Supporting Teacher Professional Development to use Tablets in Resource Constrained Schools: A Case Study of Cofimvaba schools, Eastern Cape Province, South Africa

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ABSTRACT

Over a period of three years, 360 teachers at 26 resource constrained schools in Cofimvaba, which lies in the Nciba district of the Eastern Cape Province of South Africa, have received training on how to integrate mobile tablets in their classrooms to support teaching and learning. The training modules combined the use of teaching strategies and fun with practical hands-on exercises which can be used in any type of subject for any grade when training teachers. Teachers embarked on a learning path attached to badges to reward their efforts and evidence of how they have applied their training in their classrooms. The purpose of this paper is to share this novel approach to teacher training in a unique context where schools are deprived of resources but still managed to successfully integrate mobile tablets in their classroom practices. These practices have changed the way teachers teach from standing with a textbook and chalk in front of a class sitting in rows, to standing with a tablet and learners are engaged in group work and using the tablets as a resource in a disconnected environment. The success of these training modules lies in the application of an approach of teach with and not to, earn as you learn and not just give technology, respect and humility, flexibility, innovation, creativity and co-creation.

Keywords: Teacher Professional Development, Teaching Strategies, Gamification Elements, Rewards, Mobile Technology, Resource Constrained.

1. INTRODUCTION

Educators believe that technology has great potential to improve education [1], improve student learning and changes the way educators conduct their lessons. Technology has the capacity to support powerful and sophisticated learning environments and is often seen as the golden key in facilitating technology-enhanced, student-centered teaching environments [2]. Hardman [3] also indicates that ICTs have the ability to act as a catalyst to transform pedagogical practices in classrooms. However many ICT for Education initiatives in South Africa and the rest of the developing world have resulted in failure [4;5;6]. Teachers in rural areas are willing to use technology to support teaching and learning, but are not only under-qualified in terms of pedagogy and content knowledge, but are unable to integrate the technology into their teaching activities [4;5]. In those cases where ICT initiatives in schools do include some kind of training component, the focus is often on computer literacy, rather than how to use the technology as a tool for teaching and learning [6].

This paper will focus on an intervention which is coined as the Information Communication and Technology for Rural Education Development (ICT4RED) initiative, which is a large-scale pilot (over 3 years) that is testing the use of tablets in 26 deep rural schools in the Nciba district of Cofimvaba in the Eastern Cape Province of South Africa.

The macro-economic perspective of the area is one of few economic opportunities, high unemployment, low incomes, a shrinking population of economically active people and a growing number of school-going youth. The pilot extends to include 3 senior secondary schools (Grades 10 – 12) and 23 junior and primary secondary schools (Grades R to 9) [7]. The challenge is to introduce technology (in this case tablets and other supporting ICT infrastructure) in ways that will improve teaching and learning, support sustainability beyond the project and ensure true integration into existing education processes, whilst managing very real logistical and infrastructure problems. This is a challenge that can be seen as significant for ICT in Education initiatives in rural areas.

This initiative was part of The Technology for Rural Education Development (TECH4RED) research programme which aims to contribute to the improvement of rural education via technology-led innovation. It was initiated by the Department of Science and Technology (DST) in collaboration with the Department of Basic Education (DBE), the Eastern Cape Department of Education (ECDoE) and the Department of Rural Development and Land Reform (DRDLR) in South Africa.

The TECH4RED is applying a range of technology-intensive interventions, including initiatives in ICT, nutrition, health, water, sanitation and energy to determine the extent to which the programme will enable positive contributions at all levels and spheres of influence in the school system [8]. The learning from this programme will enable evidence-based policy development within government. ICT4RED thus is part of TECH4RED and is the component within TECH4RED which focus only on how technology can support teaching and learning.

ICT4RED as a component of the larger TECH4RED, aims to investigate the application and deployment of tablets, supported by other technologies (which include school infrastructure, network connectivity, e-textbooks and other electronic resources) to the identified 26 schools. In order to do this a 12-component conceptual model was developed to identify various components that would need to form part of an overall project plan during the 3 project phases. A champion was selected for each of these components, who was given the responsibility (with support from the Programme and Project Managers) to conceptualize, design, plan, manage and implement their component.

The ICT4RED 12-Components aims to identify the components that need to be considered to facilitate the transformation of a prevalent traditional pedagogy to a technology enhanced emerging pedagogy for the information age.

