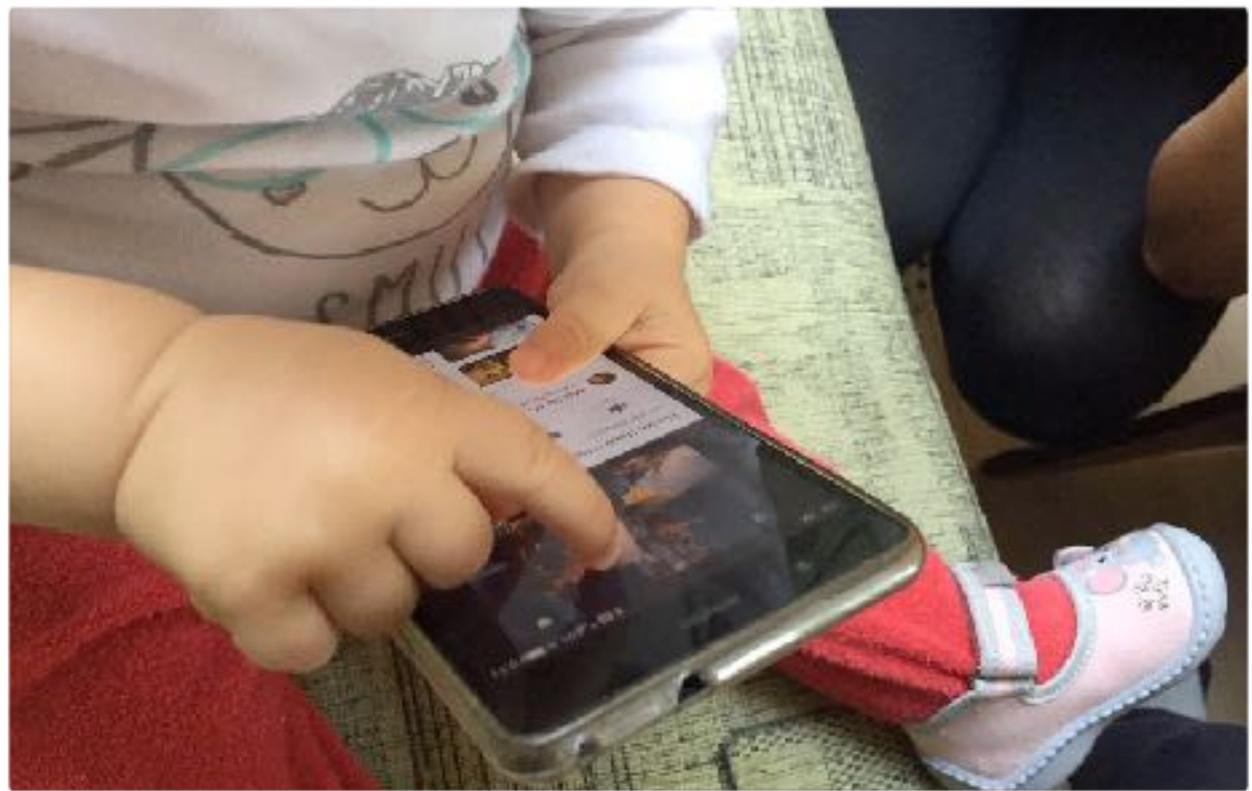# Children's Writing With And On Screen(s)

A Narrative Literature Review

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http://digilitey.eu

Contents

Abstract

This report aims to establish the current empirical evidence concerning writing on screen by young children from birth to age eight through a literature review that examined studies published between 2010-2017. Our definition of writing was deliberately broad and included children's multiple modalities of expression, that, as part of children's digital literacies, can involve 'accessing, using and analysing texts in addition to their production and dissemination' (Sefton-Green et al., 2016, p.15). The methodology followed the methods of a systematic literature review, which involved two steps. First, we defined the term 'writing on screen' on theoretical and practical grounds and established basic criteria for inclusion/exclusion of studies concerned with this phenomenon. Second, we generated a set of deductive codes and a framework for coding published studies and evaluating their significance and reliability. This methodological process led to the formulation of six key conceptual categories that can be used in evaluating children's writing on screen in research and practice: Researchers' epistemologies and perspectives; Study methods and methodologies; Social and adult influence on the activity; Object and tool influence on the activity; Child's dispositions and characteristics observable outside the activity and Child's engagement and behaviours related to the activity. The six conceptual categories are described, nested in published literature and applied to a set of representative studies to illustrate their interpretative value. We conclude with recommendations for how the categories can be used in future research.

Photographs on front page and 5 by Natalia Kucirkova; photograph on page 8 and 12 by Deborah Wells Rowe

Executive summary

Children's writing on screen is one of the many multi-faceted activities that children engage in on a daily basis. As a specific activity related to content production rather than content consumption, children's writing on screen is an emerging field of study, still debating the remit and role of e-writing in young children's lives.

This review makes a methodological and conceptual contribution to this new field. The methodological contribution relates to the integrative approach that we adopted for the review and that we present in full detail for future adoption and refinement. Our methodological approach combined the methods of a systematic review with a broader narrative review and resulted in a deductive-coding framework. The framework can be applied to interrogating extant published literature but also for prospective study design and data analysis. The deductive codes in the framework direct attention to the macro, meso and micro levels of analysis and consist of:

Macro influences:

Researchers' epistemologies and perspectives

Study methods and methodologies

Meso influences:

Social and adult influence on the activity

Object and tool influence on the activity

Micro influences:

Child's dispositions and characteristics observable outside the activity

Child's engagement and behaviours related to the activity

This report illustrates how the framework applies to a set of representative studies in the field and how it could be used for future literature reviews.

