

Research into literacy and technology in primary classrooms: an exploration of understandings generated by recent studies

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Published version

BURNETT, C. (2009). Research into literacy and technology in primary classrooms: an exploration of understandings generated by recent studies. *Journal of research in reading* (special issue: New developments in literacy and technology), 32 (1), 22-37.

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*Research into literacy and technology in primary classrooms:
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Suggested shorter title:

Research into literacy and technology in primary classrooms

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Research into literacy and technology in primary classrooms: an exploration of the kinds of understandings generated by recent studies

Abstract

Whilst much has been written about the implications for 'literacy' for practices surrounding digital technologies (Gee, 2000a; Luke and Carrington, 2002; Snyder, 1998), there has been surprisingly little research investigating new literacies in primary classrooms (Andrews, 2003; Labbo and Reinking, 2003; Lankshear and Knobel, 2003). This review examines the kinds of understandings that have been generated through studies of primary literacy and technology reported during the period 2000-2006. It uses Green's distinction between 'operational', 'cultural' and 'critical' dimensions of primary literacy (Lankshear and Bigum, 1999; Snyder, 2001) to investigate the focus and methodology of 38 empirical studies. It explores ways in which research may be informed by assumptions and practices associated with print literacy, but also highlights the kinds of studies which are beginning to investigate the implications of digital texts for primary education. The paper concludes by arguing for further ethnographic and phenomenological studies of classroom literacy practices in order to explore the complex contexts which surround and are mediated by digital texts.

Key words:

literacy, technology, digital literacy, ICT, new literacies

Introduction

Over recent years, writers have argued that literacy is being redefined in response to digital technology (referred to here as ‘technology’) (Gee, 2000a; Luke and Carrington, 2002; Snyder, 1998) and that schools must find ways of acknowledging new literacies or risk perpetuating an outdated curriculum which offers little connection with children’s present or future lives (Gee, 2004; Goodwyn, 2000; Pahl and Rowsell, 2005). Despite this, reviews of research into literacy and technology have suggested that relatively few empirical studies have explored digital literacy in primary schools, addressing instead the use of technology to support the existing print literacy curriculum (Andrews, 2003; Labbo and Reinking, 2003; Lankshear and Knobel, 2003). This paper examines critically the extent to which recent studies of technology and literacy acknowledge or investigate dimensions of digital literacy in primary classrooms. Part 1 explores the changing nature of literacy, using Green’s distinction between ‘operational’, ‘cultural’ and ‘critical’ (Lankshear and Bigum, 1999; Snyder, 2001) dimensions of literacy to outline the conceptualisation of ‘digital literacy’ which underpins this review. Part 2 reviews empirical studies designed to investigate and evaluate technology use within primary literacy. It focuses on their research contexts and methodologies in order to identify the kinds of knowledge being generated and explore underpinning assumptions regarding technology and literacy. Part 3 draws general conclusions and suggests reasons for such assumptions, whilst Part 4 includes proposals for broadening the scope of research in order to investigate more fully the potential relationship between technology and literacy in primary education.

1 Changing literacies

Whilst definitions of ‘digital literacy’ are wide-ranging (Lankshear and Knobel, 2006; Merchant, 2007), ‘digital literacy’ here is confined to practices surrounding digital text production, involving any screen-based verbal written text. In considering both practice and potential for digital literacy in classroom, this review reflects a socio-cultural model of literacy. In contrast to a ‘skills-based’ approach, literacy is conceived as a series of ‘literacies’ emerging from varied and situated social practices (Barton et al, 2000). From this perspective, literacy involves ‘ways of participating in culturally, historically and institutionally situated social practices, not just as internal

cognitive states manifested in behaviour' (Gee, 2000b: 113). In articulating this sociocultural perspective, like the Australian 'Digital Rhetorics Project' this paper uses Green's model of literacy to highlight 'operational', 'cultural' and 'critical' dimensions of digital literacy (Lankshear and Bigum, 1999; Snyder, 2001).

