

Art. # 1218, 19 pages, doi: 10.15700/saje.v35n4a1218

A Teacher Tablet Toolkit to meet the challenges posed by 21st century rural teaching and learning environments

 Adèle Botha and  Marlien Herselman

CSIR Meraka Institute and School of Computing, University of South Africa
abotha@csir.co.za

This article draws upon the experiences gained in participating in an Information and Communication Technology for Rural Education (ICT4RED) initiative, as part of a larger Technology for Rural Education project (TECH4RED) in Cofimvaba in the Eastern Cape Province of South Africa. The aim of this paper is to describe the conceptualisation, design and application of an innovative teacher professional development course for rural teachers, enabling them to use tablets to support teaching and learning in their classrooms. The course, as outcome, is presented as a *Teacher Tablet Toolkit*, designed to meet the challenges inherent to the 21st century rural technology enhanced teaching and learning environment. The paper documents and motivates design decisions, derived from literature and adapted through three iterations of a Design Science Research Process, to be incorporated in the ICT4RED Teacher Professional Development Course. The resulting course aims to equip participating teachers with a toolkit consisting of technology hardware, pragmatic pedagogical and technology knowledge and skills, and practice based experience. The significance of game design elements such as simulation and fun, technology in need rather than in case, adequate scaffolding and a clear learning path with interim learning goals are noted.

Keywords: classroom practice; gamification; mobile learning; teacher professional development; technology integration; toolkit

Introduction

Teacher professional development (TPD) aimed at technology-enhanced rural teaching environment in a developing context has been identified as a specific challenge (Buabeng-Andoh, 2012; Lawless & Pellegrino, 2007). Amid narratives documenting recommendations toward improving or changing teacher practice, there are very few examples that are specifically designed to enrich the rural teachers classroom practice in general, and more specifically, through the use of Information and Communication Technology (ICT).

The aim of this paper is to describe the conceptualisation, design and application of a TPD course designed for rural teachers and to highlight the design decisions taken towards relevant teacher knowledge and proficiency so as to enable classroom practise to portray a 21st century technology enhanced classroom engagement in rural classrooms. The course, as outcome, is presented in the form of a *Teacher Tablet Toolkit* designed to meet the challenges posed by 21st century technology-enhanced rural teaching and learning environments. The main research question that guided this research is: *how can a Teacher Professional Development intervention guide the development of a Teacher Tablet Toolkit to address the challenges of the 21st century rural technology enhanced teaching and learning environment?* This study, undertaken in a rural South African context as part of a larger project, addresses a concern raised in literature about the availability, quality and rigour of TPD programmes in general, and specifically those aimed at teachers in rural resource constrained settings (Lawless & Pellegrino, 2007). The study envisages contributing to a broader understanding of TPD designed for rural resource constrained teachers. In addition, it aims to pragmatically facilitate educators' endeavours to integrate technology into their classroom practice within their challenging working environment. The study further highlights some very positive initial results, and offers a demonstrated innovative artefact, and methodology, for practitioners working in the field to adapt and use.

Methodology

Design Science research methodology (DSRM) was applied to develop the TPD course. In DSRM one can develop ways of understanding and working with socio-technical systems, and to question existing structures and processes (Pirkkalainen, 2015). Due to the iterative nature of the DSR process, an artifact, as a solution, is emergent, and opportunities exist for it to evolve. The Design Science Research Process (DSRP) applied in this research is consistent with prior literature (Hevner, 2007; Hevner, March, Park & Ram, 2004; March & Storey, 2008) and include the following six steps: problem identification and motivation, objectives for a solution, design and development, evaluation and communication. The TPD course was developed as an artifact by applying the DSRM process of Peffers, Tuunanen, Rothenberger and Chatterjee (2007), and it evolved as it was evaluated and improved through three iterations or phases (viewed as case studies) in the ICT4RED initiative.

Gregor and Hevner (2013) indicate that evidence should be provided that the artifact is useful. A rigorous monitoring and evaluation (M&E) of the TPD course was done to track impact, indicate usefulness and improve the artifact. A variety of data sources were applied to improve the TPD course and included observations, interviews (both one-on-one and focus groups), audio-visual material (photographs, text- and video recordings), anecdotal stories, feedback from the M&E questionnaires, ethnographic reports, Twitter and WhatsApp feeds and from the implementation of the various components in each phase. Participants were purposively sampled

and their feedback was analysed using a hermeneutic analysis. According to Gadamer (1998:169) hermeneutic analysis is “logically a circular argument in so far as the whole, in terms of which parts...” or otherwise put “we must understand the whole in terms of the detail and the detail in terms of the whole”. The principle of the hermeneutic circle and multiple interpretations requires the researcher to understand and examine situations in parts, and as a whole, and to assign explanations to them.

Developing the Teacher Tablet Toolkit

The understanding of the meaning of toolkit used in this study is adapted from Corcoran (2003) to include a repertoire of technology hardware, pragmatic pedagogical and technological knowledge strategies and practices that can be mixed, matched and modified to address a range of classroom issues.

There are two distinct, interrelated areas of concern. Firstly, the contents of the toolkit and secondly, the process followed to equip the teachers with the toolkit through TPD; the resulting artefact being the ICT4RED TPD course.

An appropriate meta-analysis of literature, focusing on the use and integration of ICT into the teaching and learning engagement, and the TPD activities that support this, was done to identify relevant commonalities regarding obstacles, strategies and best practice. The aim of the inquiry was to harvest experience, based on best practice, and to incorporate these experiences into the content and TPD process. The relevant findings from literature were grouped into themes, which were then regarded as elements, and these are outlined in the table below with relevant references to the literature. New literature was incorporated until a point of saturation was reached. These elements, which were identified from literature, became the foundation on which the design decisions were made, and are presented in Table 1 with the relevant literature reference. The elements are discussed in the rest of the paper in more detail, based on the development of the ICT4RED TPD course. The design decisions are statements that mitigate or speak to the elements identified from literature.

From Table 1 above, the following implications and resulting design decisions were made. The design decisions are related to the Teacher Tablet Toolkit and are directed towards meeting the

challenges posed by 21st century rural learning environments and the ICT4RED TPD as an implementation process. These findings are interpreted as design decisions.

Classroom practice

From the literature, TPD has been decisively established as a critical component to changing classroom practice as well as integrating technology into the classroom. This being said, there is an acknowledgement that teachers struggle to apply the learning gained in TPD courses into teaching practice (Lawless & Pellegrino, 2007). One of the reasons offered is that the level at which TPD is pitched is often too theoretical, and teachers fail to translate the theory into practical skills and strategies (Wang & Gu, 2014). Making sense, coping and using new ICTs call for a different set of teacher knowledge and skills than that which is currently operating in schools (Lankshear & Knobel, 2006).

The knowledge and skills needed by teachers, in order to facilitate a classroom change towards technology enhanced 21st century learning engagement, are derived from the Technological Pedagogical Content Knowledge (TPACK) model (Koehler & Mishra, 2008, 2009; Mishra & Koehler, 2006). Fishman, Marx, Best and Tal (2003:645) remark that the professional development of teachers should fundamentally be about *teacher learning*. They view this as the changes in knowledge, beliefs and attitudes of teachers that would then lead to the acquisition of new skills, new concepts and new processes related to teaching practice. Teacher professional knowledge is considered as knowledge of TPACK (Grossman, 1990; Magnusson, Krajcik & Borko, 1999; Mishra & Koehler, 2006; Shulman, 1986).

During instruction, knowledge regarding content, pedagogy and technology interact with one another, and consequently produce other types of knowledge needed for the successful use of technology in learning (Abell, 2008; Mishra & Koehler, 2006). The ICT4RED TPD pragmatically applies the TPACK framework, as described by Mishra (Koehler & Mishra, 2008, 2009; Mishra & Koehler, 2006). Based on the TRACK framework, the ICT4RED TPD adapted the framework towards an *ICT4RED pragmatic TPACK framework*, which is presented in the following table:

