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# *Emerging technologies as cognitive tools for authentic learning*

**Jan Herrington and Jenni Parker**

*Dr Jan Herrington is Professor of Education and Jenni Parker is a Lecturer in Education, both in the School of Education at Murdoch University in Perth, Western Australia. Address for corresponding author: Dr Jan Herrington, School of Education, Murdoch University, 90 South Street, Murdoch, WA 6150 Australia. Email [j.herrington@murdoch.edu.au](mailto:j.herrington@murdoch.edu.au)*

## **Abstract**

Employing emerging technologies in learning is becoming increasingly important as a means to support the development of digital media literacy. Using a theoretical framework of *authentic learning* and *technology as cognitive tools*, this study examined student responses to the infusion of emerging technologies in a large first year teacher education unit over two full iterations, using a design-based research approach. This paper describes the pedagogical context of the intervention, the methodology used, and it presents an analysis of themes emerging from the data relating to the use of emerging technologies.

## **Practitioner notes**

### *What is already known about this topic*

- Emerging technologies have not yet been widely embraced within higher education courses.
- Personal use of mobile technologies is continuing to rise.
- The use of Web 2.0 technologies has the potential to transform the teacher-learner relationship.
- Harnessing the potential of technological affordances is a challenge for teachers.

### *What this paper adds*

- A pedagogical framework for integrating technology as cognitive tools within an authentic learning environment.
- Examples of pedagogical strategies to support student learning with web technologies.
- Qualitative stories about student experiences of learning with technologies.
- Evidence that authentic learning supported by emerging technologies and open access to the web can help students become more self-directed learners.

### *Implications for practice and/or policy*

- Complex and overarching authentic tasks can be designed that require significant effort by students in collaboration with others.
- Emerging technologies can be used by students as cognitive tools.
- Students can be supported to take responsibility for their learning through scaffolding and guidance for a significant task, rather than direct instructions on lesser activities.

## **Introduction**

The failure to embrace emerging technologies in higher education courses can lead to pedagogies that risk alienating a generation of learners, some of whom demand basic instruction in new technologies, and others who are technologically-literate but increasingly see a disconnect between the tools they use to learn and the tools they use to live and operate

in modern life. The personal use of mobile technologies continues to rise regardless of the base technology skills of learners, not only in response to social networking trends, but also for the affordances provided by ready access to information and web-publishing opportunities (Edmunds, Thorpe, & Conole, 2012). The use of enabling Web 2.0 technologies, have the capacity to transform the teacher-learner relationship through key affordances, highlighted by Lee and McLoughlin (2010) as: connectivity, content creation, and knowledge and information aggregation (p. 74). Harnessing the capability and potential of such affordances is a major challenge facing the sector.

In teacher education, the imperative to employ emerging technologies is even greater, as the responsibility to prepare future teachers for classrooms of autonomous learners—seeking relevance, connectivity and engagement—is paramount (McLoughlin & Lee, 2010). It is negligent of the profession to assume that pre-service teachers will learn their ICT skills on their own, as reported by MacDonald (2009), who found that while inexperienced teachers were more comfortable using technology in classrooms than more experienced teachers, they wanted more formalised support in their learning of pedagogical uses of ICTs. Many educational technology units or courses at university set out to ‘teach’ pre-service teachers how to use different technologies. As a result, such units are often taught in computer labs in a lock-step fashion, where all students advance together through the curriculum, and thus only a few programs (such as word processing, spreadsheets, etc.) can be covered. Oppenheimer (1997) likened this to teaching hammer rather than carpentry. Such an approach also fixes the instructional approach to the specific software or program, meaning that the gains pre-service teachers make in mastering the use of the technology are ephemeral, expiring long before they have a chance to implement the ideas in the classroom.

In this paper, we report on a design-based research study exploring the use of emerging technologies, not as objects of study in their own right, but as cognitive tools to be used to solve problems (Kim & Reeves, 2007) within an authentic learning environment (Herrington, Reeves, & Oliver, 2010). The study aimed to investigate the approach with particular reference to three main foci:

1. *The potential of emerging technologies is mostly unfulfilled* (Veletsianos, 2010). Emerging technologies as fundamental foundations for learning, rather than ‘integrated’ in a bolt-on fashion without changes to pedagogy.
2. *Digital media literacy continues its rise in importance as a key skill in every discipline and profession* (Johnson, Adams, & Cummins, 2012). To support digital media literacy, teacher education programs need to provide opportunities for pre-service teachers to learn, think, collaborate and create with technology as tools.
3. *Theoretical considerations are paramount* (Phillips, Kennedy, & McNaught, 2012). Authentic learning theory (Herrington, et al. 2010) and the use of emerging technologies as cognitive tools (Kim & Reeves, 2007) can be used to guide the design of a learning environment to engage pre-service teachers at a deeper level.