Table 1: ICT4RED 12- Components

Change	
Current Less of "traditional pedagogy"	21st Century Classroom More of "emerging pedagogy for the information age"
Focus areas	
Learner and home	
Teacher and school	
Government and Policy	
Component	
Project Management	Financial Management, Procurement Implementation management
School ICT Infrastructure	Devices, Wireless LAN, Storage and Power
Network	WiFi Mesh, Satellite, Backbone connectivity, Internet
Change Management	People (District, SMT), Technology Process
Teacher Professional Development	Training Preparation, In the class.
Content	Standards, Conversion, Creation & Customisation
Operations Management	Logistics, Support & Maintenance Distribution
Communication	Marketing strategy, Social Media Strategy, Knowledge Management
Monitoring & Evaluation	Learner, Teachers, School
Evidence-Based Policy	Academic Research, Implementation guidelines, Policy guidelines
Community Engagement	Learners & Parents, Teachers, Community
Stakeholder Management	District/Circuit officials, Local Leadership, Provincial

For the purpose of this paper only the Teacher professional development (TPD) component will be expounded. The TPD aimed to meet teachers where they are with reference to their teaching and technology proficiency, and to scaffold their development incrementally in order for their classroom practice to reflect a 21st century teaching and learning engagement as modelled on the EPG [9] emergent proactive.

A resource constrained environment for the purpose of this paper, is best described by Anderson, Anderson, Boriello & Kolko [10] as environments where there is low-income communities and low bandwidth. These environments provide unique constraints (e.g., cultures where people are unfamiliar with or afraid of technology, environments where power and network connectivity are scarce and expensive).

2. CHALLENGES FACING TEACHERS WHO EMPLOY TECHNOLOGY IN THEIR CLASSROOMS IN SOUTH AFRICA

Challenges facing teaching and learning in South Africa [11] include: the apartheid legacy of unequal education infrastructure; high levels of poverty in communities; weak quality of learning and teaching; lack of accountability across the system; corruption and inefficiencies in the system; ineffective leadership and managements; on-going changes in the curriculum; and ineffective implementation of the language policy. Some goals for The Action Plan 2014 of the Department of Basic Education in South Africa include ensuring an environment that inspires learners to want to come to school to learn and teachers to teach, increasing learner access to a wide range of media, including computers, which enrich their education, improving the average performance across all grades, increasing the number of learners who have mastered the minimum mathematics competencies, and increasing the number of learners to pass physical science [12]. However, there exists a digital divide in South Africa [13] among learners and teachers who are already disadvantaged due to a range of social inequalities.

ICT can potentially help address challenges such as inadequate resources and under-qualified educators [3], yet it is in resource constrained environments that educators are having most difficulty in integrating the use of ICTs into teaching and learning.

By addressing the ICT needs for educators in these communities, the prospects for both education and the community at large may be improved. The impact of a developing context is evident in findings that suggest that schools in under-resourced areas could not afford in-house technical support and they had to rely on external support arrangements, which were often deemed insufficient. Furthermore, most educators have inadequate ICT and pedagogical competencies for effective integration of ICT into their work. Learners from disadvantaged backgrounds often have low technical skills, and because most of them do not have computers at home they have no opportunity to practice and hone skills what are introduced in lessons. Consequently, educators spend large amounts of time dealing with the functional use of technology, instead of teaching the subject content [13].

3. METHODOLOGY APPLIED

In creating the modules for the Teacher Professional Development component the design science methodology was applied. Design Science research focuses on creation and the purpose of design is "to change existing situations into preferred ones" [14]. Design science addresses 'wicked problems' in Information Systems [14] and is fundamentally a problem-solving paradigm. Wicked problems as explained by [14] relate to the ill-defined environmental contexts, creativity and teamwork to produce effective solutions. There are compelling arguments to accept the educational exploitation of ICT within resource constrained environments such as the Cofimvaba school district as a wicked problem.

The research, grounded in the philosophy of pragmatism applied the deductive reasoning approach.