Table 1 Relevant elements from literature

Element from Literature	Component	Reference from literature
Classroom practice	Critical elements of Technology Integration into classroom practice are pedagogy, learning design and integration of technology into teaching and learning. TPD is singled out as the most important factor.	Bauer and Kenton (2005), Bower (2008), Dobozy (2013), Forrest (2009), Guzman and Nussbaum (2009), Hedberg (2011), Herrington, A, Herrington, J and Mantei (2009), Kervin and Mantei (2009), Mueller, Wood, Willoughby, Ross and Specht (2008), Mumtaz (2000), Olney, Herrington and Verenikina (2009), Peralta and Costa (2007), Smolin, Lawless and Burbules (2007), Vannatta and Fordham (2004), Vrasidas and Glass (2004)
	All TPD should help teachers to successfully teach the curriculum to students.	Fishman et al. (2003)
	Teachers find it difficult to apply educational knowledge and pedagogical skills, which they have been exposed to in TPD sessions, in the classroom.	Wang and Gu (2014)
	The teaching activity tends to be skill orientate and experience driven.	Wang and Gu (2014)
Teacher Attitude	Teacher professional knowledge is tacit, personal and situated.	Wang and Gu (2014)
	Student-orientated pedagogical approaches have a direct positive influence on the innovative use of ICT.	Drent and Meelissen (2008), Peralta and Costa (2007), Woodrow (1992)
Teacher Experience	Teacher's positive attitude about the adoption and integration of ICT is significant to the successful integration.	Bobrowsky, Marx and Fishman (2001), Buabeng-Andoh (2012), Hew and Brush (2007), Keengwe, Onchwari and Wachira (2008), Loughran and Gunstone (1997)
	Teachers tend to teach the way they have been taught.	Fullan (2007), Guzman and Nussbaum (2009)
	Teachers need to have successful experiences in technology integration that can change their perceptions and classroom practices.	Bate, Bevan and Robert (2004), Fullan (2007), Mumtaz (2000), Yeung, Taylor, Hui, Lam-Chiang and Low (2012)
Teacher Support	Teachers adopt technology easier if they see value to their teaching. If technology makes a lesson more fun, interesting, easier, more diverse and/or more enjoyable.	Carney (1998), Cox, MJ, Preston and Cox, K (1999), Mumtaz (2000)
	Initial and immediate success with technology by teachers is advisable.	Youngman and Harrison (1998)
Technology Access and Hardware	Long-term collegial support helps to translate integration of ICT.	Al-Awidi and Alghazo (2012), Carney (1998), Malinowsky, Rosenberg and Nygård (2014), Radaelli, Lettieri, Mura and Spiller (2014)
	Physical access to technology is essential for integration.	Harland and Kinder (1997), Kinder and Harland (1991), Vrasidas (2015)
	Availability of technology does not translate into use. Teachers are more likely to adopt technology if it is readily available to them. Personal ownership and exclusive use over an extended period.	Vrasidas (2015)
	More complex technology has a greater chance of leading to abandonment.	Carney (1998), Cox et al. (1999), Mumtaz (2000); Youngman and Harrison (1998)
TPD Process	Portability of the equipment is advisable so that it can move between the home and the workplace.	Aldunate and Nussbaum (2013)
	Mandating change is not necessary successful. Rather, it prepares teachers to improve their competencies in ways that they can appreciate the value of technology. TPD approaches need to be revisited towards cultivating positive attitudes towards technology integration.	Youngman and Harrison (1998)
	Presence of early adopters and innovators impact positively on the likelihood of adoption by other teachers.	Yeung et al. (2012)
	Longer-term interventions have a higher incidence of innovative adoption.	Aldunate and Nussbaum (2013)
		Fishman, Best, Marx and Tal (2001), Lawless and Pellegrino (2007), Wilson and Berne (1999)

Table 2 ICT4RED pragmatic TPACK framework for the *Teacher Tablet Toolkit* adopted for this study (adapted from Botha (2014))

TPACK framework	<i>Teacher Tablet Toolkit</i> adaption	Operationalised as
<p>Technology knowledge: technology knowledge (TK) includes the knowledge and skills to adapt and use relevant technology (Mishra & Koehler, 2006).</p> <p>Content knowledge: “Content knowledge (CK) is knowledge about the actual subject matter that is to be learned or taught” (Mishra & Koehler, 2006:1026).</p>	<p>Appropriate technology knowledge related to an Android™ Tablet and its use to support the teaching and 21st Century learning engagement.</p> <p>Content related towards being, participating, teaching and learning in a digital world. Teachers are considered the subject domain experts. The toolkit enhances their knowledge of skills and strategies to facilitate a 21st century learning environment.</p>	<p>Technology skills related to the tablet. Full lists of the skills that the toolkit consists of are outlined in the ICT4RED TPD Course (Botha & Verster, 2014).</p> <p>These were imparted as practical skills and extend to include: collaborative group work strategies; assessment strategies (self-assessment, peer assessment and group assessment); time management in class, learner centered learning environments; and debating. Full lists of the strategies that the toolkit consists of are outlined in the ICT4RED TPD Course (Botha & Verster, 2014).</p>
<p>Pedagogical knowledge: “pedagogical knowledge (PK) is deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims” (Mishra & Koehler, 2006:1026).</p>	<p>The pedagogical knowledge that was incorporated limited to teaching strategies that would successfully outline the integration of technology into a 21st century learning environment. The choice of strategies was done on its robustness and replicability. Knowledge on own practice was encouraged through reflection on practice towards reflective practitioners.</p>	<p>Teaching strategies that are appropriate for use with Tablets towards emergent learner centered practices in the teaching and learning engagement. There were 10 strategies that met the criteria (Botha & Verster, 2014). Reflective practices were incorporated.</p>
<p>Technological content knowledge: “Technological content knowledge (TCK) is knowledge about the manner in which technology and content are reciprocally related” (Mishra & Koehler, 2006:1028).</p>	<p>Technological content knowledge (TCK) extended to include the use of tablet technology to facilitate the attainment of a 21st century learning engagement over 10 iterations.</p>	<p>Teachers as co-creators construct their own meaning and demonstrate proficiency related to technology skills and content of relevant skills to facilitate a 21st century learning environment. The teachers integrate their own knowledge of the requirements of the curriculum and use their own technology.</p>
<p>Pedagogical content knowledge: “This knowledge includes knowing what teaching approaches fit the content (Mishra & Koehler, 2006:1027)”.</p>	<p>Pedagogical content knowledge extended to include the use of the teaching strategies and skills to facilitate the attainment of a 21st century learning engagement over 10 iterations.</p>	<p>Teachers as co-creators construct their own meaning and demonstrate proficiency related to relevant skills and teaching strategies to facilitate a 21st century learning environment. The teachers integrate their own knowledge of the context, their learners and the requirements of the curriculum.</p>
<p>Technological pedagogical knowledge: “Technological pedagogical knowledge (TPK) is knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings” (Mishra & Koehler, 2006:1028).</p>	<p>Technological pedagogical knowledge extended to include the use of the teaching strategies by integrating technology to facilitate the attainment of a 21st century learning engagement over 10 iterations.</p>	<p>Teachers as co-creators construct their own meaning and demonstrate proficiency related to relevant technology skills and teaching strategies to facilitate a 21st century learning environment. The teachers integrate their own knowledge of the context and their learners and use their own technology.</p>
<p>Technological pedagogical content knowledge: “TPACK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to</p>	<p>TPACK extended to include the use of the teaching strategies to facilitate the attainment of a 21st century learning engagement through technology over 10 iterations.</p>	<p>The result of the ICT4RED TPD should enable: pedagogy knowledge as teaching strategies, being facilitated by tablet technology proficiency, and their knowledge of skills and strategies to facilitate a 21st century learning environment. As co-creators, teachers construct meaning and demonstrate proficiency by integrating the above with their own knowledge of the</p>

TPACK framework	Teacher Tablet Toolkit adaption	Operationalised as
learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge" (Mishra & Koehler, 2006:1029).		context, and their learners, use their own technology, content of relevant skills to facilitate a 21st century learning environment, and the requirements of the curriculum.

From the ICT4RED pragmatic TPACK framework for the *Teacher Tablet Toolkit* adopted for this study and outlined in Table 2, the following was adopted design decision:

- Each TPD session would be facilitated through a specific learner-centric teaching strategy. For example, the Jigsaw teaching strategy would be introduced through the use of a jigsaw teaching strategy, storytelling as a teaching strategy would be introduced through storytelling etc.
- Each TPD session would demonstrate different strategies to facilitate a 21st century learning environment.
- Each TPD session would facilitate the attainment of new technology skills.

Teacher attitude

The positive attitude of teachers towards the adoption and integration of technology is significant to its successful integration. As such, this study acknowledged the complex, multidisciplinary nature of the domain and the myriad of aspects that influence the attitude of teachers to adopt and integrate technology. The study further acknowledges and notes the wealth of research that has been done in this field. Pragmatically, however, the engagement of the study could never address all of the richness of findings. Nonetheless, a recurring theme has been the voluntary engagement of the teachers in programmes, TPD activities and workshops (Bobrowsky et al., 2001; Buabeng-Andoh, 2012; Hew & Brush, 2007; Keengwe et al., 2008; Loughran & Gunstone, 1997).

- This study adopted a design decision to ascribe to voluntary participation.

Teacher experience

Teachers have been on the receiving end of many hours of workshops in the last couple of years. An example of this would be two major interventions, namely the introduction of Outcomes Based Education in 1997 (Department of Education, 1997) and the introduction to the Curriculum Assessment Policy Statement starting in 2012 (Department of Basic Education, 2011). Teachers have thus had a fair idea of the nature of workshops and were reluctant to attend activities that would encroach on their afternoons. As they also often live far from the school, workshops would impact on their transport arrangements as well (Herselman & Botha, 2014). The ICT4RED TPD, however, had to take place in the afternoons. In an effort to mitigate

possible workshop fatigue and to integrate other identified success factors for the integration of technology into classroom practice outline in the table, *Gamification* as a design strategy was selected to provide a more joyful, but focused engagement (Botha, Herselman & Ford, 2014a; Herselman & Botha, 2014).