## **Research methodology**

In order to investigate the use of emerging technologies as cognitive tools in the authentic learning environments, a design-based research approach was used comprising four broad iterative phases, as illustrated in Figure 1 (Reeves, 2006).

<Figure 1 about here>

*Phase 1* of the study comprised an exploration of the problem including a literature review and consultation with practitioners to explore the nature and extent of the problem of emerging technologies and their effective use in teacher education. One major issue concerned the fact that commonly used pedagogies often focus on teaching *about* the technologies themselves, rather than how students can use them as tools, that is, to learn *with* rather than *from* technologies (Jonassen & Reeves, 1996). Too often these courses focus on the hardware and software that is deemed appropriate to use in classrooms and it is these concerns, rather than theoretical or pedagogical concerns, that determine the curriculum (Phillips, et al., 2012). Any solution would involve the use of emerging technologies as tools rather than objects of study.

In *Phase 2*, the solution was designed, that is, the learning environment was created to align with design principles of authentic learning and emerging technologies as cognitive tools. The unit was designed so that students could engage with a variety of technology tools, as and when required, to achieve a real purpose in creating genuine products rather than as simple skills that could be checked off as completed.

In *Phase 3*, the learning environment was implemented with the target population in two full iterations across two years with complete cohorts (271 and 326 students respectively) with revisions occurring between iterations. Data collected (with ethical approval) included two surveys, full transcripts of chats and discussion forums, email correspondence, student artefacts including blogs, websites, examination transcripts and authentic products. Such a wealth of data will enable future analysis to be conducted from a range of different perspectives. In this paper, however, we focus principally on qualitative data obtained from open-ended survey questions to explore the key issues emerging from the investigation. In *Phase 4*, design principles are created as a contribution to both theory and practice.

## **The design and implementation of the learning environment**

A first year university semester unit in a Bachelor of Education was designed according to principles of authentic learning that addressed these issues. The unit is a large compulsory unit where students learn about using new technologies in three key roles: as social beings (social context), as students at university (research context), and as teachers in primary school classrooms to facilitate their own students' learning (pedagogical context). To date, the unit has been offered twice in its entirety, both internally (across two campuses) and externally, with about a third of the cohort studying by distance.

### *Authentic learning framework*

Over recent years, there has been much interest in authentic learning in the research and development literature. There are a number of online courses that employ its principles, such as in media and communication (Collis, Foth, & Schroeter, 2009), history (Morrissey, nd), hospitality education (Deale, Elders, & Jacques, 2010), legal studies (Barton, McKellar, & Maharg, 2007), instructional design (Clinton & Rieber, 2010), literature (Fitzsimmons, 2006), environmental science (Meyers & Nulty, 2009), professional learning (Teräs, & Teräs, 2010), and multicultural (Leppisaari, Herrington, Vainio, & Im, 2013) and multidisciplinary contexts (Diamond, Middleton, & Mather, 2011).

In defining authenticity in pedagogy, Gulikers, Bastiaens, Kirschner, and Kester (2008) contended that authenticity is a personal response that is largely 'in the eye of the beholder' (p. 401), but others such as Petraglia (2009) argued that it is *persuasion* that is 'at the core of authentication' (p. 179). The pedagogical framework used to guide the design and implementation of the unit in this study was principally that of *authentic learning* or *authentic*

*e-learning* as defined by Herrington, et al., (2010). The framework comprises nine guiding design elements where the learning environment provides: (1) an authentic context, (2) authentic tasks and activities, (3) access to expert performances, (4) multiple perspectives, (5) collaboration, (6) reflection, (7) articulation, (8) coaching and scaffolding, and (9) authentic assessment (p. 18). Each of these elements is instantiated in aspects of the unit through tasks, activities, supports, resources and required products.

