

**Designing and implementing an
Information Communication Technology for
Rural Education Development (ICT4RED) initiative
in a resource constrained environment:
Cofimvaba school district, Eastern Cape,
South Africa**



ICT4RED



TECH4RED
ENHANCING EDUCATION

Marlien Herselman and Adele Botha
2014



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Designing and implementing an Information Communication Technology for Rural Education Development (ICT4RED) initiative in a resource constrained environment: Cofimvaba school district, Eastern Cape, South Africa

This book is a representation of the activities, which were recognised as essential components to consider, when implementing a certain ICT4D initiative in a resource constraint area in the poorest province of South Africa which is faced with significant educational challenges. This initiative was coined the ICT4RED initiative and was a research, development, innovation and implementation project that changed the way in which teachers teach with technology in their specific context over a period of 3 years (2012-2015).

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Contents

Section 1.	Designing and implementing an ICT4RED initiative	1
1.1	Introduction	1
1.2	Background to the ICT4RED initiative.....	3
1.3	Implementation principles	11
1.4	Scope of the ICT4RED initiative	12
1.5	The design (methodology) and implementation (phases) of the ICT4RED initiative	13
1.6	Evolution of the ICT4RED phases.....	27
1.7	Conclusion.....	65
1.8	References	65
Section 2.	ICT4RED Implementation Framework.....	70
2.1	Introduction	70
2.2	ICT4RED initiative principles and ethos.....	71
2.3	Initiative Management.....	75
2.4	Implementation processes	76
2.5	Final ICT4RED Implementation Framework.....	76
2.7	Conclusion.....	81
2.8	References	81
Section 3.	Teacher Professional Development	83
3.1	Introduction	83
3.2	Methodology used	83
3.3	Phase 0.....	85
3.4	Phase 1.....	93
3.5	Phase 2.....	93
3.6	Phase 3.....	109
3.7	Phase 4: Reflections, Transfer and Transform	118
3.8	Conclusion.....	122
3.9	References	123
Section 4.	Monitoring and Evaluation	128
4.1	Introduction	128
4.2	The importance of Monitoring and Evaluation of Information and Communication Technology for Education (ICT4E) Initiatives.....	128
4.3	How the monitoring and evaluation of ICT4RED was approached.....	130
4.4	How the Monitoring and Evaluation Framework was Developed	131
4.5	An Overview of the ICT4RED Monitoring and Evaluation Framework.....	134
4.6	Choosing Evaluation Focus Areas and Evaluation Questions.....	137
4.7	Considering the Monitoring and Evaluation Framework in terms of the NEPF and OECD DAC Criteria.....	140
4.8	Choosing appropriate Evaluation Methods for each of the Evaluation Questions.	142
4.9	How the Evaluation Methods were Designed, Tested and Implemented	145
4.10	How ethical clearance and provincial approval for the initiative was obtained.....	163

4.11	Implementing the Monitoring and Evaluation Framework – Some Lessons	164
4.12	References	166
Section 5.	Managing ICT Deployment in Schools	168
5.1	Initiative Management	168
5.2	Operations Management	171
5.3	Summary	200
5.4	References	201
Section 6.	Change management	202
6.1	Changing a community	202
6.2	Changing the principals	206
6.3	Summary	212
6.4	References	213
Section 7.	Sustainability and Value through Improved Decision-making	215
7.1	Introduction	215
7.2	Sustainability and value in ICT4D initiatives	216
7.3	A decision-making view on sustainability	219
7.4	Understanding costs: Total Cost of Ownership model	231
7.5	Selecting technology for sustainability: multi-criteria technology selection model	238
7.6	Enabling Sustainability through Improved Decision Making	242
7.7	Summary	245
7.8	References	247
Section 8.	The use of social media in the management of an ICT for Education initiative.	249
8.1	Introduction	249
8.2	Literature Review	250
8.3	Methodology	253
8.4	Data Analysis	262
8.5	Findings	272
8.6	Conclusions and recommendations	274
8.7	References	275
Section 9.	Synthesis of the ICT4RED initiative	279
9.1	Introduction	279
9.2	Addressing the aim and objectives	279
9.3	What were the biggest success factors?	282
9.4	Other significant results	284
9.5	Challenges	286
9.6	Recommendations for further implementations	287
9.7	Recommendations relating to sustainability and policy	289
9.8	Evaluation	294
9.9	Summary	298
9.10	References:	298

Acronyms

CAPS	Curriculum Assessment Policy Statements
DBE	South African Department of Basic Education
DRDLR	South African Department of Rural Development and Land Reform
DSR	Design Science Research
DST	South African Department of Science and Technology
EAYL	Earn as You Learn
ECDoE	Eastern Cape Department of Education
ICT4D	Information and Communication Technology for Development
ICT4RED	Information and Communication Technology for Rural Education Development
ICTE	Information and Communication Technology in Education
IS	Information Systems
IT	Information Technology
LTSM	Learner Teacher Support Material
M&E	Monitoring and Evaluation
MoA	Memorandum of Agreement
MoU	Memorandum of Understanding
NDP	National Development Plan
NEIMS	National Education Infrastructure Management System
NGO	Non-Governmental Organisation
SGB	School Governing Body
SMT	School Management Team
Tech4RED	Technology for Rural Education Development
TPACK	Technological Pedagogical Content Knowledge
TPD	Teacher Professional Development

Executive summary

This book is a representation of the activities, which were recognised as essential components to be considered, when implementing a certain ICT4D initiative in a resource constrained area in the poorest province of South Africa which is faced with significant educational challenges. This intervention was coined the ICT4RED initiative and was a research, development and implementation project that changed the way in which teachers teach with technology in their specific context over a period of 3 years (2012-2015).

The book aims to provide an overview of the design and implementation of an *Information and Communication Technology for rural education development initiative* in a resource constrained environment.

Various frameworks, models, guidelines and tools were developed by adopting Design Science Research as the chosen methodology. Certain specific case study phases were applied within the Design Science Research process and lessons were learnt in each phase which was documented as the initiative moved from one phase to the other. Certain steps were followed during each phase. The book provides an overview of how each of the components, within the ICT4RED Implementation Framework (Section 2), were managed and how they were operationalised to provide specific deliverables or to reach certain aims.

The core team (one representative from each component) met once a week to track and trace progress and deliverables. What emanated from this ICT4RED initiative was far more than just frameworks, models, processes or tools, to be tested and refined, it was a *change* in the way 350 teachers (in 26 schools) applied technology and teaching strategies to support their teaching and learning and to improve their 21st century teaching skills. This initiative can be viewed as a successful intervention within a specific period of time involving specific people in a specific context where technology was deployed to support education.

What became evident from this initiative was that it was NOT about the technology, but about the PEOPLE who are empowered to use the technology in order to improve their lives and that of their learners!

New technology is common, new thinking is rare.

- Sir Peter Blake-

This book will guide readers through the journey of this initiative and it is hoped that it will inspire all new prospective students, teachers and academia to realise that the value of using technology does not lie in that it can ever replace the teacher, but that it can *enhance* teaching and learning and *transform* traditional teaching methods in a classroom. This transformation can only be successfully done where technology is earned and not just given away or provided free of charge.

The book is divided into Sections (1-9). **Section 1** provides the Introduction and Background to the ICT4RED initiative and describes how the ICT4RED Framework evolved and how it was adapted after every phase. The methodology, which underpinned the development of the framework, is also dealt with.

Section 2 delivers an overview of the ICT4RED implementation framework, as one of the key artefacts to describing the ICT4RED initiative.

