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Socio-material directions for developing empirical research on children's e-reading: a systematic review and thematic synthesis of the literature across disciplines

Abstract

This review integrates literature on cross-disciplinary quantitative and qualitative studies related to children's reading on screen published between January 2016 and September 2017, with a focus on the researchers' epistemological perspectives on knowledge and learning. Johri's (2011) framework of socio-material assemblages, which synthesises epistemological dualities, is used to examine the ways in which researchers conceptualise children's learning with digital books. The review shows that extant empirical studies map directly onto the social part of Johri's framework (examination of child and adult variables and behavioural characteristics) and on the material aspects of children's digital books (examination of the book's content and features). Only theoretical studies pay equal attention to social and material aspects in their conceptualisation of children's reading on screen. Overall, it is recommended that in addition to cross-disciplinary and multiple methods, researchers consider socio-material assemblages to advance the field. A socio-material perspective could address time and space shifts in children's reading on screen and might provide the springboard for future epistemological developments within the field.

Keywords: children's reading on screen; digital reading; e-reading; e-books; digital books; apps; literature review; interdisciplinarity.

Heeding the call for a more transdisciplinary approach to reading research and responding to the efforts of the pan-European research networks to ‘identify gaps in knowledge, fostering co-ordinated and collaborative research’ in children’s use of technologies (DigiLitEY 2014), this paper presents an integrated interdisciplinary review of latest research developments in a specific domain concerned with children’s reading on screen: children’s digital books. The value of interdisciplinary work for understanding children’s learning with digital books is examined through the prism of socio-materiality, an analytical framework which unifies epistemological perspectives on how learning occurs and how knowledge is acquired with learning technologies (Johri 2011).

Epistemological perspectives on learning

Grant and Booth (2009) point out that mixed method reviews provide ‘a potentially more complete picture of the research landscape in a specific topic area’ (p.100) but researchers need to be aware of the ontological and epistemological differences followed in different disciplines. Researchers’ epistemological perspectives on children’s learning are typically dichotomised as two approaches to knowledge and learning (see Hofer & Pintrich, 1997 for a useful overview). One school of thought believes that knowledge can be tested, measured and objectively evaluated and that it involves the acquisition of skills and content that can be learnt through a transmission process. The adoption of this epistemology is exemplified with national and international league tables in Western countries that rank children’s performance. The second school of thought conceptualises knowledge as a process of ongoing discovery and inquiry where the learner participates in activities, relationships and creative work that shape his or her understanding of living with others. According to this epistemological view, knowledge becomes visible in practice, action and through

relationships. This epistemological approach is currently marginalised in national and international curricula but richly represented in educational research.

While some researchers explicitly state their perspective on children's learning, others' epistemological perspectives become apparent in the design of their studies and/or interpretation of their findings. Johri (2011) argues that the two principal epistemological perspectives on learning project to the opposing positions on social versus material affordances of learning technologies. As such, they do not overcome the dichotomy between an old and new epistemology, but they propagate it in an alternative narrative. To overcome the binaries, Johri (2011) suggests a theoretical framework of socio-materiality.

Socio-material understanding of technology and in posthumanism

Socio-materiality challenges the separation of technology and humans. The fusion of the two words indicates that all materiality is social and that all social action happens through materiality and that their boundaries are enacted in practice. The material constitutes the social and the social constitutes the material. The practice of using technologies is socio-material and so is the practice of reading books. As Leonardi (2012) helpfully explains, socio-materiality is richly theorized and empirically studied by researchers who subscribe to a range of theories, including actor-network theories (Latour, 2005), organization theory and organizational behaviour (Orlikowski & Scott, 2008), sociology of technology (Wajcman, 2008) and posthumanism (Barad, 2003). Two major approaches towards realism – the agential and critical realism – include socio-materiality in their models but place different emphasis on temporality, non-essentialism and empirical approaches to its study (Scott & Orlikowski, 2013). Socio-materialism enjoys a prominent place in the posthumanist perspective on literacy, where it is part and parcel of new materialism studies which perceive humans (including feelings or cognitive responses) and materials (and the environment in which these materials are used) as inseparable (e.g., Kuby, 2017). Given the multiple

theoretical viewpoints and methodological approaches to children's reading on screen, this paper deliberately considers the generative role of socio-materiality without committing to a specific theory or method of investigation.

