ARTICLE

Journal of Early Childhood Literacy

SAGE PUBLICATIONS
London, Thousand Oaks, CA and New Delhi
VOL 3(1) 59–82
[1468-7984(200304)3:1; 59–82;031944]

New technologies in early childhood literacy research: A review of research

COLIN LANKSHEAR *University of Ballarat, Australia*
MICHELE KNOBEL *University of California, USA*

Abstract Against the background of Michael Kamil and Sam Intrator's landmark reviews of research about new technologies and literacy development, this article maps recent research concerned specifically with the 0–8 years age group. Drawing on databases of research conducted in North America, Britain and Australasia, it affirms that the early childhood dimension is even more radically under-researched than other age ranges with respect to new technologies and literacy development. The authors develop an analytic framework comprising four quadrants to categorize the various studies conducted in the early childhood age range, and assign these to their appropriate quadrants. This reveals a lopsided distribution of the meagre corpus of studies available. The article provides a map of the field against which early childhood educators can judge 'at a glance' how far their personal areas of interest are served by existing research. It simultaneously pinpoints areas where new research is needed to fill important gaps.

Keywords new technologies; review of literature

Introduction

Our aim in this article is to map some recent research pertaining to new technologies and early childhood literacy in ways that may be useful to early childhood educators and researchers. For our purposes, we are confining 'new technologies' to computer-based applications, and 'early childhood' refers to the age range 0–8 years.

Background

The most comprehensive and sophisticated work available to date in English that reviews research literature on new technologies and literacy

development is probably the work of Michael Kamil, Sam Intrator and colleagues (Kamil and Intrator, 1998; Kamil et al., 2000; Kamil and Lane, 1998). Undertaken in the mid-1990s, Kamil and Intrator searched the ERIC and PSYCHINFO databases for research studies published in journals from 1986 to 1995. They used very open criteria for locating texts to include in their review. Their initial database search used five key descriptors: technology, computers, reading, writing and literacy. Queries using 'computers' and 'technology' as qualifiers were used to look for topics in reading, writing, speaking, listening and literacy. The researchers required only that the study reported in the articles be based on empirical data collection for it to count as a research publication, and they included reviews of research studies as well. The original database search was supplemented with a hand search of the journals in which articles appeared. This was to find items missed by the initial search and to eliminate articles revealed by the search but that did not in fact meet the researchers' criteria. Articles in journals not readily available to the Stanford-based team were excluded from consideration. In the end, the set that Kamil, Intrator and colleagues analysed contained 350 articles.

Kamil et al. (2000) provide the most recent account of this research, adding appropriate subsequent studies and reviews of new technologies and literacy development research to their discussion. They discuss the corpus of studies in terms of six categories of research problems, questions and interests, and also advance some general observations relevant to our work here. Two of their general observations are of particular interest here. The first is that overall there is a paucity of research in the area of technology and literacy – and we need to note that Kamil and his colleagues included a much wider range of research in their review than computer-based applications alone.

The second is that this paucity is actually *intensified* in mainstream journals concerned specifically with reading, writing and literacy. Kamil and Lane (1998) report that for the years 1990 to 1995 they could find only 12 research articles on technology in relation to reading and writing in the 4 English language journals with the highest citation rates for literacy research: *Written Communication*, *Research in the Teaching of English*, *Reading Research Quarterly* and the *Journal of Literacy Research* (formerly the *Journal of Reading Behavior*). During that period these journals had published a total of 437 articles. Only 3 of the 12 research articles they located dealt with reading and technology, with 2 of these 3 articles principally concerned with audio and television. In addition, there were 9 articles dealing with technology and writing out of 181 articles published in the first two journals listed above. There had been 256 articles published in these two reading journals during 1990 to 1995.

To this overall paucity of published research articles we can add, for our present context, that the 350 articles actually analysed by Kamil and Intrator account for the entire school age range. Only a fraction of these deals with the 0–8 years age range. Moreover, if we project from the rate of articles published by the journals the researchers could access to include the journals they could not, it seems unlikely that more than 450–500 articles addressing technology and literacy development for the entire school age range would have been published in academic English language journals during the decade 1986 to 1995.

The six headings which Kamil and colleagues (2000) used to discuss the corpus of research they analysed are 'Computer and Composition', 'Hypermedia, Hypertext, and Literacy', 'Multimedia Effects on Literacy', 'Special Populations', 'Motivation', and 'Computers and Collaboration'. As a background to our own mapping work we will briefly note some of Kamil and colleagues' main findings for the school age range as a whole.

1. Computers and composition

There is some evidence to suggest that students produce better quality writing when they use word processing rather than pen and paper. A meta-analysis of research conducted by Bangert-Drowns (1993) suggested that where students received identical reading instruction, groups that were allowed to use word processing facilities produced marginally higher quality writing than groups who were confined to pen and paper. No effect was evident on attitudes toward writing, although word processor users produced longer texts (Kamil et al., 2000: 773).

2. Hypermedia, hypertext and literacy

The review of research indicated very little empirical research has been reported in the area of hypermedia, hypertext and literacy. The limited range of reports points to three main kinds of learning situations employing hypertext:

- Literary, where readers are encouraged to create unique stories.
- Informational, where hypertext is used for adding information that allows readers to explore material presented as text in more detail.
- In the creation of study or learning environments.

The small body of research identified to 1998 is piecemeal, hopelessly inconclusive and little if any of it appears to apply to the 0–8 years range (cf. Kamil et al., 2000: 774).

3. Multimedia effects on literacy

A number of published studies investigate the effects of using multimedia materials that integrate text, image, animations and sound on literacy learning. Most of the work reported by Kamil and his colleagues is concerned with cognitive aspects of literacy, such as how learners synthesize multimedia information, what kinds of comprehension processes are involved, and how learners exhibiting different learning styles fare with multimedia resources. Once again, little of this research appears to be based on studies of children in early childhood. There is some evidence to suggest that learners with limited prior knowledge of a topic tended to learn better with multimedia than with conventional material, as did learners identified as 'visual' or 'auditory' in their learning styles (Kamil et al., 2000: 775; Mayer 1997). Other research (e.g. Sharp et al., 1995) suggests that dynamic visual displays like animations and simulations are superior to static media for building mental models and comprehending stories (Kamil et al., 2000: 776). Overall, Kamil and colleagues cautiously observe an emerging conclusion that multimedia applications 'facilitate the construction of mental *models* and augment learning outcomes' (Kamil et al., 2000: 776, emphasis in original).

