

A design-based research approach implementing a palette of educational technologies to foster 21st century skills

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This paper discusses how a design-based research approach will be used to design and implement a palette of learning technologies as part of a multi-mode approach in open distance learning. A conceptual-theoretical framework is proposed consisting of the interrelationship between pedagogy and technology and content, design principles, criteria for excellence and higher level outcomes. The intention is to outline guidelines for supporting teacher-students in an open distance learning environment, not only to master knowledge relating to a specific subject area, but also to acquire skills such as self-regulated learning, critical thinking and lifelong learning. Supplementing teacher-students' knowledge and skills will enable them to prepare their twenty-first-century learners for the increasingly interconnected global society they will work and live in.

Keywords: Design-based research, authentic learning, 21st century skills, open distance learning.

Introduction

After eighteen years of freedom from the apartheid era, South Africa still faces a dysfunctional educational system. We need to recognise the effect of inequalities of the past on teaching and learning. For the sustainable future of education in South Africa, the South African government need to look at the prospects of our learners (Jansen, 2011). With tens of thousands of learners failing examinations on a regular basis, schools in South Africa need leadership and enthusiastic teachers. Teachers hold the future of their learners in their hands and for many of our learners, "a solid school education represents the only means for ending the cycle of family poverty" (Jansen, 2011, p. 41).

South African universities offering open distance learning (ODL) provide flexible learning opportunities to students. Many teacher-students teach in remote rural areas and ODL removes barriers such as time, geographical, social and economic constraints. With the growing availability of new educational technologies higher education institutions are in a position to address the changing expectations of students relating to the quality of the learning experiences that will ensure that teaching and learning are relevant to their needs (Garrison & Vaughan, 2008). Unqualified and under-qualified teachers in South African schools have the opportunity to improve their qualifications and teaching skills through ODL.

In addition to mastering knowledge in a specific subject area, these teacher-students have to attain skills needed to creatively navigate the twenty-first-century. Within the South African context many teachers attended dysfunctional schools and it is important to supplement these teacher-students' knowledge and skills so that they will be able to prepare their twenty-first-century learners for the increasingly interconnected global society they will work and live in. Contemporary literature on pedagogy recommends pedagogical practices involving interactive, authentic, technology enriched teaching and learning practices in order to enhance the learning experience of students (Herrington, 2009; Moore, Fowler, & Watson, 2007).

This paper discusses how a design-based research approach can be used to design and implement a palette of educational technologies such as paper-based guidelines, interactive white board sessions, screencasts, videos on DVDs, audio recordings; Mobi-site downloads, as well as content learning management systems as part of a multi-mode approach. The intention is to outline certain guidelines for supporting teacher-students not only to master knowledge relating to research methodologies, but also to acquire skills such as self-regulated learning, critical thinking and lifelong learning.

The next section contains an overview of the background to the project. This is followed by the conceptual framework and an outline of design-based research. These sections will be followed by a discussion of how the four phases of design-based research can be implemented in a programme to enhance the learning experience of students, as well as supplement the teacher-students' knowledge and skills.

Background

Learning inequalities remain problematic in South Africa. These comprise the diversity of students in terms of age, gender, language use, culture, insufficient Internet access and living in remote rural areas. The introduction of e-learning in ODL may offer a solution in the South African context, but insufficient internet access is seen as one of the major factors hampering the realization of e-learning potential in open distance education in the African context (Ololube, Ubogu, & Egbezor, 2007). Mobile learning (m-learning) may provide a solution to the challenge of access to the internet, as the scale and ubiquity of mobile networks often provide the only infrastructure in rural areas (GSMA, 2010).

Teacher-students in open distance education require more and diverse support and scaffolding to acquire skills and competencies often far removed from their daily existence and environments. With the use of the palette of learning technologies teacher-students will have the choice to opt for learning activities best suited to their requirements and needs. Spector (2001, p. 8) notes that the “big lesson about technology and learning from the 20th century is that less is known about how people learn than many educational researchers are inclined to admit”. Irrespective of the type of learning experience, learning with technology offers the advantage of allowing students the freedom of choosing *when, what, where* and *how* they want to study. A structured approach to combining pedagogy and technology may contribute towards addressing learning inequalities effectively, and may also foster 21st century skills in an open distance learning environment.