The ICT4RED engagement with the schools has been integrated over 3 years, with an initial pilot study at 1 school in 2012. In 2013 the engagement was scaled to 11 other schools and in 2014 to the remaining 14 schools. In total therefore the engagement extends to 26 schools. This engagement will encompass 6 500 learners, 360 teachers and 32 district officials. The following phased approach was used:

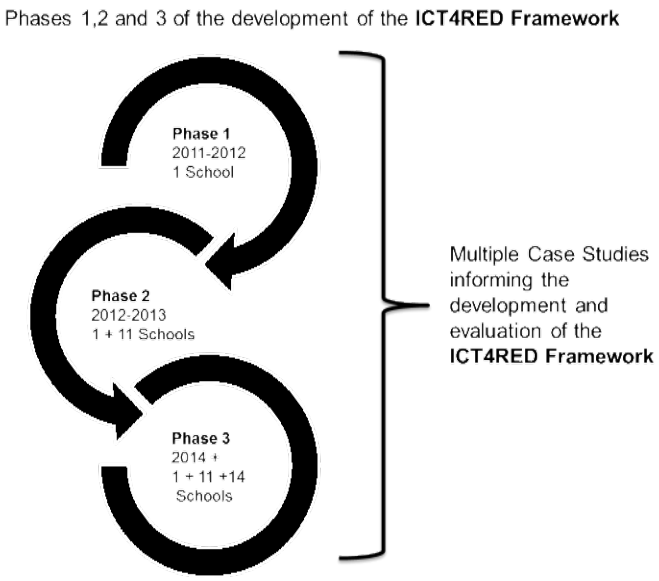


Figure 2: Phases of the development of the ICT4RED framework

Design science research creates artifacts which is something created by humans usually for a practical purpose and [15] differentiate among four different types of artifacts: concepts, models, methods and instantiations. Thus as the aim of the Teacher professional development component was to develop a training component for teachers as an artifact (method), two important characteristics of design science artifacts which will be addressed are relevance and novelty [16]. First, an artifact must solve an important problem: i.e., being relevant. Second, to differentiate design science research from routine design, Hevner. March & Park [17] suggest that design science research should address either an unsolved problem in a unique and innovative way or a solved problem in a more effective or efficient way. Furthermore, Pries-Heje, Baskerville and Venable [18] and Carlsson, S., Henningsson, S., Hrastinski, S., & Keller, C. [19] are of the view that DS research in IS should be underpinned by a socio-technical perspective.

Thus for the study documented in this paper, the problem of supporting and providing resources to rural, disconnected resource constrained teachers who were required to change their classroom practice to reflect a 21st century engagement, were unique and the TPD course that was developed innovative in that it focused on teaching strategies and not on technology competencies. The following section will outline the design decisions made and detail the operationalisation of these decisions within the rural disconnected environment.

4. TEACHER PROFESSIONAL DEVELOPMENT (TPD) CURRICULUM DESIGN

Mindful of the objective of the TPD curriculum, the constraints of the environment and the cost (both monetary and opportunity costs) a number of TDP curriculum design decisions were make. These are outlined and motivated briefly.

1. Tablets were chosen as the technology that would support the teachers. As all educators had access to a mobile deviced it was felt that the the barrier to proficiency would be significantly reduced in this way. Android devices was chosen due to the open nature of the operating system and the large quantlty of free apps that are available
2. The training would take place over a broad spectrum of teachers and as such the TPD could not be subject of phase specific. The teacher, as content and context expert would have to become a co-creator in the proces.
3. Technology would be provided **in use** and not **in case.** This was operationalised through a concept that was called "earn as you learn" It implied that the need for technology hardware would first be created and then met and only when certain well devined goals had been achieved on the side of the teachers and the insitutions. These goals were articulated as badges that teachers had to achieve in order to progress and eventualy, when they had evedenced that they had the required competencies and skills to use the device meaningful within the learning engamement, the device ownership was transferred to the individual teacher. Depending on the demonstrated cometencies and skills of the educators at a school, the school would receive, or earn, various technology hardware.
4. The TPD course was designed in such a way that it did not require any internet connectivity. Although consensus was that this was not the most desirable way to structure the course it was pragmatic. Initailly all of the schools were disconnected and there was very limited infrastructure that would support sufficient connectivity. A internet like experience was catered for through a local WiFi environment and oppertunities to connect to the internet incorporated in various ways through challenges.
5. Gamification as a design strategy was implimented to facilitate an element of fun and play as it was felt that teachers would be less threatened in such interactions. The allocation of badges as clear goals in the teachers' learning path would profide oppertunities for regular meaningful feedback and ensure that the

TPD sessions actually translated into a change of classroom practice.

6. The modules would 'walk the talk'. This implied that no teaching strategy or technology skill would be presented if it was not demonstrated and modelled to the teachers. As such the Jigsaw teaching strategy was introduced and modelled through jigsaw, storytelling through storytelling and so forth.
7. The TPD would build a Toolkit of skills, technology and competencies that would empower teachers to integrate technology meaningfully into their classroom practice in order to portray a 21st century engagment. Each module in the curriculum would be **about** relevant content **through** a teaching strategy **using** technology to facilitate the teaching and learning interaction. In addition teachers would be exposed to:
    - best practice in groupwork
    - different assessment strategies
    - concept of a reflective practitioner
    - concept of online learning and additional resources

The toolkit would consist of:

- Teaching strategies

Nine teaching strategies were identified as relevant. The criteria for the strategy was that it needed to work well in classrooms with or without technology, that it had to be learner centered and that teachers would be able to adapt it across the learning spectrum to all levels of teaching and all subjects.