4. Special populations

According to Kamil and colleagues' findings, a growing body of research focuses on the capacity of computing applications to assist children deemed to have learning disabilities and who struggle with conventional forms of instruction. Kamil and colleagues claim that 'a growing body of literature reflects the extension and application of multimedia learning to benefit second language learners, at-risk children, and very young, preliterate children' (Kamil et al., 2000: 777). Isolated studies of young children 'with learning disabilities and difficulties with writing' tentatively suggest that users of special word processing programs 'demonstrated increased spelling accuracy and legibility' (Kamil et al., 2000: 777; see also MacArthur, 1998). Another isolated study (Boone et al., 1996) found 'some positive implications for the further development of multimedia programs to teach pre-reading lessons to kindergarten students of differential abilities (Kamil et al., 2000: 777), and a qualitative study by Labbo, Reinking and McKenna (1995) explored the computer's potential as an 'informal tool' to promote literacy development in kindergarten-aged children.

5. Motivation

Across the age ranges of school students, computers are seen by numerous researchers as having an effect in increasing motivation, interest in and enjoyment of schoolwork, involvement in tasks and time-on-task,

persistence and the like, in literacy acquisition and practice as well as in wider areas of the curriculum. Kamil and colleagues (2000) cite several studies that support the view that 'computer use by children can increase their involvement in and enjoyment of writing and reading, thereby improving the quality of what they produce' (p. 778). Once again, however, it appears that only a fraction of the small amount of work that has been published relates directly to children up to 8 years old.

6. Computers and collaboration

A tiny corpus of studies (e.g. Bump, 1990; Dickenson, 1986; Hawkins et al., 1982; Kent and Rakestraw, 1994; Mehan et al., 1985) tentatively suggests that using computers 'fosters higher levels of interaction and collaboration', especially within writing activities (Kamil et al., 2000: 780). Hence, Dickenson (1986) concluded on the basis of a study of a mixed first–second grade classroom that whereas students scarcely spoke to each other when completing normal individual writing work, their collaborative work around the computer involved considerable talk about plans for texts, revision, and matters of meaning and style (cf. Kamil et al., 2000: 780). The study by Kent and Rakestraw of two boys in first grade suggested that the computer plays a valuable role in 'facilitating complex language use' (Kamil et al., 2000: 780).

Toward mapping recent research about new technologies and early childhood literacy

The overall picture painted by the impressive review of research at the technology–literacy interface conducted by Kamil, Intrator and colleagues is quite gloomy so far as the hopes of early childhood educators and researchers looking for strong and clear guidance from research in relation to their varied interests and perspectives are concerned.

To begin with, it is clear that the corpus of research pertaining to the early years is relatively small. Second, there is no ready way of deducing from the original review which of the tentative conclusions and generalizations applies to early childhood literacy and to what extent. Third, it seems that most of the work analysed and reported by Kamil and colleagues has a cognitive and quantitative orientation, which marginalizes the interest many early childhood educators and researchers have in research of a qualitative nature and/or research that looks at social and cultural aspects of literacy acquisition in relation to new technologies. A further issue concerns the extent to which the survey conducted by Kamil and colleagues, of necessity, treats 'literacy' in a monolithic way rather than

factoring in different theoretical conceptions of literacy: for example, distinguishing studies that address literacy as a sociocultural phenomenon from those that treat it as a set of cognitive processes, or from an encoding–decoding perspective, and so on.

In undertaking the very modest survey that follows, we have tried in part to see whether there has been any recent change to the trend observed by Kamil and others that the literacy–technology interface is a marginal research interest area and, specifically, is under-represented within journals specializing in literacy-related research. We have also tried to confine our search as far as possible to studies concerned with the 0 to 8 years age range. Finally, we have developed a framework for mapping the studies we have found that employs a range of dimensions and variables associated with 'new technologies', 'literacy', and 'early childhood learners' respectively.

Trawling some representative literacy and general purpose education journals

Prior to conducting a search of some popular databases, we undertook a similar exercise to that reported by Kamil and Lane (1998). We took the three reading and writing journals surveyed by Kamil and Lane that have the greatest 'face validity' for early childhood literacy: namely, the *Reading Research Quarterly* (RRQ), the *Journal of Literacy Research* (JLR), and *Research in the Teaching of English* (RTE), which are all from the USA. To these we added *The Reading Teacher* (RT), also from the USA. We then selected four journals published in Britain with particular relevance to the field. These were: *Language and Education* (L and E), *The British Journal of Educational Technology* (BJET), the *Journal of Early Childhood Literacy* (JECL), and *Contemporary Issues in Early Childhood* (CIEC). To these we added the *Australian Journal of Language and Literacy* (AJLL). We then surveyed the contents of these journals from 1999 (with the exception of the two early childhood journals, JCEL and CIEC, which have only begun since 2000, and the *Australian Journal of Language and Literacy*, which only had online contents for the 5 most recent issues), and looked for any articles concerned with literacy and new technologies. Articles we identified were then screened for relevance to *early childhood* literacy, and for status as *research* articles, using the same criterion as Kamil and Intrator (involving empirical data collection). Table 1 summarizes the results.

On this basis we conclude that the trend observed by Kamil, Intrator and colleagues of *extreme marginalization* within specialist reading and writing journals of research articles concerned with new technologies and literacy continues, with this marginalization exacerbated for the early childhood years.

Table 1 **Summary of journal contents in area of new technologies and early childhood literacy 1999–2002**

Journal	*Issues Surveyed (1999–present)*	*Total Articles*	*Articles in Broad Area*	*Articles Relevant*
RRQ	14	86	5	1
JLR	13	57	1	1
RTE	16	62	0	0
RT	16	76	4*	1
L and E	13	39	1	0
BJET	16	150	5	1
JECL	5	20	2	1
CIEC	7	41	0	0
AJLL	5	23	0	0

*All four articles appeared in the same themed issue for April 2002

A larger look

Next we conducted a larger search covering the past five years (1996/7–2002). We wanted documents reporting research based on the collection and analysis of empirical data for the purposes of advancing substantive claims about literacy acquisition and/or literacy practices of children up to 8 years old and involving the use of computing technologies. We included reviews of research reports where they contained a demonstrable empirical component dealing with the early childhood age range. We excluded documents that only evaluated software. We also excluded accounts of 'how to use' new technologies in early childhood literacy education (e.g. Kahn, 1997), along with texts concerned with policy, and conceptually or theoretically-based commentaries and critiques (e.g. *Computers in the Schools,* 1999), unless these contained a significant free-standing component meeting the description above of the kind of documents sought. This decision was guided by observations by Thomas Fleming and Helen Raptis (2000: 12), among others, that just 25 percent of all the educational technology literature of the 1990s available in English could be described as empirically-based research. They calculated that 25 percent comprises of commentaries, opinions, discussions and theoretical ruminations. A whopping 44 percent describes uses of multimedia and other applications with different kinds of learners, *largely on the basis of 'anecdotal commentaries about the outcomes that can be achieved through media use'* (Fleming and Raptis, 2000: 12, emphasis added).