Our conceptual contribution relates to defining 'writing on screen' in non-oppositional terms, acknowledging that it carries several dualistic associations such as on-screen versus off-screen and writing versus drawing.
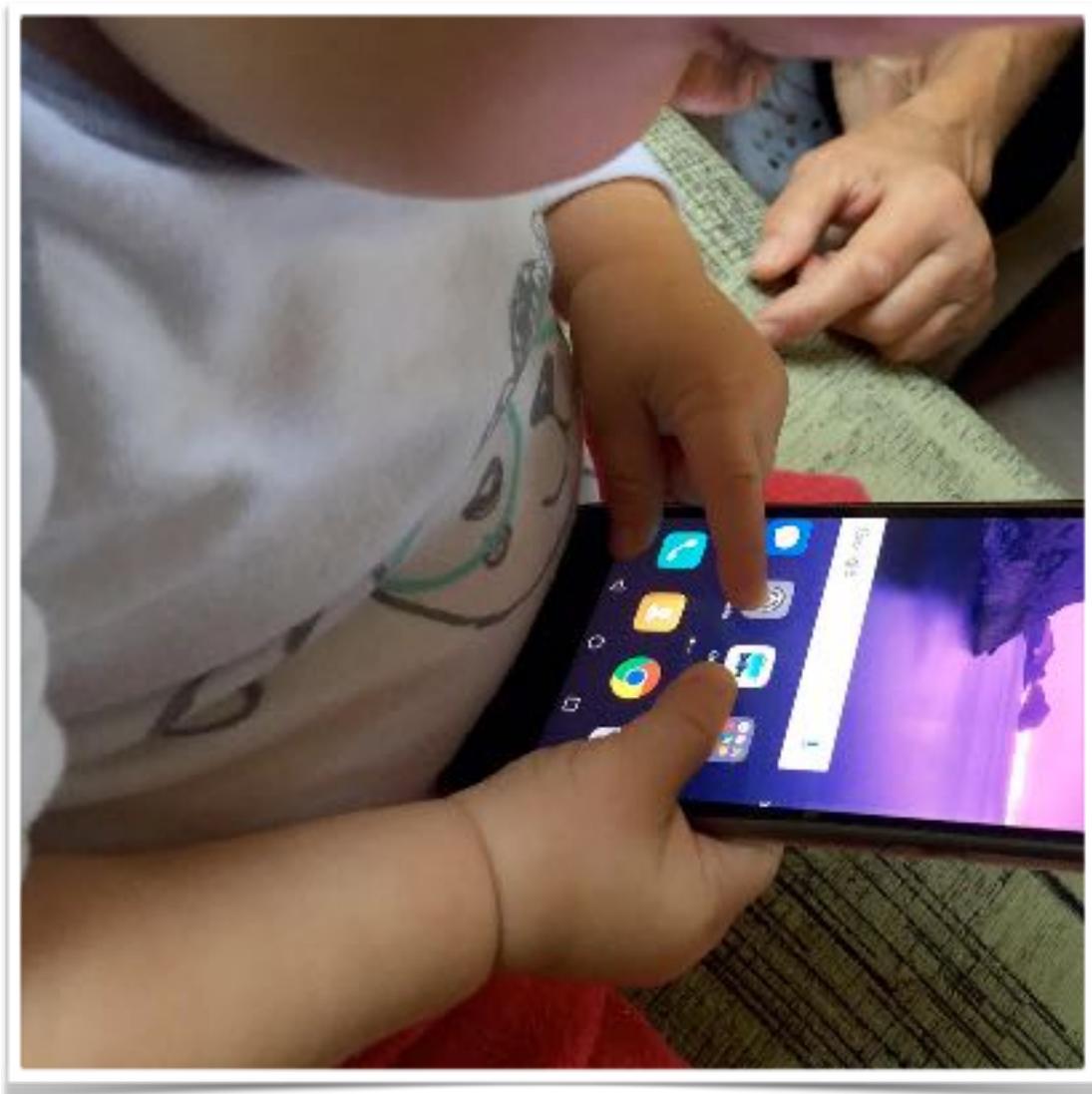
1
Introduction

In the past ten years, there has been a sharp increase in the access and use of digital technologies (such as smartphones and tablets) by young children growing up in Anglo-American countries but also in Europe, Asia and Africa (for an indication of numbers see Common Sense Media, 2013 in the USA; Ofcom, 2014 in the UK; Australian Bureau of Statistics, 2016, in Australia and Chaudron et al., 2015 in seven European countries). Several explanatory frameworks have been developed to offer a view on the socio-material, educational and cultural implications of children's experiences with these new digital devices. For example, the educational perspective seeks to understand the added value of digital technologies in children's learning to read (e.g., Bus, Takacs & Kegel, 2015), experiment-based psychology and neuroscience research highlight the effects of digital technologies on text processing (e.g., Wolf, 2007) and literary scholars call for increased attention to embodied learning and physical engagement with digital texts (Mangen & Balsvik, 2016).

While early research aimed to provide insights into access and frequency of technology use, more recent studies have begun to illuminate patterns of use in relation to specific screen-based or screen-mediated activities. Some technology-mediated activities replicate activities happening in the physical/non-digital world (e.g., card matching games), some augment them (e.g., sharing digital books with an international network of friends) and some limit them (e.g., constructing a castle with colourful building blocks on screen). The activity we focus on here is writing and composing on and with screens. Following on the pioneering work by Marie Clay (1987), the review is specifically concerned with the signs and symbols that children produce on, and with, technologies. We aim to review the field in terms of its key research foci and directions in relation to this particular activity.

The report combines aspects of a traditional literature review (such as the documentation of the methods and findings of the literature review process), with some less traditional aspects (such as the detailed discussion of the key terms and evaluation criteria). The main objective to critically evaluate the research studies conducted so far and make recommendations for future research, practice and design in this area. The report was produced as one of the outputs for the COST DigiLitEY Action, funded by the EU Framework Programme Horizon 2020.

The COST DigiLitEY follows the EU High Level Literacy Group's recommendations to respond in a coordinated manner to the challenges and potentials of digital technologies that affect children's learning at home and school. The Action is an interdisciplinary network of researchers who have joined forces to generate and openly share knowledge about children's use of technologies in their respective countries. The network aims to address the challenge of data concentration in a few, often Anglo-American countries, and produce research projects and publications that address global concerns about children's use of technologies at home and school.

COST DigiLitEY is divided into five Working Groups (WGs), and each WG is co-ordinated by two chairs. This report is one of the outputs of Working Group no3, called Reading and Writing on Screen, co-ordinated by Professor Adriana Bus (Free University, Netherlands) and Dr Natalia Kucirkova (UCL Institute of Education, UK). The objectives of the WG3 are: (i) To identify the current state of knowledge in the area across Europe and contextualise this within the international arena. (ii) To develop a theoretical framework for understanding young children's engagement with multimodal texts. (iii) To identify key research questions in the field for future study. (iv) To identify key messages for policy makers. More specifically, the WG aims to identify the current state of knowledge on young children's reading and writing on screen by synthesising current available evidence and examine the implications of this area for policy in relation to education, parenting and the media industry.

As the name reveals, the Working Group3 has a dual remit – to study children's reading and writing on screen. We recognise that 'reading and writing are both composing acts' (Graves & Hansen, 1983) and that in real life the two activities are interwoven rather than neatly separated, especially when it comes to the development of children's early literacy skills. For pragmatic issues (clarity, timeframe and word limitations), this review focuses selectively on children's writing on screen.