Section 3 summarises how Teacher Professional Development (TPD) was developed and deployed.

Section 4 covers the importance of the Monitoring and Evaluation framework and how it was applied in the ICT4RED initiative, over a period of 3 years. It is not the intention to focus on results but to share *how* the M&E framework was used to obtain results and effect impacts.

Section 5 provides details regarding Initiative Management, Operations Management and School ICT. The focus is on *how* the ICT4RED initiative applied different processes, used certain tools and actioned suppliers to equip schools and teachers in the Cofimvaba school district.

Section 6 addresses the ways in which Change Management and Stakeholder Management contributed to the integration of technology in a resource constraint community in a specific context.

Section 7 focusses on Sustainability and how value is derived through improved decision-making. The issue of sustainability, and how it plays an important role in the ICT4RED initiative, is discussed. Total Cost of Ownership-, Cost utility- and Tablet selection-models, which were developed to address sustainability, are also discussed.

Section 8 deals with the use of social media in the management of the ICT4RED initiative. The Twitter and WhatsApp feeds (over a period of time)

were analysed and provided some interesting results.

Section 9 provides a synthesis in which the objectives and aims, and how these were achieved, are addressed. This last section also looks at changes, which were eminent in the context of the initiative, and ends with some recommendations for similar future endeavours.



Photo 1-1: TPD Phase 2

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It is not about the technology; it is about sharing knowledge and information, communicating efficiently, building learning communities and creating a culture of professionalism in schools. These are the key responsibilities of all educational leaders.

- Marion Ginapolis-

Initiative Participants

The following participants are recognized:

- CSIR Meraka Institute (Initiative Management and component championing)
- Department of Science and Technology (DST) and Department of Rural Development and Land Reform (DRDLR) (Initiative Sponsors)
- DST, DRDLR, Department of Basic Education (DBE) and Eastern Cape Education Department of Education (Initiative Stakeholders)
- Human Science Research Council (HSRC) (Monitoring and Evaluation of TECH4RED)
- Benita Williams Consultants (Monitoring and Evaluation)
- Impact Advantage (Modelling)
- CoZaCares Foundation (Content)
- Maskew Miller Longman (Content)
- Pearson (Content)
- SchoolNET SA (Teacher Professional Development)
- AfroFusion (Communication)
- Hive Holdings (Technology infrastructure design, Operations Management)
- Tipp Focus (Change Management)
- Nelson Mandela Metropolitan University Govan Mbeki Mathematics Development Unit (Content)
- Fort Hare, Rhodes, Nelson Mandela Metropolitan University, University of Pretoria, University of Johannesburg, University of the Free State, University of South Africa, University of Manchester, Monash University (Postgraduate students and Research)
- Faranani (Professional Services)
- University of Pretoria (Ethnography and Content)
- Lymmyl Technologies (ICT Infrastructure Implementation and Support)
- Liquid Telecom (Satellite Connectivity)
- Maggie Verster (Teacher Professional Development)
- Sandy Malapile (Stakeholder Management)
- Uys du Buisson (Operations Management)
- Redline (Wireless Mesh Networks and Wi-Fi Implementation)
- Google South Africa (Technology infrastructure)

Section 5. Managing ICT Deployment in Schools

M. Herselman

Contributors:

R. Miril; O.Qwabe; S.Byliefeldt; F. Wallace and U. du Buisson

This section will focus on how initiative management, operations management and School ICT were managed in the ICT4RED initiative. The essence of what each had to deliver will be highlighted. Although each of these components have already been discussed under the framework in Section 1 it is important to indicate what each provided to support the Teacher Professional Development component. Without proper initiative management, operations management and the School ICT provision the ICT4RED could not have addressed its aims and objectives.

5.1 Initiative Management

As was already indicated under Section 1 and 2, where the ICT4RED implementation models and frameworks were discussed, Initiative Management supported the whole initiative and was the component which was essential to drive all the other components.

The main role of the Initiative Management component was to take strategic leadership of the initiative, re-conceptualisation, planning and delivery. The Initiative Manager had overall responsibility to ensure that the overall strategic objectives are met.

This also involved constant open communication with funders and primary stakeholders (government departments, general public, participating schools and communities, partners like Eastern Cape Department of Education) and potential partners and funders. An externally facing website was necessary to share content with the outside world and an internal initiative-focused communication and sharing platform was also developed as a resource repository for initiative participants.

The initiative manager had to ensure that the Blogs are constantly updated, social media accounts and records are kept and branding is done. Therefore a communications strategy was developed with guidelines on branding and ways of communication on the initiative. It was important to

capture how communications will be managed throughout the life cycle of an initiative of this calibre. **The Communication strategy** (as an artefact) provides a Plan which describes the planned and periodic communications occurring between all the ICT4RED Initiative stakeholders. This plan also covered scheduled written and oral communications, responses to unsolicited requests for information, the frequency of the scheduled communications, and the responsible person(s) for providing the information. The Communication Plan is an integral part of the overall Initiative Management and will be used to provide guidance to the ICT4RED initiative. Based on this strategy the initiative manager had to present the initiative at various forums, do conference presentations and collaborate or support publications on the initiative. Important weekly meetings were scheduled with the rest of the team to keep track of developments within every other component and to manage risks and challenges.

This is why the knowledge management function also resided within this component. The initiative manager had to negotiate budgets with the funders if underestimations or additional costs arise. The applications for ethics approval at various organisations or at national departments were also controlled and managed from this component. Any other high level approvals and final decisions on deployment, implementation and involvement of other parties had to be done within this component.

The initiative manager provided advice, reports and inputs to stakeholders, which can affect policy changes in the long term, especially regarding deployment of technologies in schools. The initiative manager also had to provide evidence of how this initiative has affected a change in behaviour of the whole community (which includes representatives from the provincial Department of Education, district officials, principals, teachers, learners, parents and local suppliers). There had to be close collaboration between this activity and all other activities, so that learning and knowledge can be shared in transparent and easy-to-digest ways.

Evidence-based policy needs of government and stakeholders had to be managed and supported. This includes engagement with universities and experts in the research fields of Education and ICT4D were important to share lessons learnt and best practices. Recruitment of postgraduate students was important to show impact and human capital development, if they can base their studies on the initiative in the fields of Education,

Information systems, IT/Computer Science. The postgraduate students were supported with a once off payment (via their university student accounts) and their studies and publications were a support mechanism to market the ICT4RED initiative through their publications and presentations. For this purpose Memorandum of Understandings (MoU) and Memorandum of Agreements (MoA) had to be signed with the respective universities. A process of engagement with universities and the process of selection of students are artefacts of this part of the initiative management component.

To get postgraduate students involved, special attention was paid to get university students from universities which are in the same province than the ICT4RED initiative. The following process was applied:

- Universities and specific departments/Faculties are approached to present the ICT4RED initiative to them to determine if any of their students, staff or other researchers associated with their university will be interested to be part of the initiative at postgraduate level. They did the selection themselves and the ICT4RED team were requested to provide an overview of the initiative and also some ideas on what are the possibilities for postgraduate studies.
- Prospective students had to provide a summarised overview of their possible title, scope, and a one pager which addressed the what, where, when, how and why as a starting point within 2 weeks for further discussions.
- Individual in-depth discussions were held with interested students and their supervisors at the universities.
- Students had 6-9 months (depending on the university) to complete a proposal which had to be accepted by their respective research committees.
- Students had to get their own ethical approval at their universities. Any other ethical approval which was gained before the ICT4RED initiative was implemented was provided to them. The Department of Basic Education: Eastern Cape Province provided a letter of approval to conduct the ICT4RED initiative and do research based on the initiative.
- A MoA was signed with each university and its respective Faculties and departments with timelines and specific deliverables.