As of yet, there is limited agreement on a single understanding of gamification. The most commonly used definition is that *gamification is the application of game dynamics and mechanics into non-gaming environments*, as defined and proposed by Deterding, Dixon, Khaled and Nacke (2011). Deterding et al. (2011) refer to the goal of gamification as making non-gaming products and services more enjoyable and engaging. Glover (2013) highlights the motivational and engagement aspect and Marache-Francisco and Brangier (2014 :205) contend that gamification "is about designing for an experience that drives the user through a journey". During this process, the main service is enhanced (Huotari & Hamari, 2012). This enhancement is co-created by the game designer and the player, as they progress towards a goal. Botha et al. (2014a) make a case for a Gameful Educational User Experience as a goal of Educational Gamification. The game elements for play, as outlined by Costello and Edmonds (2007), derived from a survey of play theories and were adopted in an effort to steer the TPD sessions (in the design for Gameful Educational User Experience) from an individual participant's or user's perspective. These game elements (which include creation, exploration, discovery, difficulty, competition, danger, captivity, sensation, sympathy, simulation, fantasy, camaraderie and subversion) were purposefully incorporated to facilitate the ICT4RED TPD sessions (Botha et al., 2014a). The principles that guide the ICT4RED TPD course were identified and adapted from Stott and Neustaedter (2013) as: freedom to fail, rapid feedback, progression and storytelling. They represent the Gamification design principles, heuristics or lenses used towards the Gameful Educational User Experience (Deterding et al., 2011; Shaffer, 2008). This study adopted a design decision to ascribe to:

- *Freedom to fail*. This is operationalised as a safe space to experiment and multiple opportunities to master skills and demonstrate proficiency.
- *Rapid feedback*. Structured as feedback on micro-goals (such as mastering skills during the TDP

sessions), meso-goals (such as progression badges) and macro-goals (such as completing the course, graduating and attaining South African Council for Educators (SACE) points). Each module's outcome is evaluated by means of clear goals that are assessed, and the teacher's attainment of the goals is then accredited with a badge (Botha, Salerno, Niemand, Ouma & Makitla, 2014b). Further interim goals were added, the attainment of which resulted in teachers earning technology hardware. The macro-goal of completing the course is accredited by a certificate and transfer of ownership of the tablet. The teacher, in addition, receives 10 SACE points on completion.

- Progression in both pedagogical skills and relevant content skills to facilitate a 21st century learning environment and technological proficiency.
 - In relation to the *technology progression*, the teacher is nudged into becoming an online learner, and encouraged towards becoming a lifelong learner and contributor in the digital world (Botha et al., 2014a; Herselman & Botha, 2014). The participant is assumed a novice and scaffolded to progress from:
 - being able to use the tablet as a personal device (I can work with a tablet); to
 - use as professional device (I can teach with a tablet); and
 - cumulating in the use of a tablet as a collaborative tool (I can collaborate through the tablet).
 - In relation to the *pedagogical progression*, the participant is assumed to have a single teaching strategy (lecturing) and through a series of badges as interim learning goals, additional teaching strategies (Botha & Verster, 2014).
 - For the *content* of relevant skills to facilitate a 21st century learning environment progression (Botha & Verster, 2014).
- Storytelling: the narrative is articulated as a learning path that is operationalised through the attainment of 13 compulsory badges that represent the 13 compulsory learning goals of the curriculum.

Teacher support

Collegial, facilitator and course material support help to translate integration of ICT (Al-Awidi & Alghazo, 2012; Malinowsky et al., 2014; Radaelli et al., 2014). This study adopted the following design decision:

- New skills are accompanied by paper based How To skill sheets.
- Each module contained classroom practice based ideas for different subjects. In addition, there are suggestions for applying the teaching strategy that the module focusses on for when the teacher has only 1 device in the class, for when the teacher has 5 devices and for when the learners each has his/her own device.
- Teachers were supported by means of a WhatsApp group. Most teachers already have access to and use WhatsApp.
- The schools' proximity to one another creates an opportunity to foster a larger support group.

- Facilitators must preferably be local. Teachers that have graduated from the previous iteration will be used to support and facilitate teachers undergoing the next iteration.

Technology access and hardware

Physical access to and availability of appropriate technology to integrate into classroom practice is essential, as indicated in Table 2 from the literature. It is advisable that the technology be used in school and at home. In addition, the teacher should know how to integrate said technology in order to reach curriculum objectives. To address these concerns, this study adopted the following design decision:

- Technology needs to work for a teacher, in his/her private capacity, before it can work for them in their professional capacity. As such, the teacher have 24/7 access to the device, and should further be encouraged to use it in a personal capacity.
- Technology for teachers would be 3G enabled and teachers would be helped to connect their devices to Wi-Fi hotspots.
- The ICT4RED initiative would not fund access to the internet through sponsored airtime.
- The course would not be dependent on internet access and would provide for an *internet like experience*, if and when needed, through a local server and Wi-Fi.
- Technology should assist the teacher in reaching curriculum objectives.
- To lower the barrier of proficiency, technology hardware will be chosen that resembles technology that teachers already own and are therefore familiar with. Tablets running with an Android™ operating system (OS) will be used.
- Technology hardware is distributed in use rather than in case. This is operationalised through an "Earn as you Learn" strategy linked to the badges as interim learning goals. Teachers will thus earn the tablets by completing the TPD course and by showing evidence of how they have integrated the pedagogical, technology and content learning from the TPD session into their classroom practice.
- It is assumed that 20% of teachers will not want to participate and change their classroom practice. This was based very loosely on the Parento principle and work by Hill, Maucione and Hood (2007).

TPD process

The course is structured as scaffolded sessions and based on the *Gradual Release Of Responsibility Instruction Framework* (Pearson & Gallagher, 1983). Fisher and Frey (2013) note that this framework was originally developed to aid in reading instruction and that its origins are linked to several theories. They highlight Piaget's (1952) work on cognitive structures, Vygotsky's (1962, 1978) deliberations on the zones of proximal development, Bandura's (1965) work on attention, retention, reproduction and motivation and the work on scaffolded instruction by Wood, Bruner and Ross (1976). Fisher and Frey (2013: 2) reflect that "[t]aken together, these theories suggest that learn-

ing occurs through interactions with others; when these interactions are intentional, specific learning occurs". The idea of a purposeful shift of cognitive load from

- the facilitation as a simulation,
- to co-creation by the facilitator, badge collectors and teachers,

- towards the independent practice and application by the teacher, underpins the TPD process. This gradual release is illustrated in Figure 1. The simulation aims to combine teacher specific knowledge and skills in a practical way to demonstrate their application to teachers.

ICT4RED TPD Responsibly

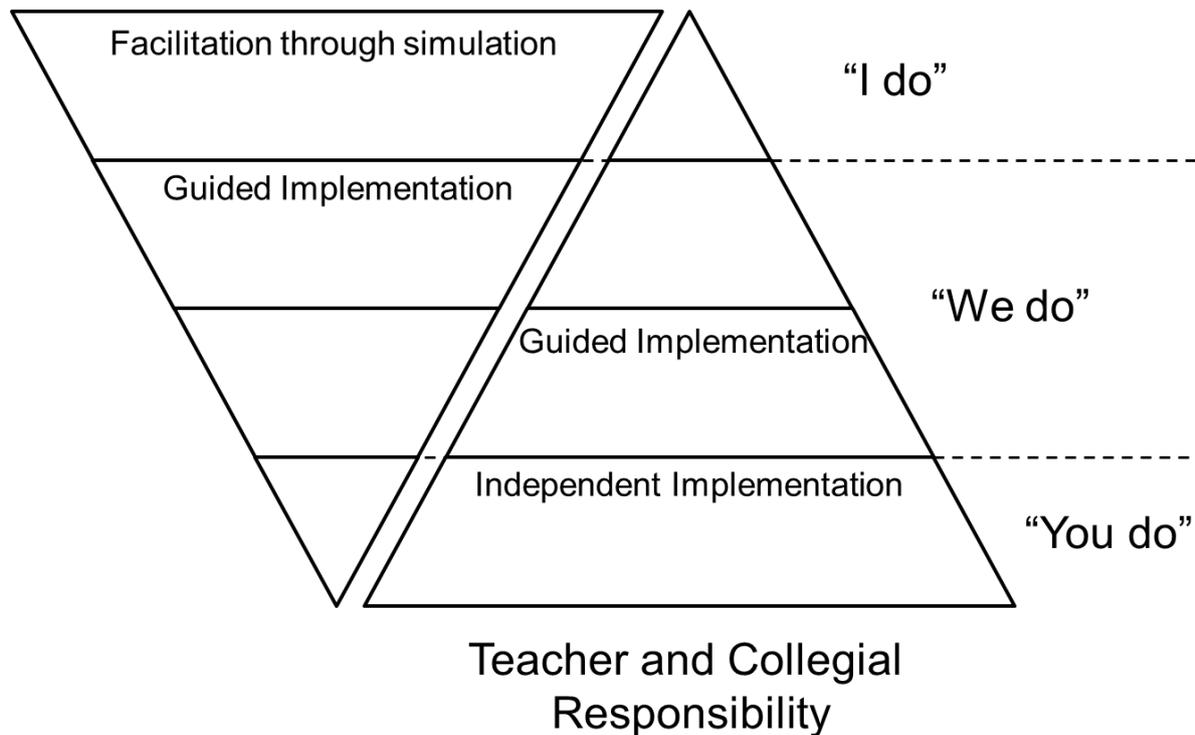


Figure 1 ICT4RED TPD process (adapted from Gradual Release of Responsibility Instruction Framework Pearson (Pearson & Gallagher, 1983).