2
Definitions and terms delimitations

The task of defining and specifying children's writing on screen is pursued throughout the report, but it is important to establish, right at the beginning, what falls into the remit of our review and what is meant by 'writing' and 'screens' in this context.

2.1. Screen(s)

Writing on and with screens is adopted as an umbrella description to encompass the diverse range of digital technologies that young children engage with when composing their own contents. The technologies include mobile and tablet devices (IOS and/or Android), also known as smartphones and tablets, as well as portable and stationary PCs, laptops, Wiis, LeapReaders, Kindle and similar reading devices. Given that the review focuses on studies published between 2010-2017, a significant proportion of research is concerned with portable, multimedia and touch-sensitive technologies, development of which has been significantly advanced and accelerated in the last decade. These technologies merge texts with audio, pictures/photographs and drawings and have become an important source of entertainment and education for pre- and primary school-aged children. From a socio-cultural perspective, children's engagement with these technologies is not only a result of economic and design developments but also a reflection of globalisation, multiculturalism and urbanism that affect children's sense of self and social relevance.

2.2. Writing

For young children and many researchers, the boundary between writing on screen and off-screen is blurred, as they consider both being part of one continuum of meaning-making. Composing on and with screens has been described by a range of terms, including digital composing, creating, drawing, mark making and writing. When choosing

an appropriate term for describing this broad range of composing acts, we considered other writing-related terms, including authoring, composing, art-making, sign-making, text creation and story-making.

We adopt the term writing for this review and define it as 'an active practice of producing signs and symbols on paper or any other solid medium' (Rowe, 2016). Writing can refer to 'alphabetic meaning-making practices that are digitally mediated, whether those practices involve the use of laptop or desktop computers, online or offline practices, word processing or messaging software.' (Merchant, 2008, p. 197, emphasis by authors). Writing can also refer to children's multiple modalities of expression, which in addition to alphabetic composition (Selfe, 2009) include gestures, eye gaze, body positioning, sounds (recorded and music), photography, exploratory play, drama, as well as creating pictures, drawings, marks and symbols (Harste, Woodward & Burke, 1984).

Our focus on "writing" indicates our intention to profile studies that focus on children's compositions that carry a linguistic message. As Sticht (1979) helpfully explained, thoughts can be represented in a linguistic mode that uses speech and writing and in an iconic mode that represents thoughts in pictures. We give more weight to the former representation of thoughts. This means that single modes that do not carry a linguistic component (e.g., a child's photo of a house or a child's drawing of a self-portrait) are not considered writing as they do not represent the child's attempt at a linguistic composition. Conversely, writing is often used as a term in studies that have some component of print literacy.

Writing on and with screens is writing that is mediated by a digital device. This digital device can be used by the child independently, with another child or with an adult. In this definition, the composing act does not need to happen on the screen but it needs to be mediated by the screen. For example, a child tracing a letter on the screen and then copying the letter on paper is writing with the screen. This distinction is important as it specifies the context of the composing activity but does not constrain it to 'digital composing' or 'e-writing'.

Following our socio-cultural orientation we conceptualise writing as an activity that includes a range of options and decisions that are socially- and culturally-bound. In the context of writing on screen this means that: 'the author of a digital text can usually select how to express a meaning from a large palette of modal options: words (Which font? Which size?); still images (WordArt, a personal photograph, an online image?); moving image (a Youtube clip, a personal video?); colour (which background or font colour, which shade?) etc. So the medium chosen to convey a message is also a cultural phenomenon: it is not simply a question of technology but of social and cultural practice, and how modes have come to be used in a given medium.' (Sefton-Green et al., 2016, p.21).

Sefton-Greene et al.'s (2016) considerations are commensurate with our work in which we aim to go beyond competence and skills-oriented view of early literacy. Our disciplinary background and previous work in this area have further influenced our broad definition of children's writing on screen. Notably, Selfe's (2009) work on multimodal composing and detailed documentation of children's actual composing acts in the classroom resonates with our understanding of children's writing: 'I argue that our contemporary adherence to alphabetic only composition constrains the semiotic efforts of individuals and groups who value multiple modalities of expression' (Selfe, 2009). Selfe also cautions that narrowly defined writing undermines children's experiences in schools: 'When teachers of composition limit the bandwidth of composing modalities in our classrooms and assignments, when we privilege print as the only acceptable way to make or exchange meaning, we not only ignore the history of rhetoric and its intellectual inheritance, but we also limit, unnecessarily, our scholarly understanding of semiotic system' (Selfe, 2009).

In sum, then, we understand writing as a multimodal composing practice that includes all modalities available to young children's composing, including oral (audio), verbal, written, and pictorial mode (which encompasses drawings, marks or digital photographs) and a linguistic component. In our definition, both the multimodal and linguistic components need to be present to count as 'writing on screen'. We focus on the process and product of children's writing and perceive both as the means of communicating the child's inner world as well as reflecting the wider social forces that shape childhood.

2.3. "Early" writing

In alignment with the mission of DigiLitEY COST Action, our literature review focuses on children aged 0 to 8. This age span is heavily targeted by children's producers, publishers and designers interested in developing programs and devices that would support children's learning. The early years are also a sensitive developmental period in childhood and is of special interest to educators, policy-makers or health professionals. We reviewed studies that have researched children's writing from birth up to the age of eight (i.e. 7 years 11 months). We included studies concerned with children with special educational needs, as long as the children's abilities corresponded to the chronological age of 0-8-year olds (as reported by the authors of the individual studies).

2.4. Writing environments

The context of writing is a key consideration in evaluating the impact of any writing-related intervention. Writing mediated by mobile technologies often blurs the boundaries between formal, non-formal and informal learning, as documented by previous research (e.g., Passey, 2010; Radović & Passey, 2016). In this review, we therefore included studies concerned with writing in all learning environments, mediated by peers and family, at home or in the classroom or in the "non-formal" space between the two.

3
Aims and objectives of this review

This report has two key aims:

1, To provide a broad and narrative overview of the key conceptual and methodological issues in studies concerned with children's writing on screen and published between 2010-2017;

2, To advance the field and meaningfully advise practitioners and researchers interested in the potential of digital technologies for children's literacy, with a specific focus on children's writing on screen.

The two aims are interwoven given that there is a need for a critical synthesis of existing evidence for both practice and research. As part of this objective we engaged in both a systematic and narrative literature review. This report focuses on the narrative strand of the literature review and includes all the practice literature as well as those articles we identified as research studies.

