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New Digital Technologies: Educational Opportunities for Australian Indigenous Learners

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This article presents a number of possibilities that digital technologies can offer to increase access for Indigenous people to higher education in Australia. Such technologies can assist Indigenous high school students acquire the knowledge and skills they require to be accepted into higher education courses. They can also assist Indigenous students to be more successful in their higher education studies. While this article is contextualised to the Australian higher education setting specifically, the principles derived within may be applied to other disadvantaged groups worldwide. It may be concluded that the despite the barriers to the uptake of digital technologies, the potential offered holds much promise for such groups. In Australia, Indigenous people are the most severely under-represented in higher education, with access rates that have been declining over the past 6 years. Therefore, this issue has been classified as a matter of the highest national priority (Bradley, Noonan, Nugent, & Scales, 2008, p. 16). Concurrently, evidence is mounting that digital learning environments are able to produce positive learning outcomes for Indigenous students, albeit with a number of barriers to their uptake. This literature review explores: current trends in digital technologies and tertiary instructional practices, barriers to the uptake of digital technologies for Indigenous learners in Australia, and the potential of digital technologies for accommodating Indigenous learning styles. A number of implications for practice are discussed, based on the review of the literature.

■ **Keywords:** digital technologies, Indigenous high school students, learning

Digital Technologies and Instructional Practices

Digital technology emerged during the 1980s, and has gained widespread adoption, including transforming numerous aspects of educational delivery (Conroy, 2010; Duff, Carter, Spangenberg, & Miller, 2010; Paechter & Maier, 2010; Seeley Brown & Adler, 2008; Smith & Caruso, 2010). Since their introduction, digital technologies have been embraced by the Australian tertiary educational sector for the delivery of its programs. In 2001, a national Australian survey found that more than half of the then 43 Australian universities offered 207 fully internet based courses (a course is a structured combination of approved units, generally leading to an award). Another key finding in that study was that 50,704 university units (a unit is a discrete component of study within a subject area that is part of a course) had web-based content (Bell, Bush, Nicholson, O'Brien, & Tran, 2002). Recent studies have shown that web based education has become a standard offering across most Australian universities (Preston et al., 2010; Taplin, Lee, & Brown, 2011).

The popularity of online learning is due to the temporal and proximal flexibility provided to learners (Means, Toyama, Murphy, Bakia, & Jones, 2009) and the fact that it provides new forms of communication (Kirkwood, 2008). There is a considerable body of empirical research that shows the superiority of online or computer based learning over face-to-face instruction in many circumstances with respect to increasing student performance (Angus & Watson, 2009; Li & Xin, 2010; McKee, Costello, Adams, & Porter, 2010; Means et al., 2009) and eliciting student engagement (Chen, Lambert, & Guidry, 2010; Oliver, 2008). Such access and achievement relate to the nature of digital

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technologies which are beginning to erode the boundaries between learning and socialising.

As distinct from the initial web technologies that were focused on information dissemination, the term Web 2.0 represents an entire series of new applications that facilitate group collaboration to produce online digital content (O'Reilley, 2007). This interactive, social and read–write web format has enabled knowledge to be readily collected and disseminated (Senior, 2010), which has broadened the narrow institutionally defined concept of e-learning (as content that is delivered through a learning management system) to one that is much more all-encompassing. Web 2.0 applications are those such as wikis, weblogs and social networking sites (which are able to facilitate collaboration and information sharing); podcasts, and RSS feeds. However, while there have been a number of innovative Web 2.0 initiatives undertaken by early adopters worldwide (McLoughlin & Wee, 2010), this potential has not yet been realised in mainstream higher education (Schulmeister, 2010; Williams, Karousou, & Mackness, 2011).

Mobile learning tools have the potential to support remote groups. One domain that has shown promising developments is in the area of literacy and language learning. This was demonstrated in an action research project by Kim (2009) that proved to be highly effective and well received by migrant Indigenous children in Latin America. In this particular context, mobile learning was shown to be a suitable learning tool for Indigenous populations lacking adequate internet access to information technology. The content that was utilised by these learners was in the form of pre-packaged material loaded into a handheld machine, and podcasts. Mobile learning tool characteristics that are particularly suitable for 'at risk' learners are that they are generally *ubiquitous*; *hidden* (integrating so seamlessly into the user's personal context that it is not apparent to others); *personal* (placing the learner in full proximal and temporal control of the device); and *integrated* (bringing learning into the learner's personal context which can be highly motivational for their learning; Böck, 2010).

Mobile learning has also been used as a platform for launching other methods of digital learning which can engage the learner on a number of levels. Augmented reality games refer to 'virtual experiences that are played out in real-world spaces ... players can discover contextualized clues only via the digital interface where he or she arrives at the right location with a mobile device' (Bidarra & Martins, 2010, p. 176). Games such as these offer the learner a multisensory experience, which is contextualised in reality, and adds an emotional dimension to learning which makes for a holistic and therefore powerful learning experience.

A related technical innovation that has attracted interest as a means of improving online learner engagement is the animated pedagogical agent (APA) which is defined as a computerised persona that guides the learner through multimedia learning environments (Craig, Gholson, & Driscoll, 2002; Heidig & Clarebout, 2011). It is argued that the endowment of APAs with lifelike properties encourages learners to interact with environments inhabited by them (Lester et al., 1997). The anthropomorphic qualities of such personas are thought to activate the social interaction schema (Domagk, 2010), which facilitates learning. Furthermore, the ability to customise APA gender, age, race, clothing, vocal and linguistic properties, emotional expressions and gesture makes them a useful pedagogical ally. A prominent example of an APA being used in Indigenous education is that of the Messaging Architecture for the Retrieval of Versatile Information and News (MARVIN) system (Easterby-Wood & Jones, 2005). Like other APAs, MARVIN has the ability to convey messages in appropriate traditional dialects, and embody life-like characteristics based on authentic personas from these remote regions. This implies that the technology has the potential to reach to older generation desert people who are not likely to be proficient in the English language (Rothwell, 2003). While the application of this technology to deliver health education messages was initially the main impetus for its use, its educational potential has been expanded to include the intergenerational transmission of cultural knowledge (Barber & Tuovinen, 2006). Indeed, the educative use of APAs is limited only by the imaginations of educators and users, given that the technology is relatively inexpensive to procure, simple to use, easily customised, and the resulting products are easily disseminated.