The *operational* dimension relates to the processes of making meaning. Digital technology offers new affordances for composition and comprehension, and this, it has been argued, has implications for what is understood by reading and writing (Burbules, 2002; Marshall, 2000). As Kress (2003) explores, screen-based texts are read according to the logic of the image rather than the page and hyperlinks enable readers to take varied pathways through and between texts, juxtaposing information in different ways. Writing screen-based texts may involve multimodal composition incorporating the appropriation of images and texts from other sources, with consequent implications for notions of authorship. Moreover, texts can be easily forwarded and updated, enabling rapid communication with a range of audiences. Given these new affordances and contexts, composition in digital environments is often marked by innovation and creativity (Crystal, 2001; Shortis, 2001). Regarding the operational dimension, then, the curriculum may need to ensure that children can capitalise on the affordances of technology to 'read' and 'write' multimodally and be confident in experimenting with new possibilities.

The *cultural* dimension concerns the significance of new opportunities for individuals, groups and societies. This includes how that different contexts shape and are shaped by digital literacy. Various studies have explored the innovative and agential ways in which children use technology outside school (Ito et al, 2005; Merchant, 2001; Robinson and Turnbull, 2004). As Luke (2005) argues, it seems that many children construct multiple identities and discourses mediated by technology. Supporting the cultural dimension involves encouraging children to reflect on their existing and developing uses of technology in different contexts. This may include consideration of the integration of digital literacy within classroom culture and the extent to which engagement with digital texts affords new relationships between teachers, learners and knowledge.

The *critical* dimension addresses how texts position readers and writers and the power relations evident within social contexts mediated by digital technology (Cope and

Kalantzis, 2000). This is particularly important given greater access to diverse texts from different sources and how economic and social activity may be increasingly mediated by electronic environments (Snyder, 2001). Developing this critical dimension involves critical analysis of texts encountered and of values embedded within software and forms of computer-mediated-communication. As has been argued (Nixon and Comber, 2004), critical literacy may also be nurtured through involvement in text production, empowering children to challenge existing power relationships through presenting their own perspectives and experiences.

Whilst the operational/cultural/critical framework highlights broad-ranging implications for digital literacy in education, recent reviews have suggested that studies of technology and literacy are sparse and mainly restricted to technology used to support print literacy. Lankshear and Knobel (2003), in their review of research into technology and literacy for the 0-8 age group, highlighted that most studies have focused on stand-alone computer use to support encoding and decoding text. Andrews et al's series of systematic reviews, exploring the impact of technology on literacy learning for children aged 5-16 from 1990-2001, similarly suggests that much research has been underpinned by behaviourist assumptions about literacy development, ignores the notion of literacy as social practice and barely acknowledges the changing nature of literacy (Andrews et al, 2002; Burn and Leach, 2004; Locke and Andrews, 2004; Torgerson et al, 2003). This imbalance, Andrews (2003) argues, reflects a continuing emphasis on the 'effect' of technology within literacy in educational contexts, which derives from a conceptualisation of technology as simply a tool and is driven by an educational policy-making arena which reifies evidence-based practice. Highlighting the limitations of quasi-experimental studies, Snyder (2001) argues for more qualitative research which explores technology use within particular social settings in order to explore the social, cultural and personal experiences students bring to school, and the varied and changing demands of the contexts and communities in which they operate.

2.1 The review

Against this background, this review uses the distinction between operational, cultural and critical literacy to consider 38 empirical studies published from 2000 to 2006. All consider examples of the integration of technology within literacy education for

children aged 5-11 in English-speaking classrooms. The search for relevant studies was informed by an awareness of the different discourses around both literacy and ICT. Key words, database choices and journals hand-searched were therefore chosen to yield studies drawn from different discourses. (A full list of these is included in Appendix 1.) Studies exploring technology use within literacy by children with English as an additional language, special educational needs, or with language or literacy difficulties were excluded: the complex issues needed to contextualise such analysis were beyond the scope of this study. Whilst the approach to selection was systematic, it is recognised that this review is limited in scope. Consequently, studies yielded are used to exemplify the kinds of understandings enabled by different sorts of research rather than draw definitive conclusions about the relative emphasis of research in this field. Importantly, this review does not seek to question the integrity of studies cited. On its own terms, each raises useful insights into technology use within literacy education. However, by exploring their foci and methodologies, the review highlights how opportunities and tensions within this field of research are enabling or limiting insights significant to digital literacy in primary schools. This helps articulate the scope of current research, highlight possible omissions and ultimately prompt suggestions for future research priorities.