The concept of socio-materiality is important on several grounds. Johri (2011) suggests that socio-materiality 'can play a critical role by helping us overcome an inherent dualism in the learning technologies literature between the social implications of technology use and the material aspects of technology design; this dualism either privileges the social or the technical while failing to provide proper attention to the socio-material assemblage' (p. 210). This view builds on Barley's (1988) assertion that treating technology as either material or social leads to technology and social determinism. A socio-material perspective advocates that the social and material aspects are neither in an interaction nor in a causal relationship to each other. Rather, socio-materiality focuses on practices that dynamically bring social and material aspects into concert with each other. This paper aimed to establish the extent to which the psychology and education reading research field might contribute to a socio-material understanding of children's reading on screen. The review follows the framework of socio-materiality to integrate qualitative and quantitative studies from diverse disciplines concerned with children's reading on screen to answer the following research question: How do research studies with diverse methods and disciplinary orientations contribute to a socio-material understanding of children's reading on screen?

Reading on screen and children's digital books

The review focuses on children aged between 0-8 years, that is the age group that corresponds to pre-school and primary-school age in most countries (Unicef 1994). As the name suggests, children's reading on screen is reading that involves a screen-based technology such as a stationary computer, portable laptop, tablet, smartphone, touchscreen, TV or Leapster™. The accessibility and affordability of screen-based technologies for

children have changed rapidly in the past ten years, with increasingly more and younger children using screens for daily play and learning (Holloway, Green & Livingstone 2013). Touchscreens such as smartphones and tablets are especially popular and prevalent among young children growing up in English-speaking Western countries (Ofcom, 2017; Common Sense Media, 2014) and are increasingly used for reading activities with young children.

Children's reading on screen is a broad topic and this review's specific focus on children's digital books is not without a theoretical underpinning. Bolter and Grusin (2000) outline how new forms of media build on previous media and "remediate" each other. Their theoretical framework explains that new media (which in our case are digital books) refashion old media (printed books) and through the prominence of new features, reflect and co-create new cultural practice (reading on screen). From this perspective, studying the added value of digital books prompts us to consider the benefits above and beyond traditional books.

Commensurate with their nascent form, the terminology referring to digital books fluctuates and includes several terms, including apps (story book apps or picturebook apps), enhanced e-books, ibooks or digital books. This paper adopts the term digital books for simplicity and generalisability. Digital books available for touchscreens present stories in three modes: images, texts and sounds and some contain haptic interactivity. Digital books for touchscreens are therefore more than text and illustrations delivered digitally. Unlike simple e-books available for desktop computers or adult reading devices such as Kindle, digital books for touchscreens also offer the possibility to add users' own texts or voiceovers or to customise a given content with users' drawings and illustrations. For example, the *Dino Tales Jr.* digital story by Kuatos Studios Ltd. gives children the option to listen to the story and see the individual words highlighted as it presents the text, as well as the option to narrate their own story and save it as a video to be shared with others. There is also the option to

choose the dinosaur's characteristics (colour, spikes, name etc.) and play various games accompanying the main dinosaur narrative. Dino Tales Jr. is an example of a native app, which was developed specifically for touchscreens, with an original narrative and design.

This review is focused on children's reading of *fictional stories* that have a *narrative structure*. As Hixton (2010) explains, 'Story is the way we as human beings give meaning to ourselves and our relationships with others and with the universe itself. Narrative is the basis of memory, the way in which we store these meanings within our consciousness as individuals and as a race.' (p.264). Digital books present stories via images (illustrations) and texts but unlike printed books, also contain unique multimedia and interactive features. For instance, with Me Books™ readers can add their own voice-overs to accompany a classic story. With Mr Glue Stories™, children can add their own drawings to the digital pages. The books can be printed out and kept as paperback copies or saved as a digital version and flexibly edited over repeated readings.