The e-portfolio is another digital technology that can greatly enhance learning by providing a *bridge* between the conceptual knowledge acquired in university classrooms which may otherwise be decontextualised from reality, to the *real world*. Specifically, students can use the e-portfolio to showcase their learning through the use of 'video resumes and other medial rich artefacts that highlight skills and key capabilities' (Von Konsky et al., 2010, p. 174) according to the relevance to real world contexts. The e-portfolio is a versatile tool that can be used in collaborative ways to elicit *deep learning*. For example, Cheng (2009) used the e-portfolio platform to foster self-reflection by requiring students to capture their self-reflections on video, and to upload them on to the e-portfolio for their fellow students to comment on. She found the medium to have a highly motivational effect on students to produce and showcase their self-reflections (Cheng, 2009).

Aside from the e-portfolio, learner-generated digital video (DV) projects are valued by educational researchers for their ability to support authenticity in learning, especially when learner/creators are encouraged to share and discuss their creations with a relevant audience (Kearney, 2011). A particular genre of DV is 'digital storytelling', and is defined by Rolon Dow (2011, p. 171) as 'the use of digital media to create and share stories that integrate images, videos, music and audio narratives'. It has been used successfully as a medium for exploring the significance of race

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in adolescent educational experiences (Rolon-Dow, 2011), and so could be instrumental in illuminating racial inequalities, thereby giving Indigenous students legitimacy to express such concerns.

The opportunities offered by many of these digital technologies are promising, because they are able to transcend the cognitive aspects of learning, and engage the social, emotional and even physical learner domains (Johnson, 2010), therefore providing a more holistic learning experience. It is reasonable to assume that in many circumstances digital technologies are superior in engaging the learner, so people who do not have access are at a distinct disadvantage.

Barriers to the Uptake of Digital Technologies for Australian Indigenous Learners

In Australia, while the potential instructional benefits of digital information and communication technologies hold promise for Indigenous learners, the uptake of digital learning for this population has not resulted in the anticipated growth in numbers of Indigenous higher education students. Indigenous people are still the most severely underrepresented in higher education (Bradley et al., 2008, p. 16). It is argued that three barriers to the use of digital technologies at least partly account for this disproportionate underrepresentation; namely physical, literacy, and content barriers. Such barriers have been discussed in *digital divide* literature for decades (e.g., Dyson, Hendricks, & Grant, 2006; Gurnstein, 2000).

First, while it would appear that physical access to the internet is improving for Australian Indigenous learners, nevertheless a significant gap remains between this group and that of mainstream Australians. In the 2011 census, more than one-third (37%) of Aboriginal and Torres Strait Islander households reported not having an internet connection, as compared to only 23% for other households (Australian Bureau of Statistics, 2011). Thus, this problem remains as an impediment to the uptake of digital technologies for many Aboriginal and Torres Strait Islander people. Furthermore, the implementation of the National Broadband Network (NBN), which has been touted as a solution to enable faster broadband services to Australians in regional towns, even extending to people dwelling in more remote regions of rural Australia (Conroy, 2009), is not anticipated to offer significant improvements for remote Indigenous communities in the near future. A recent study showed that upload speeds will be inadequate to support streaming needs for education delivery to remote users, thereby widening the gap between remote Indigenous communities and the broader community (Tugwell, 2011).

Second, digital access is more than physical access and includes foundational skills required to interact with the technology. There are two key aspects to this problem, namely the low literacy levels of Indigenous Australians in general, and the inadequate information and communication technology (ICT) skills of teachers. Literacy outcomes for Indigenous people are significantly below the results of their non-Indigenous counterparts as evidenced by national literacy benchmark results (Samaras, 2005). This has negative implications not only for Indigenous computer literacy levels (Barraket, Payne, Scott, & Cameron, 2000; Curtin, 2001; Duggan, 2009; Dyson, 2002; Gibb, Hamilton, & Haley, 2004; Samaras, 2005), but also comprehension of academic discourse and discipline specific jargon. This state of affairs is aptly summarised by Gibb (2006) who asserts that rural Indigenous students commencing study are not intuitively equipped with the skills and knowledge to participate in university practices. The second aspect of this problem pertains to the teachers' lack of competence both in using computers and integrating ICTs into their teaching practices (Bingimlas, 2009), which presents significant barriers to their learners.

Finally, equity of ICT access cannot result in equity of information access for Indigenous Australians unless relevant and accessible content is available (Samaras, 2005). It is widely held that cultural material designed for Anglo Australians are not pedagogically appropriate for Indigenous Australians (Henderson, 1996). The idea that cultural values permeate educational computing environments implies that it is impossible to create a learning environment that is culturally neutral (McLoughlin & Oliver, 1999). It is therefore understood that the design of learning environments needs to be adaptive enough to incorporate cultural norms of the society it aims to educate.

Learner Characteristics of Indigenous People

The idea that Australian Indigenous learners have a characteristic learning style was first reported as the result of a systematic naturalistic observation of Aboriginal children in a remote setting (Harris, 1980). Harris (1980) carried out research from 1975 to 1976 at Minglingimbi, a remote Aboriginal community in the Northern Territory, and his findings were subsequently summarised by Hughes and More (1997). Harris expanded the concept of Australian Indigenous learning to include the learning context, and isolated a number of characteristics of traditional informal education. They are: observational learning preferred over verbal; experiential learning over listening; learning settings that are contextually meaningful, discouragement of questioning behaviours; valuing of the teacher over the information; ways of doing things perpetuated; group solidarity promoted over individual superiority; acquisition of knowledge directly from the expert in an apprentice-novice system; and fusion of emotional and intellectual domains.