We used a range of online search engines and services to locate potential studies. Our main literature searches were conducted using the

academic search service, *Proquest*, and search strings (used primarily for keyword and document abstract searches): (a) early childhood + literacy + technology; (b) young children + literacy + technology; (c) children + literacy + technology; (d) child + technology + reading; (e) computers + child + reading; (f) computers + literacy OR reading; (g) computers + reading; and (h) computers OR technology + reading. *Proquest* is an international, multidisciplinary text database, offering full-text journal articles in a range of areas, as well as abstracts and citations. It covers the areas of biomedical science, business and marketing, computing, education, health, nursing, religion, social sciences and telecommunications.

This base search was supplemented by means of additional search services. These included: *ERIC* document and abstract searches; *EdResearch Online*, a full-text and fee-based document service provided by the Australian Council for Education Research; *InfoTrac*, an academic index comprising mostly full-text articles and other documents from areas including the humanities, current events reporting, sociology, and communications studies among others; *Ingenta*, which provides full-text access to more than 130 journals published by Blackwell Science; *WebSPIRS*, an index to a range of Australian published abstracts and which includes the AUSTROM group of databases which in turn includes the Australian Education Index (1978–), the Australian Library and Information Science Abstracts (1982–), and the Australian Family and Society Abstracts (1980–), among others. Four online *ERIC* Clearinghouses were also searched for relevant research articles and reports. These clearinghouses included the ERIC Clearinghouse on Information and Technology; the ERIC Clearinghouse on Reading, English, and Communication; the ERIC Clearinghouse on Elementary and Early Childhood; and the ERIC Journal of Early Childhood Research and Practice (which acts as a research clearinghouse). These searches were supplemented in turn with a search using Google.com – an online, general access search engine. We used this mainly to locate the personal article archives of key figures in the field and to locate online conference papers not archived in academic indices and databases.

Two additional search strategies were employed in preparing for this review. First, we searched the USA and the Australian digital dissertation and theses databases. Second, we targeted names and studies cited repeatedly across the corpus of texts, abstracts and citations we gathered and fed them into specialized searches that drew on a range of search engines and databases.

The corpus

We found Fleming and Raptis' assessment reflected in the new technologies and early childhood literacy research literature. The corpus of systematic, empirically grounded research revealed by our database search and subsequent hand check is very thin. Interestingly, a recently published *Handbook of Early Literacy Research* (Neuman and Dickinson, 2001) contains no chapter devoted to new technologies. We had particular trouble locating qualifying studies for the UK. For example, not a single reference among 36 items for 'Research findings about school and ICT' listed at 'http://www.literacytrust.org.uk'; was remotely relevant to our topic. The same held for the resources listed on the British Educational Communications and Technology agency (BECTa) site at 'http://www.becta.org.uk'. The great bulk of the material available does not profess to be research, and what currently exists is typically in the form of 'preliminary reports', and the work being done tends to focus on primary schools rather than early childhood specifically. In light of current expenditure throughout the UK on ICT for literacy education via the National Grid for Learning, the near absence of a respectable and readily available research corpus, including a specialist focus on the early years, is astounding. Like the corpus reported by Kamil and colleagues, the domain continues to be swamped by work from the USA. As we will see, the modest nature of the corpus we have mustered does not matter in terms of our approach here, since an important pattern is abundantly clear.

The searches we conducted delivered 9 research reports, 6 reviews of research literature, and 22 published articles and documents from clearinghouses. The 9 research reports identified comprised 4 funded reports and five dissertations (the latter all from the USA). The dominant emphasis among the four funded projects identified by searching was on disabilities and disadvantage (Comber and Green, 1999; Hutinger, et al. 1997; Parette and Murdick, 1998). Three studies from the project led by Barbara Comber and Bill Green conducted in several South Australian schools formally designated 'disadvantaged' addressed learners in the 0 to 8 years age range. One (Hill, 1999) analysed video recorded snapshots of learning episodes. Key findings were that the use of IT engaged young learners for long periods, promoted reciprocal learning, and engaged learners in multiple forms of literacy. A second (Bills and Thomson, 1999) traced collaborative work undertaken by teachers and students from multiple year levels to construct a website. The third (Barnett, 1999) focused on Non-English Speaking Background (NESB), new-arrival students involved in cross-age and cross-stream tutoring on early elements

of word processing, with Grade 6/7 students tutoring Reception/Grade 1 students.

The study by Hutinger and colleagues (1997) reports an early childhood emergent literacy technology project. It focuses on 16 pre-school classes involving learners with mild to moderate disabilities working with interactive literature-based, authoring and tool function (graphics and story making) software. It reports significant gains in communication and other emergent literacy behaviours, as well as enhanced interpersonal interactions among learners. The study reported by Hutinger and Johanson (2000) reports a project researching the implementation and maintenance of an effective early childhood comprehensive technology system within a school serving disabled learners. It describes what worked and why in the successful implementation of the system.

The remaining funded project (Lankshear et al., 1997) contained multiple site studies which included studying uses of multimedia, hypertext, and word processing applications with Grade 2 learners (including many NESB new arrival students) from the standpoint of a '3D' sociocultural model of literacy. This model sees literacy as having three integral dimensions – operational, cultural and critical – each of which must be addressed in literacy education, and emphasizes the importance of motivated connections between classroom activities and 'mature' versions of social practice in the world beyond school. Strengths and weaknesses of the observed practices are discussed.

The doctoral dissertations comprise an eclectic group. Kathryn Abel (2001) reports effects of email use in English language acquisition of preschool (4–5 years of age) children of mixed language backgrounds, using pre- and post-tests of conventional reading and writing measures. She found that language acquisition improvements among the groups using email over the 4 to 10 month study period were significantly greater than learners who did not use email, but that improvements did not vary significantly by gender. Sevilla Banister (2001) investigated teacher and student perspectives on computer use in kindergarten and third grade classes within an urban elementary school. Student views emphasized use of computers at the kindergarten level for skill practice and enrichment, and for creative writing and reading comprehension at the third grade level. Kristine Drake (2001) used expert opinion to identify a range of 'best practice' new technology applications and strategies for supporting reading. She surveyed elementary teachers in the Palm Springs Unified School District to gauge the extent to which and manner in which particular practices were being employed, and to identify issues teachers associated with their use. Linda Lyke (2001) investigated education websites

concerned with literacy development and designed for primary school teachers and learners in Florida. She investigated the sites in relation to developmental appropriateness and literacy content appropriateness using nationally recognized standards, and found them wanting. C.R. Phillips (2000) studied the effects of using an integrated computer program (i.e. *Successmaker*) on maths and reading development using conventional (encoding/decoding, comprehension) measures, and found some indication of improvement associated with use of the program, particularly in reading.