Previous literature reviews on children's reading on screen

This review is not a historic review; there are valuable analyses that examine patterns in early literacy literature over longer time spans (e.g., Teale, Whittingham & Hoffman, 2018). The paper builds specifically on narrative literature reviews concerned with reading on screen, including Chau (2008), Biancarosa and Griffiths (2012), Miller and Warschauer (2014), Reich, Yau and Warschauer (2016), and on broader reviews and commentaries concerned with children's use of digital media, including; Neumann and Neumann (2014), Troseth, Russo and Strouse (2016) and Sefton-Green, Marsh, Erstad, and Flewitt (2016). The original contribution made by this review is that it synthesizes studies with contrasting epistemological approaches to children's learning and focuses on positive contributions made by mixed method research nested in interdisciplinary approaches to a narrowly defined topic.

The paper aims to exemplify an integrated approach to the examination of children's reading on screen with a literature review that is theorised and applies rigorous review techniques.

Aims and objectives

The review is a systematic literature review with a narrative synthesis of all studies. The review is not a traditional systematic review in that it does not aim to provide answers about effectiveness or strength of evidence in a specific area. Rather, the review specifically acknowledges the need for plurality of approaches and includes a methodologically diverse range of studies, including ethnographic and practitioner research that are often omitted from systematic literature reviews. Attention is paid to divergent findings, viewpoints and assumptions underlying the studies (Tashakkori & Teddlie 1998, 2003), with methodological recommendations for ensuring interdisciplinarity and socio-materiality. The aim is to provide insights into all published research in a specific time period, and to offer an interdisciplinary perspective on the topic, deliberately avoiding models that propagate hierarchies of evidence.

The review's interdisciplinary approach follows the explicit suggestion of European E-reading organisations to consider synergies between experiment-based research and studies from the arts and humanities in the study of reading on and off screen (E-Read Consortium 2014) and to collaborate across disciplines to achieve concomitant impact on practice (COST Action IS1410 2014). These objectives are rooted in the urgent need to address the low quality in children's digital books across Europe (see e.g., Papadakis and Kalogiannakis 2017; Sari, Takacs and Bus 2017) and for research to catch up with the rapidly developing landscape of children's reading on screen.

Review Methodology

This review is a systematic *narrative* literature review because it aims to stimulate debate in the educational community and because it includes qualitative and practice-based studies, effectiveness of which cannot be quantified. However, unlike typical narrative literature reviews, this review does not cover a broad field and argue a specific point (see Jones 2004; Green, Johnson and Adams 2006). The present review is systematic because it follows a stage-based approach that was established a priori and stringent criteria that were used to include or exclude studies in the overall analysis. The search procedure followed the keywords and process established by Miller and Warschauer (2014), who reviewed literature on children's reading on screen using two keywords - 'digital reading' and 'children' - to search the Google Scholar and ERIC databases. This review restricted children's age to zero to eight-year-olds and only included articles published between January 2016 and September 2017 to directly build on previous literature reviews and provide the latest available evidence on the topic. In addition to searching the databases, Miller and Warschauer (2014) selected ten leading journals in the reading research field for manual search. The same list of journals was searched for this review, but was supplemented with ten additional leading journals, which publish mixed-method and/or qualitative studies in the area: Literacy, Journal of Early Childhood Literacy, Language and Education, Journal of Literacy and Technology, International Review of Qualitative Research, Reading & Writing, Teachers College Record, International Journal of Child-Computer Interaction, Frontiers in Psychology and Cambridge Journal of Education. The selection of these ten additional journals was guided by the following criteria: the journal's impact factor, acceptance/rejection rate, regularly published empirical studies that feature international research, regularly published empirical studies that feature mixed and qualitative method studies, open-access policy, published research is widely cited and the journal is well-known in its respective field. All twenty journals were

manually searched for relevant studies. This selection procedure generated a list of twenty-eight articles; the Appendix lists all studies included in the analysis.

Following standard thematic analysis procedure (e.g. Braun & Clark, 2006), the 28 studies were allocated to themes and sub-themes by the strength of their association with the themes. The analysis was deductive and followed a priori themes derived from Johri's framework of research concerned with social, material and socio-material aspects. These initial themes were supplemented with sub-themes derived from the data. The analytical steps were all performed by the first author. To ensure robustness and reflexivity in the thematic analysis process, the development of the analytical frame proceeded in an iterative manner and was discussed with a second coder and the author's colleagues who are recognised experts in the field (see acknowledgments). The purpose of the discussions was not to achieve perfect consensus but to identify the purported usefulness of socio-materiality for children's reading on screen.