However, the demographic and contextual specificity of this study implies that these findings need to be

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generalised with caution (Marshall, Northcote, & Lenoy, 2001). The fact that much of this work was grounded in Indigenous children's learning behaviours means that the generalisability of the results of these studies to adult learners cannot automatically be assumed (Marshall et al., 2001). It is also important to consider that having a particular contextual learning background enhances the child's effectiveness in contextual learning (Harris, 1980), which was certainly demonstrated in the case of the desert Aboriginals. Furthermore, as Wolf (2007) pointed out, models derived from direct observations of students' learning preferences have tended to be regarded with scientific scepticism due to the perceived subjectivity of phenomenological data.

This methodological concern was addressed when scientific empirical data about Australian Aboriginal learning strengths became available in a landmark study by Kearins (1986) who compared Aboriginal and Anglo Australian adolescents (Experiment 1) and children (Experiment 2) on their performances on tasks involving visual-spatial memory. This study was unique because it fulfilled the criteria of cultural and ecological validity by applying testing procedures that were compatible with each group's particular culture (Dingwall & Cairney, 2010). This included the cultivation of prior social connections with the community before the commencement of experimentation, and the selection of testing activities that were familiar to the participants (Kearins, 1986). In the first experiment, Australian Aboriginal adolescents from a particular desert region performed significantly better than their Anglo Australian counterparts on the visual-spatial task involving the memorisation and relocation of objects on a grid. This finding was replicated in the second experiment, which was designed to examine the visual–spatial memory of younger children. In this particular study, the two groups of Aboriginal participants were recruited respectively from a small desert-fringe town (non-traditional Aboriginal) and from central desert regions in the Northern Territory (semi-traditional), while the Anglo-Australian participants were recruited from a forestry and farming area near Perth in Western Australia. As before, both groups of Aboriginal children performed significantly better than their Anglo counterparts. Also, within the Aboriginal group, the youngest semi-traditional children outperformed their non-traditional counterparts, while the older children had comparable scores (Kearins, 1986).

Seminal findings such as these add credence to the idea that childrearing practices can impact upon learning (Taylor, 2011). These allude to the mediating effect of culture, aptly defined by Hofstede and McCrae (2004, p. 58) as 'the collective programming of the mind which distinguishes the members of one human group from another' on Indigenous learning. When contrasting Anglo and Indigenous cultures using Hofstede's (2004) framework, Simonsen (1999, as cited in Reece, Nesbitt, Gillard, & Donovan, 2010) found that the Indigenous culture he surveyed in Cape York Peninsula, Queensland: leaned more strongly towards centralised power (as opposed to distributed power); were slightly more collectivistic (as opposed to individualistic); were more feminine in outlook; were much more risk avoidant and had a much shorter-term orientation as compared to their Anglo Australian counterparts. Despite the fact that Simonsen's work was based on a discrete Indigenous culture, these findings can be generalised to other Indigenous cultures to a certain extent. However, even in the Australian context it is important to understand learning related cultural differences between urban, rural and remote Indigenous children, adolescents and adults. This can significantly impact on the appropriateness of the design of particular digital learning environments.

Thus, if education is *cultural transmission* (Singleton, 1974, as cited in Eckermann, 2006), those not born into the dominant cultural paradigm are essentially foreigners in an alien culture. Undoubtedly, early socialisation of Indigenous students into this new paradigm provides them with the skills required to operate successfully in that paradigm, as it becomes a part of their learning schemata. According to Brewer and Nakamura (1984, p. 2), schemata which are 'higher-order cognitive structures that have been hypothesised to underlie many aspects of human knowledge and skill' affects cognition in the way that new and existing knowledge interact with respect to perception, language, thought and memory (Brewer & Nakamura, 1984). As such, many Indigenous students who reside in rural and remote settings may not to have the same opportunities at acculturating to the dominant educational paradigm as many of their urban counterparts due to factors such as family socioeconomic disadvantage, smaller school sizes, reduced quality of educational resources at school, less access to home computers, teacher issues such as inexperience, recruitment and retention, and difficulties in locating staff to teach in critical areas such as English as a Second Language (ESL), mathematics and science (Welch, Helme, & Lamb, 2007).

Given the importance of cultural and environmental contexts in learning, one useful avenue of research is the investigation into differences in learning strengths of urban, rural and remote Indigenous learners, using culturally relevant measurement tools. As indicated earlier, the older Aboriginal children in the Kearins' (1986) study performed equally well regardless of whether they were from non-traditional or semi-traditional backgrounds, when the testing was culturally appropriate, but this did not apply to younger children. However, these findings relate to a specific visual-spatial skill, clearly aligned with traditional practices.

Although the Kearins (1986) study was conducted close to three decades ago, the problematic practice of classifying ability without adapting testing conditions or material for cultural appropriateness remains common to this day. As

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Dingwall, Pinkerton and Lindeman (2013) demonstrated in their qualitative study into the validity of the administration of cognitive performance tests such as the Weschler Adult Intelligent Scale (WAIS) to Aboriginal clients in the Northern Territory, the practice of classifying cognitive ability without adapting testing conditions or material for cultural appropriateness is an ongoing problem. Specifically, such testing procedures are raising validity concerns for the psychologists who administer them, with respect to English language ability, education and acculturation into mainstream educational environment, which come down to whether clients are from a remote or urban location. (Dingwall et al., 2013).