To incorporate this understanding, the study adopted the following design decision/s:

- The value of the strategies and skills will be demonstrated through student-orientated teaching strategies.
- Teachers will be guided to become co-creators and apply the teaching strategy, technology skills, content skills and strategies in their own classroom.
- Facilitators and badge collectors will support the teachers in their co-creation.
- The school, as a system, will benefit from supporting teachers.
- Opportunities will be created for the development of champions, within the school, through additional challenges (not simulated) and criteria for school advancement by "earning" shared technology hardware will be formulated.
- Teachers should also be encouraged to create their own communities of practice amongst themselves. The purposeful facilitation of communities of practice (in which teachers can share best practices and newly created lessons in their subject areas) will be done through the facilitation of sessions at a

single venue to afford teachers the opportunity to meet and discuss issues.

The *Teacher Tablet Toolkit* thus incorporated the teacher professional development course as well as other elements which resulted in specific design decisions. Elements like *gamification* and rewards informed the TPD course to evolve into a toolkit. This allowed for a new, innovative way to involve and empower teachers to become co-creators of their own environment and to be exposed to technology-enhanced 21st century skills enhancement.

The Innovation of the *Teacher Tablet Toolkit*

This toolkit is innovative as it presents a practice and peer evaluated course and methodology of how teachers in rural, resource-constrained contexts can be empowered and supported to integrate technology to address 21st century teaching and learning challenges. Technology is not just earned, but teachers become innovative co-creators of con-

tent within their own subjects and grades. As the new knowledge, skills and strategies spill over into classroom practice; teachers become facilitators and thus demonstrate and lead learners towards creating and evaluating content and information on tablets to enhance their own learning.

The following presents an outline of how the design decisions were integrated into the Tablet Teacher Toolkit, through the ICT4RED TPD course and methodology, to equip participating teachers with technology hardware, pragmatic pedagogical and technology knowledge and skills and practice based experience.

Teacher Tablet Toolkit

The *Teacher Tablet Toolkit*, in order to meet the challenges of the 21st century rural technology enhanced rural learning environment, is a repertoire of technology hardware, pragmatic pedagogical teaching strategies, technological skills as mobile skills, and 21st century knowledge (content) and practices, which can be mixed, matched and modified to address a range of classroom issues.¹ Each module in the curriculum would be about relevant content through a teaching strategy using technology to facilitate the teaching and learning interaction.

Each TPD session is three hours in duration and facilitated in the afternoon at the school. In some cases, when the schools were either too remote or too small (one school only had three teachers), schools were grouped in clusters at a venue chosen by the teachers. The course lasted about one year, in order to accommodate the school

calendar. During each phase, a Tablet Fun Day was held. The aim of this day was to afford teachers an opportunity to meet teachers from other schools and to practice some skills which were specifically linked to internet access.

The 21st century learning design of the ICT4RED TPD course was evaluated using the Microsoft Partners in Learning (n.d.) rubrics. These rubrics were developed and tested internationally for the Innovative Teaching and Learning Research project and the evaluation of the ICT4RED TPD Course was done by expert review. Each of the six Microsoft Partners in Learning (n.d.) rubrics represents an important skill, which the teachers need to develop and employ in their own classroom practice. These skills are collaboration, knowledge construction, self-regulation, real-world problem-solving and innovation, and the use of ICT for learning and communication. The rubrics offer a guide to evaluate the 21st century learning design by assigning a number from 1 to 4 (1 being the least and 4 being the most) to each learning activity, according to how strongly it offers opportunities to develop a given skill (Microsoft Partners in Learning, n.d.). The full scope of the underpinning and evaluation is beyond the range of this paper, and only the results of the evaluation are supplied to validate the design.

Each of the 10 modules are linked to at least one badge as a learning outcome. The following table presents the Jigsaw badge, linked to Module 1. The table outlines the instructions, what the expectation is and what to provide as evidence.

Table 3 Evaluation result of the 21st Century Learning Design Rubrics. Implementation of the Microsoft Partners in Learning (n.d.)

Module	Teaching strategy	Collaboration	Knowledge-building	Use of ICT for learning	Self-regulation	Real-world problem-solving and innovation
1	Jigsaw	2	3	4	4	4
2	Storytelling	1	1	3	4	3
3	Role-play	3	4	2	4	4
4	Learning stations	1	3	4	4	4
5	Mind mapping	1	4	4	3	4
6	Flipped classroom	1	1	3	4	2
7	Game-based learning	3	4	2	2	2
8	Fieldtrip/scavenger	4	3	3	3	4
9	Gallery walks	3	4	2	3	4
10	Reflection	1	2	2	4	4

There are 13 compulsory badges and five challenge badges, where the main difference is that the challenge badges are not facilitated. The compulsory badges are ICT4RED badge, jigsaw, storytelling, roleplay, learning stations, Educational content creator, mind-mapping, flipped classroom, game-based learning, filed trips, gallery walk, mobile skills and reflective practitioner. The optional badges are email, Twitter, application evaluation, assessment and blog collaborator.

The course is presented as a learning path where the teacher moves from a commitment (Module 1), to using the tablet for their own personal use (Module 2 and 3), to use for teaching and learning (Module 4 to 7), to use for collaborating and sharing (Module 8 to 10) (Botha, 2014). The learning narrative is presented as a pathway that the teachers follow to graduate and earn their tablet. Each module runs in the same way, illustrated in Figure 2.

Table 4 Jigsaw Badge (Botha & Verster, 2014)

JIGSAW BADGE Instructions	What to do	What to provide
Use the Jigsaw Strategy in your classroom by creating at least four expert tasks for the learners to do, or learn about. At least one of the expert groups must use a mobile device	You have created at least four expert tasks for the learners to complete. You have implemented the Jigsaw Strategy with your learners.	An electronic copy of your four tasks. This can be either a photo of hand written tasks or a word document. A photo of a Home group and an Expert group doing their tasks.

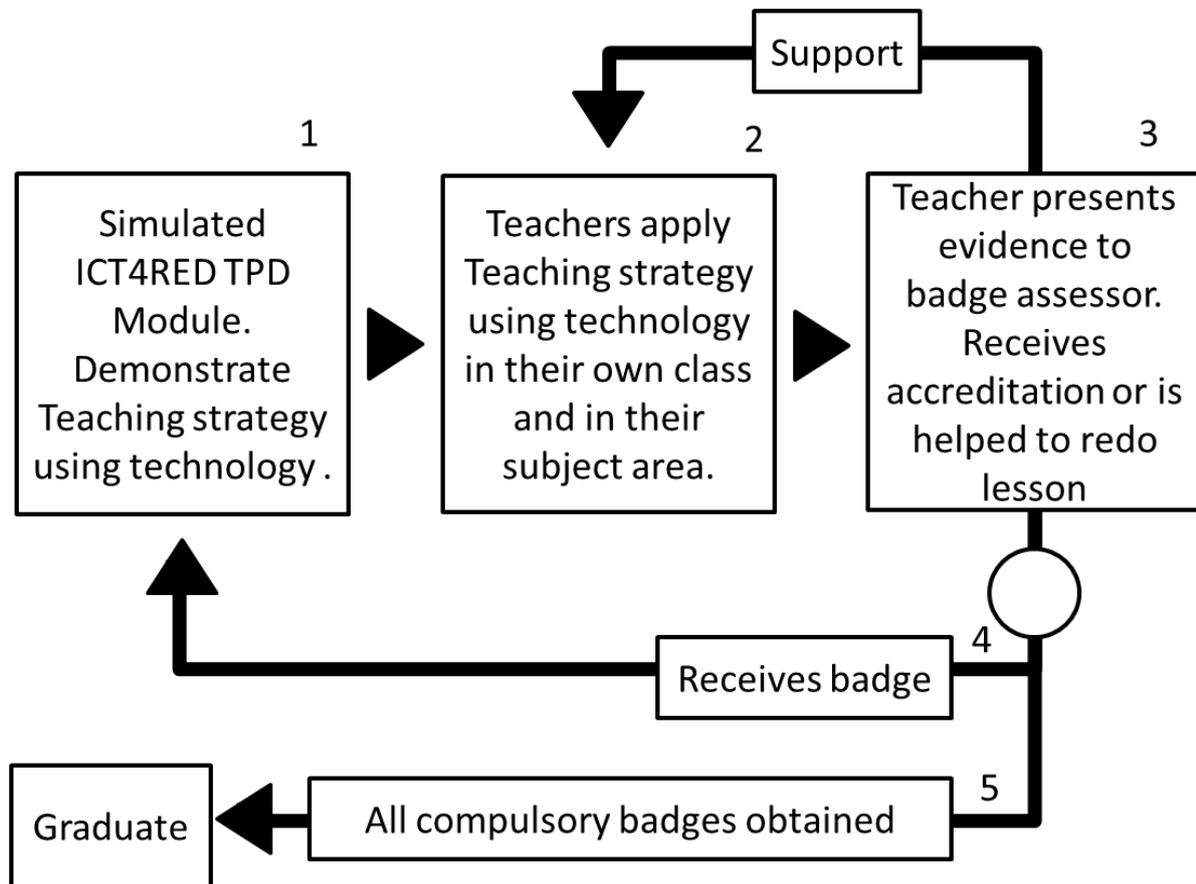


Figure 2 Course methodology (Botha, 2014)

Teachers, and their school, have the opportunity to add to their technology hardware by reaching certain objectives. The technology hardware teachers can earn is listed in Table 5. Technology hardware is linked to badges they need to

acquire.