- Each accepted proposal from the universities was supplied to ICT4RED team as proof.
- Quarterly progress reports were provided to track student progress.
- All students with their supervisors were funded to visit the Cofimvaba school district to meet the respective teachers, principals and other stakeholders involved before commencing with their field work or empirical research;
- Fieldwork trips were arranged to coincide with other activities or training dates at the schools and was done after school hours;
- Scholarship payments were done by the initiative manager. Payments were only affected after signature of the MoAs, Proof of registration of students was received and student's proposals were accepted and approved by their respective Faculties.

This process proved to be successful as some students who failed to submit their proposal were not funded.

The initiative management component supports all other components and uses their inputs to improve or advise on new directions.

The following were developed from the Initiative Management component:

- How to deploy tablets in schools (a step-by-step guide) – known as The Blueprint
- Communications strategy (already mentioned)
- Research framework report (which outlines the Research Methodology, approach and strategy to develop the final framework)

5.2 Operations Management

The objective of this area of focus was to establish an Operational Management environment linked to the strategy known as “Central Control, Decentralised Services”. The setup of this environment was linked to industry best practises like ITIL (formerly known as the Information Technology Infrastructure Library which is a set of practices for IT service management or ITSM that focuses on aligning IT services with the needs of the business). The four main areas of focus for this deliverable were:

- **People:** A multi-tiered approach was followed.

- **Process:** Each of the deliverables was documented in a process.
- **Policies:** All the policies that have governed the initiative were documented and signed-off by all the stakeholders.
- **Tools:** The tools monitored all the ICT components to enable proactive management as far as possible. The tools also allowed us to record all events and manage them in a structured way. (Software tools like Service-now for incident reporting, tracking and resolving issues with tablets and for Asset Management)

Here the project manager took day-to-day responsibility for planning and implementation. This includes responsibility for all administration processes, financial reporting, procurement and logistics relating to the ICT4RED initiative.

The Operations Management defined common processes and procedures, policies, roles, responsibilities, terminology, best practices and standards for managing IT before and after deployment and implementation. This also included the procurement, device management and support and maintenance of technology.

The three core objectives were:

- **Achieving stability:** it is in the nature of Operations to try to maintain the status quo, and minimize changes as the main source of service disruptions.
- **Continual improvement:** to improve the IT infrastructure and services it provides. It implies changes, and can be in conflict with the previous one.
- **Diagnosis and resolution of occurred operational failures.** Here Operations Management had to cooperate tightly with Service Desk and Incident Management.

The challenge was that these objectives were sometimes conflicting. This challenge was overcome through strong leadership, adherence to policies and processes, good management and excellent communication.

5.2.1 IT Operations

The IT Operations function is divided into two sub functions namely (a) IT Operations Control and (b) Facilities Management. Each of the sub-functions in turn has a number of activity or service categories.



Figure 5-1: IT operations for ICT4RED initiative

5.2.1.1 IT Operations Control (ITOC)

ITOC is a sub-function that centrally monitored and controlled operations tasks. These tasks included but were not limited to:

- Remote and onsite maintenance and support activities: Performing maintenance activities requested by Application Management and Technical management functions. Operations can be organized to work in shifts, in order to perform assigned after-hours tasks.
- Console management: Monitoring IT infrastructure through various IT control tools and/or real-time reporting engines.
- Job scheduling: Automated and manual execution various scripts and batch jobs.
- Backup and restore: Management of centralized and distributed backups for all environments. This includes backing up of configurations (server, desktops, switches etc.)

5.2.1.2 Facilities Management (FM)

FM managed facilities that house physical IT infrastructure such as server rooms, data centres and disaster recovery sites. It took care of all the accompanying functions including but not limited to:

- Cooling
- Power
- Security (e.g. Physical and logical access control) and Safety (e.g. fire control)
- Monitoring and alerting

FM was also responsible for large transitions such as:

- IT infrastructure consolidation
- Construction / upgrade initiatives concerning facilities, cabling, power, monitoring and alerting etc.
- Deployment of large scale hardware and / or software upgrades

The ICT service providers in the ICT4RED initiative formed part of a three-tier support service to schools in the area. Tier 1 involves the first-line support of primary technology users including principals, educators and learners. User identification and recording is captured in a service request reported to the service desk. NARYSEC Champions do a first level detection and recording and do a standard service request procedure until the issue is resolved. If not the service request is escalated to Tier 2 where the service desk reports the issue to CSIR incident management who do an investigation and diagnosis to resolve the issue. If the issue is not resolved it is escalated to Tier 3 for attention by the technology suppliers and CSIR operations management. Issues are classified as hardware, software/applications and connectivity and referred to the appropriate technology supplier for investigation and diagnosis. If a solution is proposed and the issue resolved the query is closed. If not the issue is escalated to CSIR operations management who make decisions on warranty issues, repair or scrapping of equipment and propose solutions for resolving the issue or refers it back to the technology suppliers. The progress of all service requests is recorded on the service desk database.

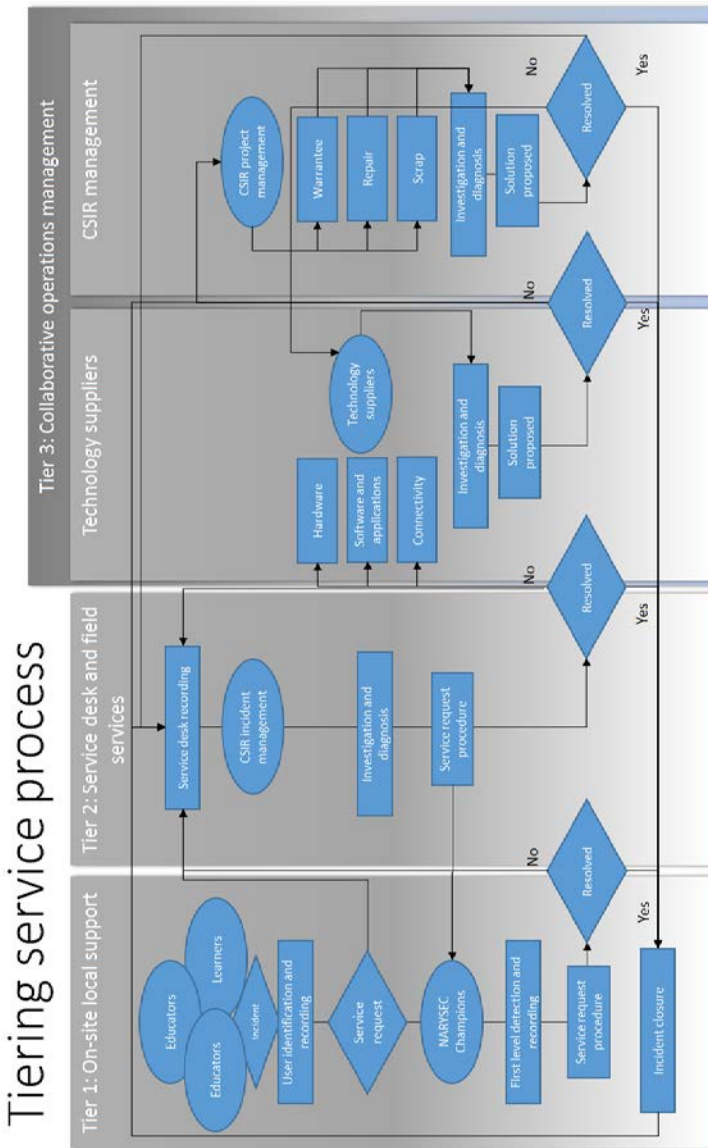


Figure 5-2: Service process for each Tier in the ICT4RED initiative

The summarised deliverables are:

- Tier 1: This was the first point of contact level for all users. Different channels were established to make it as easy as possible for the users to report problems or issues or requests. This Tier is onsite within the area where the technology gets deployed (through the NARYSEC youth). The plan was to develop local youngsters in the area to be deployed at each school.
- Tier 2: Once the user has made contact with the previous Tier and the reported incident could not be resolved then the higher Tier will take-over.
- Tier 3: This is the last level of escalation and is a combination of core skills within CSIR and External Service Partners.