Finally, the discussion on the learning characteristics of Indigenous people would be incomplete without mentioning the physical and emotional issues that are likely to have a negative impact on learning, especially among Indigenous children and adolescence. One important physical concern is the ongoing prevalence of hearing impairments caused by otitis media among Indigenous children (Dingwall & Cairney, 2010; Frigo, 1999; Northern Territory Department of Education, 1999; Samaras, 2005; Williams, 2010). Furthermore, school aged Indigenous Australians have had a significantly higher record of emotional difficulties, with one study reporting that almost one quarter of Aboriginal children aged 4–17 years were assessed, from responses given by carers, as being at a high risk of *clinically significant* emotional or behavioural difficulties (De Maio et al., 2005).

In summary, while there is little evidence for a *single* Indigenous learning style (Hughes & More, 1997; Ryan, 1992) there are certain learner characteristics shared by many Indigenous groups (which are dependent on cultural and contextual factors) which indicate preference for a more holistic learning style. Thus, an important concern is the lack of research about the interplay between the cognitive, social, emotional and physical learning aspects to inform the design of digital learning environments for Indigenous learners. Instead, the approach taken in this field has primarily been from an ethnocentric learning theory reference point (Anderson, 1988; Nakata, Nakata, & Chin, 2008). As Malcolm and Rochescouste (2003) pointed out, the literature bearing on Indigenous students in higher education tends to be favourable descriptions of particular programs by convenors, that abound with 'advice rather than analysis' (p. 16). This state of affairs is mirrored in the observations made by Milton and Vosso (2010) about the lack of research in the area of information technology in higher education to support Indigenous student learning.

Potential of Digital Technologies for Accommodating Indigenous Learning

Despite the paucity of rigorous empirical studies into this area, a number of independent studies have been suggestive of the suitability of digital learning environments for producing positive learning outcomes for Australian Indigenous students (Duggan, 2009; Dyson, 2004; McAuley & Walton, 2011; Tayler & Spicer, 2009). The compatibility between Indigenous learning strengths and computers, specifically the appeal to their visual and spatial aptititudes was observed (O'Donoghue, 1992) even before networked computing had attained widespread use. It is argued that digital learning environments with visual, as opposed to textual representation of information (e.g., graphics and multimedia) are of particular compatibility with Indigenous learning preferences. Additionally, the availability of collaborative tools such as discussion boards, wikis and synchronous chat rooms (Duggan, 2009) may help to connect remotely located Indigenous learners and enable them to retain connections to their communities, essential for sustainability of long term community development planning (Kral & Schwab, 2003).

The use of computers to mediate communication may also have a buffering effect on detrimental teacher–student and student–student interactions that have been known to occur in traditional face-to face-classrooms. The use of computers to mediate teacher–student communication avoids any possible negativity that can arise from teachers speaking in high level English when the student is grappling with comprehending English as an additional language, and so eliminating any potential feelings of public shame in the classroom (Steen, 1997). This phenomenon can arise even when positive recognition is given to the Indigenous student by the teacher. The issue of shame in general has been raised as a legitimate concern by all Indigenous participants in a recent study (Oliver, Grote, Rochecouste, & Exell, 2012). The mediating effect of computers can also buffer the students from negative peer pressure of conformity to mediocre group standards which can also be detrimental to learning (Steen, 1997).

The internet has created numerous learning opportunities that may be compatible with Indigenous learning culture. For example, there is evidence, albeit anecdotal, that Indigenous learners have readily accepted multimedia and information and communication technologies, using them creatively and passionately (Donovan, 2007). Another salient feature of networked computing is the ability to support the mobile mode of living of many Indigenous students (Donovan, 2007; Lynch, 2009; Memmot, Long, & Thomson, 2006). There have also been a number of case studies of learning management systems being used to support Indigenous students' learning (Bartlett, 2004; Duggan, 2009).

Access to digital technologies have been shown to empower even those from severely impoverished backgrounds as they are able to teach themselves to use digital tools to achieve specific learning objectives in partnership with their peers in the absence of ongoing teacher intervention. This was demonstrated in a series of 'Hole-in-the-Wall' (HiW) experiments (Mitra, 2003) which

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commenced in 1999, where the researcher embedded a computer with an internet connection in a wall of a slum area of New Delhi to investigate the ability of the local street children to use the device without instruction and recorded their activities on video. The series of studies revealed that with minimal intervention, the children were sufficiently self-motivated to teach themselves to use computers to achieve educational objectives (Mitra, 2003; Mitra & Dangwal, 2010). What was even more interesting was that the experimental group that was assigned a mediator with no prior knowledge of the subject area, but who provided verbal affirmations and encouragement to learn had significantly better scores than the group with no mediator (Mitra & Dangwal, 2010). Thus, the HiW experiments serve to illustrate the latent learning potential within each individual that may be ignited through the use of digital technologies, an effect that is magnified with human encouragement.

Implications

There are a number of implications that are apparent from this review. First, there is a need to move beyond the objectivist notion of learning as a process that involves a discrete transfer of information from the teachers' minds to those of the students, and divorced from the students and their contexts. Instead, principles drawn from constructivism (Piaget, 1973), social constructivism (Vygotsky & Cole, 1978), situated cognition (Barab & Kirshner, 2001), and embodied cognition (De Koning & Tabbers, 2011) should also be incorporated into the designs of new digital technologies. This means that the pedagogical frameworks upon which many of these technologies are based, need to be dependent on the process of knowledge construction that transcends the knower, and extends to the learning context and the activities performed by the learner (Bidarra & Martins, 2010). Thus, the use of digital technologies can be used as vessels to enable the creation and sharing of information using authentic activities (McLoughlin & Oliver, 1999).

Second, digital learning environments need to be designed with cultural adaptability as a criterion, so as to increase inclusivity to all learners. One way of achieving this is by incorporating a 'multiple cultural, rather than multicultural contextualisation of instructional design' (Henderson, 1996, p. 85). This is a design principle initially proposed by Reeves in 1992, and is based on 14 dimensions of interactive learning which certain cultures are likely to differ (Collis, 1999).