4

Methods for the systematic and narrative literature review

In an effort to establish replicability and transparency but also to facilitate future studies that might wish to build on our work, we describe our method for conducting the literature review in detail and explain why and how we made decisions about including and excluding studies.

Following standard procedure of systematic literature reviews, we followed five key steps in identifying the corpus of studies for the review: 1) defining the focus of the review and basic criteria for inclusion or exclusion of studies, 2) identifying keywords describing research activity in the area 3) using electronic and hand-searching procedures to identify potentially relevant publications; 4) developing, operationalising, and using a set of codes to systematically analyse study features, and 5) synthesising the results of analysis of relevant studies. The review included peer reviewed articles that were clearly written and methodologically sound, conducted in any country, but published and reported in English.

4.1. Selection process for the systematic review

We included qualitative and quantitative studies and all studies needed to be completed and published, given that unpublished studies do not have the sequential advantage of published work (see Steblay et al., 2011). This criterion meant that journal articles, conference proceedings, papers published in university depositories and book chapters (if peer-reviewed) were included in the systematic review. The time span of publication was

articles published between 2010-2017 (inclusive), as per the date of publication by the journal, book or other outlet.

We downloaded the full-texts of all reviewed articles and compiled them alphabetically in a shared folder. For studies which we could not access through our universities library subscription, we approached the individual authors directly with an email request for the full text (all authors we approached have replied positively and sent their full texts). We have also posted a message on the ResearchGate network asking for suggestions and tips for relevant studies that we thought might be work in progress or perhaps not picked up by the key databases.

Given the scope of the review and size of the research team, standard Spreadsheet software (Microsofts Excel, Microsoft Corporation) was used for data extraction. Shared Google drive, SPSS, Excel and Word documents were used for collecting data in a format that is ready for summary and analyses. The combination of a shared online project space meant that we could work on several strands of the project simultaneously (e.g., locating full texts and updating the database), which was an important advantage in a project with limited resources and timespan.

Through discussion and engagement with the relevant literature, we developed a comprehensive codebook to categorise all published studies. The codebook contains descriptors and examples and is fully reported in Section 4. The codebook was applied to select relevant studies and categorise the selected studies for further analysis, either following the methods of a systematic review or those of a narrative literature review. The application of the framework therefore followed a set of rules of study inclusion and exclusion.

For the systematic review database, the study inclusion parameters were:

- include seminal studies and meta-reviews published in the period 2010-2017;

- include studies drawing on any context but published in English;

- include peer reviewed articles and doctoral dissertations.

- include articles which are clear and robust and methodologically sound, so that the conclusions drawn are warranted from the data as presented and analysed;

- include empirical investigations which connect to the age group of 0-8 years.

4.2. Selection process for the narrative review

For our initial literature review the study inclusion parameters were less stringent, which produced a larger set of studies that included practice-based research or postgraduate works such as doctoral and Masters dissertations. The latter were particularly helpful in building our understanding of the key literature that informs nascent work in this area.

Our broader narrative review therefore includes research conducted from multiple research perspectives with a range of approaches, including positivist empirical work and constructivist qualitative studies. It includes studies that were written for a particular audience in mind, notably studies carried out and written-up by educational professionals for other educational professionals. This broad orientation could not be maintained for the systematic review process that excluded pictures of practice and studies that do not conform to the Anglo-American definition of what constitutes rigour and significance in academic research.

4.3. Search process

The search process included keyword search of databases, snowball approach of following up reference lists and manual searching of key journals and sources (e.g., ERIC, PsychoINFO, BEI, AEI, BPLC, COPAC, Dissertations, ECO, Education Abs, Papers First). In selecting the databases, we preserved the DigiLitEY COST Action's orientation towards interdisciplinary research and integrates literature from a number of disciplines: Applied Linguistics; Childhood Studies; Children's Literature; Computer Science; Cultural Studies;

Early Childhood Education; Information Studies; Language and Literature; Media Studies; Psychology; Sociological Studies.

We consulted our methodology with the subject librarians at the Vanderbilt and IOE Universities, who directed us to the relevant library databases and helped us generate a list of the most frequently used keywords for children's early writing. The following list of keywords (and their combination) was used for the initial search of databases:

> emergent writing, writing; joint writing; drawing; conventional writing; name writing; letter writing; spelling; alphabet knowledge; emergent writing skills; print motivation; multisensory learning; letter-name recognition; young children; graphicacy; designing; meaning making; graphic signs; finger painting; pre-school; iPads; touchscreens, screens; Touch screen tablets; Apps; Emergent literacy; Home literacy.

Following initial broad searches, conversations among the authors and the subject librarians, the keywords were condensed into a search phrase "digital AND writing AND (children OR child)". Five key databases were searched with this search phrase: ERIC, Web of Science, PsychInfo, EBSCO and SCOPUS. Studies found through this search were manually checked to accord with the above criteria, especially to ensure that the authors' definition of children corresponded to the 0-8 age bracket and that the writing activity corresponded to one of the terms defined earlier.

The coding process was facilitated with the use of a SPSS file that contained all the coding categories with a quick pull-out menu for all sub-categories.

5
Deductive analysis

The initial search process resulted in a bank of 105 studies. Preliminary screening using inclusion criteria established that 25 of these were not relevant either because the age group was older, or they weren't available in English or there was no meaning-making involved. These studies needed to be further analysed and this analysis occurred both inductively (with categories and criteria informed by the search process) and deductively (with categories informed by previous literature). In this report, we focus on the deductive analysis of the database, which was informed by a set of key studies.

To conduct the deductive analysis, we selected some studies in the area that have wide and current reviews of research in the field. We were drawn to the reviews of literature in these studies but some of them have also significantly influenced the field of children's writing on screen and off-screen either through a theoretical or conceptual contribution or a rigorously designed study with important findings. We identified these studies through conversation among us, authors, by looking at the papers' citation rate as well as the place of publication (journal name and type and its impact factor) and the practice- or policy-related impact generated by these studies. The issues that that were brought up in the larger literature about child composing are illustrated in these studies, so we reflect on their key contributions within a structure of macro, meso and micro-levels that represent the key elements that were addressed in the studies.

5.1. The Macro influences

The macro level is representative of the focus on theoretical frameworks and policy-related perspectives that shape children's actual practices at home or in the classroom. The macro level reminds us about the importance of researchers' own

epistemological stance and perspective when it comes to study design, data collection and data analysis. It also alerts us to the importance of paying close attention to the methods that are being used by the researchers and their qualitative or quantitative nature.