Service providers assigned through the NARYSEC initiative primarily formed part of the Tier 1 ICT administrator team, located at the 26 schools. The NARYSEC programme stands for The National Rural Youth Service Corps (NARYSEC) and was established in September 2010. NARYSEC's main goal is to recruit and develop rural youth; and to perform community service in their own communities (DRDLR, 2014). The NARYSEC youth in this initiative have been tasked to provide ICT support to the schools they are assigned to.

Their roles and responsibilities are provided below:

Table 5-1 Roles and responsibilities of NARYSEC Youth in support of ICT4RED at schools

Key Result Area	Responsibilities / Objectives
ICT fault reporting and response administration	Use IT Services Management Software to generate weekly reports on calls handled and performance w.r.t. call resolution Customise reports in line with stakeholder requirements
Technical support (end-users)	Log and manage all hardware or software faults or general enquiries related to end-user devices (tablets, laptops, etc.) Respond to calls (service orders) issued by Tier1 and Tier3 support
End-user training	Training with respect to use of hardware and software (tablets, laptops, printers, audio-visual equipment, content servers, Wi-Fi, Internet access)
ICT user training	On the job training of ICT users at the school who are part of Tier 2 support

Key Result Area	Responsibilities / Objectives
Special projects	Manage and assist with ad hoc special projects (e.g. data collection and analysis: user needs survey)

These young people were trained to act as support and maintenance champions at each school. They assisted the teachers and ICT committees (which will be discussed under the School ICT component) at schools with the booking and charging of tablets, and overall ICT school infrastructure.

The following signs were posted at all schools to indicate what teachers could do if their devices had problems:

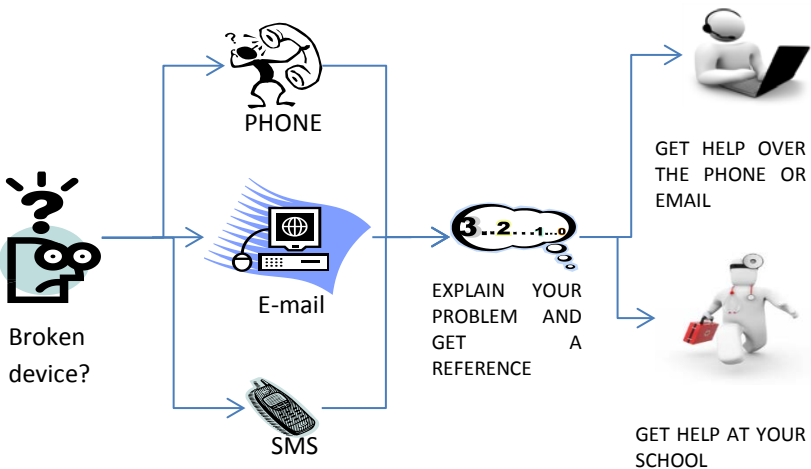


Figure 5-3: Posters made to assist teachers to report on problems with their devices

This poster was then linked to a specific held desk procedure which teachers could follow to report their individual incidents about their devices. The following held desk procedure was communicated to all teachers and ICT committees at schools:

Helpdesk Procedure

Consider any computer problems that you may have, such as:

- The tablets of any of the learners in classes are broken: the screen is cracked, the battery does not charge, or anything similar

- Any of the computer equipment at the school was stolen
- You cannot connect to the Internet
- Someone took a tablet home, and it was lost or stolen
- You need software to be installed on your computer

You can solve this by contacting the help desk. This can be done as follows:

- Phone the helpdesk at *****
- Send an email to ***
- Send an sms to ****

You will be asked to provide the following information:

- Describe the problem
- Give the serial number(s) of the equipment that is affected
- Give the address of the school where the equipment can be found
- Give contact names and numbers of people that know about the problem

You will receive a reference number

The problem will then be solved immediately (over the phone or via email), the NARYSEC person will be asked to deal with the issue or someone will be sent to your school to assist you.

5.2.2 Device Management

The following were seen as important for device management and for support and maintenance of the technologies which were deployed to schools and the district:

- **Asset Management:** All the assets which were deployed were recorded and a full Asset Lifecycle management tool exists for this purpose.
- **ITSM (IT Service Management):** This was the central system as far as Incident -, Change -, Problem -, Workforce – and Asset Management was concerned.
- **Monitoring:** ICT components which were deployed were remotely managed from an availability and capacity point of view.
- **Continuous Improvement:** Maturity levels were monitored to measure what can be implemented to bring the initiative in line with peers and industry best practises.

- **Service Level Management:** All SLA (Service Level Agreements) were managed and governed by this area of expertise and tools.

In this component the ICT4RED initiative was managed via the following phases:

- Research and Development
- Plan
- Site Survey
- Detailed Site Plan (DSP)
- Work Commence Order (WCO) – Create
- Work Commence Order (WCO) - Accept
- Provisioning
- Site Prep
- Implementation/Installation
- Site Sign-off
- Quality Assurance (QA)
- Fix Issue List
- Transition to Operations
- Operational Management

The above phases were managed via the ITSM system (Service-Now) and each phase is a stage gate i.e. workflow will prevent you to skip or move on to a next phase unless the previous phases have been signed-off.

It was important to ensure that pre-agreed deliverables were signed with the successful bidder and it provided them a clear Detailed Site Plan (DSP) and Work Commence Order (WCO) before work commenced. Any changes to the WCO had to follow a proper Change Management process before work commenced.

5.2.3 **Service-Now**

Service now (<http://www.servicenow.com/solutions.html>), is a cloud-based service which supports operations. This means that all information, incidents and processes are available anywhere where there is access to the Internet. Service Now creates a single system of record.

The power of it lies in the fact that if it is used correctly, it manages business processes from start to finish with integrated solutions for:

- Asset and Configuration: identify and monitor IT service assets and their relationships.
- Planning and Policy: define IT strategies and manage projects.
- IT Services: deliver IT services and support to business users.
- IT Operations Management: track and manage IT resources and systems.
- Non-IT Services: automate business processes outside of IT.