Also linked to the individual progression of the teachers is the hardware the school can earn as well as the criteria needed to qualify. The hardware and criteria are listed in Table 6.

Table 5 Individual Teachers' Technology Hardware (Botha, 2014)

Badges achieved	Tablet Accessory Earned
ICT4RED, Mobile Skills and Reflective Practitioner.	Tablet cover
Jigsaw, storytelling, roleplay	Secure Digital (SD) card
Learning stations, educational content creator, mind-mapping, flipped classroom and game-based learning	Earphones
Field trips and gallery walk	Tablet pen
All 13 compulsory badges	Tablet

Table 6 School Achievement criteria (Botha, 2014)

80% of five badges per participant For the school to earn a projector the ideal would be: Each teacher tried a minimum of four new teaching strategies. This is a total of five badges per teacher. We expect the school to have achieved 80 % of this total. For a school with 10 people on the course, it would imply that they can earn a total of 50 badges. Eighty percent of this is 40 badges.	Projector
To give the school some incentive, this implies that the total needs to be 80% of five badges per participant. If teachers undertake more badges, they will achieve the total sooner. If not all teachers are undertaking the compulsory badges. This will be achieved much later in the intervention. Doing this helps champions to establish themselves.	
80% of 7 badges per participant For the school to have Mobikits, the ideal would be: Each teacher tried five new strategies, where teachers have started to create digital content by contributing to the Educational Content Creator Badge. This would imply that they have something to share with the learners. They have become contributors.	Mobikit/s (Set of 12 tablets in a charging unit)
80% of nine badges per participant. For the school to have tablets for learners, the ideal would be: Each teacher tried eight new strategies, the Mobikit is actively being used, and teachers are creating digital content and is integrating the technology into the teaching and learning.	Additional Mobikit/Tablets to learners. Wi-Fi link to the Internet

Outcomes

The ICT4RED TPD Course was developed over a period of three years. The 26 schools that completed the outlined course's results are presented

below in Table 7. During this time, one teacher went on maternity leave, one teacher was hospitalised, three principals decided not to participate and one teacher passed away.

Table 7 Graduation Results

School	Total participants	Total graduating	Merit graduations	Total badges
School 1	17	17	0	302
School 2	18	18	6	325
School 3	8	8	0	144
School 4	16	16	4	289
School 5	15	15	3	264
School 6	3	3	0	51
School 7	12	12	0	198
School 8	13	13	1	206
School 9	7	7	0	107
School 10	12	12	0	182
School 11	15	15	12	287
School 12	6	6	0	73
School 13	8	8	4	96
School 14	4	4	3	56
School 15	4	4	2	55
School 16	12	12	8	161
School 17	6	6	4	82
School 18	6	6	4	83
School 19	7	7	2	95
School 20	8	8	4	107
School 21	3	3	0	38
School 22	4	4	1	53
School 23	10	10	10	146
School 24	6	6	6	87
School 25	9	9	6	124
School 26	26	26	11	387
TOTAL	255	255	91	3998

All teachers who opted in, and were able to, completed the course and earned their tablets. A total of 3,998 badges were earned, and 91 teachers completed more than half of the optional badges to earn a merit graduation. All these badges were assessed according to criteria supplied by assessors

who were not directly involved in the facilitation process and were verified by an external party for quality control. In addition, all the schools earned their equipment and received tablets for the learners.

The ICT4RED Teacher Professional Development Course was licensed under the Creative Commons Attribution-Non-commercial-ShareAlike 3.0. and can be downloaded, changed and implemented free of licencing charges from <http://www.ict4red.blogspot.com/p/about.html>.

Conclusion

The creation of a course like this is not an easy undertaking. It is part science and part craft. The resulting design is by no means a perfect course, but initial results have suggested that it does equip rural teachers with a toolkit consisting of technology hardware, pragmatic pedagogical and technology knowledge and skills, and practice-based experience. The use of tablets has been a catalyst for teachers to use other forms of technology. In addition, the teachers demonstrated sufficient confidence to experiment with the use of software and hardware in their teaching practice. The course is also currently being translated into Afrikaans (for use in the Northern Cape).

- The gamification of the course was no easy task, and it took two iterations to arrive at a point where it was not merely ‘badges on leader boards’. We use the term gamification rather broadly and acknowledge that it is a contentious term. The flow from training experience to classroom practice was facilitated by the interim goals, articulated by the badges. The badge goal, achievement, assessment and the conferring of the badges served a number of functions:
- It outlined clear transparent expectation;
- It provides an opportunity for the teacher to demonstrate individual proficiency;
- It acknowledges achieved competence;
- It allows teachers to individualise and appropriate learning into practice;
- It acts as a scaffolding environment for achieving the teacher development goal;
- It allows the initiative initiators to acknowledge individual growth;
- It acts as an early warning signal of teachers falling behind;
- It allows for timeous investment in further technology needs; and
- It allows for champions to surface and to be acknowledged.

Initial success is suggested when one regards the completion and participation rate. Technology was applied to support teachers in adapting their method of teaching. Instead of teaching learners with chalk and a blackboard, teachers are now teaching learners in small groups, armed with a tablet and assisting learners in groups to facilitate meaningful engagement with the content. The innovation of the course lies within unique combination of elements and the methodology used, to encourage participation and spill over into classroom practice.

TPD remains a costly endeavour, and these costs escalate when remote, rural areas are targeted. The investment that is made in monetary value is

significant, but so is the opportunity cost for the teachers involved. As such, careful consideration needs to be made as to how the investment will be evaluated, and what the required short, medium and long-term changes will be. Technology in and of itself will not influence classroom practice and teachers that are not comfortable with the personal use of the technology will be very hesitant to use it in their classrooms. The TPD endeavour needs to bridge the gap between the potential and the teacher’s reality in such a way that they are empowered, and remain in control of their classroom practice.

Although the specific application of the ICT4RED TPD course lies within a very contextualised area, there are many elements that could be replicated with due consideration to the nature of the course. As an available artefact, the opportunity is available for practitioners and organisations to adapt it to their own needs. An online connected iteration and success in other environments could be possible areas to investigate as a next step.

Notes

- i. Module outline is attached as Appendix A.

Acknowledgements

This work acknowledges the TECH4RED Initiative, and more specifically the ICT4RED component, which was initiated by the Department of Science and Technology (DST) and supported by the Department of Rural Development and Land Reform (DRDLR), the Department of Basic Education (DBE) and the CSIR. The wonderful people in the Nciba district of Cofimvaba in the Eastern Cape Province of South Africa and the support provided by the Eastern Cape Provincial Department of Education, the ICT4RED core team, other outsourced companies and universities are also acknowledged.

The reviewers and editors of this journal are acknowledged for their hard work and effort on our behalf. This article remains a proudly South African tribute.

References

- Abell SK 2008. Twenty years later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education*, 30(10):1405-1416. doi: 10.1080/09500690802187041
- Al-Awidi HM & Alghazo IM 2012. The effect of student teaching experience on preservice elementary teachers’ self-efficacy beliefs for technology integration in the UAE. *Educational Technology Research and Development*, 60(5):923-941. doi: 10.1007/s11423-012-9239-4
- Aldunate R & Nussbaum M 2013. Teacher adoption of technology. *Computers in Human Behavior*, 29(3):519-524. doi: 10.1016/j.chb.2012.10.017