- Content

Relevant content that would enable the teachers to confidently engage in the information age.

- Technology skills, competencies and hardware

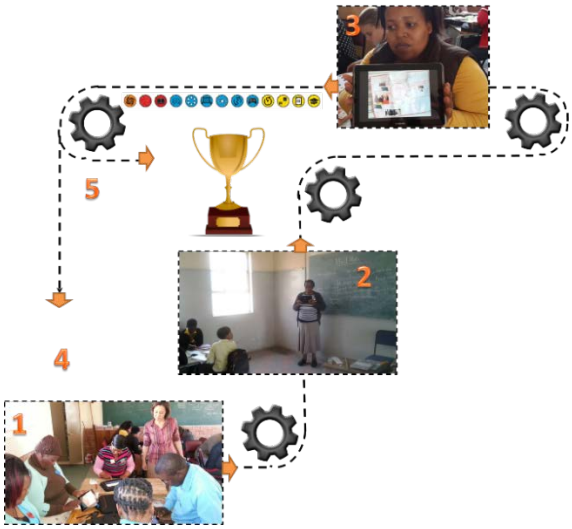
These were relevant skills and competencies to enable teachers to confidently use the technology to enhance the teaching and learning interaction. The technology hardware would consist of the enabling environment and attachments that would facilitate the teaching and learning interaction. This would include access to a projector, Mobikits, charging stations, content server etc.

Having outlined the major design decisions that were taken, the following section details the implementation of the TPD course.

5.

6. IMPLEMENTATION OF THE TPD COURSE

The course takes about a year to implement the 10 modules depending on the time constraints. The implementation takes place as illustrated in the diagram below:



1. The learning strategy, skills and other competencies are simulated during the TPD session. This provides an opportunity to experience the strategy, learn about a topic and gain technology skills.

2. Subsequent to the TPD session, the participating teachers have about 3 weeks to apply te strategy using technology in their own class. They need to record some evidence as outlined in the badge criteria.

3. A badge evaluator evaluates the evidence provided and either award the badge or gives meaningful imput on possible improvements. In this case the teacher can resubmit at any given time.

4. If there are still modules left, another TPD session will be done and the process repeats.

5. If all the the modules have been presented the participating teacher has the opportunity to graduate should they have achieved the minimum criteria.

The TPD course narrative is one of changing classroom practice to portray more of an "emerging pedagogy for the information age" and less of a "traditional pedagogy" [20; 21].

Table 2: Towards Emerging pedagogy for the information age [20; 21]

Aspect	**Less of "traditional pedagogy"**	**More of "emerging pedagogy for the information age"**
Active	Activities prescribed by the teachers Whole-class instruction Little variation in activities Pace determined by program	Activities determined through negotiation Small groups Varied activities Pace determined by learners
Collaboration	Individual	Working in teams

Aspect	Less of "traditional pedagogy"	More of "emerging pedagogy for the information age"
	Homogeneous Groups Everyone for him/herself	Heterogeneous groups Supporting each other
Creative	Reproductive learning Apply known solutions to problems	Productive Learning Find new solutions to problems
Integrative	No link between theory and practice Separate subjects Discipline-based Individual teaching	Integrating theory and practice Relations between subjects Thematic Teams of teachers
Evaluative	Teacher- directed Summative	Student directed Formative

The transformation was operationalized through a learning path that consists of 13 interim goals articulated as badges. The learning path changes focus from committing to the programme, to using the technology for personal use, evolving into using the technology for teaching and learning to ultimately using the technology to collaborate, communicate and share. This progression is detailed in the graphical image below:

Figure 1: Learning path Narrative

This is represented as follow in a sequential manner. Each of the learning goals articulated as badges in the course is represented by an image and is physically awarded in the form of a sticker to add to the learning path. Originally it was planned to award Mozilla open badges but the disconnected environment and the teachers not having a digital presence or email made the electronic badges irrelevant until much later in the intervention.

