

1. Introduction

1.1 Overview

Historically, there has been considerable debate as to whether young children should use technology, both at home and at school (Alper, 2011; Blackwell, 2013; Children Now, 2007; Cordes & Miller, 2000; Kirkorian, Wartella & Anderson, 2008; House, 2012; Lindahl & Folkesson, 2012; Morgan, 2010, Paret, Quesenberry & Blum 2010, Plowman & McPake, 2013). One side argues that technology is developmentally inappropriate for young children who need to consolidate their knowledge using concrete materials (Cordes & Miller, 2000; Healy, 2004; House, 2012; Plowman & Stephen, 2003), and that too much screen time can overload their senses (House, 2012) resulting in attention difficulties and poor concentration (Cordes & Miller, 2000; House, 2012). Furthermore, it has been argued that overuse of technology puts young children at risk of developing muscular-skeletal injuries (Children Now, 2007; Cordes & Miller, 2000; Plowman & Stephen, 2003) and visual difficulties (Cordes & Miller, 2000). Other arguments suggest that young children are especially vulnerable to media messages (Cordes & Miller, 2000; Lieberman, Fisk & Biely, 2009) and that violent television and video games have been associated with aggression and anti-social behavior (Anderson & Bushman, 2001; Children Now, 2007; Cordes & Miller, 2000). Other detriments

include impaired literacy skills, loss of imagination (Cordes & Miller, 2000) and a lack of social skills, resulting in social isolation (Cordes & Miller, 2000; Healy, 2004).

The other side of the debate argues that developmentally appropriate use of technology can enhance young children's learning (Blackwell, 2013; Blackwell, Lauricella & Wartella, 2014; Children Now, 2007; Hillman & Marshall, 2009; Lindahl & Folkesson, 2010; Plowman & Stephen, 2003; Vernadakis, Avgerinos, Tsitskari & Zachopoulou, 2005), particularly in the area of emergent literacy skills (Cassell, 2004; Parette, Quesenberry & Blum, 2010; Plowman, Stevenson, McPake, Stephen & Adey, 2011). Technology use is associated with increased motivation (Lindahl & Folkesson, 2010; Plowman & Stephen, 2003; Vernadakis et al., 2005), student-centered learning practices (Blackwell, 2013) and the development of social skills through collaboration (Alper, 2011; Cassell, 2004; Cicconi, 2014; Children Now, 2007; Lieberman, 2009; Shifflet, Toledo & Mattoon, 2012). Another benefit that has been demonstrated is that the use of technology can support children with disabilities and special needs (Children Now, 2007; Cordes & Miller, 2000; Hutinger & Johanson, 2000; Muligan, 2003). Finally, supporters of this side of the debate suggest that early experiences with digital technologies help young children develop the necessary technology skills and fluency that will be needed in their future (Hillman & Marshall, 2009; Rosen & Jaruszewicz, 2009).

More recently, the debate has shifted and the issue has changed from whether technology should be used in early childhood settings, to how it should be used and

whether it makes a difference in children's learning and development (Children Now, 2009; Ko & Chou, 2014; Parette et al., 2010; Rosen & Jaruszewicz, 2009). Indeed, the question for educators and policy-makers has become how to best integrate technology into pedagogical practice and curriculum design in early childhood settings, which often value play-based learning (Plowman, McPake & Stephen, 2012). Several researchers recommend that practitioners take a thoughtful approach to the use of technology by carefully considering the design of the technology to determine if it supports creativity, curiosity, and play, promotes interaction among children and provides an authentic learning experience (McManis & Gennewig, 2012; National Association for the Education of Young Children & the Fred Rogers Center, 2012; Plowman et al., 2012; Rosen & Jaruszewicz, 2009). Rosen & Jaruszewicz (2009) introduce the term *developmentally appropriate technology use (DATU)* and suggest this includes preparing a technology environment in early childhood settings that supports child-initiated learning, encourages collaborative problem solving and takes a play-based, inquiry orientation.