2.2. Categorisation of studies

In order to highlight understandings generated through different kinds of research, this review considers firstly studies that used predominantly quantitative methods (22) and secondly those that used predominantly qualitative methods (16). This distinction was not straightforward; studies were rarely exclusively qualitative or quantitative and the qualitative studies, particularly, varied in purpose, context and methods. Categorisation was, therefore, based on the relative weight given to evidence presented. Within each category, studies are subdivided to highlight those that investigated technology used to support *print* literacy and those that explicitly explored *digital* literacy. The focus on studies exploring *print literacy* assumed that any use of technology involves digital literacy (in accessing and interacting with and around the technology and digital texts encountered). The analysis therefore considered whether this was acknowledged and, if not, whether operational/cultural and critical dimensions of digital literacy could provide alternative insights into the print literacy practices described. Separate analysis of studies which explicitly address

digital literacy explored whether assumptions regarding print literacy seemed to be influencing research into digital literacy and so affecting the kinds of insights made possible.

2.3.1 Studies using predominantly quantitative methods

Print literacy

17 studies were examined in this category.

All measured the impact of a particular program or intervention in relation to predetermined print literacy outcomes. Whilst perhaps predictable, this signals the conceptualisation of technology as a tool to support existing literacies rather than as central to new literacy practices. Moreover, literacy ‘gains’ were measured using standardised tests or tasks designed by the researcher. In order to be quantifiable, these focused on operational aspects of literacy, such as phonological awareness, word recognition or narrative recall. In no cases are either these tests or the kinds of literacy they measured problematised. The ‘effect’ on literacy is seen in operational, rather than cultural or critical terms.

This focus on impact often also means that the nature of children’s engagement with digital environments is beyond the scope of the research. Riley and Ahlberg (2004), for example, demonstrate the impact of using technology to support pupils when planning narratives and suggest this may enhance creativity in composition, whilst Vincent (2001) investigates children’s use of a multimedia environment as a stimulus for verbal composition. Given the focus on impact, however, these studies are less useful in considering the particular significance of these digital environments. In contrast, Hofmeister (2002) attempted to measure impact as evidenced through behaviour within a digital environment, developing a scale to gauge the cognitive complexity of asynchronous discussions around literature. However, the scale draws from work relating to conventional classroom discourse around literature. Had the study considered the distinctiveness of online discourse (Burnett, 2003; Burnett et al, 2002), this may have generated different insights into children’s interactions.

This neglect of the features of digital environments seems particularly evident in the studies which measure children's understanding of talking books (Doty et al, 2001; Trushell et al, 2001; 2003; 2005; Donnelly, 2005; Lewin, 2000). Having measured comprehension through asking questions and prompting recalls of stories, all suggested that elements, such as animation and sound effects, can distract from comprehension of a story unless designed to complement the written text. These findings are useful and highlight important design considerations to inform educators and software designers. However, the measurement of comprehension focuses only on aspects associated with printed, linear texts. None acknowledge that linear retelling may be an inappropriate measure for comprehension of a multilayered digital narrative. As Labbo and Kuhn (2000) note, distinctive aspects of the process of reading interactive books may be ignored if it is treated as analogous to reading printed books. Within these studies, the programs seem to be perceived as surrogate teachers rather than *texts*. No studies considered cultural or critical dimensions as relevant to children's engagement.

This treatment of digital environments as surrogate teachers rather than texts also seems evident within a further set of studies which make varied claims about the role of interactive features in exploring the potential of 'talking' or interactive books and other programs to support the development of phonological awareness (Chera et al, 2003; Wood, 2005; Littleton et al, 2006; Brabham et al, 2006; Cassady et al, 2003). Again these do not address the processes involved in accessing and interacting with texts on screen. Exploring children's engagement with programs as digital texts could provide insights into reasons why they do or do not achieve the impact intended.