It has the following applications and operations:

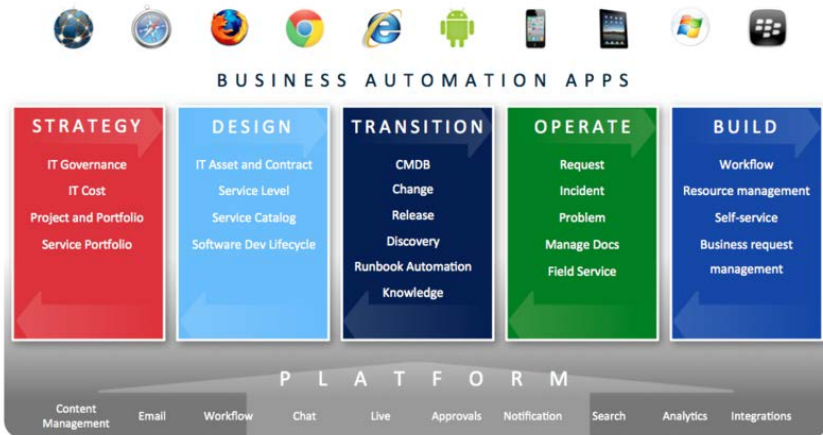


Figure 5-4: Components for Service-now as an ITSM software tool

Service-now Components that have been used for ICT4RED initiative were:

- Configuration Item Management which assists with where an item is, what its status (in stock/in use/in maintenance) is, who is the owner of the item, supplier of the item, warranty etc. It also allows one to add the user data (name, surname, contact detail and location) as well as location data which include the site name, latitude, longitude and to which project it is linked (ICT4RED).
- Incident Management where Service Level Agreements and business rules are actively used in the system. This indicates for example the time it takes to resolve an incident and can calls can

be logged from OMA which is an automated process. The call logging from users in the field is a manual process.

- Service Desk where calls are logged. This is then divided into tiers (as indicated in Figures 5-3).
- It captures the Field Service Management (Support and Maintenance) for service orders for Field Services.
- Knowledge Base where all the Policies, Processes, maps, how to etc. are stored.
- Reports can be automated with regards to all data in the system e.g. Users, Locations, Incidents, etc. These can be visible inside Service-now or emailed to users
- Supplier Management module which ensures the reliability and cost-effectiveness of outside suppliers. The supplier management team negotiates contracts with external suppliers, and regularly reviews these contracts to ensure that they are being met. The Service-Now platform provides tools for defining and monitoring these contracts.

This was found to be an excellent tool to support ITSM. From the main components illustrated in Figure 5-4 above ICT4RED mainly used the Design and Operate components (light blue and green blocks).

Device management was also done at the CSIR before devices were sent to the district office, which then send it to the individual schools. The serial numbers were linked to the school and individual teacher tablets were also linked to the school for asset management purposes.

5.2.4 Tablet preparations before deployment

The mobile tablets had to be prepared before teachers and schools can receive these. Different content were loaded for teacher tablets than for learner tablets.

For teachers

Before deploying the tablets to the teachers it was important to load specific supporting material and Teaching Applications on the devices. This included the following:

- All the TPD training modules and Applications which support the training for each of the 10 TPD training modules;

- Curriculum Assessment Policy Statements or CAPS (curriculum documents based on the South African education system). CAPS form part of the National Curriculum Statement Grades R-12, which represents a policy statement for learning and teaching in South African schools and comprises the following (Department of Basic Education, 2014): Curriculum and Assessment Policy Statements (CAPS) for all approved subjects
- National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R – 12; and
- National Protocol for Assessment Grades R – 12
- Old examination papers for all the grades (depending on available content providers) and papers, which could be found from teachers in all grades, and for all subjects, were placed on tablets of the teachers.

For schools

Tablets that are deployed to schools in the Mobikits were also pre-loaded with certain specific content and applications. All tablets had to contain the same content, applications and additional materials in order for all teachers to have an equal access to the same material and content. This was done at the CSIR.

Once the tablets arrived from the suppliers, a master device had to be made, which contained all the applications loaded either from the Play store or from an Android application package (**APK**) which is the package file format used to distribute and install application software and middleware onto Google's Android operating systems. This was manually installed. Books and videos were also copied to the devices. A backup was made from the Master device using **CMD** (term commonly used to mean 'command') in order to make an image of that master device.

The next step was to enable USB debugging on each tablet, to restore the backup file (which was created earlier). This allowed for a complete tablet that was similar to the master tablet.

The master tablet assisted in ensuring that no other installations had to be done of any Applications or content. The only challenge was that it was very time consuming and sometimes took an hour to complete one tablet.

Email accounts (per school) had to be created through the administration console of each tablet. Once this was done, it had to be manually loaded onto each tablet. Tablets were then packed into the Mobikits with cables. Each Mobikit consisted of 15 tablets and serial numbers for all these tablets were scanned and placed onto the asset management tool (service-now) with a user ID and site ID.



Photo 5-1: Example of the Mobikits where black sponge was used to line the cases where 10 tablets could be placed. Underneath the tablets were place for the chargers and extension plugs. This was the first version of the Mobikits the later Mobikits consisted of 15 place holders for tablets and was blue in colour.

5.2.5 Network

The objective of this area was to design, implement and manage a network between the schools and to the Internet.

The main deliverables for this area were:

- **Backhaul Connectivity:** Establish a network to connect the ICT4RED initiative to the outside world.
- **Access Network:** Create connectivity between the schools and to the backhaul network.
- **Internet:** Give all the schools Internet access and monitor that access.
- **Central Processing and Storage:** This will be the central data store and content management environment.

The figure below provides an overview of the Wi-Fi coverage and how it was grouped to do the implementation between the different schools.

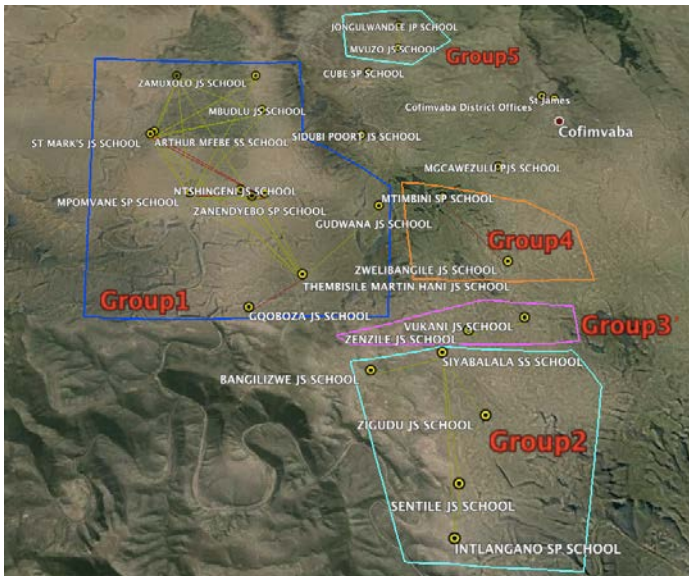


Figure 5-5: Wi-Fi between schools

Each school was connected to the Internet through a VSAT link at the school. The In-School Wi-Fi Zone was supporting the equipment that provides the Internet connectivity at the school. A secure room was provided for the network cabinet, content server and related equipment.

All access to the wireless network and wired network in the school were authenticated.

The Wi-Fi network allowed registered users to access the network when the WAN link (VSAT) is down (there is no Internet connectivity). Wi-Fi access was provided on 2.4GHz and 5GHz channels to allow devices (tablets and notebooks) to select the best channel for the optimal throughput. This approach also reduced the risk of interference within the network between APs.

The required coverage standards were $\geq -75\text{dBm}$ for both 2.4GHz and 5GHz across the school buildings and the capacity (AP) had to be able to support 60 concurrent sessions.

Lightning is prevalent in the area and hence protection had to be designed into the way buildings were interconnected in order to reduce damage to network equipment. It was essential that good practice had to be designed into the solution in order to achieve the most reliable network for the schools.