The studies were mined with a heightened focus on their methodological strengths and limitations. The studies' interdisciplinary contribution to the evidence base on children's digital reading was interpreted with an eye towards a unified, socio-material, perspective on children's reading on screen. Synergistic possibilities among the diverse studies were interpreted using Klein's (2008) framework for evaluating interdisciplinary research. Klein cautions against 'narrow gauged or horizontal forms of interdisciplinarity' (1998, p.124). The discussion of studies therefore attempted to reconcile variations in the methodological and operational definitions by focusing on the theme of socio-materiality across qualitative and quantitative fields. This approach meant that general methodological principles, such as heterogenous and convenience sampling in qualitative studies and homogenous and restricted sampling in experimental studies, were not construed as limitations but rather considered for their added value to the overall evidence base. In addition, specific effort was made to

include research conducted in various European countries and to add an international dimension to current literature reviews that tend to be dominated by Anglo-American studies (see e.g. Jonsen, Maznevski and Schneider 2011).

Findings

All twenty-eight studies were conceptually divided into three broad areas related to the social, material or socio-material aspects of children's reading on screen. In terms of methods, the studies were scrutinised for their design and qualitative or quantitative orientation. Ten studies were more closely related to the quantitative methods area and eighteen to the qualitative methods area. In terms of disciplines, studies from various disciplines, including education, information processing, cognitive psychology and speech and hearing science, were present in the review corpus.

Based on Johri's (2011) conceptualisation, social aspects in Theme1 relate to the social and psychological aspects and social practices involved in children's reading with digital books. The stakeholders, or key actors, in the social practices influence the environment in which reading of digital books occurs and the psychological aspects it involves. These stakeholders can be either immediately linked to the child, such as the children's family members, or they can be more distant, such as the wider socio-cultural environment in which children grow up. Whether proximal or more distant, socio-cultural structures are constituted through relationships, meaning-making and communication patterns. In the reviewed studies, there were three key social influencing factors that fell into three sub-categories: 1.1. the influences of the family, 1.2. factors related to school and 1.3. children's influence such as their prior experience and socio-cultural background.

Theme2 - material aspects - relates to the physical properties of technologies (Johri, 2011). Different technologies have different material characteristics. Kucirkova (2017) analysed material properties of children's print/physical books, audio books, simple e-books

and enhanced e-books and concluded that their materiality can be interpreted in terms of internal and external material properties. External material properties are peripheral and easily noticeable, such as the weight and portability of a reading device/object, as well as its surface and mechanisms for turning pages (clicks, swipes, physical turning). Internal material properties relate to graphic design, interactivity and multimedia (audio/text/illustrations) embedded in individual books. Sub-theme 2.1 encompasses studies that focus on the material form of a book and some of its material properties (e.g., interactivity and surface of the book). These studies treat digital books as a unified material object that can be compared to other books/material objects in terms of effectiveness and impact. Sub-theme 2.2. relates to studies that divide up the unit of a book into its format and content and investigate or discuss both elements in relation to children's reading experiences. Studies in this sub-category take into account both internal and external properties and consider their intertwined relationship to the narrative. Theme3 relates to studies that emphasise socio-materiality, that is studies that see beyond the material/social duality and consider the two aspects as interwoven. Johri reiterates that 'socio-materiality is not about the material going away, but about encapsulating the meaning of the material, how it matters, in learning practice' (Johri, 2011, p. 211). No sub-theme emerged from the data for this theme.

The alignment between the reviewed studies and the social, material and socio-material aspects is presented next. The Appendix identifies the country of publication, the associated theme, country of research and methodological approach.

Theme1: Social aspects

1.1. Family influences (5 studies). Three qualitative studies looked at parents' attitudes towards their children's reading on screen at home and the role of elders and grandparents in shaping children's experiences of digital books. For example, Paciga and Quest (2017)

examined with ethnographic methods and provided a detailed account of the key role played by a parent in supporting the digital reading experience of her two children. Heydon, McKee and Daly (2017) used an ethnographic approach with fifteen elders and nine pre-schoolers to examine the ways in which digital books might expand children's reader identities and promote intergenerational dialogue. Similar themes were explored by Akhter (2016) in an ethnographic study of a seven-year-old British Bangladeshi girl and her grandmother exploring digital texts and the Qur'anic literacy.