The six reviews of research literature identified in our search were all conducted by North American researchers. Besides the reviews by Kamil and Intrator (1998), Kamil and Lane (1998), Kamil, Intrator and Kim (2000), and Fleming and Raptis (2000) mentioned earlier, we found further reviews of computer use with young children in literacy education by Susan Haugland (1999) and Donald Leu (2000, see below). Most of the studies addressed by these reviews predate our focus on the years 1996/7–2002, and the reviews influenced our approach to discussing the corpus rather than informing the corpus itself.

Of the 22 published articles and clearing house documents meeting our criteria for inclusion, 17 cluster into 3 distinct groups. The remaining 5 studies are eclectic.

The first group of eight studies deals with uses of CD-ROM story books in early literacy research and development. Two (Smith, 2001, 2002) investigate a young boy's patterns of engagement with CD-ROM and other story book media. Cynthia Smith reports different patterns of interaction by the child with traditional picture books, child-generated LEA (Learning Experience Approach) story books, and CD-ROM books respectively, and his acquisition of multiple story literacies.

Two more studies in this group (Doty et al., 2001; Matthews, 1997) investigate the effects of using CD-ROM story books on reading comprehension. Using univariate analyses of difference on oral retelling and comprehension tasks, Doty and colleagues found no significant difference in retellings between children using the CD-ROM version and children using the print version of the same book. They did, however, find a significant difference in favour of the CD-ROM format on the comprehension questions. In a study using 3 experiments with 37 matched pairs of third grade students, Kathryn Matthews found no significant effect in using CD-ROM format over print format on reading comprehension assessed by open-ended questions. She found a significant effect in favour of the CD-ROM users on comprehension assessed by story retelling, however. She also found amongst the students who used print-based stories in the first

experiment that their comprehension – assessed by means of retelling – increased significantly in the second experiment when CD-ROM versions of two additional stories were used.

In a fifth study in the CD-ROM story book group, Linda Labbo and Melanie Kuhn (2000) used a distinction between 'considerate' (multimedia effects that are integral to and coherent with the story) and 'inconsiderate' (incongruent or incidental effects) CD-ROM stories in a study involving a kindergarten child. They found that considerate CD-ROMs supported the child's understanding and retelling, and enlisted active meaning making responses. Inconsiderate CD-ROMs impeded cohesive retellings and fostered passive viewing.

Two further studies (Higgins and Cox, 1998; Higgins and Hess, 1998) explored facets of vocabulary development using CD-ROM stories with 15 and 22 third grade learners respectively._Combinations of testing for the effect of using animated clues and supplementary instruction were used with a focus on unfamiliar words. In the first study, requiring attendance to the animated clues typically produced more effective learning of unfamiliar words. In the second study it was found that children who received supplementary instruction involving synonyms in conjunction with using the animated clues did significantly better on post-tests of the meaning of unfamiliar words than those who only used the clues.

In the final CD-ROM story book study, Amy Humble (2000) compared the effectiveness for enhancing reading fluency of silently reading a story while listening to it on CD-ROM with reading aloud to an adult (classroom parent, teacher aide). The results were almost identical, prompting the conclusion that a CD-ROM picture book could provide an effective substitute for adults when none was available for helping to enhance reading fluency.

Moving to the remainder of the corpus of published articles, two studies (Turbill, 2001; Wepner and Tao, 2002) looked at the teacher/teaching aspect of using new technologies in early childhood literacy education. Focusing on why teachers of early literacy find it difficult to integrate new technologies into their curriculum, Jan Turbill identified three key factors: lack of time and expertise to explore and understand software; narrow definitions of literacy held by teachers; and lack of understanding of and confidence in the capacity of new technologies to enhance literacy in the early years. Shelley Wepner and Liquing Tao undertook an interview and observation-based study of the perceptions of four experienced teachers of their shifting responsibilities for using new technologies in early childhood settings and what they have to do to accommodate new expectations. They found that teachers saw themselves as having to devote more time to their

own professional development, as having to spend more time planning instruction, and as having to know how to take into account the equipment available to them and how to work with students in different ways depending on what was available. Teachers also thought of themselves differently, had different expectations of and from administrators, and embraced willingness to take risks.

A cluster of seven studies focused on the use of new technologies in relation to the literacy education of diverse groups of young learners (Boone et al., 1996; Brett, 1997; Clements, 1998; Godt et al., 1998; Howell, 2000; Hutinger and Clark, 2000; Parette and Murdick, 1998). Studies ranged from using hypermedia lessons developed for each letter of the alphabet in a non-segregated kindergarten classroom with 'at risk' students and students with literacy learning difficulties (Boone at al., 1996), to investigating the effectiveness of using a computer-based skills program with first grade learners identified as candidates for reading failure (Howell, 2000; Parette and Murdick, 1998). In all cases the studies reported positive effects which, in addition to enhancing language and communication development, included improving social interactions, promoting cooperative work with peers, and aiding the shift from concrete to representational thought (cf. Hutinger and Johanson, 2000: 160).

The eclectic group of five remaining studies respectively address the collateral effects of using the *Wiggleworks* program with Kindergarten/Grade 1 learners (Ross et al., 2001), the use of hypermedia authoring software in process writing with 6–9 year olds (Mott and Klomes, 2001), the measured effects on reading levels and positive reading attitudes of using networked computers in 24 Kindergarten and Grade 1 classrooms (Casey, 1999), the measured effect of computer-aided instruction on the conventional reading skills of first grade students by whole group and by gender (Erdner et al., 1996), and an investigation of the literacy education resources available for early years learners on Britain's National Grid for Learning (Lankshear and Knobel, 2002).

A framework for mapping the corpus

With such a small body of literature it makes no sense to seek systematic trends at the level of findings in the manner of Kamil and colleagues. In any event, Donald Leu (2000) argues that in many cases it will be impossible to make research-based generalizations with any kind of shelf life. This is because of the rapid rate at which literacy is being redefined by the impact of new technologies and the ever shifting 'envisionments' new technologies 'intimate' for communication and information (Leu, 2000: 745). We

only need to consider the extent to which email has changed in the past decade to appreciate how short the shelf life of claimed purposes, uses, effects, processes, learning outcomes, and so on, might be for a wide range of computer applications in literacy education.

Instead, we want to propose an approach to *mapping* corpuses of research at the interface of new technologies and early literacy that may be useful to many individual producers and consumers of research in ways that complement work based on an umbrella approach concerned with major categories and global findings. We will briefly sketch a number of variables and dimensions that can be used in different combinations to develop frameworks useful for organizing and thinking about relevant research in accord with one's particular needs or interests. Our approach to developing a mapping tool, among the many possibilities open to early childhood researchers, employs some dimensions and variables associated with 'new technologies', 'literacy', and 'teachers and learners'.