- Bandura A 1965. Influence of models' reinforcement contingencies on the acquisition of imitative responses. *Journal of Personality and Social Psychology*, 1(6):589-595. doi: <http://dx.doi.org/10.1037/h0022070>
- Bate P, Bevan H & Robert G 2004. 'Towards a million change agents'. A review of the social movements literature: Implications for large scale change in the NHS. Leicester: NHS Modernisation Agency. Available at <http://discovery.ucl.ac.uk/1133/1/million.pdf>. Accessed 25 November 2015.
- Bauer J & Kenton J 2005. Toward technology integration in the schools: Why isn't happening. *Journal of Technology and Teacher Education*, 13(4):519-546.
- Bobrowsky W, Marx R & Fishman B 2001. *The empirical base for professional development in science education: Moving beyond volunteers*. Paper presented at the Annual Meeting of the National Association of Research in Science Teaching (NARST), St. Louis, MO, 26 March. Available at <http://www.umich.edu/~hiceweb/papers/2001/BobrowskyNARST2001.pdf>. Accessed 25 November 2015.
- Botha A 2014. *Learning Briefs: Teacher Professional Development - Curriculum and Courseware construction*. ICT4RED. Pretoria, SA: TECH4RED, CSIR Meraka.
- Botha A, Herselman M & Ford M 2014a. *Gamification beyond badges*. In IST-Africa Conference Proceedings, Le Meridien Ile Maurice, 7-9 May. IEEE. doi: 10.1109/ISTAFRICA.2014.6880651
- Botha A, Salerno C, Niemand M, Ouma S & Makitla I 2014b. Disconnected electronic badges in resource constrained environments: A use case from the rural Nciba district in the Eastern Cape. In *Proceedings of the Second International Conference on Advances in Computing, Communication and Information Technology (CCIT)*. Birmingham, UK: Institute of Research Engineers and Doctors at Birmingham. doi: 10.15224/978-1-63248-051-4-138
- Botha A & Verster M 2014. *ICT4RED Teacher professional development*. Pretoria, SA: CSIR Meraka Institute.
- Bower M 2008. Affordance analysis - matching learning tasks with learning technologies. *Educational Media International*, 45(1):3-15. doi: 10.1080/09523980701847115
- Buabeng-Andoh C 2012. Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 8(1):136-155.
- Carney JM 1998. SIGTE research award winner: Integrating technology into constructivist classrooms: An examination of one model for teacher development. *Journal of Computing in Teacher Education*, 15(1):7-15. doi: 10.1080/10402454.1998.10784355
- Corcoran MA 2003. *Practical skills training for family caregivers*. San Francisco, CA: Family Caregiver Alliance. Available at <https://www.aota.org/-/media/Corporate/Files/AboutOT/consumers/Caregivers/Skills.pdf>. Accessed 25 November 2015.
- Costello B & Edmonds E 2007. A study in play, pleasure and interaction design. In *Proceedings of the 2007 conference on Designing pleasurable products and interfaces*. New York: ACM. doi: 10.1145/1314161.1314168
- Cox MJ, Preston C & Cox K 1999. *What factors support or prevent teachers from using ICT in their classrooms?* Paper presented at the British Educational Research Association Annual Conference, University of Sussex at Brighton, 2-5 September. Available at <http://www.leeds.ac.uk/educol/documents/00001304.htm>. Accessed 25 November 2015.
- Department of Basic Education 2011. *Introduction of CAPS in Grades R-3 and Grade 10*. Pretoria, SA: Department of Basic Education.
- Department of Education 1997. *Foundation phase (Grades R to 3) policy document*. Pretoria, SA: Department of Education.
- Deterding S, Dixon D, Khaled R & Nacke L 2011. From game design elements to gamefulness: defining "gamification". In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*. New York, NY: ACM. doi: 10.1145/2181037.2181040
- Dobozy E 2013. Learning design research: advancing pedagogies in the digital age. *Educational Media International*, 50(1):63-76. doi: 10.1080/09523987.2013.777181
- Drent M & Meelissen M 2008. Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education*, 51(1):187-199. doi: 10.1016/j.compedu.2007.05.001
- Fisher D & Frey N 2013. *Better learning through structured teaching: A framework for the gradual release of responsibility* (2nd ed). Alexandria, VA: ASCD.
- Fishman BJ, Best S, Marx R & Tal R 2001. *Design research on professional development in a systemic reform context*. Seattle, WA: American Educational Research Association.
- Fishman BJ, Marx RW, Best S & Tal RT 2003. Linking teacher and student learning to improve professional development in systemic reform. *Teaching and Teacher Education*, 19(6):643-658. doi: 10.1016/S0742-051X(03)00059-3
- Forrest G 2009. Using iPods to enhance the teaching of games in physical education. In J Herrington, A Herrington, J Mantei, I Olney & B Ferry (eds). *New technologies, new pedagogies: Mobile learning in higher education*. Wollongong: University of Wollongong. Available at <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1085&context=edupapers>. Accessed 26 November 2015.
- Fullan M 2007. *The new meaning of educational change* (4th ed). Oxon: Routledge.
- Gadamer HG 1998. *Praise of theory: Speeches and essays*. New Haven, CT: Yale University Press.
- Glover I 2013. Play as you learn: Gamification as a technique for motivating learners. In J Herrington, A Couros & V Irvine (eds). *Proceedings of EdMedia: World conference on educational media and technology 2013*. Association for the Advancement of Computing in Education (AACE).

- Gregor S & Hevner AR 2013. Positioning and presenting design science research for maximum impact. *MIS Quarterly*, 37(2):337-356.
- Grossman PL 1990. *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.
- Guzman A & Nussbaum M 2009. Teaching competencies for technology integration in the classroom. *Journal of Computer Assisted Learning*, 25(5):453-469. doi: 10.1111/j.1365-2729.2009.00322.x
- Harland J & Kinder K 1997. Teachers' continuing professional development: framing a model of outcomes. *Journal of In-Service Education*, 23(1):71-84. doi: 10.1080/13674589700200005
- Hedberg JG 2011. Towards a disruptive pedagogy: Changing classroom practice with technologies and digital content. *Educational Media International*, 48(1):1-16.
- Herrington A, Herrington J & Mantei J 2009. Design principles for mobile learning. In J Herrington, A Herrington, J Mantei, I Olney & B Ferry (eds). *New technologies, new pedagogies: Mobile learning in higher education*. Wollongong: University of Wollongong.
- Herselman M & Botha A (eds.) 2014. *Designing and implementing an Information Communication Technology for rural education development (ICT4RED) initiative in a resource constrained environment: Nciba school district, Eastern Cape, South Africa*. Pretoria, SA: CSIR Meraka.
- Hevner AR 2007. A three cycle view of design science research. *Scandinavian Journal of Information Systems*, 19(2): Article 4.
- Hevner AR, March ST, Park J & Ram S 2004. Design science in information systems research. *MIS Quarterly*, 28(1):75-105. Available at http://wise.vub.ac.be/thesis_info/design_science.pdf. Accessed 26 November 2015.
- Hew KF & Brush T 2007. Integrating technology into K-12 teaching and learning: current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, 55(3):223-252. doi: 10.1007/s11423-006-9022-5
- Hill LG, Maucione K & Hood BK 2007. A focused approach to assessing program fidelity. *Prevention Science*, 8(1):25-34. doi: 10.1007/s11121-006-0051-4
- Huotari K & Hamari J 2012. Defining gamification - A service marketing perspective. In *Proceeding of the 16th International Academic MindTrek Conference*. ACM.
- Keengwe J, Onchwari G & Wachira P 2008. Computer technology integration and student learning: Barriers and promise. *Journal of Science Education and Technology*, 17(6):560-565.
- Kervin L & Mantei J 2009. Collaborative gathering, evaluating and communicating 'wisdom' using iPods. In J Herrington, A Herrington, J Mantei, I Olney & B Ferry (eds). *New technologies, new pedagogies: Mobile learning in higher education*. Wollongong: University of Wollongong. Available at <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1086&context=edupapers>. Accessed 26 November 2015.
- Kinder K & Harland J 1991. *The Impact of INSET: the case of primary science*. Slough.
- Koehler MJ & Mishra P 2008. Introducing TPACK. In AACTE Committee on Innovation and Technology (ed). *Handbook of technological pedagogical content knowledge (TPCK) for educators*. New York, NY: Routledge. Available at http://punya.educ.msu.edu/publications/koehler_mishra_08.pdf. Accessed 26 November 2015.
- Koehler MJ & Mishra P 2009. What is technological pedagogic content knowledge? *Contemporary Issues in Technology and Teacher Education*, 9(1):60-70. Available at <http://www.citejournal.org/vol9/iss1/general/article1.cfm>. Accessed 26 November 2015.
- Lankshear C & Knobel M 2006. *New literacies: Changing knowledge in the classroom*. Buckingham, UK: Open University Press.
- Lawless KA & Pellegrino JW 2007. Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research*, 77(4):575-614. doi: 10.3102/0034654307309921
- Loughran J & Gunstone R 1997. Professional development in residence: Developing reflection on science teaching and learning. *Journal of Education for Teaching: International research and pedagogy*, 23(2):159-178. doi: 10.1080/02607479720105
- Magnusson S, Krajcik J & Borko H 1999. Nature, sources, and development of pedagogical content knowledge for science teaching. In J Gess-Newsome & NG Lederman (eds). *Examining pedagogical content knowledge: The construct and its implications for science education*. Netherlands: Kluwer Academic Publishers.
- Malinowsky C, Rosenberg L & Nygård L 2014. An approach to facilitate healthcare professionals' readiness to support technology use in everyday life for persons with dementia. *Scandinavian Journal of Occupational Therapy*, 21(3):199-209. doi: 10.3109/11038128.2013.847119
- Marache-Francisco C & Brangier E 2014. The Gamification Experience: UXD with a gamification background. In K Blashki & P Isaías (eds). *Emerging research and trends in interactivity and the human-computer interface*. USA: IGI.
- March ST & Storey VC 2008. Design science in the information systems discipline: an introduction to the special issue on design science research. *MIS Quarterly*, 32(4):725-730.
- Microsoft Partners in Learning n.d. *21 CLD learning activity rubrics: Innovative teaching and learning research*. Available at <http://fcl.eun.org/documents/10180/14691/5.3x+-+21cld+learning+activity+rubrics+2012.pdf/e240da11-07c2-4633-a86e-06c12f00d8ad?version=1.0>. Accessed 27 November 2015.
- Mishra P & Koehler MJ 2006. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6):1017-1054. Available at <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.91.7990&rep=rep1&type=pdf&a=bi&pagenumber=1&w=100>. Accessed 27 November 2015.

