood Literacy*, 22(2), 157–181. <https://doi.org/10.1177/1468798420930361>
- Kucirkova, N., & Kümmerling-Meibauer, B. (2021). Children's reading for pleasure with digital books. In *Handbook of Empirical Literary Studies*. De Gruyter.
- Kucirkova, N., Lungenmuss-Ward, N., & Mansfield-Neimi, N. (2023). *Digital books enriching children's literacy lives*. In T. Cremin, H. Hendry, L. Rodriguez-Leon & N. Kucirkova (Eds.), *Reading Teachers: Nurturing Reading for Pleasure* (pp. 35–44). Routledge.
- Kuzmičová, A., & Cremin, T. (2022). Different fiction genres take children's memories to different places. *Cambridge Journal of Education*, 52(1), 37–53. <https://doi.org/10.1080/0305764X.2021.1937523>
- Kuzmičová, A., Schilhab, T., & Burke, M. (2020). m-Reading: Fiction reading from mobile phones. *Convergence*, 26(2), 333–349. <https://doi.org/10.1177/135485651877098>
- Lee, H., Bellana, B., & Chen, J. (2020). What can narratives tell us about the neural bases of human memory? *Current Opinion in Behavioral Sciences*, 32, 111–119. <https://doi.org/10.1016/j.cobeha.2020.02.007>
- Li, H., Zhang, T., Woolley, J. D., An, J., & Wang, F. (2023). Exploring factors influencing young children's learning from storybooks: interactive and multimedia features. *Journal of Experimental Child Psychology*, 233, Article 105680. <https://doi.org/10.1016/j.jecp.2023.105680>
- Li, X., & Bus, A. G. (2023). Efficacy of digital picture book enhancements grounded in multimedia learning principles: Dependent on age? *Learning and Instruction*, 85, 101749. <https://doi.org/10.1016/j.learninstruc.2023.101749>
- Liang, C., Zhang, L., & Sun, J. (2025). The comparative impact of digital and print storybook reading on preschool children's comprehension and vocabulary learning: A two-decade meta-analysis. *International Journal of Early Childhood*, 57(2), 547–573. <https://doi.org/10.1007/s13158-024-00410-4>
- Liao, S., Yu, L., Kruger, J.-L., & Reichle, E. D. (2024). Dynamic reading in a digital age: New insights on cognition. *Trends in Cognitive Sciences*, 28(1), 43–55. <https://doi.org/10.1016/j.tics.2023.08.002>
- Lim, J., Whitehead, G. E., & Choi, Y. (2021). Interactive e-book reading vs. paper-based reading: Comparing the effects of different mediums on middle school students' reading comprehension. *System*, 97, 102434. <https://doi.org/10.1016/j.system.2020.102434>
- Lindorff, A., Stiff, J., & Kayton, H. (2023). *PIRLS 2021: National Report for England Research Report*. Department for Education.
- Liu, S. (2024). The use of digital technologies to develop young children's language and literacy skills: A systematic review. *SAGE Open*, 14(1), 1–12. <https://doi.org/10.1177/21582440241230850>
- Liu, T. C., Lin, Y. C., & Paas, F. (2022). A new application of the temporal contiguity effect in designing narrated slideshows. *Educational Technology Research and Development*, 70(1), 59–72. <https://doi.org/10.1007/s11423-021-10076-7>
- Loh, C. E., & Sun, B. (2020). Cultural capital, habitus and reading futures: Middle-class adolescent students' cultivation of reading dispositions in Singapore. *British Journal of Sociology of Education*, 41(2), 234–252. <https://doi.org/10.1080/01425692.2019.1690426>
- Long, B. T., Hall, T., Hogan, M., & Papastamatiou, N. (2018). Enhancing children's literacy skills: Designing the Q-Tales ecosystem for children's e-book design and publication. *Literacy*, 52(3), 171–179. <https://doi.org/10.1111/lit.12128>
- Lorch, R. F., Jr. (2017). What is so difficult about expository text? In J. A. León & I. Escudero (Eds.), *Reading comprehension in educational settings* (pp. 145–167). John Benjamins.