The quantitative studies of print literacy described here, then, succeed on their own terms and in doing so, are helpful in guiding resource provision. However, devised within print literacy paradigms, they focus purely on some operational dimensions of print literacy. Assumptions related to print-literacy are evident in the tools used to assess impact and the conclusions drawn from the findings. Had these studies acknowledged the social situatedness of technology use, they may have noted aspects of digital literacy that were pertinent to the success or failure of the approaches described.

Digital literacy

5 studies used quantitative methods to explore aspects of digital literacy.

Lefever-Davis et al (2005)'s study of children's use of CD-ROM storybooks differs from the studies cited in the previous section in seeking to capture the process of children's engagement. Focusing on how children seem to transfer reading behaviours from other contexts, they draw interesting conclusions about different children's responses. However, whilst they approach CD-ROMs as digital texts, their analysis of behaviour is framed by assumptions associated with the processes of reading print texts. For example, as children do not need to decode in order to access CD-ROM storybooks, Lefever-Davis et al describe engagement as 'passive'. A more open-ended approach may have captured processes particular to engagement with digital texts or considered the value of the program in supporting multimodal comprehension.

Lawless et al's study (2003), in contrast, does attempt to log the distinctive processes associated with reading digital texts. By tracking and quantifying navigational choices made by 9-11 year olds, they describe various patterns of strategy use which, they argue, are linked to different levels of effectiveness in learning from hypertext. In doing so, this study contributes to our understanding of what reading hypertext might involve. However, by quantifying interactions, it seems to simplify the complex processes involved in making meaning, such as the impact of taking varied pathways and creating different juxtapositions of meaning. It also ignores the social situatedness that may characterise such meaning-making.

The 3 remaining studies attempt to gain insights into the process of on-screen reading by isolating particular aspects. Kerr et al (2006)'s study compared reading rate, comprehension and recall of printed and screen-based texts by requiring children to read one text on paper and one on screen. Having discovered that recall of the screen-based text was less than of the paper-based example, they make important comments about the possible role of spatial memory in recall. However whilst the researchers comment on the different affordances of screen-based texts, the methodology does not seem to acknowledge the distinctive features of texts designed to be read on-

screen. By comparing responses to two identical texts, the researchers isolate a variable to support their comparison but, in doing so, limit the relevance of their findings to the screen-based representation of printed texts.

Zammit (2000) and Bernard et al (2002) similarly isolate aspects of on-screen reading through exploring respectively children's responses to different kinds of icons and the effect of typeface on reading comprehension. Again, however, the isolation of variables may be misleading as it neglects the cultural dimension of reading. This is hinted at by Bernard et al, who supplemented their analysis of children's actual comprehension by capturing children's perceptions about the readability of different typefaces. Whilst the study concluded that actual readability (measured by children's performance) was not affected greatly by typeface, the findings related to children's perceptions were more varied. By contrasting measurement of effect with measurement of perception, the researchers begin to tease out the complexity of children's encounters with texts.

In these studies, attempts are made to capture how children operate within and around digital texts and the insights into the readability of textual features are valuable in informing educators about possible barriers to comprehension. In some cases, the processes measured in digital environments are those associated with printed texts whilst others clearly acknowledge the distinctive features of digital literacy. By using quantitative methodologies to measure what is measurable, however, these studies stay focused on some aspects of operational digital literacy and do not capture the complexity associated with cultural and critical dimensions.

2.3.2 Studies using predominantly qualitative methods

Print based literacy

6 studies used qualitative approaches, often in addition to quantitative methods, to investigate technology use to support operational dimensions of print literacy.