New technologies

Two aspects seem especially relevant here: types and purposes.

(a) *Types of computing media* We may distinguish between *types* of computing media according to whether the hardware is free-standing or networked, and whether the software employed at a given time is interactive or non-interactive. This pair of distinctions yields several combinations (see Figure 1).

These combinations can be made more complex by distinguishing between different kinds of *networks* (local area, wide area, etc.), and between different kinds of *interactivity* (e.g. a user or users interacting with another person, or with multiple people; a user or users interacting with an object or some kind of inanimate 'other' like a 'bot' or an avatar, or with multiple objects, etc.).

(b) *Social purposes associated with computing mediated text production, distribution and exchange* While the borders between them may sometimes be blurred, and the same computer application may range over different purposes, we might identify Communication, Entertainment, Information, and Instruction purposes, among

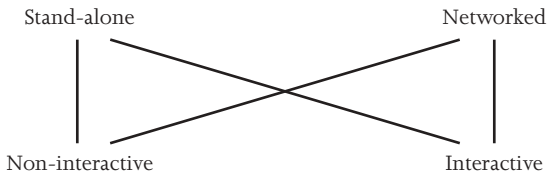

Figure 1 **Combinations of computing media hardware and software**

others, as being among the social purposes particularly significant to the new technologies-literacy interface. We return to this point later.

Literacy

We can draw two simple distinctions here and develop continua corresponding to each. The first is between literacy understood as 'the generic capacity to encode and decode alphabetic print', and literacy seen as *competent handling of texts that are meaningful to 'insiders' of particular sociocultural practices and discourse communities* (cf. Gee, 1996; Gee, Hull and Lankshear, 1996: 1–9).

The second distinction is between literacy seen essentially in terms of *printed texts*, and the notion of *multi-modal literacies* involving texts of different modes (Kress and Jewitt, 2003). Digital code allows meaningful texts to be produced, distributed and exchanged in varying ratios and with more or less equal ease among numerous formats including print, sound, icons, graphics and animations.

With these distinctions we can think in terms of a continuum extending between literacy as encoding/decoding and literacy as 'discursive prowess'. Drill and skill or basic skill approaches belong down the Encoding/Decoding end of the continuum. Approaches that involve learners acquiring competence with authentic forms of informed meaning making among experts within contexts of participation in 'mature' versions of social practices would belong at the 'Discursive Prowess' end of the continuum. Approaches like 'process writing' would be somewhere near the middle of this continuum. Similarly, learning activities based on the model of the book as text (whether literal print books or electronic books) belong at the 'Print' end of the second continuum. Approaches that emphasize design and production of multimedia texts will belong at the Multi-modality end.

If we take a position near the Encode/Decode and Print ends of these continua we would be interested in research that focuses on letter recognition, skill sharpening, and enhanced fluency with reading and writing conventional linear texts via use of word processing software, drill and skill software, electronic early reader books, audio software functions for matching sounds to letters, authoring software and so on. Conversely, if we take a position nearer the Discursive Prowess and Multi-modality ends of their respective continua we might be interested in research that investigates how, for example, youngsters participate in appropriate online communities where 'insiders' (experienced proficient members) can help newcomers acquire, refine and redefine the norms and 'moves' involved in becoming a 'true member' of a *Digimon* (games playing) or *Sim* (simulation) community, or a young writers' or bloggers' network, and so on.

Teachers and learners

Various distinctions might be used here. At a very general level, we can distinguish between research that focuses mainly on the teacher/teaching aspects of the technology–literacy interface, research that focuses mainly on the learner/learning aspects, and research that attends to both aspects.

With respect to learners specifically, we can distinguish between learners who are identified as having special learning needs, disabilities or difficulties (which it is thought might be met more fully with the assistance of new technologies) and learners who are not identified in this way. Because different kinds of classifications and arrangements occur in different countries it is difficult to reach a concise agreed distinction here. We can also distinguish between learners seen as being learning *disadvantaged* on account of such factors as language background, socio-economic status, race-ethnic affiliation and so on, and those who are not. This is also a difficult and contentious distinction to pin down. When seen from the standpoint of research in relation to such learner groupings, however, we can distinguish between research that attends to issues of race, class, ethnicity, physical-intellectual ability and learning difficulties (and thus addresses a diversity of learners), and research that is focused on a restricted diversity of learners, i.e. usually white, monolingual, able-bodied and so on. While it is not optimal, we might mark a continuum for learners ranging from this 'diversity of learners' to 'restricted diversity of learners'. Research falling under the umbrella of 'diversity of learners' is that which attends to the kinds of learning issues we have identified. At present it appears that research that is concerned with a diversity of learners is less extensive than research that focuses on a restricted diversity of learners.

Some potential research 'scenarios'

It is too complicated to build a single matrix from all the dimensions, continua and variables we have assembled here. It is, however, easy enough to construct some multi-dimensional *quadrants* that indicate a range of possible research study 'scenarios' (see Figure 2).

For each quadrant we can employ one or more variables and continua (see Figure 3).

> Quadrant 1 will cover research that investigates situations where stand-alone machines are used to enhance encoding and decoding skills. This research would focus on encoding/decoding either print and/or multi-modal texts, and for one or more social purposes. It would include the use of non-interactive and/or interactive software. The research may be conducted with a greater or

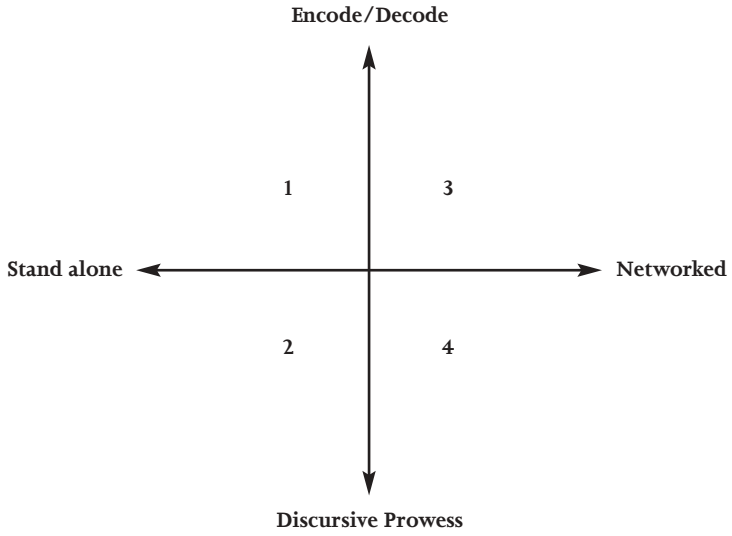

Figure 2 **Quadrants for 'scenarios' in research**

Software:	**Interactive ---------- Non Interactive**
Personnel:	**Teachers ---------- Learners**
Learners:	**Diversity ---------- Restricted Diversity**
Text Form:	**Print Text ---------- Multimodal**
Purposes:	**Communication --- Entertainment --- Information --- Instruction**

Figure 3 **Key variables operating in literacy and computing research 'scenarios'**

lesser diversity of learners and with a greater or lesser focus on teacher and learners respectively.