It does so by including a number of cultural viewpoints into an *eclectic paradigm* (comprising objectivist-constructivist-critical theory paradigms) to enable multiple cultures to remain immersed in their cultural identities (Henderson, 1996). While this paradigm may appear dated, it can be adapted for application to the newer digital technologies.

Third, ownership of the media that ends up on the World Wide Web for educational purposes is an issue of concern for Indigenous learners, especially when the media comprises salient aspects of their heritage, which is then commodified or appropriated (Brown & Nicholas, 2012). These authors suggest that losses may be incurred when these concerns lead to relinquishment of access to genealogical information, conflict over control of stewardship of, and access to, heritage information, reduced respect for sacred objects, and decline of cultural distinctiveness authenticity and livelihood through commercialisation. They report that a number of Indigenous groups worldwide have harnessed digital technologies as a means of promoting collaboration, knowledge sharing and producing culturally appropriate models for dealing with these potential losses.

Fourth, teachers' lack of competence in using computers and integrating ICTs into their teaching practices can be addressed by professional development, and enough time and technical support to gain mastery of this ever changing landscape (Bingimlas, 2009).

Finally, as the HiW studies illustrate, the provision of tools that enable access to digital technologies are essential. However, their influence is limited without the element of human encouragement. Therefore, endeavours such as the OLPC (One Laptop Per Child) project in Australia, which aims to improve learning opportunities for primary aged children by providing them with an inexpensive internet enabled laptop, may yield greater benefits if the recipients are provided with connectivity to an Indigenous elder who takes on a coaching role to provide encouragement to the learners. Even though the coach may not have expertise in that particular domain of knowledge, this form of intergenerational learning may provide learners with empowerment to extend themselves to learn.

Summary and Conclusion

The possibilities for increased educational outcomes with the uptake of digital technology in Indigenous learning contexts are clear. It is evident that the potential offered by new digital technologies can redefine the concept of e-learning due to the democratisation of information sharing, facilitation of mobility, and engagement of learner domains beyond the cognitive, to include the social, emotional and physical. Some notable barriers to the uptake of such technologies, which need to be addressed if this potential is to be realised, include ongoing physical access to the internet, lack of foundational skills to interact with the technology and incongruity between cultural values implicit in the educational computing environments, and those of the learners who use them. It is suggested that there is a good fit between the cultural characteristics of Indigenous people, and the connectivity enabled by digital learning environments. Finally, evidence for the potential of digital technologies for accommodating

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Indigenous learning is clear. This evidence includes the compatibility between the contextual learning backgrounds of Indigenous learners from rural and remote settings who have more exposure to visual–spatial learning opportunities; the buffering effect from counterproductive peer and teacher interactions; the fit between the opportunities that ICTs can offer and Indigenous culture; and the empowerment that access to such technologies can bring to learners.

Implications for practice include the need to consider constructivist epistemologies in the design and utilisation of digital learning environments and the need for cultural adaptability as a learning design consideration. There is a need to exercise caution with respect to digitising material that carries cultural and historical significance, but also an equally strong need to investigate innovative new ways to overcome these threats. Additionally, teachers need to be provided with professional development to improve their skills in using digital technologies. Finally, digital tools, and pedagogical philosophies are only as effective as the actual people who are entrusted with enriching the educational experiences of Indigenous learners as the HiW studies illustrate. This literature review argues that the benefits that new digital technologies can bring to Indigenous learners needs to be accompanied by research that explores the complexities of human learning, beyond that of the cognitive to encompass the social, emotional and physical domains, elements that are often missing in educational research due to the fragmenting of the complexity of human learning. In this way it will be possible to design digital learning environments that are more likely to suit the distinctive needs of urban, rural and remote Indigenous students.

References

Anderson, J.A. (1988). Cognitive styles and multicultural populations. *Journal of Teacher Education*, *39*(2), 2–9.

Angus, S.D., & Watson, J. (2009). Does regular online testing enhance student learning in the numerical sciences? Robust evidence from a large data set. *British Journal of Educational Technology*, *40*(2), 255–272.

Australian Bureau of Statistics. (2011). *2075.0 — Census of Population and Housing - Counts of Aboriginal and Torres Strait Islander Australians, 2011*. Canberra, Australia: ABS. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/2076.0main+features702011

Barab, S., & Kirshner, D. (2001). Rethinking methodology in the learning sciences. *The Journal of The Learning Sciences*, *10*(1/2), 5–15. Retrieved from http://www.jstor.org/stable/1466827

Barber, J., & Tuovinen, J. (2006). Creation mother — Avatar-based Indigenous multimedia intergenerational culture communication project. In T. Reeves & S. Yamashita (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2006* (pp. 2523–2529). Chesapeake, VA: AACE.

Barraket, J., Payne, A.M., Scott, G., & Cameron, L. (2000). *Equity and the use of communications technology in higher education: A UTS case study*. Retrieved from http://www.dest.gov.au/archive/highered/eippubs/eip00_16/eip00_16.pdf

Bartlett, C. (2004). *Investigating flexible delivery strategies that meet the needs of Remote Area Teacher Education Program (RATEP) Diploma of Education (Aboriginal and Torres Strait Islander) students*. Retrieved from http://www.aare.edu.au/06pap/bar06866.pdf

Bell, M., Bush, D., Nicholson, P., O'Brien, D., & Tran, T. (2002). *Universities online: A survey of online education and services in Australia* (02-A). Retrieved from http://www.detya.gov.au/highered/occpaper/02a/02_a.pdf

Bidarra, J., & Martins, O. (2010). Exploratory learning with Geodromo: Design of emotional and cognitive factors within an educational cross-media experience. *Journal of Research on Technology in Education*, *43*(2), 171–183.

Bingimlas, K.A. (2009). Barriers to the successful integration of ICT in teaching and learning enviornments: A review of the literature. *Eurasia Journal of Mathematics, Science, and Technology Education*, *5*(3), 235–245.