While qualitative studies document the ways in which varied adult groups influence children's reading on screen, quantitative studies evaluate the importance of this influence. Strouse and Ganea (2017b) found that parents of 1 to 4-year-olds report strong preference for print books versus digital books, and that they also enjoy reading them more with their children. Yuill and Martin (2016) compared parent-child affective engagement with print versus digital books with twenty-four 7 to 9-year-old children, The researchers found that the physical proximity between parent and child during shared reading on a touchscreen versus paper negatively affected the parent-child engagement. Yuill and Martin (2016) emphasise the importance of 'studying embodied and affective aspects of shared reading to understand the overall implications of screens in children's transition to independent reading' (online).

1.2. School influences (4 studies). Martin-Beltrán, Tigert, Peercy and Silverman (2017) compared teachers and children using traditional books, tablet text, and video in kindergarten and fourth-grade students. The study was a design-based research project and part of a larger study examining four culturally and linguistically diverse schools in the USA. The authors found that print books were more effective in supporting traditional literacy outcomes (such as story comprehension for example). An ethnographic approach with teacher as participant led Ghiso (2016) to explore digital books in a classroom of US 6 to 7-year olds in relation to how the digital books (mis)align with a curriculum that would value children's multilingual

repertoires. Ciampa (2016) argued for a whole-school teacher-development approach to ensure consistency and sustainability in the use of digital books in schools, whilst Roskos, Brueck & Lenhart (2017) looked at entire libraries of children's digital books, arguing that their technological architecture needs to better incorporate readers' active engagement.

1.3. Child influences (7 studies). Studies that fall into this category discuss the influence of individual children's socio-cultural background and developmental factors on the children's experience of reading on screen. Based on an observation of 7 to 8-year-old Swedish children in the classroom, Sofkova Hashemi (2017) outlined how children's prior language and cultural experiences influenced children's choice of digital books read at school. A comparative study by Christ, Wang & Erdemir (2016) with twenty-seven US and twenty-eight Turkish 4 and 6-year-olds and twelve digital books read in the school, noted differences in children's engagement when children read digital books in their native or foreign language. Rees, Nadig and Rvachew (2017) compared the reading episodes with parents of typically developing children versus children with language impairments and found that parents of typically developing children coordinated their responses in relation to child's engagement, whereas parents of children with language impairments tended to ask more questions and demand more responses from their children. The authors call for a more participatory approach with children with special needs, a message echoed by Véliz, Espinoza, Sauvalle, Arroyo, Pizarro and Garolera (2017) and their work with deaf and hard of hearing children reading digital books.

Some studies focused on both cognitive and affective outcome measures. For example, Ross, Pye and Randell (2016) studied two kinds of shared reading behaviour in parent-child dyads: cognitive and emotional scaffolding. They found that children's story comprehension was diminished with digital books, but emotional engagement was increased during mother-child reading of digital books on touchscreens. Lasley, Sosebee and Cox

(2017) found that children's initial motivation to read digital books was higher than traditional books, but that this interest waned when the intervention finished. In a naturalistic observational study Aliagas and Margallo (2016) adopted a dual focus on children's cognitive and emotional responses to the books. The authors combined the definition of interactivity as proposed by experimental psychologists (Takacs, Swart & Bus 2015) and narrative theory by Ryan's (2006) typology of interactivity. This interdisciplinary combination allowed Aliagas and Margallo to comprehensively explain the different responses to the same books by three Spanish children aged 2, 4 and 5 years.

Theme2: Material aspects

2.1. Format comparisons (3 studies). Studies in this category compare digital books versus print books, with both media conceptualised as distinct material units. Strouse and Ganea (2017a) compared children's learning of new animal labels from reading print and digital books with 102 US/Canadian toddlers aged between 17–26 months. The researchers found that children were more attentive and more engaged when reading the digital book and that the digital book was more conducive to children's word learning than the print book. In a sample of 28 parents and children from low income communities, Rvachew, Rees, Carolan and Nadig (2017) compared paper and digital books and showed that well-designed digital books can support parents in engaging their children in reading.