Despite these recommendations for a thoughtful approach to the use of technology with young children, some research suggests that technology use in early childhood education is often inconsistent and/or limited (Aubrey & Dahl, 2014; Blackwell, 2013; Lindahl & Folkesson, 2012; Parette et al., 2010), and when technology is used, it often consists of simple drill and practice software (Chera & Wood, 2003; Children Now, 2007, Mama & Hennessy, 2010; Rosen & Jaruszewicz, 2009; Wang, Kinzie,

McGuire & Pan, 2010; Wohlwend, 2010). Edwards (2013) proposes the reason for this inconsistency is that international curriculum documents separate descriptions of play as learning from descriptions of technology use as learning, rather than combining them. Educators struggle to bridge the gap between pedagogical understandings of play and the use of technologies (Edwards, 2013; Lindahl & Folkesson, 2010; Plowman et al., 2012; Turja, Endepohls-Ulpe & Chatoney, 2009). Rosen & Jaruszewicz (2009) include an inquiry orientation in their description of child-initiated learning in a play-based environment. Play and inquiry are closely related constructs in early childhood education, as children develop inquiry through play (Youngquist & Pataray-Ching, 2004). Integrating technology into such a child-centred setting is more challenging than in the older grades which are more often based on direct instruction, rather than play and inquiry (Plowman et al., 2012).

The most recent literature review of the use of technology in early childhood education is five years old (Burnett, 2010). Burnett's (2010) review included children of a wide age range (infants-8 years old) and focused solely on literacy. Given the details of Burnett's dated review, coupled with the fact that new hardware and software applications have emerged since Burnett's study, in addition to the report of inconsistent use of technology in early childhood settings, an updated review is warranted.

This updated literature review includes studies from 2009-2014, narrows the focus to children aged 3-6 years (early childhood education age), and broadens the scope from literacy to student learning (in any subject) and engagement.

1.2 Previous Literature Reviews

Four previous literature reviews have been conducted focusing on early childhood education and technology (McCarrick & Li, 2007; Lankshear & Knobel, 2003; Yelland, 2005; Burnett, 2010). Each of these reviews will be discussed in turn.

The first review, conducted by McCarrick & Li (2007) focused on research from 1984-2004 with subjects in the age range of three to five years old. They concentrated on research relating technology to four domains of development: social, cognitive, language development and motivation. Their findings indicated that social interactions among children are higher when computers are used. They also cited support for using computers to help scaffold children's learning (either with an adult, peer or computer assisted scaffolding) and related this to the Zone of Proximal Development or the "difference between what a child can learn by himself and what he can learn with a skilled partner" (p. 84, McCarrick & Li, 2007). McCarrick & Li (2007) also noted computers are highly motivating for preschoolers. Finally, they reported that the research does not show an improvement in language skills with computer use, nor was it found to be a hindrance. They suggested that further research be conducted using

larger sample sizes, well-defined learning environments, and multiple developmental domains.

The second review by Lankshear & Knobel (2003) focused on research from 1996-2002, and students up to eight years old. Their literature review concentrated on technology in relation to literacy. The methodology used to find and select articles was clearly explained and uncovered 22 articles, six reviews and nine research reports. They organized the research into three categories: CD-ROM story books and language development, teacher/teaching aspect of using new technology, and new technology in relation to literacy education. The general findings indicated either a positive relationship or no relationship between technology use and literacy skills. However, Lankshear & Knobel categorized the types of studies looking at trends in the type of research. The authors created four quadrants (see Figure 1), which they used to map each study. Quadrant 1 covered research where stand-alone machines were used to enhance reading skills, specifically encoding and decoding skills. Quadrant 2 included research where stand-alone machines were used to enhance the discursive prowess within communities of sociocultural practice. Quadrant 3 involved research where networked machines were used to enhance encoding and decoding skills. Quadrant 4 incorporated research where networked machines were used to enhance discursive prowess within communities of sociocultural practice. Within each of these quadrants, other variables were considered, such as the use of non-interactive vs. interactive

software, the diversity of learners and focus on teacher and learners respectively. They found that very few studies clustered in Quadrant 2 and no studies were found for Quadrant 4, which, according to Lankshear & Knobel (2003), are the types of literacy experiences related to higher level thinking. They suggested that their review not only affirmed that technology use in early childhood is under-researched, but that the research that did exist was one-sided, focused on areas of reading/receiving (Quadrants 1 and 3) rather than writing/generating (Quadrants 2 and 4). Lankshear & Knobel (2003) strongly recommended further research into new technologies in early childhood education which focus on the higher level literacy skills found in Quadrants 2 and 4.