At the opposite pole, Quadrant 4 will cover research that investigates situations where networked machines are used to enhance discursive prowess within communities of sociocultural practice. Again, it would include the use of non-interactive and/or interactive software with a greater or lesser diversity of learners and with a greater or lesser focus on teacher and learners respectively.

Quadrant 2 will cover studies investigating situations that use stand-alone machines and other hardware with a view to enhancing discursive prowess within communities of sociocultural practice involving print and/or multimodal texts for some relevant social purpose. Computer uses may involve

interactive and/or non-interactive applications with a greater or lesser diversity of learners. The relative emphasis may be on teachers, learners or both.

Quadrant 3 will cover situations involving the use of networked machines in order to enhance encoding/decoding competence in some combination or other of the variables identified.

A map of the corpus

Using the four quadrants yields a dramatic but not unexpected map of the corpus of reports and articles mobilized here. Of the 31 distinguishable studies (counting the three studies separately from Comber and Green, 1999), no less than 24 can be assigned to Quadrant 1. These include four of the six funded report studies (Barnett, 1999; Hutinger at al., 1997; Hutinger and Johanson, 2000; Lankshear et al., 1997), and three of the five doctoral dissertations (Banister, 2001; Drake, 2001; Philips, 2000). Seventeen of the articles fall within this first quadrant. These include six of the eight CD-ROM studies (Doty et al., 2001; Higgins and Cox, 1998; Higgins and Hess, 1998; Humble, 2000; Labbo and Kuhn, 2000; Matthew, 1997). Both of the teacher-oriented studies effectively fall into this quadrant as well (Turbill, 2001; Wepner and Tao, 2002), since Turbill notes the narrow definitions of literacy harboured by the teachers in her study. Not surprisingly, all seven studies concerned with a diversity of learners (Boone et al., 1996; Brett, 1997; Clements, 1998; Godt et al., 1998; Howell, 2000; Hutinger and Clark, 2000; Parette and Murdick, 1998) fall within the first quadrant. Finally, three of the five remaining studies (Erdner et al., 1996; Mott and Klomes, 2001; Ross et al., 2001) also cluster in Quadrant 1. Within this first quadrant, the studies that seem to belong furthest from the strict Encoding/Decoding skills end of the continuum and nearer the center are, in order, those studies concerned with vocabulary development (Higgins and Cox, 1998; Higgins and Hess, 1998), reading comprehension (Doty et al., 2001; Matthew, 1997), process writing and multi-modal text production (Lankshear et al., 1997; Mott and Klomes, 2001), and active, interpretive forms of meaning making (Labbo and Kuhn, 2000).

Just three studies appear to fall within Quadrant 2 (Hill, 1999; Smith, 2001, 2002). In all cases, however, these studies appear to lie nearer the center of the 'literacy' continuum than toward anything that might seriously be regarded as 'discursive prowess'. Smith's research subject, James, is being initiated into some form of proficiency as a consciously multiliterate reader of stories. In addition, only by drawing a long bow can learners in the classroom described by Hill be seen as being actively recruited to insider or expert status with respect to producing multi-modal

multimedia texts of the kinds found in mature versions of their corresponding 'real world' practices.

Four studies can be assigned reasonably unambiguously to Quadrant 3 (Abel, 2001; Lankshear and Knobel, 2002; Lyke, 2001). One (Bills and Thomson, 1999) can probably be assigned to either Quadrant 3 or 4, with Quadrant 3 seeming much more likely. Not surprisingly, perhaps, Quadrant 4 is bereft. Here again, only on a very open interpretation may the Bills and Thomson (1999) study of early childhood teachers and students working to construct a website be assigned there.

With regard to the variables associated with literacy and with teachers and learners respectively some early patterns are evident. On the surface there appears to be a reasonably even distribution between studies of practices employing multi-modal resources (alphabetic text, pictures/graphics and sound) and resources that are predominantly alphabetic text-oriented. What we find, however, is that the overwhelming emphasis is on using these resources to promote abilities to handle conventional alphabetic print texts rather than to *generate* multi-modal texts and to understand principles of making multi-modal meanings. This skew is understandable given current literacy policy directions that continue to insist on the predominance of alphabetic text and, moreover, to approach literacy education with an assumption that high proportions of learners will actually have to *struggle* to become encoders and decoders. From our perspective, this trend is most unfortunate. Apart from anything else, it entails an absurd 'under-realization' of the potential of new technologies to orient children toward literacy futures that will be very different from the past. This skew is also partly explained by the corpus of studies involving learners with mild to moderate disabilities that aims at documenting and promoting emergent literacy behaviours.

Needless to say, the corpus of studies is swamped by an emphasis on developing a generic capacity to encode and decode alphabetic print rather than to promote competence as 'insiders' of practices and discourse communities that extend beyond conventional classroom reading and writing. Most of the studies involve 'reading/receiving' text-mediated meanings rather than 'writing/generating' meanings. The nearest any of the studies come to the latter is in some of the larger research projects where teachers and learners were faced with creating web-pages and occasionally pondered aspects of effective design. Yet, as we show elsewhere with reference to the example of Alex and his *Koala Trouble* stories (Lankshear, 1997; Lankshear and Knobel, 2002), young learners can become highly proficient and self-conscious 'insiders' of discourse communities as 'writers' and 'readers' alike.

Finally, with respect to the teachers and learners variable most of the studies are primarily concerned with reporting learner outcomes and with the apparent role of new technologies in this. As a result, many of the studies say little about teachers and learners as teachers and learners per se – that is, in their pedagogical roles and performances. The two studies by Cynthia Smith (2001, 2002) and the studies by Abel (2001) and Labbo and Kuhn (2000) are notable exceptions here. In those studies where the emphasis is mainly on teachers (e.g. Drake, 2001; Hutinger and Johanson, 2000; Turbill, 2001; Wepner and Tao, 2002), the research tends to focus more on teacher accounts of what they do than on observations of pedagogy in action.

Concluding comment

It is, however, precisely the kind of activities that would be researched by studies falling within Quadrant 4 that most closely approximate to the kinds of literacy education experiences required for higher level participation in the kind of knowledge–information society described by leading theorists (e.g. Castells, 1996). The other quadrant that is most relevant in this respect is Quadrant 2, which is almost equally bereft so far as our corpus is concerned.