The School of Continuing Teacher Education (SCTE) of the Faculty of Education Sciences at one of the largest distance learning universities in South Africa offers open distance learning through an ‘off-campus’ mode of education to unqualified and under-qualified teachers. The SCTE offers three in-service programmes: the National Professional Diploma in Education (NPDE, 3 years, NQF level 5), the Advanced Certificate in Education (ACE, 1 year, NQF level 6), and the B Ed Honours (B Ed Hons, 2 years, NQF level 7). Currently there are approximately 27,000 distance students enrolled (NWU, 2012). These students live in South Africa and Namibia, mostly in remote and deep rural communities. There are 35 study centres all over South Africa and Namibia. Contact sessions during weekends form the core of the student support system at these centres. Facilitators are employed and trained to tutor the different modules at the centres. For each module, three contact sessions and one vacation school per semester are presented, comprising an introduction to the module, content coverage and preparation for the examination. At present lecturers use interactive white board sessions as a synchronous approach of contact with the students. Learning materials are mainly paper-based, consisting of study guides, text books and a DVD containing additional information such as PowerPoint™ presentations and video footage. In line with current trends in the field of open distance learning, the SCTE has started to implement the use of ICTs such as Moodle, a learning management system (LMS), interactive white boards (IWB) and mobile learning (m-learning) to supplement paper-based learning materials.

The project reported on in this paper relates to the Bed Hons programme where research facilitation is oriented as a preparation to read master’s level. The author is responsible for the research methodology modules in the Bed Hons programme. The assignments for these modules consist of a theoretical assignment and a proposal for the initial module, and a research report in the second module. In an effort to assist facilitators and students, the author compiled comprehensive guidelines on the writing of a proposal and research report, but realized that more and varied support is needed to assist the teacher-students. More importantly, they need a set of skills such as lifelong learning, self-directed learning and critical thinking skills in order to creatively navigate the twenty-first-century. A combination of design-based research and design principles may be the answer to utilize a palette of learning technologies to address learning inequalities in an open distance learning environment. Teachers in South Africa need all the support they can get in the role as future makers to realise a sustainable future for education in South Africa.

Conceptual-theoretical framework

Conceptual distinctions

Researchers use several conceptual frameworks to underpin research on new technologies in teaching and learning. Stoner (1996) adapted the systems analysis and design life cycle approach for the integration of learning technology in teaching. The adapted version consists of nine phases in the cycle: initiation, analysis and evaluation, selection of learning technologies, design integration, implementation, monitoring, adapting and evaluation of implementation. It is similar to a cycle followed in design-based research, but lacks the application of design principles and the different iterations for refining the design principles and hence not suitable for the implementation of this project.

Mishra and Koehler (2006) developed the Technological Pedagogical Content Knowledge (TPACK) that builds on the formulation of 'pedagogical content knowledge' of Shulman (1986), extending it to the 'phenomenon of teachers integrating technology into their pedagogy' (Mishra & Koehler, 2006). In this conceptual framework the primary issue is the knowledge a teacher should have to integrate technology in teaching and learning, and therefore also does not meet the needs of this project.

The conceptual model of Ossiannilsson and Landgren (2012) addresses quality in e-learning based on the benchmarking initiatives of European Union (EU) in collaboration with The European Association for Quality Assurance in Higher Education and the United Nations Educational, Scientific, and Cultural Organization, with emphasis on a holistic approach requiring change management from an organizational and pedagogical perspective.