The Network consists of different types (standard and access) of sites based on its main function in the Network. The site types and numbers are indicated below:

- Standard Sites were 21 in total;
- Access Sites (Group Entry Point) were 5 in total.

The Standard Sites connected amongst each other via HPNs as a wireless mesh. The Standard Sites also connected to the Access Sites via HPNs as part of the wireless mesh. Each group of sites (Standard sites with Access Site) constituted an independent mesh network.

Standard equipment for the Standard sites was:

- A 9U Data cabinet (Swing Frame) and inside the cabinet are:
 - Mikrotik 5 Port 100Mbps managed Router/Switch with a 12V Power Supply Unit;
 - POE Adapter 24V for the HPN, which was installed on the outside of the Building either on a wall mount bracket or on a mast.

There was also a Din Rail 12V Transformer, 16Amp Circuit breaker with connectors to accommodate the Power Supply Units. Two RJ45 Data

Modules were installed on the side the Cabinet connected to the Router Switch. These Modules provided user data access as well as VOIP and/or Wi-Fi access.

Equipment for the Access site was included:

A 12U Data cabinet with a swing frame which was fitted with a front mount shelf, a 3U Circuit Breaker housing with a Din Rail, a Wall Box, Side Mounted Single Fan and a 50mm x 50mm cut out for the UTP DATA Modules.

The Equipment that was installed in the 12U Cabinet were:

- Microtik 5 Port Gigabit managed Router/Switch with a 12V Power Supply Unit;
- POE Adapter 24V for the HPN, which was installed on the outside of the building either on a wall mount bracket or on a mast.

There was also a 48V POE Adapter for the Microwave link which was installed on a mast outside, a Din Rail 12V Transformer, 16Amp Circuit breaker with connectors to accommodate the Power Supply Units. A YAB (Yet Another Box) was supplied by CSIR and a satellite Modem in the Cabinet was linked to the Dish outside of the building to provide backup connectivity. At these sites there was also a Meissner double conversion on-line UPS with automatic by-pass and power factor correction with SNMP and HTML, Modbus/JBus and relay outputs. Two RJ45 Data Modules were installed on the side the Cabinet connected to the Router Switch. These Modules provided user data access as well as future VOIP and/or Wi-Fi access.

Satellite access equipment was also deployed at the Access sites to provide connectivity to the Internet for each group. The Satellite Internet connections had been used for the monitoring of the Network.

The satellite dishes, which were provided to each of the 26 schools, had to connect to the South African Research and Education Network (SANREN). Each had a 1024kbps Downlink and 256kbps Uplink, at a contention ratio of not more than 10:1 and supported dynamic bandwidth management within a pool of bandwidth for all sites. There uncapped data usage solutions with a proper QOS (Quality Of Service) scheme with the ability to handle a mix of 'realtime' traffic such as voice or video at the same time as non-real-time traffic. Real-time monitoring of the Satellite Link was

essential to monitor and report alarms onto our ITSM system (service-Now). The NMS, (Network Management System) provided a graphical display of bandwidth usage at each site in real time. Occupational Health and Safety issues required that VSAT antennas should be installed at least 2.4 m above ground level. 220 Volt 50 Hz AC was the electrical current of the schools.

5.2.6 Content Management and curation

The Content component in the ICT4RED initiative consisted of the following:

- Digital forms of existing paper-based South African Learning and Teaching Support Material (LTSM), such as workbooks, textbooks, lesson plans, teacher notes, CAPS documents, focusing on numeracy, literacy, mathematics, science and English as a first additional language;
- New digital/multimedia content, consisting of educational apps, quizzes, tests, games, audio books, video material, interactive workbooks, interactive stories, music, animations, that were appropriate for the South African curriculum;
- Open Educational Resources (OERs).

The aim of this component was:

Content Sourcing, Mapping and Management

- Identification of organisations and individuals willing to collaborate by sharing, developing and/or digitising a wide variety of appropriate content, that is curriculum-aligned
- Sourcing, mapping, alignment, digitisation and quality assurance of appropriate Open Source and Proprietary Content
- Source or commission additional content to fill any 'gaps' in the content repository
- Develop a content strategy and identify appropriate content to be pre-loaded onto tablets for the different phases and/or form part of the content repository.



Photo 5-2: The silver box is where the server was placed in a secure, folding container which had to be placed in a secure and ventilated area in the school.

Teacher Support

- Design and collation of ‘digital teaching packs’ to support teachers in understanding the technology environment, integrating technology into their teaching, and creating a successful blended learning environment.



Photo 5-3: Teachers showing evidence of using their tablets after receiving training in their own classrooms

Documentation Design and Revision

- Design and develop digital Content standards for widespread use in Basic Education
- Contribute to the design of a larger technology rollout model to inform national and provincial policy and implementation.

One of the first priorities of the initial pilot is the provision of digital content (CAPS-aligned and Open Source/Content, where possible) with a focus on:

- Literacy and Numeracy in the Foundation Phase
- Mathematics and Science from Grades 4 to 12
- English (FAL) across all grades

In this ICT4RED initiative we were fortunate to have had free access to all McMillan and Pearson electronic books. Teachers and learners could access these to supplement their own textbooks or to get more examples of specific content.

Over 4000 additional items for subjects other than Maths and Science (including Life Sciences, Languages, Business related subjects, Life Orientation, NSC and ANA exams, etc.) are available on the school servers. The following is a list of the content which is available on all the servers of all 26 schools:

Table 5-2: Content available on all content servers for teachers and learners to download via the Wi-Fi at schools

Grade	Content on servers
R	Workbooks for Afrikaans, English, isiNdebele, isiXhosa, Sesotho, isiZulu, Sepedi, Setswana, SiSwati, Tshivenda, Xitsonga
1	Workbooks for all First Additional Language (FAL) and Home Language (HL) for Afrikaans, English, isiNdebele, isiXhosa, isiZulu and Life skills (all languages in column above). Examination papers for Afrikaans, English, isiNdebele, isiZulu and isiXhosa, Mathematics, numbers, relationships and operations and 2014 ANA guidelines. Interactive books for English FAL.
2	Workbooks for all First Additional Language (FAL) and Home Language (HL) for Afrikaans, English, isiNdebele, isiXhosa, isiZulu and Life skills (all languages in column above). Examination papers for Afrikaans, English, isiNdebele, isiZulu and isiXhosa, Mathematics, numbers, relationships and operations and Numeracy with 2014 ANA guidelines with some 2013 Memos and tests.
3	Workbooks for all First Additional Language (FAL) and Home Language (HL) for Afrikaans, English, isiNdebele, isiXhosa, isiZulu and Life skills (all languages in