Böck, M. (2010). Mobile learning, digital literacies, information habitus and at-risk social groups. *International Journal of Mobile and Blended Learning*, *2*(3), 30–41.

Bradley, D., Noonan, P., Nugent, H., & Scales, B. (2008). *Review of Australian Higher Education*. Canberra, Australia: Commonwealth of Australia. Retrieved from www.deewr.gov.au/highereducation/review

Brewer, W.F., & Nakamura, G.V. (1984). The nature and function of schemas. In R.S. Wyer & T.K. Srull (Eds.), *Handbook of social cognition* (Vol. *1*, pp. 119–160). Hillsdale, NJ: Erlbaum. Retrieved from https://www.ideals.illinois.edu/ . . . /ctrstreadtechrepv01984i00325_opt.pdf

Brown, D., & Nicholas, G. (2012). Protecting Indigenous cultural property in the age of digital democracy: Institutional and communal responses to Canadian First Nations and Maori heritage concerns. *Journal of Material Culture*, *17*(3), 307–324.

Chen, P.S.D., Lambert, A., & Guidry, K. (2010). Engaging online learners: The impact of web-based learning technology on college student engagement. *Computers and Education*, *54*(4), 1222–1232.

Cheng, G. (2009). Digital video for fostering self-reflection in an e-portfolio environment. *Learning, Media and Technology*, *34*(4), 337–350.

Collis, B. (1999). Designing for difference: cultural issues in the dsign of WWW-based course-support sites. *British Journal of Educational Technology*, *30*(3), 201–215.

Conroy, M.A. (2010). Internet tools for language learning: University students taking control of their writing. *Australasian Journal of Educational Technology*, *26*(6),

https://doi.org/10.1017/jie.2013.8 Published online by Cambridge University Press

861–882. Retrieved from http://ascilite.org.au/ajet/ajet26/conroy.html

Conroy, S. (2009). *New national broadband network*. Retrieved from http://www.minister.dbcde.gov.au/media/media_releases/2009/022

Craig, S.D., Gholson, B., & Driscoll, D.M. (2002). Animated pedagogical agents in multimedia educational environments: Effects of agent properties, picture features, and redundancy. *Journal of Educational Psychology*, *94*(2), 416–427.

Curtin, J. (2001). *A digital divide in rural and regional Australia?* Retrieved from http://www.aph.gov.au/library/pubs/cib/2001-02/02cib01.htm#Major

De Koning, B., & Tabbers, H.K. (2011). Facilitating understanding of movements in dynamic visualizations: an embodied perspective. *Educational Psychology Review*, *23*, 501–521. doi:10.1007/s10648-011-9173-8

De Maio, J.A., Zubrick, S.R., Silburn, S.R., Lawrence, D.M., Mitrou, F.G., Dalby, R.B., . . . Cox, A. (2005). *The Western Australian Aboriginal Child Health Survey: Measuring the social and emotional wellbeing of Aboriginal children and the intergenerational effects of forced separation*. Perth, Australia: Curtin University of Technology and Telethon Institute for Child Health Research. Retrieved from http://www.ichr.uwa.edu.au/files/user17/Volume2_TechPaper.pdf

Dingwall, K.M., & Cairney, S. (2010). Psychological and cognitive assessment of Indigenous Australians. *Australian and New Zealand Journal of Psychiatry*, *44*(1), 20–30.

Dingwall, K.M., Pinkerton, J., & Lindeman, M.A. (2013). 'People like numbers': A descriptive study of cognitive assessment methods in clinical practice for Aboriginal Australians in the Northern Territory. *BMC Psychiatry*, *13*(42), 1–13.

Domagk, S. (2010). Do pedagogical agents facilitate learner motivation and learning outcomes? The role of the appeal of agent's appearance and voice. *Journal of Media Psychology*, *22*(2), 84–97.

Donovan, M. (2007). Can information technological tools be used to suit Aboriginal learning pedagogies? In L.E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and Indigenous people* (pp. 93–104). London: Information Science Publishing.

Duff, A., Carter, S., Spangenberg, B., & Miller, J. (2010). The gang's all here: Grammar goes global for Purdue, UNISA and Adelaide University. *Journal of Learning Design*, *4*(1), 1–9.

Duggan, T. (2009). *Supporting ways of learning for Indigenous Australian pre-undergraduate students using Moodle*. Paper presented at the ASCILITE 2009: Same Places, Different Spaces Conference, Auckland, New Zealand. Retrieved from http://www.ascilite.org.au/conferences/auckland09/procs/duggan.pdf

Dyson, L.E. (2002, December). *Design for a culturally affirming Indigenous computer literacy course*. Paper presented at the Annual Conference of Australasian Society for Computers in Learning in Tertiary Education, Auckland, New Zealand.

Dyson, L.E. (2004). Cultural issues in the adoption of information and communication technologies by Indigenous Australians. In F. Sudweeks & C. Ess (Eds.), *Proceedings of the Cultural Attitudes Towards Communication and Technology Conference 2004* (pp. 58–71). Perth, Australia: Murdoch University.

Dyson, L.E., Hendricks, M., & Grant, S. (Eds.). (2006). *Information technology and indigenous people*. London: Information Science Publishing.

Easterby-Wood, J., & Jones, J. (2005, August). *The MARVIN System: Bringing animation to communication and learning to life*. Paper presented at the International Conference on Engaging Communities, Brisbane, Australia.

Eckermann, A.-K. (2006). Learning styles, classroom management, teacher characteristics and rural-urban Aboriginal people: Some thoughts. *Discourse: Studies in the Cultural Politics of Education*, *7*(2), 55–68.