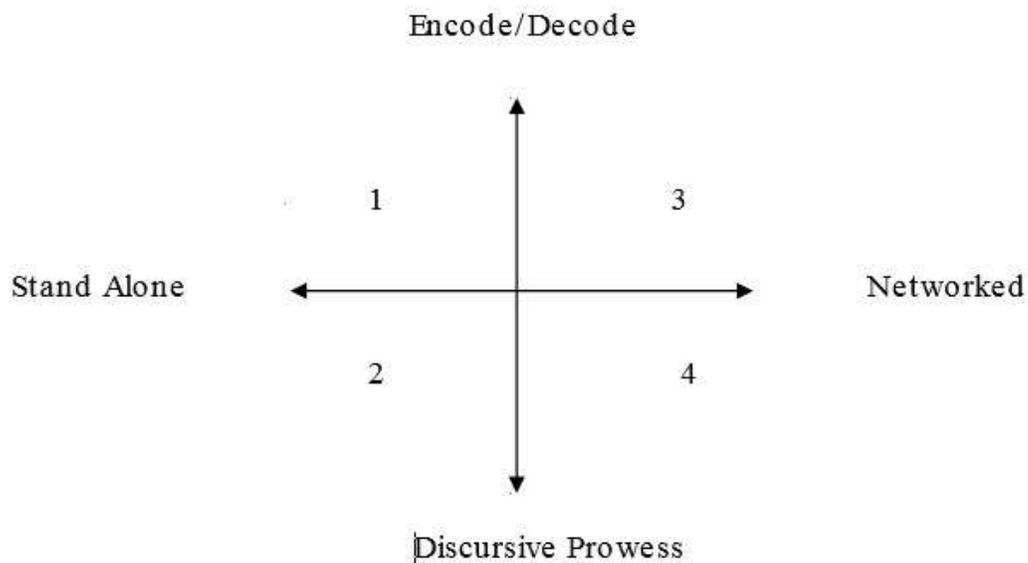


Figure 1 Quadrants for 'scenarios' in research (Lankshear & Knobel, 2003)

The third review (Yelland, 2005) examined research with children up to eight-years old, from 1994 to 2004, with a focus on four domains; literacy, numeracy, creativity and critical thinking, and the creation of knowledge building communities. Yelland began by outlining the arguments against the use of technology in early childhood settings (such as poor quality software, minimized role of teachers, social isolation, concepts being too abstract) and then cited research to disprove each of these arguments. She followed with a summary of Lankshear's & Knoble's (2003) review, while integrating other research which she organized into the four categories. Yelland (2005) suggested that the research revealed that innovation is possible when technology use is embedded in new curricula and that young children can use technology to experience concepts that were previously well beyond them. She recommended that future research should focus on innovative uses of technology, rather than a replication of previous studies. She argued that simply compared computer to non-computer contexts does not help to stimulate new understandings or add to knowledge of innovative uses of technology.

The final review, conducted by Burnett (2010) was the most recent and included research from 2003-2009. Like Lankshear and Knobel (2003), Burnett focused on literacy and technology within the infant to 8 year old age group. Burnett's (2010) method of finding research articles was well explained and produced 36 peer-reviewed articles. These articles were divided into three categories: technology as deliverer of literacy,

technology as site for interactions around texts, and technology as a medium for meaning-making. For the first category, she reported that technology as a deliverer of literacy had either a positive impact on various language skills, motivation and engagement or no impact. Regarding the second category, technology for interaction, only a few studies were found. These few studies suggested that children interact positively with each other when they work together using digital texts or literacy software. With respect to the third category, she concluded that technology can be used successfully for meaning making with this age group, especially when it is used to connect with the real world. Finally, Burnett (2010) highlighted the need for more extensive research into the area of children's engagement with digital texts. She acknowledged that most studies in her literature review were small-scale (in terms of sample sizes) and narrowly focused. She suggested that a broader 'gaze' should be taken when conducting research with young children and digital texts to allow for the possibility of identifying new possibilities and connections.