In 4 studies, a preoccupation with print literacy outcomes perhaps prevented possible insights into children's use of digital resources. Labbo and Kuhn (2000)'s investigation of a child's use of interactive books complements findings from the

quantitative studies cited above. Their qualitative methodology enables them to describe interactions with the texts in greater depth, although they are perhaps similarly limited by the focus on comprehension of linear narrative. In Watts and Lloyd (2001; 2004)'s evaluation of a multimedia package used to support independent research and journalistic writing, the qualitative elements enabled them to capture the significance of technology to those involved and consequently illuminate potential opportunities and barriers. Notably, however, they articulate children's involvement in creating a newspaper as 'active learning' (Watts et al, 2004: 51) rather than as 'literacy'. Had their analysis gone further in describing children's use of the program, they might have expanded on what was involved in this 'active learning', exploring perhaps: the processes through which children accessed information and created texts (operational dimension); the features and impact of multimodal communication in different contexts (cultural dimension); or the values implicit within sites visited or in reports produced (critical dimension). Similarly, Higgins (2002)'s study investigates the use of short films to develop children's understandings about narrative structure and Kulman et al (2006) describe first graders' use of hand-held computers to meet print literacy objectives. Whilst each outlines rich opportunities for literacy development and vivid examples of classroom practice, they stop short of articulating the processes and practices which surrounded technology use. More detailed analysis of observational data may have provided further insights into why film viewing and handheld computers seemed to prove effective in supporting composition for some children. By focusing on print literacy, these studies sometimes sideline the digital context and may miss insights into why such engagement may prove valuable (or not) to print literacy.

2 further studies adopted more open-ended approaches which enabled researchers to draw from understandings about digital environments to inform their evaluation of the use of technology to support print literacy. In their multi-methods investigation of the effectiveness of an integrated learning system (ILS), Paterson et al (2003) draw from qualitative and quantitative data to explore what literacy means in classrooms where an ILS is used. This focused on interactions in and around the computer program and its apparent effect on classroom relationships. Reinking and Watkins (2000) similarly used an approach which allowed for flexibility in focus and findings. Arguing that research into technology use needs to consider expected and unexpected outcomes, they report what they describe as a 'formative experiment', using multimedia book

reviews to engage children with reading. This approach, which seemed to echo many of the principles of action-research (e.g. see Carr and Kemmis, 1986), involved regular reviews of the intervention and its significance as the project unfolded. Through this, they acknowledged not only operational but cultural dimensions of children's literacy, highlighting the significance of technology in mediating new relationships between teachers, pupils and knowledge. Such in-depth qualitative studies would seem to have the potential to explore the 'symbiotic' relationship between literacy and technology (Andrews, 2003:31). They enable a focus not only on technology as a tool but consider how classroom activity and relationships reconfigure around technology (or not). This acknowledges that activity in digital environments may promote unexpected outcomes even when used to promote print literacy outcomes.

Digital literacy

10 studies used qualitative methodology to explore aspects of digital literacy. The first 4 described here explore the *process* of digital composition and comprehension whilst the second 6 focus on the *outcomes* of digital composition.

Whilst the qualitative methodology within these studies potentially enabled more holistic insights into children's engagement with digital literacy, sometimes implicit assumptions, apparently influenced by existing classroom discourses, seemed to limit those insights. Pritchard et al (2004), for example, observed children gathering and using information from the Internet. Unlike Lawless et al's study, qualitative methods allowed an open-ended view of children's search strategies. The study's design, however, seems to view Internet reading as problematic rather than enfranchising: tasks completed by children are designed to structure their Internet searches, anticipating difficulties rather than prompting experimentation. Consequently, children's ability to find and use information is evaluated within a teacher-led task. Quite different results may have emerged from a more exploratory study which sought to observe children's problem-solving strategies in the context of a search driven by their own interests.

In Mott and Klomes (2001)'s study of children's engagement with on-screen writing, suggestions about appropriate behaviour also seem to be underpinned by