Indeed, one of the very few studies of which we are aware in the early childhood range that can be used to indicate what is at stake here is our own limited study of an Australian child, Alex (Lankshear, 1997: 183–187; Lankshear and Knobel, 2002; Lankshear and Knobel, 2003). Alex (then aged 5) collaborated with his father to produce a series of distinctive hyper-linked narratives about the adventures of a koala named Max. Written and illustrated by a young child expressly for other children, on the grounds that Alex could find little or no content on the Internet that appealed to him, these narratives have generated in the vicinity of 10 million hits (Balson, 2001, personal communication) since they first appeared in 1996. Their enthusiastic reception involved Alex in email communication with thousands of people of all ages (up to 90 years old) from around the globe. The conception and success of Alex's site stamped him as an innovative 'symbolic analyst' of the information age in the making. Alex will by no means be unique. Yet, to date, cases like him have barely been recognized in the research literature and still less researched by investigators of the new technologies–literacy interface. Moreover, it is likely that a high proportion of such cases as exist would have to be researched in out-of-school settings, since they remain marginal to classrooms. Unless and until they *are* researched it would be unreasonable to expect school-based learning to

come seriously to terms with what are increasingly being referred to as 'new literacies'.

References

Abel, K. (2001) 'Analysis of Collaborative E-mail use on the Language Acquisition of Pre-School Children Aged 4 and 5', PhD thesis, School of Technology Management, Stevens Institute of Technology, Hoboken, NJ.

Balson, S. (2001) Personal email communication (28 October).

Bangert-Drowns, R. (1993) 'The Word Processor as an Instructional Tool: A Meta-analysis of Word Processing in Writing Instruction', *Review of Educational Research* 63(1): 63–93.

Banister, S. (2001) 'Computers in the Elementary Classroom: Teacher and Student Perspective', PhD thesis, School of Education, Indiana University, Indianapolis.

Barnett, J. (1999) 'Rivergum Plains Primary', in B. Comber and B. Green (eds) *Information Technology, Literacy and Education Disadvantage Research and Development Project*, Vol. 2, pp. 159–204. Adelaide, South Australia: University of South Australia.

Bills, D. and Thomson, P. (1999) 'Greentown District Primary', in B. Comber and B. Green (eds) *Information Technology, Literacy and Education Disadvantage Research and Development Project*, Vol. 2, pp. 123–58. Adelaide, South Australia: University of South Australia.

Boone, R., Higgins, K., Notari, A. and Stump, C. (1996) 'Hypermedia Pre-reading Lessons: Learner-centered Software for Kindergarten', *Journal of Computing in Childhood Education* 7(1–2): 39–70.

Brett, A. (1997) 'Assistive and Adaptive Technology Supporting Competence and Independence in Young Children with Disabilities', *Dimensions of Early Childhood* 25(3): 18–20.

Bump, J. (1990) 'Radical Changes in Class Discussion using Networked Computers', *Computers and the Humanities* 24(1): 49–65.

Casey, J. (1999) 'Hope of the New Century: Early Literacy, the Empowerment of Technology', *Sixty-third Yearbook of the Claremont Reading Conference*, pp. 117–24.

Castells, M. (1996) *The Rise of the Network Society*. Oxford: Blackwell.

Clements, D. (1998) 'Young Children and Technology', ERIC Document Reproduction Service No. ED416991.

Comber, B. and Green, B., eds (1999) *Information Technology, Literacy and Education Disadvantage Research and Development Project*, Vol. 2.. Adelaide, South Australia: University of South Australia.

Computers in the Schools (1991) 15(1): entire issue.

Dickenson, D. (1986) 'Cooperation, Collaboration, and a Computer: Integrating a Computer into a First-second Grade Writing Program', *Research in the Teaching of English* 20(4): 357–78.

Doty, D., Popplewell, S. and Byers, G. (2001) 'Interactive CD-ROM Storybooks and Young Readers' Reading Comprehension', *Journal of Research on Computing on Education* 33(4): 374–84.

Drake, K. (2001) 'A Study of Technology-based Best Practices which Support Literacy Learning in Elementary Schools', PhD thesis,Graduate School of Education, Pepperdine University, Los Angeles, CA.

Erdner, R., Guy, R. and Bush, A. (1996) 'The Impact of a Year of Computer Assisted Instruction on the Development of First Grade Reading Skills', *Journal of Educational Computing Research* 18(4): 369–86.

Fleming, T. and Raptis, H. (2000) 'A Topographical Analysis of Research, 1990–1999', *Teacher Librarian* 25(5): 9–15.

Gee, J. (1996) *Social Linguistics and Literacies: Ideology in Discourses*, 2nd edn. London: Falmer Press.

Gee, J., Hull, G. and Lankshear, C. (1996) *The New Work Order: Behind the Language of the New Capitalism*. Sydney: Allen and Unwin.

Godt, P., Hutinger, P., Robinson, L. and Schneider, C. (1998) 'A Simple Strategy to Encourage Emergent Literacy in Young Children with Disabilities', *Teaching Exceptional Children* 32(2): 38–44.

Haugland, S. (1999) 'What Role Should Technology Play in Young Children's Learning?', *Young Children* 54(6): 26–31.

Hawkins, J., Sheingold, K., Gearhart, M. and Berger, C. (1982) 'Microcomputers in Schools: Impact on the Social Life of Elementary Classrooms', *Journal of Applied Developmental Psychology* 3(4): 361–73.

Higgins, N. and Cox, P. (1998) 'The Effects of Animation Clues on Third Grade Children's Ability to Learn the Meanings of Unfamiliar Words', ERIC Document No: ED418686.

Higgins, N. and Hess, L. (1998) 'Using Electronic Books to Promote Vocabulary Development', ERIC Document No: ED418687.

Hill, S. (1999) 'In "Screenland" at Fairtown Primary', in B. Comber and B. Green (eds) *Information Technology, Literacy and Education Disadvantage Research and Development Project*, Vol. 2, pp. 89–122. Adelaide, South Australia: University of South Australia.

Howell, R. (2000) 'Evaluation of a Computer-based Program on the Reading Performance of First Grade Students with Potential for Reading Failure', *Journal of Special Education Technology* 15(4): 5–14.

Humble, A. (2000) 'A Comparison Study of the Traditional Ready Strategy of Reading Aloud with an Adult and the Technology Based Strategy of Computerized Talking Books', ERIC Document No: DE450349.

Hutinger, P., Bell, C., Beard, M., Bond, J., Johanson, J. and Terry, C. (1997) *Final Report: The Early Childhood Emergent Literacy Technology Research Study*. Macomb, IL: Western Illinois University. ERIC Document Reproduction Service No. ED 418545.