- Mueller J, Wood E, Willoughby T, Ross C & Specht J 2008. Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers & Education*, 51(4):1523-1537. doi: 10.1016/j.compedu.2008.02.003
- Mumtaz S 2000. Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of Information Technology for Teacher Education*, 9(3):319-342. doi: 10.1080/14759390000200096
- Olney IW, Herrington J & Verenikina I 2009. Digital story telling using iPods. In J Herrington, A Herrington, J Mantei, I Olney & B Ferry (eds). *New technologies, new pedagogies: Mobile learning in higher education*. Wollongong: University of Wollongong.
- Pearson P & Gallagher G 1983. The gradual release of responsibility model of instruction. *Contemporary Educational Psychology*, 8(3):112-123.
- Peffer K, Tuunanen T, Rothenberger MA & Chatterjee S 2007. A design science research methodology for information systems research. *Journal of Management Information Systems*, 24(3):45-78.
- Peralta H & Costa FA 2007. Teacher's competence and confidence regarding the use of ICT. *Educational Sciences Journal*, 3:75-84. Available at <http://repositorio.ul.pt/bitstream/10451/7008/1/%282007%29PERALTA,H%26COSTA,F%28ICTCompetenceConfidence%29S%C3%8DSIFO3eng.pdf>. Accessed 27 November 2015.
- Piaget J 1952. *The origins of intelligence in children*. New York: International Universities Press.
- Pirkkalainen H 2015. Dealing with emergent design science research projects in IS. In B Donnellan, R Gleasure, M Helfert, J Kenneally, M Rothenberger, M Chiarini Tremblay, D Vandermeer & R Winter (eds). *At the vanguard of design science: First impressions and early findings from ongoing research research-in-progress papers and poster presentations* from the 10th International Conference, DESRIST 2015, Dublin, Ireland, 20-22 May.
- Radaelli G, Lettieri E, Mura M & Spiller N 2014. Knowledge sharing and innovative work behaviour in healthcare: A micro-level investigation of direct and indirect effects. *Creativity and Innovation Management*, 23(4):400-414. doi: 10.1111/caim.12084
- Shaffer N 2008. Heuristic evaluation of games. In K Isbister & N Schaffer (eds). *Game usability: Advice from the experts for advancing the player experience*. Amsterdam: Morgan Kaufman.
- Shulman LS 1986. Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2):4-14.
- Smolin L, Lawless K & Burbules NC 2007. *Information and communication technologies: Considerations of current practice for teachers and teacher educators*. Chicago: National Society for the Study of Education.
- Stott A & Neustaedter C 2013. *Analysis of gamification in education*. Available at <http://clab.iat.sfu.ca/pubs/Stott-Gamification.pdf>. Accessed 27 November 2015.
- Vannatta RA & Fordham N 2004. Teacher dispositions as predictors of classroom technology use. *Journal of Research on Technology in Education*, 36(3):253-271.
- Vrasidas C 2015. The rhetoric of reform and teachers' use of ICT. *British Journal of Educational Technology*, 46(2):370-380. doi: 10.1111/bjet.12149
- Vrasidas C & Glass GV (eds.) 2004. *Online professional development for teachers*. Greenwich, CT: IAP.
- Vygotsky LS 1962. *Thought and language*. Cambridge, MA: M.I.T. Press.
- Vygotsky LS 1978. Interaction between learning and development. In LS Vygotsky (ed). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wang J & Gu L 2014. School-based research and learning activities: An innovative model for promoting teacher professional development. In CY Lin & RJ Wang (eds). *Innovations in science teacher education in the Asia Pacific* (Advances in Research on Teaching Vol. 20). Bingley, UK: Emerald Group Publishing Limited.
- Wilson SM & Berne J 1999. Teacher learning and the acquisition of professional knowledge: An examination of research on contemporary professional development. *Review of Research in Education*, 24:173-209.
- Wood D, Bruner JS & Ross G 1976. The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, 17(2):89-100. doi: 10.1111/j.1469-7610.1976.tb00381.x
- Woodrow JEJ 1992. The influence of programming training on the computer literacy and attitudes of preservice teachers. *Journal of Research on Computing in Education*, 25(2):200-219. doi: 10.1080/08886504.1992.10782044
- Yeung AS, Taylor PG, Hui C, Lam-Chiang AC & Low EL 2012. Mandatory use of technology in teaching: Who cares and so what? *British Journal of Educational Technology*, 43(6):859-870. doi: 10.1111/j.1467-8535.2011.01253.x
- Youngman M & Harrison C 1998. *Multimedia portables for teachers pilot: Project report*. Coventry, UK: British Education Communications and Technology Agency.

Appendix A

Outcomes Matrix					
Mod	Pedagogy	Outcomes	Content	Assessments	Mobile skills
Mod 1:	Jigsaw	<ul style="list-style-type: none"> • Use the jigsaw teaching and learning strategy in your classroom. • Earn the ICT4RED and JIGSAW badges. • Explore and explain the basic use of a mobile device: • Develop Basic skills: <ul style="list-style-type: none"> ▪ Use finger navigation to enlarge and reduce screen size, move and choose objects and move between tablet screens. ▪ Open and use your mobile device. ▪ Open, use and close an app. ▪ Take and look at photos. ▪ Watch a video on your device. • Personalise your mobile device by: <ul style="list-style-type: none"> ▪ Set the date and time and change the background of the home screen. ▪ Make the screen display for a longer time before switching off to save the battery. 	<ul style="list-style-type: none"> • Getting started with a mobile device. 	<ul style="list-style-type: none"> • Formative assessment (Scoring Check List) <ul style="list-style-type: none"> ○ Peer and self-assessment • Summative assessment (JIGSAW Badge) 	<ul style="list-style-type: none"> • Switch the device on and off • Navigate between screens • Open, use and close an app • Make my photo my home screen background • Manage app icons on screens • Find and open a document in a folder • Watch a video • Take and look at photographs • Change the predictive text setting • Change my device password (security) • Change the device personal information • Connect to a Wi-Fi • Name my device as a Bluetooth device • Use Bluetooth to transfer files. • Use an online browser on your tablet • Switch off automatic app updates • Change the screen time-out • How to change the owner information of your tablet
Mod 2:	Storytelling	<ul style="list-style-type: none"> • Use storytelling as a teaching and learning strategy. • Tell your story as a teacher. • Earn the STORYTELLING and EMAIL BADGE. • Understand the potential of storytelling as a way to collect artefacts for teaching. • Implement collaborative group learning into your teaching strategy. • Create a storyboard. • Explore the use of a mobile device: 	<ul style="list-style-type: none"> • Planning strategies • Story Boards • Information sharing • Collaborative practices 	<ul style="list-style-type: none"> • Summative (STORYTELLING and EMAIL Badges) 	<ul style="list-style-type: none"> • Use a slideshow or presentation app • Take and edit a photo • Watch a video • Write a journal entry using Memoires • Use Bluetooth to transfer files • Set up email on your device

Outcomes Matrix					
Mod	Pedagogy	Outcomes	Content	Assessments	Mobile skills
Mod 3	Role Play	<ul style="list-style-type: none"> ○ Watch a video. ○ Use a slideshow app to visualise your storyboard. ○ Write journal entries using a journaling app. ○ Take and edit a photo. ○ Use Bluetooth to share files. ○ Use the suggested apps. ● To use Role Play as a teaching and learning strategy. ● Identify issues related to the introduction of mobile technology in your school and classroom. ● Use Role Play to illuminate issues and source solutions. ● Collaborative group work. ● Create a school strategy regarding the use of mobile technology. ● Ensure learner safety in a connected context. ● Earn the ROLE PLAY and TWITTER BADGE. ● Explore the use of a mobile device: <ul style="list-style-type: none"> ▪ Create a video. ▪ Use your mobile device to pick learners randomly. ▪ Use spreadsheets for assessment. 	<ul style="list-style-type: none"> ● Issues in mobile implementations ● School ICT Strategy ● Student safety 	<ul style="list-style-type: none"> ● Formative (Self-assessment checklist) ● Formative (peer assessment: scoring checklist) ● Summative (badge marker: ROLE PLAY and TWITTER badge) 	<ul style="list-style-type: none"> ● Send an email using Gmail ● Attach a file to an email ● Record and watch videos ● Use a spreadsheet for assessment ● Write a journal entry using Memoires ● Use Bluetooth to transfer files ● Access and read articles ● Use an app timer ● Register for twitter ● Send tweets ● Follow hashtags
Mod 4	Learning stations	<ul style="list-style-type: none"> ● Use the suggested apps. ● Use the Learning Stations teaching and learning strategy in your classroom. ● Earn the LEARNING STATIONS and EDUCATIONAL CONTENT CREATOR BADGES. ● Explain what a digital library is. ● Understand the classroom potential of various digital resources in a digital library. ● Explore the use of a mobile device: <ul style="list-style-type: none"> ▪ Access digital library content: eBooks, Electronic tutorials, Simulations, Video and Podcasts. ▪ Manage folders and resources. ▪ Write journal entries. 	<ul style="list-style-type: none"> ● Digital libraries ● Understand the potential of various digital resources in a Digital Library ● eBooks ● Simulations ● Tutorials ● Podcasts ● Collaboration 	<ul style="list-style-type: none"> ● Formative (Grid) ● Formative (Rating Scale) ● Formative (Competition) ● Summative (LEARNING STATIONS and EDUCATIONAL CONTENT CREATOR badges) 	<ul style="list-style-type: none"> ● Access digital library content from your device ● Open and use eBooks ● Watch videos ● Manage folders and resources on your device ● Write a journal entry using Memoires ● Listen to a podcast or audio file ● Use a mobile word processor
Module 5	Mind Mapping	<ul style="list-style-type: none"> ● Use the suggested apps. ● Use mind mapping as a teaching strategy. ● Earn the MIND MAPPING BADGE. ● Evaluate the use of technology versus traditional teaching methods in your classroom. ● Create a lesson plan using a mind-map. ● Organise and manage information. ● Evaluate apps for educational purposes. 	<ul style="list-style-type: none"> ● Integrated technology teaching vs Traditional teaching methods ● Managing organising and evaluating Apps 	<ul style="list-style-type: none"> ● Formative Assessment (Self-assessment Rubric) ● Formative(Competition) ● Summative (MIND MAPPING Badge) 	<ul style="list-style-type: none"> ● Use a mind map tool ● Use a drawing app ● Use a writing app ● Install and Uninstall apps ● Take and look at photographs ● Listen to a podcast or audio file