preconceptions arising from print literacy. They focus particularly on the management of transitions between different stages of the writing process using a multimedia program, highlighting preferences exhibited by children of various ages in using computers at different stages of composition. Noting, however, that one child focused on presentation at the first stage of composition, they imply that this child has approached the writing process inappropriately. This contrasts with Matthewman and Triggs (2004)'s analysis of on-screen writing: they also note the salience of visual aspects of writing (such as font size, colour and type) at the first stages of composition, but draw from interview data to suggest that some children find the selection of such presentational (or design) features as valuable in generating ideas. Matthewman and Triggs suggest this is legitimate activity that challenges assumptions about the nature of the writing process. Baker et al (2000) similarly draw from observation to explore how digital contexts may transform classroom literacy practices. They note how children's sense of audience is increased as their work is unavoidably displayed to others when writing on screen. Exploring children's perceptions of and responses to this brings them to new understandings about the very site-specific nature of school-based digital writing. In these studies, whilst opportunities to innovate are framed within existing classroom models, the qualitative methods enable researchers to explore unintended and unexpected outcomes of children's engagement with digital technology. However, all seem to focus on operational dimensions of digital literacy.

The outcomes-related studies, in contrast, seem to go further in engaging with cultural and critical dimensions. Merchant (2003) explores interactions and identity play through emails sent between pupils and researcher during narrative writing projects and highlights the new relationships and varied identities that may be established through computer-mediated-communication. As an extension to this work, Burnett et al (2005) observed classroom relationships emerging as children in different settings collaborated online to compose PowerPoint presentations. Whilst some of the emerging data concerned operational aspects of the creation of digital texts, it also addressed cultural aspects, such as how their knowledge of audience and prior experience of electronic communication encouraged experimentation.

Other projects have begun to explore the critical dimension of digital literacy. Having observed Kindergarten children taking photographs as the focus for personal writing,

Labbo et al (2002) investigate the potential of such multimodal meaning-making to empower children to develop their own voices. From a similar perspective, Damico and Riddle (2006) focus on a project through which children created a multimedia CD-ROM which raised issues of social justice and stimulated further attempts by children to effect change.

2 further studies focus on children's behaviour within digital environments, highlighting dilemmas faced by educationalists in facilitating learning in such contexts. Paige (2006)'s study explores individual children's responses to opportunities to engage with digital resources, raising questions about how different children can be encouraged to select from and develop texts drawing from different affordances. Britsch (2005), reporting on an email project between university researchers and children designed to promote understanding and engagement in science, describes how the research team's own perceptions of their roles shifted as the correspondence proceeded. Realising how the children were interweaving the discourse of science with a personal discourse, they adapted to the children's discourse and found new opportunities to engage. Again, the open-ended research design enabled researchers to explore what digital affordances might mean within educational contexts. Rather than imposing an existing pedagogical aim, they reviewed what was possible in the light of what happened.

At times, these studies of digital literacy still seemed framed by print literacy regarding what is deemed legitimate within classrooms and the values ascribed to children's achievements. In others, however, qualitative methods did enable researchers to investigate unexpected outcomes and capture cultural and critical as well as operational dimensions of digital literacy. At times they were also able to learn from children about the significance and opportunities presented by digital literacy.

3. Commentary

Whilst the scope of this review was limited by its search strategy, it was perhaps still surprising that it yielded relatively few studies. Whilst, consequently it is not possible to draw reliable conclusions about the relative emphasis of recent research, it is interesting that the majority of studies of print literacy were quantitative (17/25) whilst the majority of digital literacy studies were qualitative (10/15). This perhaps

reflects the level of perceived understanding related to each area and the paradigms within which researchers in each area are working. It is noteworthy that all but 4 studies cited reported interventions designed purely by researchers rather than embedded classroom practice. Ethnographic studies based in classrooms with well-established digital literacy practices may well yield very different results to those reported here.

Also significant are omissions in the kinds of practice investigated in the projects reported. Firstly, there was limited use of networked or generic software or use of communications devices (such as mobile phones). Secondly, despite the significance of children's home uses of technology and the potential of digital communication to blur boundaries between classrooms and the outside world (Bigum, 2002), technology in these studies was generally used to support literacy practices which were entirely school-centred. No studies explored classroom projects attempting to link home and school technology use and only three described projects using technology to facilitate communication beyond the classroom (Merchant, 2003; Britsch, 2005; Burnett et al, 2005). The search, however, did generate studies reflecting varied assumptions, and these variations highlighted important aspects of the kinds of knowledge being generated in this area.