Henderikx's (2011) advice is to incorporate the criteria of the European Association of Distance Teaching Universities' (EADTU) E-xcellence programme into the conceptual framework of the project (Ubachs, 2009). The conceptual-theoretical framework for the implementation of a palette of educational technologies proposed in this paper comprises the following aspects:

- The interconnection and interrelation between technology, pedagogy and content, focused on the student.
- Design principles elemental in conducting design-based research and design principles as suggested by Herrington and colleagues (Herrington, 2006; Herrington & Kervin, 2007; Herrington & Oliver, 2000; Herrington, Reeves, Oliver, & Woo, 2004; Herrington & Standon, 2000).
- Criteria for excellence as expressed by the EADTU through the E-excellence project (Ubachs, 2009).
- Higher level outcomes aimed to be reached through the implementation of design principles and criteria for excellence.

Figure 1 illustrates the conceptual-theoretical framework proposed for the implementation of a palette of learning technologies in an ODL programme.

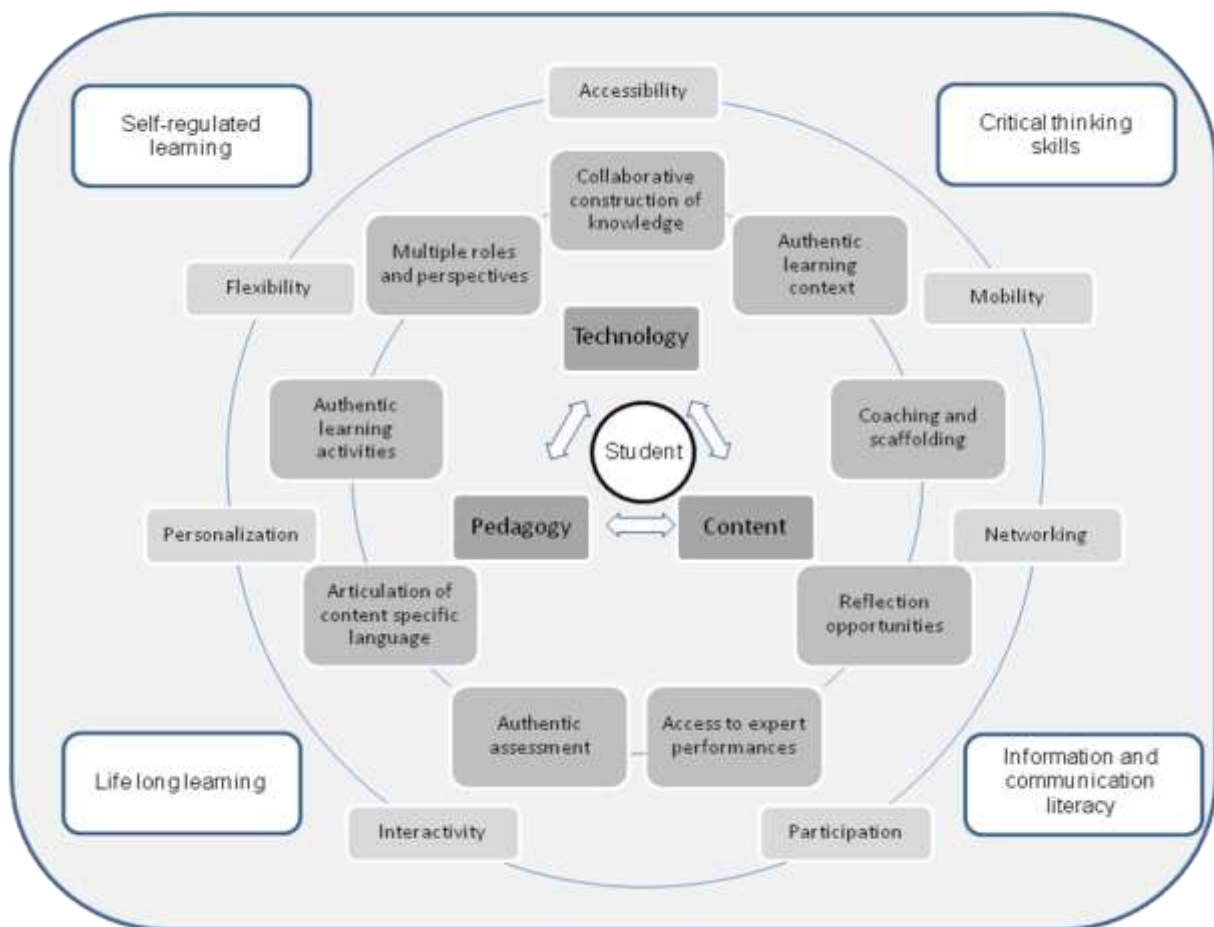


Figure 1: A conceptual-theoretical framework for implementing educational technologies in an ODL programme

The interconnection and interrelation between technology, pedagogy and content

Universities frequently use ICTs to deliver knowledge “where students learn *from* the technologies rather than *with* them as cognitive tools” (Herrington, 2009, p. 2). With the implementation of a palette of learning technologies, the intent is not to use information and communication technologies (ICTs) merely to disseminate content, but to **embrace the use of technology as cognitive tools to encourage thinking and understanding** (Herrington, 2009).

A student-centred approach to technology is proposed in this framework, with the emphasis on sound pedagogy to enable the student to interact with the content in a constructivist way. As learning with technology is a combination of “electronic”(e), and “learning”, the emphasis is placed on the pedagogy that directs the technology (Nichols, 2007a). For best practice in e-learning the ideal seems to be effective and sound pedagogy combined with reliable, user-friendly technology. Therefore, “e-learning is *dependent* on the pedagogy”, which, in turn, implies that the technology will be ineffective if the pedagogy is not sound (Nichols, 2007a, p. 2). Similarly, if the technology is neither easy to use nor reliable, “e-learning will be an exercise in frustration” (Nichols, 2007a, p. 3). Learning with technology has vast potential and offers challenges and opportunities for developing effective educational applications. In terms of the relationship between m-learning, life-long learning and open distance education in an African context, Traxler (2011) advises:

Areas that must be explored also include the balance between top-down and bottom up approaches, progressive versus traditional values in education, the need for educational technologies that enable some Africans to compete in a global knowledge economy and for educational technologies that enable others to subsist and survive, the relationships between mobile learning, lifelong learning, distance education and classroom teaching, the ethical and cultural aspects of educational interventions and the boundaries and differences between various research communities and their methodologies for example between participative design and anthropology.

Constructivist learning theories are based on the premise that people construct their own knowledge and understanding through experience and reflecting on the experiences (Jonassen, Davidson, Collins, Campbell, & Bannan Haag, 1995). Students learn best when they are actively involved in the learning process and learning is reinforced when the process is social, relevant and offers multiple ways of learning (Huang, 2002).

The characteristics of learners in our schools are constantly changed by the rapid advancement of information technology. This puts pressure on teachers to develop capabilities in co-design, co-instruction, guided social constructivist and situated learning pedagogies and assessment beyond tests and papers, in order to stay abreast of the ever-changing learning styles of their learners. Teacher-students need to develop “neomillennial” learning styles to maintain effective teaching as the nature of their learners changes (Dede, 2004). Consequently there is a need for professional development which focuses on teacher-students’ approaches to learning, their beliefs, attitudes and meta-cognitive understandings. In other words, it is necessary to facilitate teacher-students “to engage in self directed and lifelong computer learning” (Phelps, Graham, & Kerr, 2004, p. 50).

Design principles of the multimodal palette of educational technologies

Herrington and Oliver (2000) suggest nine design principles. These design principles underpin the design and development of the multimodal palette of educational technologies, as well as the collection of formative and summative data. A discussion of how these design principles will be implemented within the palette of learning technologies follows.

- *An authentic context that reflects how the acquired knowledge will be used in real life*
Scenarios of typical educational research practice form part of explanations on the DVD, IWB sessions and screencasts in formats across different platforms, downloadable from Moodle.
- *Authentic learning activities*
Scenarios of typical educational research practice form part of assignments and exercises in the study guide.
- *Access to expert performances and the modelling of processes and examples of outstanding completed research projects, reports and documents*
Examples of proposals and research reports are available on Moodle.