Grade	Content on servers
	column above). Examination papers for Afrikaans, English, isiNdebele, isiZulu and isiXhosa, Mathematics, numbers, relationships and operations and Numeracy with 2014 ANA guidelines with some 2013 Memos and tests.
4	Workbooks for Afrikaans and English (FAL & HL), language construction and conventions as well as listening and speaking with 2013 examination papers with memos and 2014 ANA guidelines. The same for all other African languages. Mathematics, natural sciences and technology, social sciences (history) and life skills workbooks and examination papers.
5	Workbooks for Afrikaans and English (FAL & HL), language construction and conventions as well as listening and speaking with 2013 examination papers with memos and 2014 ANA guidelines. The same for all other African languages. Workbooks for mathematics, natural sciences and technology, social sciences (history and geography) and life skills and 2013 examination papers, memorandums and ANA 2014 guidelines.
6	Workbooks for Afrikaans and English (FAL & HL), language construction and conventions as well as listening and speaking with 2013 examination papers with memos and 2014 ANA guidelines. The same for all other African languages. Workbooks for mathematics, natural sciences and technology, social sciences (history and geography) and life orientation and examination papers with memorandums.
7	Workbooks for Afrikaans and English (FAL & HL), language construction and conventions as well as listening and speaking with 2013 examination papers with memos and 2014 ANA guidelines. The same for all other African languages. Workbooks for mathematics, natural sciences, technology, social sciences (history and geography), economic and management sciences and life orientation and examination papers with memorandums.
8	Workbooks for Afrikaans and English (FAL & HL), language construction and conventions as well as listening and speaking with 2013 examination papers with memos and 2014 ANA guidelines. The same for all other African languages. Workbooks for mathematics, natural sciences, technology, social sciences (history and geography), economic and management sciences and life orientation and examination papers with memorandums.
9	Workbooks for Afrikaans and English (FAL & HL), language construction and conventions as well as listening and speaking with 2013 examination papers with memos and 2014 ANA guidelines. The same for all other African languages. Workbooks for mathematics, natural sciences, technology, social sciences (history and geography), economic and management sciences and life orientation and examination papers with memorandums.
10	Additional material and books for Business studies, civil technology, English FAL, geography, life orientation, life sciences, mathematic literacy and mathematics, mechanical technology, physical sciences.
11	Additional material and books for Business studies, civil technology, English FAL, geography, life orientation, mathematic literacy and mathematics, mechanical technology, physical sciences.

Grade	Content on servers
12	Examination papers for Afrikaans (FAL & HL), Accounting, Agricultural management practices, agricultural sciences, agricultural technology, business studies, civil technology, computer applications technology, consumer studies, dance studies, design, dramatic arts, economics, electrical technology, engineering graphics and design, English (FAL & HL), geography, history, hospitality studies, information technology, isiNdebele, isiXhosa, isiZulu (FAL & HL), Life sciences, mathematical literacy and mathematics, mechanical technology, music, physical sciences, religion studies, Sepedi, Sesotho, Setswana, SiSwati, tourism, Tshivenda, visual arts, Xitsonga,

The following figure is an example of how the navigation worked on the content servers:



Photo 5-4: Teacher Professional Development, Phase 2

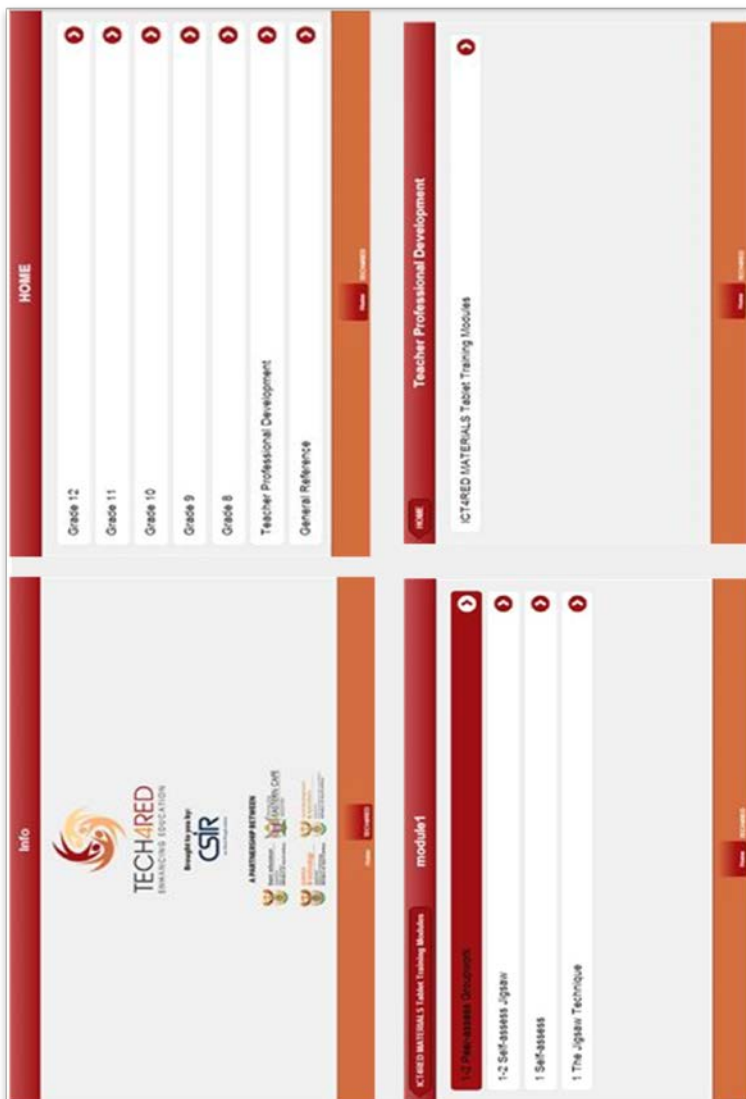


Figure 5-6: Navigation on the content server

In this ICT4RED initiative we were fortunate to have had free access to all McMillan and Pearson electronic books. Teachers and learners could

access these to supplement their own textbooks or to get more examples of specific content. The content covers Grade 4-12 and there is also a set of reading books from FundZA available for secondary schools.

The eLearning kiosk was a donation from CoZa Cares. It now mirrors the content on the school server and is accessible to learners, teachers and visitors via Wi-Fi and screen navigation. Content can be downloaded onto DVD, Flashdrive, tablets, smartphones and laptops. It works both online and offline. Here are some photos of it:



Photo 5-5: Photos of the e-learning toolbox at Arthur Mfebe school

Under the content management component a group of researchers from the University of Pretoria under the management of Dr Ronel Callaghan (Faculty of Education) were tasked to investigate which Android Application will be best suited to support the CAPS documents. In order to select these applications for all subject and for all grades, this group developed an Application evaluation software tool to address the specific requirements. Their research can be used to support many other teachers

who are searching for Application with the same purpose. It can even lead to the creation of a South African Education supporting App store.

5.2.7 School ICT

The objective of this component was to establish an 'Eco-system' in each school that was aligned to the objectives of the initiative and also offer the necessary scalability and flexibility that is expected from a 21st Century solution.

This component consisted of the design, implementation and management of the following:

- Mobile devices (tablets),
- School infrastructure that will be needed to support the mobile devices, such as local Wi-Fi networks, storage solutions, provision for charging and power, security and content servers.
- Software solutions and services

The main deliverables for this area were:

- **Electrical Supply:** Work with the different stakeholders to investigate and agree alternative energy solutions in collaboration with another initiative known as TECH4RED Energy working group. This TECH4RED was the bigger initiative under which ICT4RED was one component. For Data and Electrical Reticulation it was important to ensure that the electrical and data cabling needed plus all infrastructure to support it i.e. trunking, conduit, etc. is available at each school.

The following is a photo of the data and electrical reticulating and for charging the tablets:

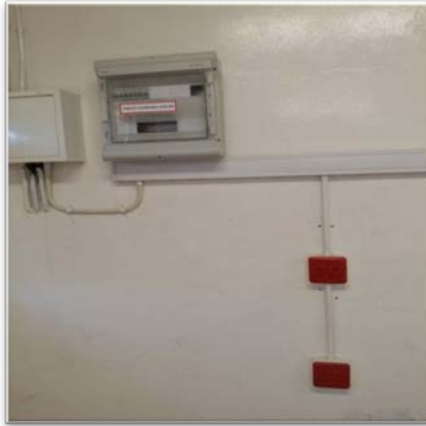


Photo 5-6: Data and electrical reticulating and for charging the tablets

- **Physical Security:** Making sure that all the equipment was stored securely when not in use. All the equipment had to be stored in secure enclosures and in the case of the tablets it had to be charged while stored.