The binary division of studies as qualitative or quantitative has limitations and simplifies some of the complexities evident within the studies presented. Despite this, the review does identify some of the varied ways that literacy and technology have been conceived by educational practitioners and researchers and highlights tensions which emerge when researching literacy and technology from within existing paradigms. It seems that in many cases, particular ideologies around literacy teaching may drive not only the kind of practices investigated but the methods used, analysis of findings and implications considered. Some studies seem to neglect aspects of technology use because they are preoccupied by print-based literacy outcomes or teaching approaches whilst others begin to describe children's engagement with digital texts and the value of these in the classroom but have difficulties articulating this. It may be that when assumptions relating to print literacy drive the focus and methodology of studies, research inevitably reinforces rather than challenges existing models of literacy.

In 2000, Reinking and Labbo suggested that researchers and educators may not yet be ready to recognise the implications of technology for literacy. Paralleling the adoption of digital technology within literacy to Piagetian theories of child development, they argue that many have only *assimilated* technology by grafting it onto existing practices. Conducting research into digital literacy, then, is potentially challenging as it must occur within existing classroom cultures and be framed by teachers and researchers who may have difficulty problematising culturally embedded practices relating to print literacy. However, they suggested that, as technology becomes increasingly inseparable from literacy in the real world, educators and researchers will move to *accommodation* through fully acknowledging the implications of technology for literacy. What seems underplayed in this analysis, however, is how new possibilities may be variously limited or prompted by educational policy regarding literacy. As Leu et al (2004) write, there have been a number of movements internationally to increase access to and use of technology in schools. However, the integration of technology within literacy policy is likely to have implications for conceptions of digital literacy.

In England, for example, despite significant increases in the technological infrastructure, recommendations for technology use have been integrated within existing curricular structures. Whilst, for example, the revised *Primary National Strategy Framework for Literacy* (PNS, 2006) has increased the emphasis on screen-based texts and encouraged flexibility in interpretation, the emphasis is on operational rather than cultural or critical dimensions of digital literacy: it requires children to ‘read and write screen-based texts’ but focuses primarily on skills and strategies. Moreover, schools’ accountability still rests on children’s achievements in standardised attainment tests (SATs), designed to measure print literacy. Such a context seems unlikely to support the kind of pupil experimentation and autonomy that may be associated with fully recognising the operational, cultural and critical dimensions of digital literacy.

This situation may be exacerbated by policy regarding educational research. The move towards evidence-based practice in countries such as the UK and USA has been seen as privileging quantitative research, which attempts to measure the impact of different approaches on attainment (Elliott, 2001; Lather, 2004). Such research may be seductive in offering clear pathways to policy makers but, as this review highlights,

may fail to anticipate or identify the complexities and potential of digital literacy. The focus on impact on achievement is particularly problematic given the kinds of measures used. If evaluations hinge on achievements in print-based literacy, there is little incentive to prioritise digital literacy. Analysis of these studies suggests that work is needed to help redefine notions of 'impact' and 'effectiveness' in ongoing research into technology and literacy. Such developments, however, would imply significant challenges to existing approaches to accountability.

4. Implications

In this review, Green's operational/cultural/critical framework helped identify the emphasis of recent studies and explore their underpinning assumptions. It seems not only that children need to be supported in developing operational, cultural and critical dimensions of digital literacy but that researchers, policy makers and practitioners should consider all three dimensions too. If children are to access the experiences needed to become active and critical users of digital texts, there is a need to broaden the scope of research into literacy and technology. There is a need to focus more extensively upon distinctive aspects of digital literacy in order to understand how children do and could make meanings within digital environments. Both quantitative and qualitative studies have a role here.

More quantitative research is needed which addresses digital literacy directly. Measurement of the processes involved in digital reading and writing could do much to inform us about operational aspects of digital literacy. Such studies could chart children's attention to particular features or pathways through digital environments. However, more preliminary work needs to be done to articulate the breadth of such engagement and generate measures more suited to digital environments.