- *Multiple roles and perspectives to enable students to gain perspectives on topics from various points of view*
Links to videos on YouTube available on Moodle, e.g. a discussion between a qualitative and a quantitative researcher with regards to the application, advantages and disadvantages of the different research designs.
- *Reflection opportunities for students to reflect on their learning, the program and the learning experience*
Within the collaborative learning groups the teacher-students will have the opportunity to reflect on their learning, the module and their experience with the use of the palette of learning technologies.
- *Collaborative construction of knowledge relating to opportunities for students to collaborate in small groups to problem-solve together*
Facilitators will use Facebook as an educational tool to enhance peer group collaborative learning within a community of enquiry framework for online learning
- *Articulation of content specific language to encourage the students to discuss their newly acquired understanding of research methodology*
Within the collaborative learning groups teacher-students will have the chance to articulate their newly acquired knowledge of educational research methodology.
- *Coaching and scaffolding for decreasing instructor involvement over time*
Screencasts in five indigenous languages will be available on Moodle, to provide scaffolding and support for students in acquiring the necessary skills and understanding of research methodology.
- *Authentic assessment of real-life research scenarios*
Scenarios of typical educational research practice form part of assignments and examination questions. and explanations on the DVD, with the IWB and screencasts.

Criteria for excellence

To successfully implement educational technologies, certain criteria for excellence such as those expressed by the EADTU through the E-excellence project (Ubachs, 2009) need to be adhered to. These are mobility, participation, personalization, networking, accessibility, flexibility and interactivity. A brief discussion of these criteria follows.

Mobility

Mobile learning (m-learning) optimizes communication between lecturers, facilitators and learners as it offers learning opportunities to rural or remote learners where the infrastructure for access to the internet is lacking (Evans, 2008). As communication and interaction are of pivotal importance in the learning process, m-learning can contribute towards the quality of education. M-learning has all the advantages of e-learning, with the added benefit of portability in the form of devices such as iPods, tablet PCs and smart phones (Evans, 2008). Lecturers should endeavour to embrace the strengths of mobile devices and design learning materials that utilize the convenience, connectivity and personalization that such a platform offers. Tablet computing presents affordable learning opportunities and are ideal for one-to-one learning. The Zimbabwean government in partnership with Apple are planning solar-powered iPad devices for rural institutions without electricity. (Johnson & Brown, 2012). Other institutions could learn from this example and invest in the use of tablets to address the connectivity challenges of their students. This implies that, with the increased use of mobile and wireless technologies, “the time and place for learning, working, and socialising will blur even more” (Bonk, Kim, & Zeng, 2006b, p. 561). An important implication for this project is that mobile and wireless technologies may be more accessible to a wider range of individuals, thus creating greater opportunities for lifelong learning.

Participation

Bonk *et al.* predicted in 2006 that learning would become more individualized, hands-on and visual with added mobility. Their survey data show that blended learning will support a bigger range of learning styles and individual differences in future. Brown and Adler support this prediction, stating that the latest evolution of the Internet, Web 2.0, “is creating a new kind of participatory medium that is ideal for supporting multiple modes of learning” (2008, p. 18).

Personalization

As learning is a personal and individual experience, personalization and individualization of instruction is paramount to effective instructional practice. Consistent with authentic learning, instruction can be personalized by providing a palette of learning technologies in order for teacher-students to opt for learning activities best

suited to their needs. Allowing students to choose from various ways to interact with learning materials, using different instruction approaches and providing self-assessment tasks to verify their progress will empower them to make decisions and reflect on their learning (Rule, 2006).

Networking

Blended learning offers opportunity to connect people, activities and events. With increased individualization, blended learning promotes collaboration, and contributes to greater connectedness. With the palette of learning technologies our teacher-students will have the opportunity to collaborate, share and create knowledge.(Van 't Hooft and Vahey,2007). In confirmation of this, the findings of the study done by Laird and Kuh (2005, p. 232) suggest that the investments in making information technology available to students are paying off as students engage in educational practices actively and collaboratively.