As mentioned, our narrative review includes studies that were written by educational professionals for other educational professionals. These studies tend to focus on the implications for practice and the connection between data and school curriculum. These studies are "pictures of practice" that offer classroom-based descriptive data about what teachers and children did around composing, with a commentary around this process but scant information about how the data were selected or interpreted. There is rarely a systematic data analysis in these studies, but there is often rich contextual detail that situates children's writing on screen in their school/home life.

5.1.1. Multiplicity of research and practice perspectives

An example of a study that supported the review's conceptualizations and acknowledges these tensions in the field of children's writing on screen is Labbo and Reinking's (2003) study. The authors address the issue of what they refer to as 'multiple realities' in interpreting children's writing on screen and caution against the danger of perceiving technology as either medium or message of children's writing. The authors present a framework 'based on potential goals, motivations, or reasons for integrating (or in some cases not integrating) new digital technologies with literacy instruction' (p. 481). Labbo and Reinking (2003) consider past research from the multiple realities perspectives and conclude that technology can support children's literacy, including writing, but it needs to be evaluated in terms of alternative educational goals.

Labbo and Reinking structure their review according to five alternative ways in which technologies could be used in classrooms: 1, technologies should be made available and 2, used to enhance the goals of instruction; 3, technologies should be used to positively transform literacy instruction; 4, technologies should prepare students for the literacy of the future and 5, empower them. These alternative goals help interpret the research evidence but also reveal the diverse and complex realities implicated in the

study of children's writing on and with screens. The study sends a strong message for considering research from multiple and alternative perspectives.

5.1.2. The importance of "Pictures of Practice"

A recognition of multiple realities is closely tied to a recognition of diverse audiences and recipients of research. Academics writing for other academics choose a different language and method than professionals writing for other professionals. It is not so much a matter of which method different stakeholders choose to document a practice (a case study can be as empirically rigorous as a randomised controlled trial), but rather the emphasis paid to methods during the study and their description after the study. Studies that we considered to be pictures of practice carry a strong advocacy message and profile the contribution of action research and teacher-research to the field. The notion of Pictures of Practice draws attention to the authenticity of the context in which the composing activity occurred as well as the methods used to evaluate the products generated in this context. As such, it motivates questions around methods and the robustness of conclusions drawn from the study. Clearly, conclusions based on a quick snapshot/one-off observation cannot be as robust as those based on several and prolonged observations.

5.1.3. Processes of children's engagement in writing on screen

The theoretical orientation and perspective adopted in the study determine the research questions and influence whether researchers focus on outputs or processes. Some research reports describe in detail the process of children's writing on screen. For example, Andersson & Hashemi's (2016) study was an illuminative piece of empirical research that examined in detail how Swedish 7-8-year olds engage with writing with and without screens. While recognising that the needs and purposes of writing have not changed and remain fundamental in driving and structuring children's writing, the authors point out that there are some new activities that shape the nature of early literacy. In their observations of Swedish primary school pupils it was the

possibility to Tweet and blog that opened up the doors to new kinds of children's writing engagement. Similarly, the focus of Davidson's study (2009) was on children' writing at home and the stark contrast that exists between children's experiences of writing at home and in schools. Using the case study method with two children and conversation analysis, the author makes the argument that there is a significant disconnect between the writing practices children encounter in schools and those that happen at home. She outlines the ways in which the use of Wikipedia and Google Search informed the children's learning at home but these paths of learning were not valorised in the school environment. With the lens directed towards specific software programs and individual children's experiences, the study contains important practice-related messages about children's writing on screen.

5.2. The Meso- influences

In early childhood research, a typical research problem involves an interaction triangle that consists of a child, adult and an object interacting together. Some studies, especially those that follow a more socio-cultural orientation, tend to emphasise the adult's mediating role in the interaction while others focus on the role of the object or technology. We locate our work in a socio-cultural perspective on children's learning (e.g., Vygotsky, 1980) that acknowledges the combined influence of society and technology on children's development and the socio-technological environment they grow up in. This epistemological orientation has influenced our own work in this area but also our approach to this literature review and interpretation of the studies included in the review. It is, however, not the dominant orientation in the early childhood field. Indeed, when it comes to children's writing on screen and the child-adult-object triangle, the field wrestles with several dichotomies.

A binary discourse that is particularly salient in relation to children's writing on screen is the tension that is known as the 'print-based literacy' versus 'multiliteracies' tension in literacy studies (Mills, 2005). Drawing on work by Featherstone, Lash & Robertson, 1995, Mills (2005) rightly identifies that 'multiliteracies are tied to the plurality and multicultural nature of local educational contexts, and of language and literacies as a consequence of cultural globalisation'. The possibility to create texts with new

technologies creates 'a fusion of linguistic, audio, iconic, spatial, and gestural modes' (Delany & Landow, 1993, cited in Mills, 2005, p.73), but many studies and indeed school writing activities, are exclusively print-oriented. A focus on the interaction around or with the writing tool can help address this tension as it redirects the problem of 'what' (multi- versus print-literacies) to the question of 'how'.

The question of how writing occurs and how it is mediated is often answered in terms of the distinction between writing and drawing. Researchers who follow the developmental psychology tradition are interested in the ways in which adults mediate children's writing, and what is being recognised as drawing or emergent writing. The "traditional view" (Vygotsky, 1967) is that writing evolves from drawing, while a more recent view (Levin & Bus, 2003, p.892) is that 'drawing and writing are systems that originate independently and that develop separately, neither one preceding the other'.

5.2.1. Adult mediation

A significant study in this area was conducted by Aram & Levin (2001), which involved forty-one 5-9-year olds from low socio-economic status families. The context for this work was off-screen composing, but we were inspired by the study's focus on adult mediation. The researchers studied how mothers help their children write words and names and then analysed the strategies mothers used during the interaction. They found that the quality of mothers' strategies was different for the individual children, with some mothers supporting children within their zone of proximal development (Vygotsky, 1978) and some stretching their understanding beyond their current level of development. The researchers analysed mothers' strategies in relation to the use of grapho-phonemic and orthographic rules. They also evaluated mothers' strategies with a six-point scale and the following six behaviours: Mother writes down all the letters of the word for the child; Mother writes down all the letters of the word as a model for copying; Mother dictates a letter; Mother retrieves a phonological unit (syllable, sub-syllable or phoneme) and immediately dictates the required letter name; Mother retrieves a phonological unit (syllable, sub-syllable or phoneme); Mother encourages/ helps the child to retrieve a phonological unit (syllable, sub-syllable or phoneme) and to link it with a letter name. Children of mothers who scored highest on the writing-

mediation techniques, had the highest scores on word writing, word recognition and phonological awareness. Importantly, this predictive effect of mothers' mediation was present even after controlling for all sociocultural factors. This study was with Hebrew speaking children so some of the mediating strategies might not apply to other languages. Nevertheless, the relevance of adult mediation for children's emergent writing was strongly signalled by the study and therefore included in our evaluation framework.