Frigo, T. (1999). *Resources and teaching strategies to support Aboriginal children's numeracy learning: A review of the literature*. Retrieved from http://research.acer.edu.au/indigenous_education/11/

Gibb, H. (2006). Distance education and the issue of equity online: Exploring the perspectives of rural Aboriginal students. *The Australian Journal of Indigenous Education*, *35*, 21–29.

Gibb, H., Hamilton, M., & Haley, C. (2004). *Access to resources for on-line learning at CSU — the particular case of rural and remote distance education nursing students*. Wagga Wagga, Australia: Charles Stuart University. Retrieved from http://www.csu.edu.au/__data/assets/pdf_file/0006/77730/Gibb2004.pdf

Gurnstein, M. (Ed.). (2000). *Community informatics: Enabling communities with information and communiation technologies*. Hershey, PA: Idea Group Publishing.

Harris, S. (1980). *Culture and learning: Tradition and education in Northeast Arnhem Land*: Darwin, Australia: Professional Services Branch, Northern Territory Department of Education.

Heidig, S., & Clarebout, G. (2011). Do pedagogical agents make a difference to student motivation and learning? *Educational Research Review*, 27–54.

Henderson, L. (1996). Instructional design of interactive multimedia: A cultural critique. *Education Technology Research and Development*, *44*(4), 85–104.

Hofstede, G., & McCrae, R.R. (2004). Personality and culture revisited: Linking traits and dimensions of culture. *Cross-Cultural Research*, *38*(1), 52–88.

Hughes, P., & More, A.J. (1997, November–December). *Aboriginal ways of learning and learning styles*. Paper presented at the Annual Conference of the Australian Association for Research in Education (AARE), Brisbane, Australia.

Johnson, G.M. (2010). Internet use and child development: The techno-microsystem. *Australian Journal of Educational and Developmental Psychology*, *10*, 32–43.

https://doi.org/10.1017/jie.2013.8 Published online by Cambridge University Press

Kearins, J. (1986). Visual spatial memory in Aboriginal and white Australian children. *Australian Journal of Psychology*, *38*, 203–214.

Kearney, M. (2011). A learning design for student-generated digital storytelling. *Learning, Media and Technology*, *36*(2), 169–188.

Kim, P. (2009). Action research approach on mobile learning design for the underserved. *Educational Technology, Research and Development*, *57*(3), 415–435. doi:10.1007/s11423-008-9109-2

Kirkwood, A. (2008). Getting it from theWeb: Why and how online resources are used by independent undergraduate learners. *Journal of Computer Assisted Learning*, *24*, 372–382.

Kral, I., & Schwab, G. (2003, November). *The realities of Indigenous adult literacy acquisition and practice: Implications for capacity development in remote communities*. Paper presented at the 43rd Annual National Conference of Adult Learning, Sydney, Australia. Retrieved from http://www.ala.asn.au/conf/2003/kral_schwab.pdf

Lester, J.C., Converse, S.A., Kahler, S.E., Barlow, T.S., Stone, B.A., & Bhoga, R.S. (1997). The persona effect: Affective impact of animated pedagogical agents. *Journal of Educational Psychology*, *81*(2), 240–246.

Li, Q., & Xin, M. (2010). A meta-analysis of the effects of computer technology on school students' mathematics learning. *Educational Psychology Review*, *22*, 215–243.

Lynch, A. (2009, July). *Understanding urban Indigenous student mobility: Considerations for literacy educators*. Proceedings of the National Conference for Teachers of English and Literacy Conference, Hobart, Tasmania.

Malcolm, I., & Rochescouste, J. (2003). Aboriginal and Torres Strait Islander literacy in higher education: Emerging linguistic evidence. *Literacy and Numeracy Studies*, *12*(2), 15–30.

Marshall, L., Northcote, M., & Lenoy, M. (2001, December). *Design influences in the creation of an online mathematics unit for indigenous adults*. Paper presented at the ASCILITE Meeting at the Crossroads Conference, Melbourne, Australia.

McAuley, A., & Walton, F. (2011). Decolonizing cyberspace: Online support for the Nunavut MEd. *International Review of Research in Open and Distance Learning*, *12*(4), 17–34.

McKee, G., Costello, P., Adams, A., & Porter, M. (2010). The use of a supplementary online learning course,and its effect on academic achievement within an undergraduate nursing programme. *All Ireland Journal of Teaching and Learning in Higher Education*, *2*(1), 15.11–15.14.

McLoughlin, C., & Oliver, R. (1999, December). *Instructional design for cultural difference: A case study of the Indigenous online learning in a tertiary context*. Proceedings of the ASCILITE Conference, Brisbane, Australia.

McLoughlin, C., & Wee, M.J.W. (2010). Personalised and self regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. *Australasian Journal of Educational Technology*, *26*(1), 28–43.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2009). *Evaluation of evidence-based practices in online learning: a meta-analysis and review of online learning studies*. Washington, D.C.: United States Department of Education. Retrieved from http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

Memmot, P., Long, S., & Thomson, L. (2006). *Indigenous mobility in rural and remote Australia*. Brisbane, Australia: Australian Housing and Urban Research Institute. Retrieved from http://www.apo.org.au/research/indigenous-mobility-rural-and-remote-australia-final-report

Milton, M., & Vosso, L. (2010, September). *Using new technologies to support the learning of Aboriginal pre-service teachers*. Paper presented at the 8th World Congress Participatory Action Research and Action Learning Conference. Retrieved from http://wc2010.alara.net.au/Formatted%20Papers/3.1.2.EDU.6.pdf

Mitra, S. (2003). Minimally invasive education: A progress report on the 'Hole-in-the-Wall' experiments. *British Journal of Educational Technology*, *34*(3), 367–371.

Mitra, S., & Dangwal, R. (2010). Limits to self-organising systems of learning-the Kalikuppam experiment. *British Journal of Educational Technology*, *41*(5), 672–688.