- López-Escribano, C., Valverde-Montesino, S., & García-Ortega, V. (2021). The impact of e-book reading on young children's emergent literacy skills: An analytical review. *International Journal of Environmental Research and Public Health*, 18(12), 6510. <https://doi.org/10.3390/ijerph18126510>
- Ma, Y., Cain, K., & Ushakova, A. (2024). Application of cluster analysis to identify different reader groups through their engagement with a digital reading supplement. *Computers & Education*, 214, 105025. <https://doi.org/10.1016/j.compedu.2024.105025>
- Mangen, A., & Kuiken, D. (2014). Lost in an iPad: Narrative engagement on paper and tablet. *Scientific Study of Literature*, 4(2), 150–177. <https://doi.org/10.1075/SSOL.4.2.02MAN>
- Mar, R. A. (2011). The neural bases of social cognition and story comprehension. *Annual Review of Psychology*, 62(1), 103–134. <https://doi.org/10.1146/annurev-psych-120709-145406>
- Mar, R. A., Li, J., Nguyen, A. T., & Ta, C. P. (2021). Memory and comprehension of narrative versus expository texts: A meta-analysis. *Psychonomic Bulletin & Review*, 28, 732–749. <https://doi.org/10.3758/s13423-020-01853-1>

- Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on Psychological Science*, 3(3), 173–192. <https://doi.org/10.1111/j.1745-6924.2008.00073.x>
- Mascia, T., Rowsell, J., Rivoltella, P. C., & Guidolin, U. (2026). *Digital Narratives for Children and Young People: Digital Narratives Observatory Report 2026*. Associazione Literacy Italia – Bologna Children's Book Fair.
- Mayer, R. E. (2021). *Multimedia learning* (3rd ed.). Cambridge University Press.
- Mayer, R. E. (2022). Cognitive theory of multimedia learning. In L. Fiorella & R. E. Mayer (Eds.), *The Cambridge handbook of multimedia learning* (3rd ed., pp. 57–72). Cambridge University Press.
- Mayer, R. E. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review*, 36(1), 8. <https://doi.org/10.1007/s10648-023-09842-1>
- McKenna, M. C. (1998). Electronic texts and the transformation of beginning reading. In D. Reinking, M.C. McKenna, L.D. Labbo, & R.D. Kieffer (Eds.), *Handbook of literacy and technology: Transformations in a post-typographic world* (pp. 45–59). Erlbaum.
- Meyer, M., Zosh, J. M., McLaren, C., Robb, M., McCaffery, H., Golinkoff, R. M., Hirsh-Pasek, K., & Radesky, J. (2021). How educational are “educational” apps for young children? App store content analysis using the Four Pillars of Learning framework. *Journal of Children and Media*, 15(4), 526–548. <https://doi.org/10.1080/17482798.2021.1882516>
- Montag, J. L., Jones, M. N., & Smith, L. B. (2015). The words children hear: Picture books and the statistics for language learning. *Psychological Science*, 26(9), 1489–1496. <https://doi.org/10.1177/0956797615594361>
- Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments. *Educational Psychology Review*, 19(3), 309–326. <https://doi.org/10.1007/s10648-007-9047-2>
- Müller-Brauers, C., Miosga, C., Fischer, S., Maus, A., & Potthast, I. (2020). Narrative potential of picture-book apps: A media- and interaction-oriented study. *Frontiers in Psychology*, 11, 593482. <https://doi.org/10.3389/fpsyg.2020.593482>
- Munzer, T. G., Miller, A. L., Weeks, H. M., Kaciroti, N. A., & Radesky, J. S. (2019). Differences in parent-toddler interactions with electronic versus print books. *Pediatrics*, 143(4), e20182012. <https://doi.org/10.1542/peds.2018-2012>
- Nardi, A. (2016). *Bambini e lettura digitale: serve ancora il supporto dell'adulto?*, Media Education. Studi, ricerche, buone pratiche, 2, 158–177. <https://doi.org/10.36253/me-8758>
- Nardi, A. (2026). *Tra carta e schermo. Riflessioni e strategie didattiche per educare alla lettura*. Sanoma.
- Noble, C., Sala, G., Peter, M., Lingwood, J., Rowland, C., Gobet, F., & Pine, J. (2019). The impact of shared book reading on children's language skills: A meta-analysis. *Educational Research Review*, 28, Article 100290. <https://doi.org/10.1016/j.edurev.2019.100290>
- OCEBM (2011). The Oxford Levels of Evidence 2. Oxford Centre for Evidence-Based Medicine. <https://www.cebm.ox.ac.uk/resources/levels-of-evidence/ocebml-levels-of-evidence>
- OECD. (2021). *21st-century readers: Developing literacy skills in a digital world*. OECD Publishing.