The elements of authentic learning were realised throughout the unit in design and implementation, and largely through the utilisation of technology as delivery and cognitive tools:

1. An *authentic context* was achieved through tapping into the pre-service teachers' own context of using technologies to create web resources for social, research and pedagogical purposes—in effect, the students brought their own authentic context to this unit.
2. An *authentic task* comprised the development of an e-portfolio in the form of a website and accompanying blog. They created a prototype shell within three weeks, and then populated their sites with the individual and collaborative products of the unit to create a multifaceted web portfolio or personal learning environment.
3. Access to *expert performances* was enabled through a textbook, keynote-style lectures, 'how to' videos, and a range of help sources provided on, or linked to, the LMS and a *Companion Website*, an open education resource (OER) that accompanied the unit.
4. *Multiple perspectives* were possible through a range of resources on the web, and through engaging with other students and teachers in person and on discussion forums and chats.
5. *Collaboration* was enabled throughout but principally in the major assignment on the creation of an authentic learning environment on a wiki.
6. *Reflection* was facilitated through a reflective journal in the form of a blog, together with complex tasks that required reflection 'in-action' (Schön, 1987), and a reflective examination.
7. *Articulation* was facilitated through formulating arguments or questions, and using the vocabulary of the discipline area in video presentations, tutorial discussions, forums, chats and peer reviews.
8. Because of the nature of the task, there was no longer a need for teachers to focus on content and information, and instead they were able to focus on providing *scaffolding* support for students principally at the metacognitive level.
9. *Authentic assessment* was instantiated in periodic assessment of maturing websites and blogs in addition to the social, research and pedagogical products created by students. Effectively, students were assessed on the products that they created, and those products were professional and polished artefacts that would be useful in their everyday personal and professional lives.

### *Overview of curriculum and research context*

The unit encouraged students to become self-regulated learners, adept at researching, collaborating and reflecting as they learn and adapt to the changing ICT landscape in schools and in society generally. It started by focusing on technology in everyday life (social), in university (research), and then in schools (pedagogical), as described below.

*Social technologies:* Initially, students were required to use new web-based technologies to solve problems or create opportunities in their everyday social and family lives. One of the first tasks required them to create a technology-based social resource of their choosing such

as: a family tree (using a website like Heritage.com), a social bookmarking site on jazz music (using Diigo or Delicious), or a poster for a community fair (using PowerPoint). Students wrote instructions on how to create a similar resource for a complete beginner, then another student peer-reviewed their directions and provided feedback.

*Learner/researcher technology use:* In the next task, students developed their technology use as learners and researchers at university by researching a curriculum topic (such as solar energy, dance, Indigenous culture, algebra, etc.) using databases (such as ProQuest, EdIT Library) to explore how technology is being used to teach in these areas in primary schools. Once the research was completed, students wrote a brief report on their findings in the style of an academic essay, using a bibliographic referencing tool such as EndNote to generate their reference lists.

*Teaching and learning technology use:* The major effort within the unit focused strongly on pedagogical approaches in a key major collaborative task, where students constructed an authentic learning environment that primary school students could complete over 2-3 weeks. Students created and published the resource in a wiki, enabling them to collaboratively construct the work online, and they created and uploaded a short movie on the making of the resource (using programs such as Camtasia, or ScreenFlow).

In the research conducted to investigate the effectiveness of the authentic learning environment, the unit was offered in the implementation phase of the design-based research approach (Phase 3) in two full iterations, with data collected as described. Consecutively, in the two iterations, 125 (46%) and 120 (37%) responses were received, and data were analysed using a constant comparative method where responses were systematically compared to determine similarities and differences, and to identify patterns and themes in responses (cf. Merriam, 2009).

## **Findings**

A number of themes emerged in the analysis of pre-service teachers' responses to the approach adopted in the unit, including issues relating to reflection, collaboration and scaffolding of learning. However, it is the themes relating principally to the use of emerging technologies, and self-regulation of learning in an authentic context that are described in more detail below.

### *Fear of technology and being left in the shadows*

The study revealed a cohort of students who exhibited a range of dimensions in their approach to technology, ranging from enthusiasm and confidence to apprehension, slight anxiety, negative beliefs and at the extreme end, sheer technophobia (Beckers, Schmidt, & Wicherts, 2008). As in Bennett, Bishop, Dalgarno, Waycott and Kennedy's (2012) study, results showed that many students could see no value in using Web 2.0 technologies in their learning, but there were a number of students who revealed a more nuanced explanation of the problem. Several students wrote of their feelings that technology was moving at such a rapid pace that it was passing them by, or they were being 'left in the shadows'. The accompanying feelings of inadequacy were enough to make them very defensive about the need to use emerging technologies in their teaching. Many students also wrote of their outright fear of technology:

I went from petrified about technology to feeling confident I could tackle anything (Respondent 8, Iteration 2)

Others described the sense of confidence that resulted from their engagement with the emerging technologies in the unit that helped to conquer the fear:

We were able to explore technology that we would have never used without this unit. There is no fear now when using technology (R111, I2).