There are various issues with the four literature reviews which indicate the need for an updated review. The greatest criticism is that they are all outdated. Three of the four literature reviews (Lankshear & Knobel, 2003; McCarrick & Li, 2007; Yelland, 2005) examined studies conducted ten or more years ago, while one review (Burnett, 2010) investigated studies conducted more than five years ago. These studies would be considered dated in many areas of research, but are particularly out-of-date in the field

of technology where the landscape changes so rapidly. An updated review including research from 2009-2014 is justified.

Three of the four reviews (Burnett, 2010; Lankshear & Knobel, 2003; Yelland, 2005) focused on the 0 to 8 age group which represents children at very different stages of development. According to Piaget's Theory of Cognitive Development, children aged 0-2 are at the sensorimotor stage, children aged 2-7 are in the preoperational stage, and children aged 7-11 are concrete operational (Piaget & Inhelder, 1969). There is evidence that children think and behave differently at each of these stages and therefore may behave differently with computers. Piaget noted that children in the preoperational stage think intuitively and conceptually, but not logically. They also have difficulty seeing different points of view. On the other hand, children in the concrete operational stage are able to think more logically and they begin to recognize varying perspectives (Piaget & Inhelder, 1969). Limiting the current study to the 3-6 age group might help reduce the variability in reported research findings and provide more reliable conclusions.

Additionally, two of the reviews (Burnett, 2010; Lankshear & Knobel, 2003) had a singular focus on the domain of literacy. Broadening the scope to include research in any subject area would give a more holistic view of technology in early childhood education.

Three of the literature reviews (Lankshear & Knobel, 2003; McCarrick & Li, 2007; Yelland, 2005) had some issues with methodology. Yelland (2005) did not report the strategies used for locating or selecting articles and two reviews (McCarrick & Li, 2007; Yelland, 2005) did not report the number of studies found. Three reviews (Lankshear & Knobel, 2003; McCarrick & Li, 2007; Yelland, 2005) included studies that were not peer-reviewed, such as dissertations, papers presented at conferences and studies cited in books. Each of these sources are not necessarily peer-reviewed which greatly reduces the credibility of the study since the quality cannot be ensured. Thus, results need to be interpreted with caution. The current literature review only includes peer-reviewed research.

Finally, all four literature reviews lacked in the descriptive detail given about each study. Three of the reviews did not provide sample sizes (Yelland, 2005) or provided them inconsistently (Burnett, 2010; Lankshear & Knoble, 2003). All four reviews lacked detail in describing the methodologies of each study. The current review gives sample sizes and a brief overview of the method used for every study.

1.3 Research Goals

The purpose of the following literature review was to analyze peer-reviewed studies on the use of technology in early childhood education settings from 2009-2014,

with a focus on children aged 3-6 years old. Studies were organized within two broad categories: student learning and engagement.

2 Method

This review focused on studies of technology use in early childhood educational settings published from 2009 to 2014. Only peer-reviewed articles (rather than project descriptions, analyses of programs, guidelines for practice, reports or conference papers), were included in this review. Well-known educational databases including EBSCOhost, Scholar's Portal, EdiTLibrary (Digital Library Dedicated to Education and Information Technology) and ERIC (Educational Resource Information Centre) were searched based on the following keywords: 'kindergarten', 'early childhood', 'preschool', 'early years', 'young children', 'technology', 'computers', 'information communication technology', 'ICT', 'multimedia' and 'digital'. Searches were limited by selecting 'only peer reviewed articles' and excluding dissertations, newspaper articles and book reviews.

It is important to note that early childhood settings include the age group 3-6 in preschool as well as Kindergarten classes. Kindergarten starts at various ages in different countries, and limiting the review to 'kindergarten' would miss relevant research papers. This is why 'preschool' was also included as a search term.

Titles and abstracts of articles found via this search were then screened for relevance. Articles that were directly related to the research goal, with subjects within