- Paas, F., & van Merriënboer, J. J. (2020). Cognitive-load theory: Methods to manage working memory load in the learning of complex tasks. *Current Directions in Psychological Science*, 29(4), 394–398. <https://doi.org/10.1177/0963721420922183>
- Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford University Press.
- Ratner, S., Ong, C., Mathers, S., & Murphy, V. A. (2025). “Did a robot write that?”: AI-generated digital storybooks. *ELT Journal*, ccaf034. <https://doi.org/10.1093/elt/ccaf034>
- Revelle, G. L., Strouse, G. A., Troseth, G. L., Rvachew, S., & Forrester, D. T. (2019). Technology support for adults and children reading together: Questions answered and questions raised. In J. Kim & B. Hassinger-Das (Eds.), *Reading in the digital age: Young children's experiences with e-books* (pp. 103–132). Springer.
- Richter, A., & Courage, M. L. (2017). Comparing electronic and paper storybooks for preschoolers: Attention, engagement, and recall. *Journal of Applied Developmental Psychology*, 48, 92–102. <https://doi.org/10.1016/j.appdev.2017.01.002>
- Rosenblatt, L. M. (1978). *The reader, the text, the poem: The transactional theory of the literary work*. Southern Illinois University Press.
- Sari, B., Başal, H. A., Takacs, Z. K., & Bus, A. G. (2019). A randomized controlled trial to test efficacy of digital enhancements of storybooks in support of narrative comprehension and word learning. *Journal of Experimental Child Psychology*, 179, 212–226. <https://doi.org/10.1016/j.jecp.2018.11.006>
- Savva, M., Higgins, S., & Beckmann, N. (2022). Meta-analysis examining the effects of electronic storybooks on language and literacy outcomes for chil-

- dren in grades pre-K to grade 2. *Journal of Computer Assisted Learning*, 38(2), 526–564. <https://doi.org/10.1111/jcal.12623>
- Schwabe, A., Brandl, L., Boomgaarden, H. G., & Stocker, G. (2021). Experiencing literature on the e-reader: The effects of narrative texts on screen. *Journal of Research in Reading*, 44(2), 319–338. <https://doi.org/10.1111/1467-9817.12337>
- Schwabe, A., Lind, F., Kosch, L., & Boomgaarden, H. G. (2022). No negative effects of reading on screen on comprehension of narrative texts compared to print: A meta-analysis. *Media Psychology*, 25(6), 779–796. <https://doi.org/10.1080/15213269.2022.2070216>
- Sikora, J., Evans, M. D. R., & Kelley, J. (2019). Scholarly culture: How books in adolescence enhance adult literacy, numeracy and technology skills in 31 societies. *Social Science Research*, 77, 1–15. <https://doi.org/10.1016/j.ssresearch.2018.10.003>
- Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333–339. <https://doi.org/10.1016/j.jbusres.2019.07.039>
- Son, S. H. C., Butcher, K. R., & Liang, L. A. (2020). The influence of interactive features in storybook apps on children's reading comprehension and story enjoyment. *Elementary School Journal*, 120(3), 422–454. <https://doi.org/10.1086/707009>
- Son, S.-H. C., & Butcher, K. R. (2024). Effects of varied multimedia animations in digital storybooks: A randomised controlled trial with preschoolers. *Journal of Research in Reading*, 47(3), 249–268. <https://doi.org/10.1111/1467-9817.12452>
- Stangeland, E. B., Campbell, J. A., Kucirkova, N., & Hoel, T. (2024). Shared book reading: a Norwegian survey of reading practices in families. *Scandinavian Journal of Educational Research*, 68(6), 1304–1319. <https://doi.org/10.1080/00313831.2023.2229369>
- Strouse, G. A., & Ganea, P. A. (2017). A print book preference: Caregivers report higher child enjoyment and more adult-child interactions when reading print than electronic books. *International Journal of Child-Computer Interaction*, 12, 8–15. <https://doi.org/10.1016/j.ijcci.2017.02.001>
- Strouse, G. A., Troseth, G. L., & Stuckelman, Z. D. (2023). Page and screen: Storybook features that promote parent-child talk during shared reading. *Journal of Applied Developmental Psychology*, 86, Article 101522. <https://doi.org/10.1016/j.appdev.2023.101522>
- Sun, H., Loh, J., & Roberts, A. C. (2019). Motion and sound in animated storybooks for preschoolers' visual attention and Mandarin language learning: An eye-tracking study with bilingual children. *AERA Open*, 5(2). <https://doi.org/10.1177/2332858419848431>