Nakata, M., Nakata, V., & Chin, M. (2008). Approaches to the academic preparation and support of Australian Indigenous students for tertiary studies. *The Australian Journal of Indigenous Education*, *37*, 137–145.

Northern Territory Department of Education. (1999). *Learning lessons: An independent review of indigenous education in the Nothern Territory*. Darwin: Author. Retrieved from http://www.det.nt.gov.au/__data/assets/pdf_file/0005/7475/learning_lessons_review.pdf

O'Donoghue. (1992). Why the Aboriginal child succeeds at the computer. *Aboriginal Child at School*, *20*(4), 48–52.

O'Reilley, T. (2007). *What is Web 2.0: Design patterns and business models for the next generation of software*. http://mpra.ub.uni-muenchen.de/4578/1/MPRA_paper_4578.pdf

Oliver, R. (2008). Engaging first year students using a Web-supported inquiry-based learning setting. *Higher Education*, *55*(3), 285–301.

Oliver, R., Grote, E., Rochecouste, J., & Exell, M. (2012). Addressing the language and literacy needs of Aboriginal high school VET students who speak SAE as an additional language. *The Australian Journal of Indigenous Education*, *41*(2), 229–239.

Paechter, M., & Maier, B. (2010). Online or face-to-face? Students' experiences and preferences in e-learning. *The Internet and Higher Education*, *13*(4), 292–297.

Piaget, J. (1973). *To understand is to invent: The future of education*. New York: Grossman Publishers.

Preston, G., Phillips, R., Gosper, M., McNeill, M., Woo, K., & Green, D. (2010). Web-based lecture technologies: Highlighting the changing nature of teaching and learning.

https://doi.org/10.1017/jie.2013.8 Published online by Cambridge University Press

Australasian Journal of Educational Technology, *26*(6), 717–728.

Reece, G., Nesbitt, K., Gillard, P., & Donovan, M. (2010, January). *Identifying cultural design requirements for an Australian Indigenous website.* Proceedings of the 11th Australian User Interface Conference, Brisbane, Australia.

Rolon-Dow, R. (2011). Race(ing) stories: Digital storytelling as a tool for critical race scholarship. *Race Ethnicity and Education*, *14*(2), 159–173.

Rothwell, N. (2003, December 9). Avatar helps heal outback. *The Australian*.

Ryan, J. (1992). Aboriginal learning styles: A critical review. *Language, Culture and Curriculum*, *5*(3), 161–183.

Samaras, K. (2005). *Indigenous Australians and the 'digital divide*. Wagga Wagga, Australia: Charles Sturt University.

Schulmeister, R. (2010). Students, internet, elearning and Web 2.0. In M. Ebner & M. Scheifner (Eds.), *Looking toward the future of technology-enhanced education: ubiquitous learning and the digital native.* (pp. 13–36). doi:10.4018/978-1-61520-678-0.ch002

Seeley Brown, J., & Adler, R. (2008). Minds on fire: Open education, the long tail, and learning 2.0. *EDUCAUSE Review*, *43*(1). Retrieved from http://net.educause.edu/ir/library/pdf/ERM0811.pdf

Senior, R. (2010). Connectivity: A framework for understanding effective language teaching in face-to-face and online learning communities. *RELC Journal*, *41*(2), 137–147.

Smith, S.D., & Caruso, J. (2010). The Educause Center for Applied Research (ECAR) Study of undergraduate students and information technology, 2010. *EDUCAUSE Review*, 1–13. Retrieved from http://net.educause.edu/ir/library/pdf/EKF/EKF1006.pdf

Steen, T. (1997). What does the literature say about computer literacy and Indigenous Australians' language. *The Australian Journal of Indigenous Education*, *25*(2), 14–22.

Taplin, R.H., Lee, H.L., & Brown, A.M. (2011). Students' satisfaction and valuation of web-based lecture recording technologies. *Australasian Journal of Educational Technology*, *27*(2), 175–191. Retrieved from http://www.ascilite.org.au/ajet/ajet27/taplin.html

Taylor, A.J. (2011). Coming, ready or not: Aboriginal children's transition to school in urban Australia and the policy push. *International Journal of Early Years Education*, *19*(2), 145–161.

Tayler, C., & Spicer, P. (2009). *Indigenous training and development project: Using technology innovatively for low literacy learners.* Secretariat of National Aboriginal and Islander Childcare. Retrieved from http://srs.snaicc.asn.au/_uploads/rsfil/00291.pdf

Tugwell, N. (2011). NBN disparity threatens to widen the gap.*ABC News*. Retrieved from http://www.abc.net.au/news/2011-07-12/nbn-disparity-threatens-to-widen-the-gap/2791840

Von Konsky, B., Oliver, B., Nikoletatos, P., & Wilkinson, H. (2010, July). *Showcase You on iTunes U: The iportfolio enables self student self-assessment of key capabilities and the public showcase of achievements.* Paper presented at the 11th ePortfolio and Identity Conference, London.

Vygotsky, L., & Cole. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Welch, A., Helme, S., & Lamb, S. (2007). Rurality and inequality in education: The Australian experience. *International Studies in Educational Inequality, Theory and Policy Volume 2: Inequality in Education Systems*, 271–293.

Williams, Karousou, R., & Mackness, J. (2011). Emergent learning and learning ecologies in Web 2.0. *International Review of Research in Open and Distance Learning*, *12*(3), 39–59. Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/883/1824

Williams, C. (2010). Phonemic awareness and early spelling skills in urban Australian Aboriginal and non-Aboriginal children. *International Journal of Speech-Language Pathology*, *12*(6), 497–507. doi:10.3109/17549507.2011.481798

Wolf, C. (2007). Construction of an adaptive e-learning environment to address learning styles and an investigation of the effect of media choice (Unpublished doctoral dissertation). Royal Melbourne Institute of Technology, Melbourne, Australia. Retrieved from researchbank.rmit.edu.au/eserv/rmit:9804/Wolf.pdf

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