5.2.2. Tool mediation and the writing medium

There are not many literature reviews dedicated specifically to children's writing with screens. Professor Guy Merchant's narrative reviews (published in 2005 and 2008 as book chapters) have elucidated the importance of the writing medium from a socio-cultural perspective. Merchant's philosophical and historical analysis of writing and technologies thus prompts reflection on the socio-historical forces shaping perceptions of what counts as writing and how the writing medium affects these perceptions.

The author makes strong historical links between current and previous use of writing tools and technologies by invoking mythology and archaeological records. He considers the evolution of writing with reference to Marie Clay's writing principles and the changes that occurred with the advent of new technologies. In comparing Clay's principles developed for writing on paper with current writing on screen, Merchant (2005) notes some key adaptations. For example, the recurring principle, ie the principle that writing is made of letters that are being repeated in various recurrences to build words and meaning, is affected by the computer-mediated possibility to hold down a key, cut and paste. The generating principle, ie that writing signs are used in different combinations to produce meaning, is not affected by the screen. The directional principle, however, is strongly affected by the screen because word processors for example restrict the direction of writing by using their own orthodox principles (see Merchant, 2005, p. 197 for details). Merchant selectively but strategically references literature that brings to fore new features of the digital medium and its influence on children's writing. For example, Matthewman and Triggs (2004) argued that on-screen writing affords more integration and fluidity to children's writing

and Merchant's own research found children's increased attention on the visual appearance of digital writing (i.e. focus on font size and colour, layout and use of images). Children's appreciation of the aesthetics of the digital text did not always align with teachers' view on writing and Merchant therefore calls for more professional attention to the new characteristics of writing produced by new digital technologies.

5.3. The Micro-Level influences

The meso-level of influence illustrates that adults and tools mediate a child's activity and thus offer possibilities for the child's engagement. However, the ways in which these possibilities are taken up by individual children vary and are contingent not only upon the wider context but also the individual differences among children. A theoretical concept that fittingly captures this complexity is that of a modal affordance, theorized by Gibson (1979) and later by Norman (2013) and Kress (2010). Affordance captures the influence of the object as well as that of the social context in which this object is or has been used; it represents its socio-material nature that is revised and taken up differently in different contexts. Affordances offer different possibilities for children's engagement, which in our focus on multimodal meaning-expression and linguistic components, raised some detailed questions around the boundaries of children's composing on screen.

If we consider writing to carry a linguistic message, we need to also acknowledge that there are some expressions that combine a linguistic and iconic representation. For Sticht (1979) a schematic representation, such as a flowchart, is an example of where the boundaries between pictorial and linguistic signs become blurred. A contemporary example could be a digital sticker (often used in messaging services) that combines a picture and text, and that is used by the child in the composing process to communicate an emotion to others. For example, this sticker (see Figure 1) representing love combines an iconic and linguistic mode to communicate an affective intentionality.

Figure1: This Viber sticker for love is from Next Games Store, freely available from GooglePlay and APKPure stores.

Stickers are different from emojis- while emojis are purposefully designed to have a standardized look across platforms (e.g., the same emoji of a smiley face is available via Facebook messenger regardless of whether the messenger is accessed from a tablet or PC), stickers are not platform-agnostic, they can be customised by the user and have a different appearance on different devices. A sticker can be considered to be a ready-made imagery that allows children to express their intentions in a polished format, readily recognised by others. Just like in a traditional composing activity, the purpose and intention of communication are part of the act of choosing and sending a sticker to someone else. However, a sticker can be sent with a single tap thus minimising the extent of child's agency in its delivery. The pre-designed format of the final product raise questions of whether this kind of activity should count as writing on screen.

Children's use of stickers provides a convenient example of why the field of children's writing on screen merits a careful consideration of individual units of analysis and clarifying what we mean by writing and drawing, digital and physical and other terms. It also challenges the notion of linear influences and brings to fore the affordances that individual children might adopt, resist or subvert in their composing acts. In our own work, we have spent a considerable amount of time clarifying our understandings of

these complex inter-relationships and this, inevitably, has brought a tendency to evaluate them in others' work too.

5.3.1. Child's dispositions and possibilities to act

Rowe (2008)'s study and later studies led by Rowe (Rowe, & Neitzel, 2010) and (Rowe & Miller, 2015) have been major contributions in understanding the importance of children's agency in interpreting their writing products and facilitating their writing in schools. Rowe (2008) argued for the importance of recognising and validating the 'social contracts' that children negotiate in relation to their writing experiences. Drawing on nine-months-long observations of the writing practices of eighteen two-year olds in a US classroom, the author locates learner agency and power in three key instances: when negotiating the physical properties of texts and where the boundaries of text begin and end; when negotiating the boundaries between art (drawings) and writing (letters) and when negotiating the ownership of texts created by children but often claimed by adults. The importance of these negotiations is compelling and raises questions about the attention paid by researchers and practitioners to children's agency and child attributes in the writing process. Children's abilities, demographic characteristics, language spoken by the child during the composing event and the status of these languages in the given environment, socio-cultural background and other markers of 'self' undoubtedly influence children's ability to negotiate the complex interplay among their writing products and adults' response to them.

5.3.2. Features of children's engagement

While substantial empirical and theoretical efforts are being pursued to clarify the role of the digital medium, a significant emerging literature looks at the features of children's engagement with technologies. Kucirkova, Littleton & Cremin (2016) theorized six such features for children's engagement with digital interactive books (also known as story apps): affective, sustained, shared, interactive, personalized and creative engagement. These features are implicated in reading and writing on and off screen,

but they are related to different modalities afforded by different media. For example, Kucirkova (2014, 2016) has studied the different modalities of expression in relation to personalized engagement and how personalized books influence children's understanding when represented in visual, audio or textual modes. For the visual mode, non-digital toddlers' books might include a small mirror surface, while digital books can be linked to the touchscreen's front camera so that children can see their own face as part of the book pages. The different modalities carry different temporal, spatial and social properties. While with a mirror, a child's face is part of the book temporarily and changes as soon as the child changes her facial expression, a digital picture, or a selfie, stores and archives the child's photograph in the cloud or on the provider's server. In terms of textual personalization, the level can range from simple ownership markers (e.g., a child can add their name to the line 'This Book Belongs To' on the book's cover) to digital books that automatically replace story characters with the names of the child and his/her family members (e.g., the Mr Glue Stories app).