It would seem then that more exploratory studies are required to map the territory of digital literacy and explore possibilities and potential rather than effectiveness within existing models. Qualitative research is needed to capture children's interactions with technology and the uses and meanings they derive from it. As Lankshear and Bigum (1999) note, if teachers are to understand how best to integrate technology and literacy, they need to go beyond consideration of simple cause-effect relationships between technology and literacy and understand their classrooms as 'complex

systems' (Lankshear and Bigum, 1999: 452). This means not only understanding how children may be encouraged to use the affordances of digital texts but the possibilities that such texts engender within learning environments.

Digital environments, in some contexts, provide opportunities for children to not only make meaning but to reach new audiences and express themselves in new ways. However, there is a need to more effectively describe such activity and find ways of understanding how such opportunities may work within educational contexts and investigate the barriers and opportunities that define the kind of digital literacy education generated within the current policy context. Phenomenological studies are needed therefore to explore teachers' and children's experience of classroom technology use and there is a need for ethnographic studies which capture the processes and interactions surrounding digital texts and the values, attitudes and relationships associated with them. As explored above, the majority of studies reviewed here focused on isolated interventions led by researchers. There is a need to focus more extensively on embedded classroom literacy practice over time in order to explore the opportunities provided and how these intersect with classroom discourses.

The operational/cultural/critical framework also highlights specific foci for further research. Within the operational dimension, qualitative research may examine how children are active in managing and navigating digital environments and in turn investigate ways of encouraging children to reflect on and further develop strategies for meaning-making. Within the cultural dimension, qualitative research offers opportunities to explore ways of using technology to mediate relationships within and beyond the classroom and explore how children respond within such contexts. There is also a need to focus on how children broker differences between digital literacy practices in and outside school and analyse the meaning of digital communication within classrooms. (Do children, for example, see their achievements in school-based digital literacy as simply about 'pleasing teacher'?) Within the critical dimension, qualitative research may explore the values children infer from and place on digital texts. This may involve exploring implicit values in classroom resources or focusing on power relationships mediated through or around technology in classroom contexts. Research is also needed which captures the complexities of projects designed to develop critical literacy, investigating the attitudes children bring and the insights and perceptions enabled. As in some of the qualitative studies cited above (e.g. Britsch,

2005; Paterson et al, 2003), this means not only exploring the nature of children's meaning-making but the significance of this to relationships between teachers and learners. It may also be that children can be involved more extensively in the research process through sharing their own experiences in contributing to debates around the relationship of technology to literacy education.

Conclusion

The findings of this review suggest that, whilst some qualitative studies are beginning to challenge assumptions underpinning primary literacy education, research foci and methodology are still influenced by assumptions and practices associated with print literacy. Whilst such assumptions may be upheld by policy, personal experience and the relative status given to different kinds of research, some studies reviewed here do produce findings that help practitioners explore the implications of digital literacy for the classroom. In extending such research, it is suggested, studies need to consider operational, cultural and critical dimensions of children's use of digital literacy and of the classroom itself as a site for digital literacy. Whilst there is evidently a role for both quantitative and qualitative research in describing the scope and effects of classroom technology use, there is a need to understand more fully what happens when technology is integrated within classroom sites, and the values, processes, interactions and relationships which surround its use. Otherwise, we are unlikely to understand fully either the opportunities or barriers it presents. There is, therefore, primarily a need for phenomenological and ethnographic studies which investigate the way that engagement with digital texts may be challenging or reinforcing classroom culture.

Appendix 1: Items used in Search Strategy

Key Words Used

Primary search terms:

Literacy

Reading

Writing

Secondary search terms (each combined with each of primary terms):

CD-ROM

computer

computer game

digital

film

ICT

ICT-use

information and communication technology

information technology

Internet

IT-use

mobile phone

moving image

multimedia

multimodal

multimodality

online

software

technology

visual

video game

word processing

web

Databases used

ERIC

Australian Education Index

British Education Index

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British Education Research Journal

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Harvard Educational Review

Oxford Review of Education Research

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Literacy Journals:

Journal of Early Childhood Literacy

Journal of Research in Reading

Literacy Journal

Reading and Writing

Reading Research Quarterly

Scientific Studies in Reading

Technology Journals:

Journal of Computer Assisted Learning

Journal of Research on Computing in Education

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