From an experimental perspective, if the reading medium influences traditional outcomes of parent-child reading, such as learning new words or story comprehension, then understanding the mechanisms underlying these differences is an important research goal for experimental studies. Drawing on theories of learning with multimedia (e.g., Mayer's multimedia theory, see Mayer 2005) dual coding theory (see Paivio 2009) and on experimental research with print books, researchers have identified some key features such as

presence of dictionaries: interactivity, music, sound effects, illustrations and moving images that could impact on children's learning from digital books. Karemaker, Jelley, Clancy and Sylva (2017) compared children's reading comprehension and word recognition after reading digital interactive books, dictionary-based digital books and what the authors refer to as "flat e-books" - that is, digital books without any interactivity features. For the ninety UK primary school children who took part in the experiment, 'flat e-books' worked equally well for children's reading comprehension as the other two more enhanced digital books.

2.2. Format and content interplay (5 studies). Experimental studies in 2.1. delineate reading on and off-screen and study reading separately from other forms of learning - an approach that is theoretically impossible for researchers who perceive format and content of digital books inseparable and study their interplay. For instance, Kervin and Mantel (2016) consider the close link between writing and reading digital texts in schools and Sofkova Hashemi and Cederlund (2017) argue that we need to first problematize the use of digital books and the role of digital technologies in children's lives more widely, before we can measure, quantify and evaluate them. Other researchers developed frameworks and evaluation criteria for establishing the quality of digital books. Namely, Bates et al. (2017) developed a framework that teachers can use to assess the quality of children's digital books based on the books' content and features. Serafini, Kachorsky and Aguilera (2016) described their favourite picture-book apps to inspire teachers to use them in their classrooms. Another way of modelling quality is to design digital books. Zhang-Kennedy, Abdelaziz and Chiasson (2017) designed a book for twenty-two 7 to 9-year old Canadian children on the topic of cybersecurity and showed that reading the book increased children's online privacy knowledge and reported privacy behaviour.

Theme3: Socio-material aspects (4 studies)

Four theoretical and conceptual papers address both social and material aspects to an equal degree. Thompson Long, Hall, Hogan and Papastamatiou (2017) outline a theory-driven framework which specifies the correspondence between socio-constructivism and the literacy opportunities afforded by digital books. The framework was developed by two education technologists and one developmental psychologist and draws attention to reading in terms of children's literacy skill development and engagement in reading. It has four broad components: developmental considerations, narrative/stories, literacy activities and design considerations. The material aspects of digital books are conceptualised in terms of design considerations and narratives/stories features and social aspects are developmental considerations and literacy activities. In a conceptual paper focused on children's reading for pleasure (also known as recreational reading or reading for enjoyment), Kucirkova, Littleton & Cremin (2017) suggest that there are six types of reading engagement that cut across digital and print books: affective, sustained, shared, interactive, personalized and creative engagement. The authors argue that these facets are not unique to one or the other medium but they become differently realised in different reading contexts. The ways in which children's engagement becomes visible is a result of the different affordances of the reading media (aka their material features) and the context of reading for individual children (aka the social aspects of reading).

Mackey (2016) enquires into the factors that influence reading on-screen and off-screen and outlines how personal and tangible engagement with texts influence affective engagement in reading. Print books often evoke childhood memories not only through their physical presence on a bookshelf but also with their tethered pages and scribbled notes, prompting content-related recollections. Drawing on her own embodied experience with texts, Mackey prompts reflection on the extent to which such personal book marks might

influence children's experience of digital books and their virtual traces. In another theoretical piece, Mangen and van der Weel (2016) highlight the historical changes in material developments to reading and propose that researchers should focus on personal and social effects of reading on screen. Personal effects include learning, modification of existing knowledge and retention and pleasure, whilst social effects of reading are information, education, cohesion and manipulation. Shared reading with a parent is an engaging, affective and embodied experience across time, as well as a cognitive task, so it is important to understand how paper versus screen affects broader aspects of these shared experiences. Mangen and van der Weel's (2016) multidimensional framework includes consideration of material and social aspects in relation to the 'Act of Reading', which includes three sub-categories: embodied interaction, mental interaction and environmental factors.