The emphasis on children's engagement and the modes of this engagement has begun to impact directly on the evaluation criteria of children's digital products used by teachers (e.g., the UKLA Children's Digital Book Award) and parents (e.g, Literacy Apps developed by the National Literacy Trust) and the meaning-making modes have been also included in our evaluation framework of the published studies.

6

Key factors in studying children's writing on screen

These key studies allowed us to generate a set of deductive codes for interrogating main issues in the published literature. We needed to condense them into a set of questions that can be used to simplify but not oversimplify the key foci and contributions from published research. Table1 summarises the key issues and the corresponding questions used in our evaluative framework.

Table1: Deductive codes and questions for analysis

Key issue	Questions
Macro-level	Was the study primarily concerned with outputs or processes?
	What was the key research question?
	What was the theoretical orientation and perspective adopted in the study?
	Was the reported study a systematically conducted empirical study or a practice snapshot or a literature review?
	In which context did the composing activity occur?
	Was the study a quick snapshot/one-off observation that lasted a few days or was it a longitudinal study that lasted several years?
Meso - level	Does the study describe the adult composing with or around the child?
	Which tools were used in the composing activity? Was the primary focus on the hardware or the software program used by the child? Was the program template-based or open-ended?
Micro-level	What are the child's demographic characteristics?
	Which languages were spoken by the child during the composing event and what is the status of these languages in the given environment?
	Which meaning-making modes were used by the children during the composing activity?

6.1. Description of the coding framework

These deductive codes were incorporated into a coding framework, detailed in Table2.

Table 2: The coding framework for the published studies

Research question/ key focus
[Type in—paraphrase]

Macro-influences

Main focus	
Process (yes/no)	Product (yes/no)

Article Type			
Practice snapshot	Empirical study- brief methods	Empirical Study- detailed methods	Literature review

Data sources			
Observation	Interviews	Survey	Products
Standardized tests			

Analysis methods			
Quantitative	Qualitative	Mixed	Other

Study duration (Macro-influences)				
Days	Weeks	Months	Years	Not specified

Context			
Location

(where the child is physically located) | Home | School | Community

If community, type in type of community location |
| Virtual Spaces | Select if applicable. If yes, type in: What digital spaces is the child visiting to compose, share, etc.? | | |
| School Type | Select from the following categories

 Preschool/kindergarten, Head Start/Sure Start, elementary/primary school; other [type in] | | |
| Program or Curriculum Descriptors | Specify the descriptors of the program by selecting:

(dual immersion language program; public elementary school; Creative Curriculum, afterschool program, other [type in], not specified. | | |

Meso-influences

Participants: Adults				
Teachers	Parent/ caregiver	Others: [type in]	No adults (explicitly stated there were none present)	Not specified

Interaction				
Child-tool	Adult-child	Peer-to-peer	Child- Home/ Community	
Tools				
Material properties	Digital

(type in descriptors of digital tools) | Non-digital

(type in descriptors of page-based tools) | Both | Not specified |

Micro-influences

Child's Composing Product/Process: What is the Child Composing or Doing?				
Type in: Brief description of the child's composing product or process				
Participants: Children				
Nation/Country	List the nation(s) where data were collected (Categories include: UK, USA, Canada, Australia, New Zealand, Europe and Other [list which other when selected]			
Age Range	2-3	3-4	4-5	5-6 6-7 7-8
Gender	Male	Female	Both genders	Not specified (NS)
Sample Size (children; classes; families)	[Type in total number of children; total number of classes, families, or other units described]			
Languages Spoken at Home	List languages spoken by the children at home, as described by the researchers. (categories include English and other) [list which other when selected]	Not specified		
Languages Spoken during the Composing Event	List languages spoken by the children during the composing event	Not specified		

Language Status	English as main language	Other majority language	Minority language	Not specified
Special Education Needs	Intellectual disabilities	Physical disabilities	Both intellectual and physical disabilities	Not specified

Meaning-Making Modes Used by Children				
Video	Child Drawing On Screen	Child Drawing Off Screen	Child Photography	Selecting Pre-made Images
Voice Recordings	Music or Sound	Talk (not recorded) but part of meaning-making	Dramatic play on screen	Dramatic play off screen
Gesture	Text Off Screen	Text On Screen	Exploratory play off screen	Exploratory Play On Screen
Other Modes? [list] speech recognition is an example of other modes				

6.2. Applying the coding framework

To illustrate the application of the framework, we outline the values we have assigned to four representative studies. These four studies are a mixture of practice-oriented, dissertation and purely empirical studies that we selected from the database of 105 studies.

Baker, E. B. A. (2017). Apps, iPads, and Literacy: Examining the Feasibility of Speech Recognition in a First-Grade Classroom. Reading Research Quarterly, 52(3), 291-310.

Bigelow, E. (2013). iWrite: Digital message making practices of young children. Vanderbilt University. Nashville, TN.

Dalton, B., & Grisham, L. D. 92013). Love That Book: Multimodal response to literature. Reading Teacher, 67(3), 220-225.

Husbye, N. E., Buchholz, B., Coggin, L. S., Powell, C.W., & Wohlwend, K. E. (2012). Critical lessons and playful literacies: Digital media in PK-2 classrooms. Language Arts, 90(2), 82-92.

Table 3: Coding applied to four representative studies

Research question/ key focus			
(1) Baker - Feasibility of using speech recognition technology to support struggling readers in narrative writing			
(2) Bigelow - The digital practices of preschool digital natives with iPads			
(3) Dalton & Grisham - Strategies for encouraging multimodal response to literary and informational text			
(4) Husbye et al. - Filmmaking as a tool for creating shared multimodal text			
Main focus			
Process (1) (2) (3) (4)		Product (1) (2) (3) (4)	
Article Type			
Practice snapshot (3)	Empirical study-brief methods (4)	Empirical Study-detailed methods (1) (2)	Literature review
Data sources			
Observation (1) (2) (4)	Interviews (1) (2)	Survey (2)	Products (1) (2) (4)
Standardized tests	Not specified (3)		
Analysis methods			
Quantitative	Qualitative (1) (2) (4)	Mixed	Not specified (3)
Study duration			
Days	Weeks	Months (2) 6 mnths	Years (1) (4) 1 yr	Not specified (3)
Context			
Location	Home	School (1) (2) (3) (4)	Community
Virtual Spaces	NA		
School Type	Preschool/kindergarten (2) (4)		
	Elementary/primary school (1) (4)		
	Not specified: (3)		

Program or Curriculum Descriptors	Public elementary school (1) (4) Creative Curriculum (2) Not spedfied (3); (4): preschool program not specified						

Participants: Adults							
Teachers (1) (3) (4)	Parent/caregiver	Others: [type in] (1) (2) (4) Researcher			No adults	Not specified	

Interaction							
Child-tool (1) (2) (3) (4)	Adult-child (1) (2) (3)		Peer-to-peer (4)		Child- Home/Community		

Tools							
Material properties	Digital (2) (3)	Non-digital		Both (1) (4)		Not specified	

Child's Composing Product/Process: What is the Child Composing or Doing?