### *Sense of achievement and liberation*

Overall, the predominant tone emerging from the data was one of achievement and personal fulfillment. Many students wrote of a learning path that went from uncertainty to one of personal pride and satisfaction with their efforts. For example, one student wrote that the best aspect of the unit was:

The personal achievement I felt at building a website, I didn't know I was capable of this. (R99, I1)

But this result was often achieved in a 'rollercoaster' ride of emotional ups and downs as students struggled with the demands of the tasks. As one student wrote:

I have had so many meltdowns, breakdowns and moments where I just cried at the problems, and then the feeling of achievement when I finished (R33, I1)

'Conquering technology' was another frequently used allusion in the student comments, and one respondent also described the feeling of liberation as if from an oppressive adversary:

I really felt liberated from the scary shackles called 'technology' (R8, I2)

### *A whole new world of technology*

Quite a few respondents wrote about the feeling of experiencing 'a whole new world' that had not been open to them before, as one respondent described it: 'being subjected to a range of new software and technology that I never knew existed' (R93, I2). Another described the impact that this knowledge was having on different areas in her life as she discovered a range of platforms for dissemination of ideas and resources:

I cannot believe the amount I have learnt ... I now have a YouTube channel, Diigo, Shelfari bookshelf, a webpage, a blog and I have been introduced to so many resources ... the knowledge I learnt will help me through my social life, my learning and my career as a teacher (R104, I2)

### *Future proofing*

An interesting theme emerged from the data relating to the use of emerging technologies, in particular the use of Web 2.0 technologies and mobile devices as pedagogical tools. Some students objected to consideration of mobile phones in the classroom, arguing that they were banned in schools so why spend time exploring their pedagogical potential:

I don't think it is a good idea to encourage students to use their mobile phone during class. I have come straight from high school and know for a fact that mobiles were never used for work. (R30, I2)

One pre-service teacher objected to the focus the unit placed on being prepared to implement emerging technologies in their future classes and that the curriculum should have focussed solely on the types of technologies that are found in classrooms today:

This unit should be about how we as a teacher today can use technology not in 50 years time. (R36, I2)

Such resistance to engagement with emerging technologies is not uncommon (cf. Bennett, et al., 2012), but this was very much a minority view with many students commenting in one way or another about their future use of technology as teachers. One student, commenting on the creation of a class activity in a wiki, wrote about imagining herself as a teacher:

Making an authentic lesson plan with other students gave me a real taste of what it will be like as a teacher, working with other teachers and structuring lessons using technology for student learning and involvement. (R49, I1)

Another respondent wrote about going beyond the unit to explore an ever increasing range of emerging technologies:

It has got me very excited about the possibilities of using ICT in the classroom and inspired me to experiment and research beyond the limits of the unit. (R17, I2)

### *Responsibility for learning*

One of the key issues that emerged from the data was the issue of self-regulated learning. It related strongly to the nature of the design of the unit and its attempt to move away from the more didactic teaching about educational technologies to one where students learn to use emerging technologies in practice as they create genuine products. Creating learning environments where students are largely responsible for their own learning in sometimes contentious, especially when students believe that they are entitled to their 'money's worth' and they should be 'taught'. This is a criticism often made in relation to authentic learning (Herrington, et al., 2010), and is reflected in the words of one pre-service teacher who preferred the teacher to be responsible for what was taught and how it was learnt:

You spend thousands of dollars on your education ... All sessions should have been conducted in computer labs ... should have been workshops ... set readings ... everything that is expected of you in each assignment should be known from the beginning. (R2, I1)

Other students also suggested that more directed instruction would have been preferable, such as one who requested:

Explain everything a lot more. Me like many other students have spent hours figuring out things. (R54, I1)

But there were many students who wrote positively of the experience, clearly seeing the relevance of completing authentic tasks, and how their learning throughout was building to the creation of a major product. As one student wrote:

The best aspects were the authentic assessments that wrapped up into one whole assignment. The scaffolding of learning was brilliant and loved how [the website e-portfolio] is now a great reference tool for us now and to be used in the future with other subjects ... knowing if I don't know about something, I know how and where to research it. (R8, I2)

It possibly requires a major shift for pre-service teachers in their first year of university, who are accustomed to the learning climate of exam-oriented high school, to fully embrace an authentic learning environment based on self-regulated learning which provides not only a great deal of choice, but also a range of exciting technologies and web tools that they may not have encountered before. Nevertheless, for those students who did make the leap, the results appeared to be personally and professionally very meaningful. Students wrote of being 'challenged like I have never been challenged before', and 'this unit has changed my belief about what it means to teach and what it means to learn', and of learning about emerging technologies 'changing my life'. Despite challenges and resistance, the effort to address digital media literacy is essential and ultimately rewarding.