Discussion

Although focused on a relatively short time period of published literature, this review exemplifies the current trends in research concerned with children's reading of digital books. As an illustrative example, the review includes diverse multi-method studies by focusing on what Klein (1998) identifies as strengths of interdisciplinary work: the focus on outcomes as well as the quality of the process, boundary crossing and methodologic pluralism. The aim was to establish the ways and extent to which research studies with diverse methods and disciplinary orientations contribute to a socio-material understanding of children's reading on screen.

In the reviewed corpus, there were no in-depth *empirical* examples of how the social and material aspects are inseparable with children's reading of digital books. Although all researchers acknowledged both material and social influences on children's reading, the

empirical studies highlighted either their social or material aspects. Socio-materialism, however, argues that the social and material are inseparable. Such an understanding was only present in the *theoretical* articles included in the literature review.

The Findings show that the empirical studies constitute a model of predictors and mediators that significantly contribute to the advancement of knowledge of children's reading on screen. Studies conducted in the Material strand of literature either conduct comparative experiments with digital books and other reading formats, such as print books versus flat e-books, or they focus on both content and format of digital books to develop evaluation frameworks and criteria. Studies in the Social strand, on the other hand, foreground parents' influence on children's reading of digital books, which includes parents' attitudes and preferences of children's reading materials as well as parent-child physical proximity during book reading. The second sub-theme in the Social strand focuses on the (mis)alignment between digital books and traditional literacy outcomes, school curriculum, teachers' professional knowledge, as well as on new curriculum materials, such as digital libraries, that bring digital books to the classroom. The third sub-category in the social strand foregrounds children's abilities (language, learning and literacy) and compares children's affective and cognitive responses.

Studies in both the social and material strands foreground the multitude of influences within each category. For example, studies in the sub-theme 'Schools' consider the role of traditional literacy outcomes, the role of the curriculum and societal expectations around academic achievements in reading, as well as teachers' facilitative role in reading on screen, the professional training and educational materials necessary to support children's reading on screen in schools. What remains an empirical tension is the focus on the relationship between specific types of adults' mediation with a generic model of digital books or, conversely, the relationship between specific features of digital books with a unified type of social

interaction. Future studies need to include a *detailed* analysis of both aspects (types of social interaction and types of digital books) to avoid the risk of mis-representing the key issues in children's reading on screen. This risk is already present in the practical positioning of the *multiple purposes* that digital books could serve. While researchers rarely take one-dimensional views, media often portray digital books as either 'damaging children's sleep and health' (BBC News, 2014) or as magic bullets to boost children's reading abilities (Telegraph, 2015). The research on children's digital books would be in a stronger position to counteract simplified impact narratives if it studied the joint and equally weighted influence of the social and material aspects of children's digital books.

The *theoretical* studies in the review have considered the design, narratives and developmental outcomes as an assemblage of socio-material influences. Socio-materiality can be accommodated from various theoretical perspectives and the four conceptual papers in the review expand the current list to new theoretical orientations. The socio-material aspects suggested in the theoretical papers in Theme3, such as embodiment, affordances and Acts of Readings, make headway in characterising children's digital books. This is a significant contribution as it expands the theoretical toolbox available to literacy and technology scholars interested in socio-materiality.

The important question that emerges from these findings is why has socio-materiality not been exploited in *empirical* studies with children's reading on screen? One might argue that it is because the reviewed studies do not subscribe to the perspective of socio-material entanglement in children's reading with digital books. Alternatively, it might be that researchers who follow socio-materiality, identify with the version of socio-materiality that is rooted in agential realism (Barad, 2003; 2007). According to this perspective, socio-materiality would be incompatible with the study of effects and impacts of children's reading on screen. However, the theoretical studies were not constructed in a posthumanist frame and

yet they considered the sociomaterial entanglements of children's reading on screen. It might thus be that the Findings are attributable to two key factors:

First, it needs to be acknowledged that over decades, reading researchers have accumulated evidence of social and material aspects as separate influencing factors on children's reading. The researchers studying digital books continue the tradition of non-digital books that separates social and material aspects as distinct mediators in children's learning. Second, cross-sectional and longitudinal studies with digital books are rare, if not non-existent, with interactive digital books. Given the newness of the interactive reading format for children, large databases have not been established. Without a large database, it is difficult to examine multiple outcomes. A socio-material lens unequivocally calls for an examination of simultaneously occurring multiple effects. The wide range of potential material and social factors implicated in children's reading on screen make it difficult for researchers to identify the key variables of interest, let alone their combinations.