(1) Using SR to support written composition of stories and personal narrative

(2) Digital text (email) and multimodal message making

(3) Using audio, video and multi-media authoring tools to enable multimodal response to literature

(4) Collaborative multimodal story and filmmaking

Participants: Children							
Nation/Country	USA: (1) (2) (3) (4)						
Age Range	2-3	3-4 (2)	4-5	5-6	6-7 (1)	7-8	Mixed (3) (4)
Gender	Male		Female		Both genders (1) (2) (4)	Not specified (3)	
Sample Size (children; classes; families)	(1) 8 children (2) 15 children (3) NS (4) 4 classes						
Languages Spoken at Home	English (1) (2) (3) (4) Other			Not specified			

Languages Spoken during the Composing Event	English (1) (2) (3) (4) Other		Not specified	
Language Status	English as main language (1) (2) (3) (4)	Other majority language	Minority language	Not specified
Special Education Needs	Intellectual disabilities	Physical disabilities	Both intellectual and physical disabilities	None specified (1) (2) (3) (4)

Meaning-Making Modes Used by Children					
Video (2) (4)	Child Drawing On Screen (2)	Child Drawing Off Screen (1) (4)	Child Photography	Selecting Pre-made Images (1) (2) (3)	
Voice Recordings (2) (4)	Music or Sound		Talk (not recorded) but part of meaning-making (1) (2) (4)	Dramatic play on screen (4)	Dramatic play off screen (4)
Gesture (4)	Text Off Screen (1) (2) (4)	Text On Screen (1) (2) (3)	Exploratory play off screen (4)	Exploratory Play On Screen (2)	
Other Modes? [list] (1) Speech Recognition					

7

Implications and recommendations

7.1. Research implications and future avenues

Our coding framework outlines a method that can be applied to future reviews of children's writing on screen. It can be also used to evaluate current practices in formal, non-formal or informal contexts in which children compose with and on screens. The framework and the method we followed allowed us to generate a database of studies that can be further analysed with criteria of systematic reviews or with research questions characteristic of broader literature reviews. In a traditional systematic review, studies that use less stringent methods would be excluded in the search process. In our review, pictures of practice would not be suitable for a systematic analysis of evidence, but we logged these studies and kept them on file, because we consider them to be part of the rich spectrum of research concerned with children's writing on screen.

As a result, the final database of studies can be interrogated with various research questions and analysed from various theoretical perspectives. In Kucirkova, Rowe, Oliver & Piestrzynski, (submitted), we focus on the following research questions:

-How has children's writing on screen been defined and measured in the research conducted between 2010-2017?

-What was the purpose of the composing event and the modalities selected for children's writing on screen?

In our future work, we aim to address the following research questions:
-What is the content of children's writing at this young age and which attributes characterise children's writing on screen?

-What is known from the existing literature about the effectiveness of early introduction to writing on screen?

-To what extent does children's writing on screen support their reading skills and broader literacy skills?

6.2. Limitations

Although we aimed to be inclusive of research conducted in any country worldwide, we limited our search to studies published in the English language. With a small team based in the UK and USA this is perhaps an understandable limitation but we recognise that a truly international review of literature would need to include studies published in any language. For future reviews, we recommend that researchers include the cost of translation into their budget. We also recommend that researchers engage in collaboration with international research networks to locate literature published in different languages. There are different research cultures and research traditions across the world and we caution that our search strategy has strongly followed the Anglo-American tradition. Future work could address the shortage of international evidence by using a shared analysis framework, but sourcing studies from alternative and additional databases.

Another limitation of our review concerns the choice of the final keywords used for mining the literature. Although we started with a long list of keywords and related terms, we needed to focus on one. The choice of the word 'writing' would have inevitably excluded studies exclusively focused on multimodal composing and work that is located more in the children's art literature. We recommend using the verb 'composing' as a possible keyword for future publications and literature searching and research interested in the multimodal aspect of children's writing.

6.3. Practical implications for designers

Some of the coding criteria, in particular those relevant for children's engagement, could be refined and re-purposed for evaluating the quality of children's software programs

developed for children's multimodal writing. Current rubrics and criteria for evaluating the quality of children's media (e.g., Common Sense Media http://www.commonsensemedia.org/; Digital Storytime http://digital-storytime.com), rely on broad usability categories (e.g, is the app easy to operate) rather than what it affords for children's multimodal writing. Our coding criteria could be incorporated as additional categories for more detailed and specific scoring of children's digital technologies.

6.4. Practical implications for teaching professionals

This last section discusses the pedagogies that are needed to support the most inspirational pedagogical practices, as defined by the framework. The framework can be used as a reference point for practitioners who plan for writing activities in the classroom and who aim to offer a wide range of multimodal engagement possibilities in their classrooms. For example, teachers and early years practitioners could consider the availability and accessibility of diverse meaning-making modes for children. They could consider how diverse modes for art-making (e.g., child drawing on screen, child drawing off screen, child photography, selecting pre-made images) as well as dramatic play, exploratory play and text production on and off screen are represented in their teaching plans. We do not suggest that teachers provide opportunities for all meaning-making modes in one session, but rather that they aim for an optimal balance of on- and off-screen writing and the multiple forms these can take.

A broader definition of children's writing on screen could inspire policy around what constitutes appropriate assessment frameworks for children's writing. The current national assessment frameworks focus solely on children's writing off-screen, which misrepresents their abilities and daily out-of-school practices (see Twining et al., 2017). Unlike the majority of papers included in our literature review, this report is written in an accessible language and made freely available online. This dissemination channel could be leveraged to communicate the key messages to a range of stakeholders and raise awareness about the complex nature of children's writing on screen.

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