Moore *et al.* (2007) discuss the possibilities of using tablet PCs for sharing information among students, as well as for problem-solving and problem-posing exercises in large or small group settings. Downes (2006) describes how the web changed from “being a medium, in which information was transmitted and consumed, into being a platform, in which content is created, shared, remixed, repurposed, and passed along” by the “newly empowered learner.”. With the advent of Web 2.0 come E-learning 2.0 which, according to Downes, are “not a single application, but a collection of interoperating applications – an environment rather than a system”. He argues that E-learning 2.0 has the potential to empower students in a completely new way. Brown and Adler (2008, p. 18) concur and argue that “the most profound impact of the Internet, an impact that has yet to be fully realized, is the ability to support and expand the various aspects of social learning”.

Accessibility

With the fast-changing job requirements and expectations, Bonk *et al.* predict that on-demand learning will become a requirement of a global workforce(2006b). The web will be used to provide timely, authentic information for the solving of case problems. The present trend towards problem-based learning, scenario learning and online case-learning will continue, with the pedagogy employed and the learning results as the most important aspects rather than the actual technology used (Bonk et al., 2006b). Brown and Adler (2008, p. 18) argue that “the most visible impact of the Internet on education to date has been the Open Educational Resources (OER) movement which ensures free access to an extensive range of learning materials. Use of the internet has enabled students to access powerful instruments and simulation models (Brown & Adler, 2008, p. 18).

Flexibility

Using a palette of educational technologies, including e-learning, is “a way to increase flexibility in and improve access to postsecondary education” (Oblinger & Hawkins, 2005). With the growing population of adult learners having to balance their work, family life and studying, open distance learning enhanced by e-learning is a workable option and offers the advantage of allowing students the choice of when, where and how they want to study (Evans, 2008; Oblinger & Hawkins, 2005).

Interactivity

“Learning-by-doing is generally considered the most effective way to learn” (Lombardi, 2007). As with personalization, interactivity is an important aspect of a successful learning environment (Oblinger & Hawkins, 2005).

Higher level outcomes

Life-long learning

Our teacher-students need to keep abreast in a world where technology is changing on a daily basis and new training courses are continually introduced in the workplace and in higher education institutions. Lifelong learning is no longer a dream, but has become an essential requirement in the striving towards professional development. In order to meet this requirement of lifelong learning, technology-enhanced learning environments, such as blended learning and e-learning, are utilised increasingly in higher education. These technology-enhanced learning environments make use of the swiftly growing and expanding potential of technology (Beller & Or, 1998; Bonk et al., 2006b; Moore et al., 2007; Oliver, Herrington, & Reeves, 2006; Souleles, 2004; Surry, Ensminger, & Jones, 2005).

Self-regulated learning

An important objective of the implementation of the palette of learning technologies is to help our teacher-students to acquire the cognitive skills and inclinations to become self-directed learners. With the advantage of

m-learning the teacher students will be able to study the way Sharples (2000) quotes the UK Government's Green Paper on lifelong learning:

In future, learners need not be tied to particular locations. They will be able to study at home, at work, or in a local library or shopping centre, as well as colleges and universities. People will be able to study at a distance using broadcast media and on-line access. Our aim should be to help people learn wherever they choose and support them in accessing how they are doing and where they want to go next.

Critical thinking skills

As future makers, our teacher-students need to develop key competencies for sustainable development within the South African education sector Barth et al. (2007) report that, with regard to the acquisition of key competencies, data from their research proved reflection to be one of the significant learning processes. Taking a critical stance with regard to one's actions and having the ability to reflect on them seems to be a decisive prerequisite in the learning process. On an individual level, reflecting on one's personal method of learning, questioning and examining tried and tested routines are necessary steps in the learning process. These authors contend that, in group context, "reflecting on the collaboration leads to identifying possible solutions which could take new, as yet, untried directions" (Barth et al., 2007, p. 425).