## **Discussion and implications**

In this paper, we have described a learning environment in a first year teacher education unit, where emerging technologies were not taught as static resources. Instead, we borrow from Dohn's (2009) preference for viewing Web 2.0 not as a particular set of technologies but instead denoting practice. The approach adopted in the unit allowed students to choose many of the technologies that they would use, and to customise the products they created to suit their own personal and pedagogical interests. Because of this, students spent much time researching available technologies before choosing one that suited their own purpose, and



then, in the creation of significant resources, they delved deeply into technological affordances. Students discovered a range of technology tools in this manner, and the result was clear—they learned a great deal more than we could ever have taught them.

A key product of a design-based research approach is the emergent principles that can be used to guide the design of other similar learning environments facing similar problems, and also importantly to contribute to theory. The principles that guide the design of the educational technology unit described in this paper, are being refined with each iteration, but include elements such as: (1) design complex and overarching authentic tasks that in their completion require significant time and effort in collaboration with others; (2) employ emerging technologies as cognitive tools, so that the technology is used consistently by students (not solely the teacher); (3) ensure students take responsibility for their learning by providing scaffolding and guidance for a significant endeavour, rather than direct instructions on lesser activities; and (4) require a final published and polished product that can be shared and displayed.

The study has confirmed that emerging technologies can be used not only as fundamental foundations for learning as noted by Veletsianos (2010), but in every stage of the learning cycle. Important skills related to digital media literacy (Johnson, Adams, & Cummins, 2012) can be readily acquired through largely self-regulated authentic learning tasks, and the use of technologies appear to have the facility to extend mental effort and capability when used as cognitive tools (Kim & Reeves, 2007). Emerging technologies were not only the object of study in this implementation, but also the delivery mechanism, the means for communication and articulation, the tool for collaboration, the platform for the publication of final products, and importantly, the cognitive tools for thinking and creating valuable technology-based products.

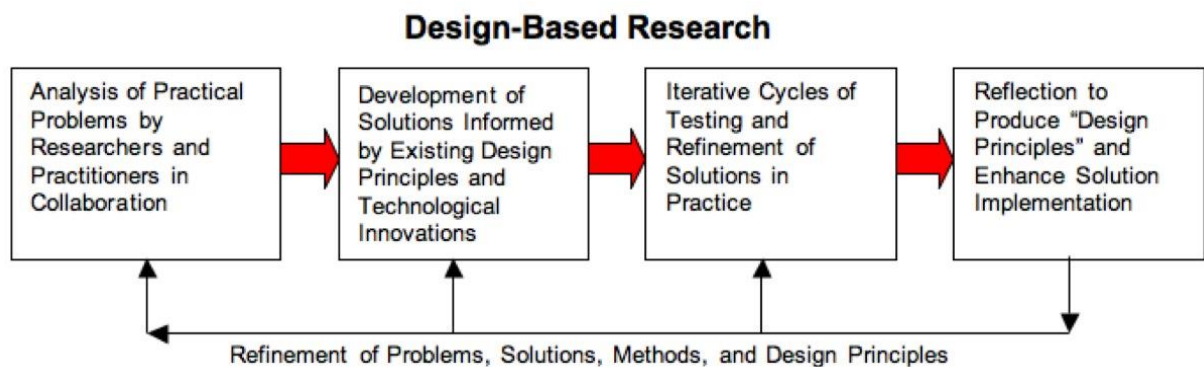
Future iterations of the unit will continue to be refined using research findings to strengthen the authenticity of the environment and to improve the pedagogical strategies used. For many participants, the learning environment is a rollercoaster ride, but one that in the end leaves them with a feeling of accomplishment and excitement at the possibilities that emerging technologies afford for teaching and learning.

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**Figure 1:** Four phases of design-based research (Reeves, 2006, p. 59)