During the progression along the learning path, the need for specific technology hardware is created and then met as the teachers as participants reach a certain level of competence as illustrated through the attainment of goals articulated as badges. These participant teacher hardware earnings are mapped against the badge progression in the following Table 3:

Figure 2: Sequential Learning Path represented by a road to be followed and badges to be earned.

Table 3: Tablet accessory earnings linked to badge progression

Badges achieved	Tablet Accessory
ICT4RED	Tablet Cover
Jigsaw Storytelling Role Play	SD Card

Badges achieved	Tablet Accessory
	Earphones Tablet Pen

The schools additionally earn technology in use. Their earnings are mapped against the progression of their teachers in attaining competence and skills as outlined in the table below:

School Achievement	
	The diagram gives an indication of the estimated time when the schools will be eligible for the School to receive the various technologies. 1. Projector 2. Mobikit[1] 3. Additional mobikits, Internet connection or 1:1 tablet rollout to learners.
80% of 5 badges per participant For the school to earn a projector the ideal would be: Each teacher tried a minimum of 4 new teaching strategies, This is a total of 5 badges per teacher. We expect the school to have achieved 80 % of this total. So for a school with 10 people on the course, it would imply that they can earn a total of 50 badges. 80% of this is 40 badges. To give the school some incentive, this implies that the total needs to be 80% of 5 badges per participant. If teachers do more badges, they will achieve the total sooner. If not all teachers are doing the compulsory badges this will be achieved much later in the intervention.	Projector
80% of 7 badges per participant For the school to have Mobikits the ideal would be: Each teacher tried 5 new strategies, 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
80% of 9 badges per participant For the school to have tablets for learners, the ideal would be: Each teacher tried 8 new strategies, The Mobikit is actively being used Teachers have are creating digital content and is integrating the technology into the teaching and learning.	Additional Mobikit /Tablets to learners

[1] A mobikit is a Mobile container as big as a suitcase that provides secure storage and charging for, and includes 15 seven inch preloaded Android devices.

7.

6. OUTCOME AND DISCUSSION

Of the 137 teachers that took part in the second phase, all of them achieved all the compulsory badges and ownership of the tablets were transferred to them. Their feedback was overwhelmingly positive and indicated that they felt they were able to integrate technology meaningful into their classrooms. Significant was the teachers' willingness to also use computers and other ICT in their classrooms.

The TPD curriculum, as teaching strategy centered rather than technology centered, models the use of effective teaching strategies with technology as a tool. As the strategies can be used with or without technology it broadens the teachers' available repertoire of competencies. It is based on empowering the teachers (tablets and professional development) and preparing the schools (change management and supporting infrastructure) before rolling out to learners.

The rollout of technology hardware in use rather than in case which we have coined as the *Earn As You Learn (EAYL)* system has proved to be extremely successful. The decision not to gift technology to individuals or institutions, but for them to earn it by achieving interim clearly defined goals, is something that can be widely replicated. It has led to impromptu study groups by teachers after school, as they work together to earn badges as individuals and as schools, so that they can obtain hardware that are associated with a level of achievement.

Simulating the teaching interaction is underpinned by the notion that teachers teach the way they're taught. By modeling the teaching strategy during TPD, it becomes easier for them to

mimic in the classroom. In addition, we created safe spaces and enough motivation to try new things out. The choices of individual activities were purposefully done to facilitate a fun experience for them to relieve the possible tedium of yet another workshop. The TPD course has been published under a Creative Commons license which would enable further contextualization by other institutions to enable a larger audience to benefit from the ICT4RED learning and experiences.

7. RECOMMENDATIONS FOR FURTHER IMPLEMENTATIONS

Integrating technology is a facilitated process and as such meaningful integration needs to be planned and facilitated. This is not a process that happens overnight and can be experienced as disruptive and stressful to the school system as well as the individual teachers. As such change management forms an important mitigating activity.

Teachers need to be met where they are and their current competencies and skills matched to expectations and activities. As this is often not possible when doing TPD with a number larger number of teachers, it is advisable to aim at the lowest common denominator and to scaffold from there.

If you cannot demonstrate it, don't do it. Actions speak louder than words and there is very little that can replace the actual experience of a strategy. It is often easier to lecture but as teachers often teach like they are taught it is imperative that strategies and skills be modelled.

The teacher professional development interaction is costly and needs to be seen as an investment in more than just mastering a technology for the sake of it. Careful consideration needs to be given to content, strategy as well as technology use.

The interaction design of a TPD learning interaction must be a positive learning experience for the teacher to translate into a willingness to experiment in their own classroom. In conclusion simplicity and repetition is key.

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