Information and communication literacy

For a sustainable future within the South African context, teacher-students need to develop relevant competencies such as information and communication literacy as they must be able to prepare their twenty-first-century learners for the increasingly interconnected global society they will work and live in. In their article on the development of key competencies for sustainable development in higher education, Barth *et al.* (2007, p. 416) state that, seen against the backdrop of globalisation, "acquiring relevant competencies within and by academic work cannot be a private concern of faculty, staff or administration. Absolutely essential is a new learning culture which does not confirm academic tradition, but examines its potential for a sustainable future, in an open-minded and participative process".

Institutions should create a supportive organisational climate for e-learning as a support for face-to-face training programmes in skills development. Providing programme facilitators trained in coaching participants, focusing on the accomplishment of self-directed learning, assisting participants in the attainment of goals, modelling positive emotive skills, and encouraging the practice of new skills may help to realise the promise of blended learning (Kruger, 2008).

Design-based research

Design-based research will explore how to design and develop authentic learning experiences with a palette of learning technologies addressing learning inequalities in an open distance learning environment.

Phase 1: Analysis and exploration of the problem

Phase one addresses the problem: the analysis and exploration of practical problems by the researcher, practitioner and designer and a literature review. With an instructional design background, the author will fulfil the roles as practitioner, researcher and designer. During this phase the researcher will articulate the problem, have discussions with practitioners and carry out a literature review on work that has been done in the field. At the end of phase one the researcher will formulate the research questions (T C Reeves, 2006).

Up to date two studies have been done as part of phase one. The author adapted the Charles Sturt University Student Educational Technology Survey to determine the teacher-students' use of educational technology, their skills in using these technologies and how they expect these technologies to help them with their learning. In the second study the author explored the views of facilitators regarding the use of screencasts to augment learning materials in open distance learning (Kruger, 2010).

Phase 2: Development of a possible solution to the problem

During phase two solutions will be developed, informed by existing design principles and technological innovations. Design principles as suggested by experienced researchers in the field will be applied to design authentic learning activities to address the problem (Herrington, 2009; Herrington & Kervin, 2007; Herrington

et al., 2004). Technologies to be used are interactive whiteboard sessions, screencasts, DVD with videos and interactive learning activities on Moodle.

Phase 3: Implementation and evaluation

For the duration of phase three the solutions developed in phase two will be implemented and evaluated in iterative cycles. During this phase data will be collected and analysed in order to answer the research questions. The researcher will modify the learning environment pending the attainment of the pedagogical outcomes.

Phase 4: Reflection and reporting

In phase four the researcher will reflect on the process followed to refine the design principles implemented. These refined principles could inform other researchers in similar situations (Thomas C Reeves, Herrington, & Oliver, 2005).

Conclusion

With a design-based research approach, the author proposes to implement a palette of educational technologies to outline guidelines for supporting teacher-students not only to master knowledge relating to research methodologies, but also to acquire skills such as self-regulated learning, critical thinking and lifelong learning. Reeves *et al.* (2005, p. 110) state unequivocally:

Certainly, the need for a more socially responsible research agenda in instructional technology has never been greater. Instead of continuing to tinker around the edges of teaching and learning challenges by conducting quasi-experimental studies focused on small changes in learning environments or even conducting one-off qualitative studies of esoteric cases, instructional technology researchers and their colleagues in other academic disciplines must begin to tackle the huge problems we face in the first quarter of the 21st century. Design research offers a positive step in that incredibly important quest.

Research emanating from the implementation of the palette of educational technologies, will hopefully contribute towards a better understanding of the pedagogical practices involving interactive, authentic, technology enriched teaching and learning practices. This will not only enhance the learning experience of teacher-students, but also foster the attainment of 21st century skills. These are crucial to supplement our teacher-students' knowledge and skills, since they are future makers, responsible for creating a sustainable future for education in South Africa.

"Education is the most powerful weapon you can use to change the world." Nelson Mandela

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