The following is a photo of how each school was provided with a cage where equipment could be securely stored:



Photo 5-7: School security

The following charging station was a prototype of the ones that were provided to schools:



Photo 5-8: Charging Station

- **Tablets:** Establish a minimum specification for tablets to be supplied to the learners and teachers. Teachers got 10 inch and learners 7 inch Android tablets. Mobikits with 15 tablets in each were provided to each school if they show evidence of use and only after their teachers have completed the 1st four badges.

The following is a photo of the learner with their tablets:



Photo 5-9: Learners with their tablets

The following is a photo of the teachers using their tablets:



Photo 5-10: Teachers with their Tablets during a TPD session

The following is a photo of the Mobikits:



Photo 5-11: Mobikits

Photos of the Mobikits which were handed over to schools after their teachers have earned their tablets and have received training in using their tablets in their classrooms

- **Wi-Fi Zone:** Each of the schools has received a dual band (2.4Ghz and 5.8Ghz) Wi-Fi network that covered all the classrooms in the school and also supported the high density of end-user equipment linked to an initiative of this nature (as was discussed in Section 5.2 above)

The following photo shows the Wi-Fi equipment on the roof of one school:



Photo 5-12: Wi-Fi equipment

- ***Email and Calendaring:*** Enable every user (Teachers and Learners) to have each their own email address. The email and calendaring must be available outside the school infrastructure.

To make decisions on all the above each school established their own ICT Committee and the decision of who should be elected to serve on this committee resided with each individual school.

Purpose of ICT committee at the schools was to make decisions about the following:

- Drawing up of the schools ICT policy;
- Identify learner champion to serve on committee;
- Monitor the use, safety and security of tablets;
- Check if tablets are functioning well and batteries are fully charged;
- Check tablet content is relevant;
- Organise training workshops with staff members and coordinators;
- Help those that are behind in training;
- Complete tasks given by facilitator;
- Make sure tablets are moved from store room to the classrooms;
- Check equipment safety and that tablets are stored correctly;
- A record of all faults with tablets or initiatives is kept;
- Community awareness campaign-parents should know about this

initiative so they are not surprised when they will be bringing tablets home in future and help safe guard them;

- Make sure all tablets are allocated to teachers using an IMEI to track usage.

The ICT committees performed a variety of important tasks that was important for integrating the technology sustainably into the participating schools. It was important to continue to monitor the functionality of the School ICT committees, as the planned change management processes implemented as part of the initiative comes to an end.

It was also realised that each school will have to have an ICT champion to assist teachers with tablets bookings and charging as well as overall ICT maintenance and support (as was already indicated above under Operations management). This where the NARYSEC youth group were used to support teachers with the ICT maintenance and support functions.

The aim is to develop a process for sharing information between stakeholders inside the initiative. This includes an ICT4RED website and a social media strategy. Social media accounts and branding for the initiative were also undertaken. Section 8 provides an overview of how the Twitter and WhatApp social media platforms were used to support the management of the ICT4RED initiative.

5.3 Summary

This section provided the overview of the detail and depth which was covered under the components of initiative management, operational management as well as School ICT. It underlines the importance of coordination, support and maintenance and the role of the principals, ICT committee and district to provide the devices, maintain it and support the teachers in their training (TPD).

Careful planning and execution of various processes are necessary to make the deployment of tablets to schools a reality. Even after these were deployed they have to be monitored, loaded, stored and decisions have to be made about when to use the tablets for which subjects and for which grades on a daily basis. The role of the ICT champion at each school cannot be under estimated as well as the role of the ICT Committee. All of these decisions can also not be realised if the principal is not 100% committed to

support and manage the integration of technology into his/her school. For this purpose it was necessary to also focus on change management in this school district and also to involve the district officials.

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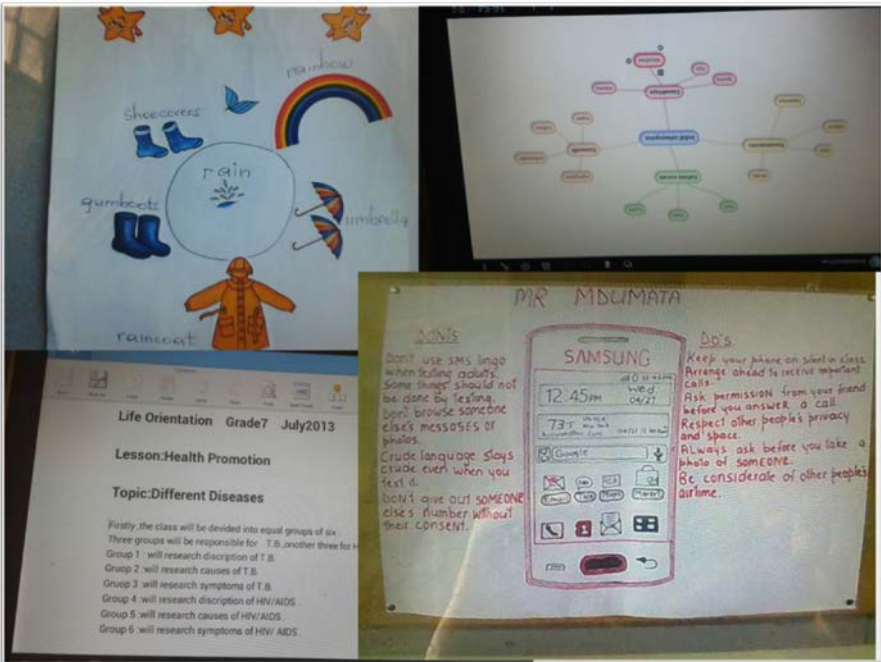


Photo 5-13: Some evidence for badges collected during Phase 2.

List of contributors

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Community Engagement	Merryl Ford
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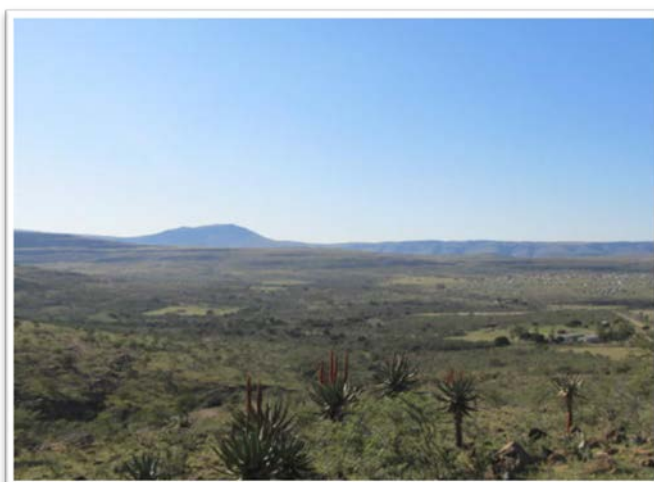


Photo 9-2: Bangilizwe Junior Secondary School

This book was
PEER
reviewed
by experts
in the field of
ICT4D,
Mobile
learning
a n d
ICT
in Education



ICT4RED

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