A continued research tradition ensures that cumulative science is replicable (Lakatos 1971) but it might not necessarily identify new goals or move the field towards a new empirical paradigm. The paper closes with comments on a few desiderata in future research in children's digital books that takes socio-materiality as a conceptual foundation for empirical studies that follow various designs and theoretical perspectives.

The potential contribution of socio-materiality to empirical studies on children's reading on screen

Socio-materiality offers a strong theoretical perspective that could guide the earliest conceptions of study design and encourage new ideas in selecting the variables of interest both in terms of antecedent processes and their outcomes. Critical socio-materialism includes a consideration of temporality, which is missing in the current studies of children's digital

books. Jensen (2008) explains that time- and space- shifting occurs because of new forms of user-control in interactive technologies. He makes the comparison between traditional broadcast media and mobile phones and outlines how mobile Internet-equipped technologies allow for anywhere anytime access to content, which disrupts the space and time boundaries imposed by static non-interactive technologies. Children's experiences with digital books offer layers of meaning that can be explored and activated over periods of time, through users' own input. Interactivity in digital books does not only occur between the user and the technology but it extends to other users, with feedback sent to the designer. In addition, the same digital book can be accessed simultaneously in different places across the world. It thus shifts time and space of the reading experience and it often involves a nexus of reading technologies. For instance, a child can begin reading an e-book on a school PC, continue reading on her iPad at home and post a book review on a public blog that is globally accessible. The simultaneous or sequential time/space experience of digital books has not been considered in the reviewed studies.

A socio-material framework could contribute a significant time- and space- dimension to the study of children's reading on screen. Figure1 illustrates the suggested socio-material approach, which could guide studies interested in time and space shifting of children's contemporary reading experiences.

Figure1 to be inserted about here

For a socio-material understanding, future studies need to collect data on both social and material aspects of children's reading on screen in multiple locations and at multiple times. In Johri's (2011) work, a socio-material "bricolage" was evident in studies that relied on participatory research methods and that followed participants' use of technologies across

geographical boundaries and time zones. Future research in children's reading of digital books could draw inspiration from participatory studies as suggested by Johri, as well as studies concerned with children's story making, including writing and multimedia composing on screen. Baroutsis (2018) used socio-material assemblages to study the material and spatial aspects of children's *writing* on screen in the school. The author's frame-by-frame analysis of the time-lapse photographs points to the innovative methodologies that can be opened up with a socio-material perspective. Harwood and Collier (2017) drew on socio-materiality to explore children's *play* experiences in a forest school. In an ethnographic study, they mapped the children's use of wooden sticks to children's play and documented how the materiality of the stick interacted with the children's thoughts of what it could represent with a range of tools, including notebooks, iPads, Go-Pro cameras. Future empirical studies of children's *reading* on screen could be advanced with the use of multiple or aggregate data collection tools that are currently employed in socio-material studies in other contexts of children's learning.

In conclusion, there is a rich theoretical foundation for a socio-material understanding of digital books but its study is pursued as two parallel interests in two schools of thought, with researchers either studying the social implications of technology use or the material aspects of technology design. Socio-materiality, and its serious dealing with time and space, could serve as a bridge for the currently compartmentalized structure of social and material aspects of children's digital books and the historical epistemological dualities in the research of learning technologies that they reflect. A socio-material approach could better account for the complex character of digital books *and* combined methodological approaches to their study. Given that socio-material perspective goes beyond disciplinary boundaries and beyond technological or social determinism, it could inspire researchers to work across paradigms. This might not be desirable by all reading researchers and some will prefer to advance the

theories and findings within their given paradigm. However, as this review argues and demonstrates, working across paradigms in empirical studies under the auspices of a united perspective on socio-materiality would constitute a ground-breaking addition to the field.

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