Outcomes Matrix					
Mod	Pedagogy	Outcomes	Content	Assessments	Mobile skills
Mod 6:	Flipped classrooms	<ul style="list-style-type: none"> • Explore the use of a mobile device: <ul style="list-style-type: none"> ▪ Use a mind mapping tool with learners. ▪ Use a drawing app as a discussion tool. ▪ Install, uninstall and manage apps on your device. ▪ Create folders of apps. ▪ Share files using Bluetooth and or Wi-Fi. ▪ Create a screenshot. • Use the suggested apps. 			
		<ul style="list-style-type: none"> • Use Flipped Classrooms as a classroom strategy. • Describe the benefits and limitations of a flipped classroom. <ul style="list-style-type: none"> ▪ Analyse a flipped classroom lesson plan. ▪ Find and evaluate flipped classroom resources. ▪ Choose apps that can support a flipped classroom. ▪ Design and critique mobile infused flipped classroom lesson plans. • Do the FLIPPED CLASSROOM BADGE and the ASSESSMENT BADGE • Explore the use of a mobile device: <ul style="list-style-type: none"> ▪ Create videos for pre-class activities. ▪ Scan or copy learner work using a scanning app. ▪ Complete electronic word and spreadsheet templates. • Use the suggested apps. 	<ul style="list-style-type: none"> • Flipped Classrooms • Lesson Plans 	<ul style="list-style-type: none"> • Formative: (peer) (rubric) • Summative: (FLIPPED CLASSROOM BADGE and the ASSESSMENT BADGE) 	<ul style="list-style-type: none"> • Categorise apps and make folders for similar functioning apps • Save and share files using Bluetooth or Wi-Fi • Create a Screenshot • Access and read an e-publication • Write a journal entry using Memoires • Switch off automatic app updates • Choose a student randomly using an app • Transfer files and folders between your tablet and a USB flash drive • Create a lesson plan using an Excel template • Scan learners work • Watch and Create videos • Complete electronic word and spreadsheet templates • Transfer files and folders between your tablet and a USB flash drive • Save and share files using Bluetooth or Wi-Fi • Access and read an e-publication • Write a journal entry using Memoires • Access, Manage folders and resources on your device • Install and Uninstall apps • Choose apps that can support a flipped classroom • Use an App timer

Outcomes Matrix					
Mod	Pedagogy	Outcomes	Content	Assessments	Mobile skills
Mod 7	Game Based Learning	<ul style="list-style-type: none"> • Use the game based learning strategy in your classroom. • Earn the GAME BASED LEARNING BADGE. • Explain the following issues around Copyright and Licensing: Fair Use, Plagiarism, Licensing, Public domain, Shareware software, Freeware software, Open source, Attribution and Creative Commons licensing. • Explore the use of a mobile device: <ul style="list-style-type: none"> ▪ Play electronic games. ▪ Play QUIZ games. ▪ Use a spreadsheet to keep score. ▪ Make music. ▪ Choose students randomly. • Use the suggested apps. 	<ul style="list-style-type: none"> • Copyright • Plagiarism • Creative Commons Licencing • Quiz game 	<ul style="list-style-type: none"> • Formative (rubric) • Summative (GAME BASED LEARNING BADGE) 	<ul style="list-style-type: none"> • Write a journal entry using Memoires • Find and watch a video • Play electronic games • Use a spreadsheet to keep score • Make music using an app • Choose a student randomly using an app • Use an App timer • Write a journal entry using Memoires • Watch a video • Use a slide presentation to participate in a quiz show. • Access, Manage folders and resources on your device • Record and watch videos • Complete a lesson using a word processor • Create a photo collage • Create and read a QR code • Create and edit video • Take and edit photos • Share files across devices using Bluetooth • Find Locations using Global Positioning System (GPS) coordinates • Write a journal entry using Memoires • Use a timer App • How to contribute to a blog • Use the Internet to source information. • Take and share photos. • Create a professional profile for yourself on a social learning network.
Mod 8	Field trips	<ul style="list-style-type: none"> • Describe the value of a Field Trip as a teaching strategy. • Earn the FIELD TRIP BADGE. • Explain different uses of QR codes in educational settings. • Plan, facilitate and assess a scavenger hunt. • Explore the use of a mobile device: <ul style="list-style-type: none"> ▪ Decode (read, scan) QR codes. ▪ Take photos, make photo collages. ▪ Take videos and watch videos. ▪ Read geographical (GPS) information. • Use the suggested apps. 	<ul style="list-style-type: none"> • QR codes • Scavenger Hunts • Collaboration 	<ul style="list-style-type: none"> • Formative (Activity Score Sheet) • Summative (FIELD TRIP BADGE) 	<ul style="list-style-type: none"> • Create a photo collage • Create and read a QR code • Create and edit video • Take and edit photos • Share files across devices using Bluetooth • Find Locations using Global Positioning System (GPS) coordinates • Write a journal entry using Memoires • Use a timer App • How to contribute to a blog • Use the Internet to source information. • Take and share photos. • Create a professional profile for yourself on a social learning network.
Mod 9	Gallery walks	<ul style="list-style-type: none"> • Use a Gallery Walk as a teaching and learning strategy. • Plan and facilitate a Gallery Walk. • Do the GALLERY WALK BADGE. • Explain what digital identities are and evaluate the authenticity of digital profiles. • Explain what phishing is and avoid being a victim of phishing. 	<ul style="list-style-type: none"> • Digital Identities • Phishing • Online safety • Cyberbullying • Personal Learning networks • Professional Learning communities 	<ul style="list-style-type: none"> • Formative (Discussion and outcomes checklist) • Summative (GALLERY WALK BADGE and BLOG COLLABORATOR badge) 	<ul style="list-style-type: none"> • Create a photo collage • Create and read a QR code • Create and edit video • Take and edit photos • Share files across devices using Bluetooth • Find Locations using Global Positioning System (GPS) coordinates • Write a journal entry using Memoires • Use a timer App • How to contribute to a blog • Use the Internet to source information. • Take and share photos. • Create a professional profile for yourself on a social learning network.

Outcomes Matrix					
Mod	Pedagogy	Outcomes	Content	Assessments	Mobile skills
Mod 10: Looking back	Reflection	<ul style="list-style-type: none"> • Create a personal digital identity. • Evaluate and join online learning communities. • Understand online safety and assist learners to be safe online. • Use your mobile device to: <ul style="list-style-type: none"> ▪ Access digital profiles. ▪ Create a digital profile. ▪ Access community spaces. ▪ Share resources on your virtual platform. ▪ Create personal networks. ▪ Take photos. ▪ Reflect using a journal like Memoires. • Use the suggested apps. • Explain and give examples of innovative teaching strategies. • Discuss these strategies in relation to 21st century learning skills. • Create a video or slideshow of your mobile journey. • Present a slideshow to your peers demonstrating: <ul style="list-style-type: none"> ▪ How to use teaching strategies. ▪ How you can use your mobile device. • Earn your REFLECTIVE PRACTITIONER BADGE. • Earn your MOBILE SKILLS BADGE. • Explore the use of a mobile device: <ul style="list-style-type: none"> ▪ Access and save documents. ▪ Share saved documents using email or Bluetooth or the Wi-Fi server. ▪ Create and edit a video or a slideshow presentation. • Use the suggested apps. 	<ul style="list-style-type: none"> • How to present 		<ul style="list-style-type: none"> • Leave comments on a social network or blog. • Share resources using your social network. • Create a blog. • Contribute to a blog.
					<ul style="list-style-type: none"> • Create a slideshow • Save a document • Create and edit a video • Insert pictures into a slideshow • Present using a slideshow