Hutinger, P. and Clark, L. (2000) 'TEChPLACEs: An Internet Community for Young Children, their Teachers and their Families', *Teaching Exceptional Children* 32(4): 56–63.

Hutinger, P. and Johanson, J. (2000) 'Implementing and Maintaining an Effective Early Childhood Comprehensive Technology', *Topics in Early Childhood Special Education* 20(3): 159–178.

Kahn, J. (1997) 'Scaffolding in the Classroom: Using CD ROM Storybooks at a Computer Reading Center', *Learning and Leading with Technology* 25(2): 17–19.

Kamil, M. and Intrator, S. (1998) 'Quantitative Trends in Publication of Research on Technology and Reading, Writing, and Literacy', in T. Shanahan and F. Rodríguez-Beown (eds) *National Reading Conference Yearbook 47*, pp. 385–96. Chicago, IL: National Reading Conference.

Kamil, M., Intrator, S. and Kim, H. (2000) 'The Effects of Other Technologies on Literacy and Literacy Learning', in M. Kamil, P. Mosenthal, D. Reason and R. Barr (eds) *Handbook of Reading Research: Volume 3*, pp. 771–88. NJ: Lawrence Erlbaum.

Kamil, M. and Lane D. (1998) 'Researching the Relationship between Technology and Literacy: Agenda for the 21st Century', in D. Reinking, M. McKenna, L. Labbo and

R. Keiffer (eds) *Handbook of Literacy and Technology: Transformations in a Post-Typographic World*, pp. 323–41. Mahwah, NJ: Lawrence Erlbaum Associates.

Kent, J. and Rakestraw, J. (1994) 'The Role of Computers in Functional Language: A Take on Two Writers', *Journal of Computing in Childhood Education* 5(3–4): 329–37.

Kress, G. and Jewitt, C., eds (2003) *Multimodal Literacy*. New York: Peter Lang.

Labbo, L. and Kuhn, M. (2000) 'Weaving Chains of Affect and Cognition: A Young Child's Understanding of CD-ROM Talking Books', *Journal of Literacy Research* 32(2): 187–210.

Labbo, L., Reinking, D. and McKenna, M. (1995) 'Incorporating the Computer into Kindergarten: A Case Study', in K. Hinchman, D. Leu and C. Kinzer (eds) *Perspectives on Literacy Research and Practice: Forty-Fourth Yearbook of the National Reading Conference*, pp. 459–65. Chicago, IL: National Reading Conference.

Lankshear, C. (1997) *Changing Literacies*. Buckingham, UK: Open University Press.

Lankshear, C., Bigum, C., Durrant, C., Green, B., Honan, E., Morgan, W., Murray, J., Snyder, I., and Wild, M. (1997) *Digital Rhetorics: Literacies and Technologies in Education – Current Practices and Future Directions*. Canberra: Department of Employment, Education, Training and Youth Affairs.

Lankshear, C. and Knobel, M. (2002) 'Children, Literacy and the UK National Grid for Learning', *Journal of Early Childhood Literacy* 2(2): 167–95.

Lankshear, C. and Knobel, M. (2003) *New Literacies: Changing Knowledge in the Classrooms*. Buckingham: Open University Press.

Leu, D. (2000) 'Literacy and Technology: Deictic Consequences for Literacy Education in an Information Age', in M. Kamil, P. Mosenthal, D. Reason and R. Barr (eds) *Handbook of Reading Research*, Vol. 3, pp. 743–70. New Jersey: Lawrence Erlbaum.

Lyke, L. (2001) 'Analysis of Primary Education Websites', PhD thesis, College of Education, Florida Atlantic University, Miami..

MacArthur, C. (1998) 'Word Processing with Speech Synthesis and Word Prediction: Effects on the Dialogue Journal Writing of Students with Learning Disabilities', *Learning Disability Quarterly* 21(1): 1–16.

Matthews, K. (1997) 'A Comparison of the Influence of Interactive CD-ROM Storybooks and Traditional Print Storybooks on Reading Comprehension', *Journal of Research on Computing in Education* 29(3): 263–70.

Mayer, R. (1997) 'Multimedia Learning: Are we Asking the Right Questions?', *Educational Psychologist* 32(1): 1–19.

Mehan, H., Moll, L. and Riel, M. (1985) 'Computers in Classrooms: A Quasi-Experiment in Guided Change', Final Report NIE 6–83–0027. San Diego: University of California.

Mott, M. and Klomes, J. (2001) 'The Synthesis of Writing Workshop and Hypermedia-authoring: Grades 1–4', *Early Childhood Research and Practice* 3(2), URL (consulted October 2002): http://ecrp.uiuc.edu/v3n2/mott.html

Neuman, S. and Dickinson, D. (2001) *Handbook of Early Literacy Research*. New York: Guilford Press.

Parette, H. and Murdick, N. (1998) 'Assistive Technology and IEPs for Young Children with Disabilities', *Early Childhood Education Journal* 25(3): 193–8.

Phillips, C. (2000) 'The Effects of an Integrated Computer Program on Math and Reading Improvement in Grades 3 through 5', PhD thesis, College of Health and Human Sciences, University of Tennessee, Knoxville.

Ross, J., Hogaboam-Gray, A. and Hannay, L. (2001) 'Collateral Benefits of an Interactive

Literacy Program for Grade 1 and 2 Students', *Journal of Research on Technology in Education* 33(3): 219–34.

Sharp, D., Bransford, J., Goldman, S., Kinzer, V. and Vye, N. (1995) 'Dynamic Visual Support for Story Comprehension and Mental Model Building by Young At-risk Children', *Educational Technology Research and Development* 43(1): 25–42.

Smith, C. (2001) 'Click and Turn the Page: An Exploration of Multiple Storybook Literacy', *Reading Research Quarterly* 36(2): 152–83.

Smith, C. (2002) 'Click on Me! An Example of how a Toddler used Technology in Play', *Journal of Early Childhood Literacy* 2(1): 5–20.

Turbill, J. (2001) 'A Researcher goes to School: Using Technology in the Kindergarten Literacy Curriculum', *Journal of Early Childhood Literacy* 1(3): 255–80.

Wepner, S. and Tao, L. (2002) 'From Master Teacher to Master Novice: Shifting Responsibilities in Technology-infused Classrooms', *The Reading Teacher* 55(7): 643–53.

Correspondence to:

COLIN LANKSHEAR, School of Education, University of Ballarat, PO Box 663, Ballarat, Victoria 3353, Australia. [email: colin@coatepec.net]

MICHELE KNOBEL, Department of Education, University of California, Irvine, 2001 Berkeley Place, Irvine CA 92612, USA. [email: michele@coatepec.net]