- Sun, H., Roberts, A. C., & Bus, A. (2022). Bilingual children's visual attention while reading digital picture books and story retelling. *Journal of Experimental Child Psychology*, 215, 105327. <https://doi.org/10.1016/j.jecp.2021.105327>
- Sweller, J. (2020). Cognitive load theory and educational technology. *Educational Technology Research and Development*, 68, 1–16. <https://doi.org/10.1007/s11423-019-09701-3>
- Sweller, J., Van Merriënboer, J. J. G., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. *Educational Psychology Review*, 31(2), 261–292. <https://doi.org/10.1007/s10648-019-09465-5>
- Sylla, C., Gil, M., & Pereira, Í. S. (2022). Untangling the complexity of designing tools to support tangible and digital intercultural storytelling in troubled times: A case in point. *Literacy*, 56(1), 3–17. <https://doi.org/10.1111/lit.12263>
- Thissen, B. A. K., Menninghaus, W., & Schlotz, W. (2021). The pleasures of reading fiction explained by flow, presence, identification, suspense, and cognitive involvement. *Psychology of Aesthetics, Creativity, and the Arts*, 15(4), 710–724. <https://doi.org/10.1037/aca0000367>
- Torppa, M., Niemi, P., Vasalampi, K., Lerkkanen, M., Tolvanen, A., & Poikkeus, A. (2020). Leisure reading (But not any kind) and reading comprehension support each other. A longitudinal study across grades 1 and 9. *Child Development*, 91(3), 876–900. <https://doi.org/10.1111/cdev.13241>
- Toste, J. R., Didion, L., Peng, P., Filderman, M., & McClelland, A. M. (2020). A meta-analytic review of the relations between motivation and reading achievement for K–12 students. *Review of Educational Research*, 90(3), 420–456. <https://doi.org/10.3102/0034654320919352>
- Vackova, P., Cermakova, A. L., & Kucirkova, N. I. (2023). *Children's digital books: Development, testing and dissemination of quality criteria*. University in Stavanger.
- Van den Broek, P., & Kendeou, P. (2022). Reading comprehension I: Discourse. In M. J. Snowling, C. Hulme, & K. Nation (Eds.), *The science of reading: A handbook* (pp. 239–260). John Wiley & Sons.
- Verhallen, M. J. A. J., & Bus, A. G. (2011). Young second language learners' visual attention to illustrations in storybooks. *Journal of Early Childhood Literacy*, 11, 480–500. <https://doi.org/10.1177/1468798411416785>
- Vygotskij, L. S. (1978). *Mind in society: The development of higher psychological functions*. Cambridge, MA: Harvard University Press.

- Wang, R. (2022). Application of augmented reality technology in children's picture books based on educational psychology. *Frontiers in Psychology*, 13, 782958. <https://doi.org/10.3389/fpsyg.2022.782958>
- Wexler, N. (2025). *Beyond the science of reading: Connecting literacy instruction to the science of learning*. ASCD.
- Wu, Z., & Amzah, N. A. (2023). Researching the effects of e-book on children's emergent reading conducted from 1999 to 2022: A bibliometric review. *Language Related Research*, 14(3), 289–320. <https://doi.org/10.29252/LRR.14.3.12>
- Xu, Y., Aubele, J., Vigil, V., Bustamante, A. S., Kim, Y.-S., & Warschauer, M. (2022). Dialogue with a conversational agent promotes children's story comprehension via enhancing engagement. *Child Development*, 93(2), e149–e167. <https://doi.org/10.1111/cdev.13708>
- Yari, M., Hadad, A., & Korat, O. (2024). The effect of amount, type and reoccurrence of interactions in electronic books on word learning and story comprehension by kindergartners. *Education and Information Technologies*, 29, 6841–6863. <https://doi.org/10.1007/s10639-023-12077-w>
- Yuill, N., & Martin, A. F. (2016). Curling up with a good e-book: Mother-child shared story reading on screen or paper affects embodied interaction and warmth. *Frontiers in Psychology*, 7, 1951. <https://doi.org/10.3389/fpsyg.2016.01951>
- Zhao, S., & Unsworth, L. (2017). Touch design and narrative interpretation: A socio-semiotic approach to picture book apps. In N. Kucirkova & G. Falloon (Eds.), *Apps, technology and younger learners: International evidence for teaching* (pp. 87-98). Routledge.