

Introduction

Information and communication technologies (ICTs) are the defining feature of the 21st century. In today's knowledge economy and information society, ICT capabilities are a core skill. Consequently, ICTs are a ubiquitous feature in national education policies, and education institutions at all levels have been supplied with ICT facilities (e.g. desktop computers). However, the focus of ICTs in education has increasingly moved from a mere supply of equipment and teaching of ICT

capabilities to the question of how ICTs can support and transform the practice of teaching and learning itself.

Realising these structural challenges, the Information and Communication for Rural Education (ICT4RED) initiative was designed by the Department of Science and Technology (DST), the Department of Rural Development and Land Reform, the Department of Basic Education, the Eastern Cape Provincial Department of Education (ECDoE), and the Council for Scientific and Industrial

Research (CSIR) to test the extent to which ICTs can improve the quality of teaching and learning in rural environments. From 2012 to 2015 the DST collected evidence, knowledge, and learning through ICT4RED to inform and influence follow-on work after the previous White Paper on e-Education, which was published by the Department of Education in 2004, and aimed to transform learning and teaching through ICTs. The ICT4RED initiative had the explicit objective of designing and implementing a scalable ICT solution to

support teachers and the district in a resource-constrained rural environment. An aspect of the project focused on the understanding of the *sustainability of a project*, given the lack of resources at schools and in the ECDoE. The concern was the difference in access to resources: the project team had ample resources for deployment over the duration of the project, especially human resources (technical skills, educational expertise and management resources). These were focused and fully committed to successful delivery, in contrast to the scarce and diluted resources of the local environment that needs to sustain the project in the long run.

Practitioners that implement ICT-based interventions in South African schools find that only around 2% of the participating schools reach the desired status of sustained adoption and the resultant benefits. This represents a significant waste of scarce resources. A key consideration is the narrow focus of an intervention; schools have the fewest resources, but are targeted instead of the education system the school is part of. This system allocates and manages the resource distribution to schools, and

its capability and resource levels have to be improved over time to support the change introduced by an intervention.

In ICT in education, the concept of e-readiness is often used to describe the sustainability concern presented above. E-readiness has been designed as a statistical measure composed of a quantifiable set of indicators and summarised as a broad set of characteristics that defines an organisation, society, and country's e-readiness. The higher the e-readiness index, the better the preparedness for ICT adoption.

The key consideration is to define the scope of the system that is being targeted by an intervention. If the focus of the intervention is at country level, the country can be considered as being able to use ICT effectively to achieve objectives. The World Bank has referred to country-level e-readiness in terms of ICT infrastructure, accessibility of ICTs to society as a whole, and legal and regulatory frameworks (Naidoo and Klopper, 2005).

If the focus of the deployment and usage of ICTs is, for example, a school, then short- and long-term support for all of the aspects that are required to achieve the objectives of the deployment (from infrastructure to well-trained teachers) is provided by a system that includes the school, the parents, and the provincial and national education institutions. Each system in this set of systems has different levels of readiness, and the weakest link will determine the readiness of the system for the deployment of a particular type of initiative. Readiness is therefore a combination of the properties (readiness) of the system and the particular requirements of an initiative.

E-readiness has to be assessed for the system(s) that are relevant to an initiative's design. When assessing a school's readiness for an initiative, the focus must be on developing pointers to systemic weaknesses; these will in turn guide the assessment of the rest of the system. This document draws on the knowledge gained during the ICT4RED project to inform policy considerations.

Legislative context

South Africa has been a pioneer policy maker in the introduction of ICTs in the national education system.

The goal of South Africa's 2004 White Paper on e-Education was for every learner in the country to be ICT capable by 2013, and for teachers to use ICT to enhance teaching and learning (Ford and Botha 2010).

One of the key priorities in the new development strategy for South Africa, the National Development Plan (Vision 2030) (NDP), is "improving the quality of education, skills development, and innovation" (NDP 2012:16). The role of ICTs in rural education is not described in detail as an enabler of teaching and learning. A call is made for sufficient support for schools, which would presumably include ICT support. The strengthening of the accountability chain from top to bottom is considered a prerequisite for improving education outcomes, emphasising the importance of improved management of the system as a whole.

A supportive policy environment and vibrant technological innovations have not always translated into meaningful access to and use of ICTs in all South African schools. The government budget for basic education already represents a high percentage of the overall budget, and there is little room to increase expenditure. The dominant cost component is teacher salaries. Therefore, infrastructural challenges and a basic lack of resources (e.g. finances, human capital and ICT support capability) in rural education in particular have compromised the nation-wide application of ICTs in education.

ICT for Rural Education and Development (ICT4RED)

ICT4RED was piloted in the Cofimvaba school district in the Eastern Cape between 2012 and 2015. Participating schools received supporting technological infrastructure such as WiFi equipment, safe-keeping and charging facilities, and IT support. Towards the completion of the project in March 2015, a design science research methodology was applied to develop an ICT4RED evidence-based implementation

framework, which included consideration of how to design for long-term sustainability. ECDoE provincial and district officials were engaged to develop budgets using a decision-support tool, and to discover how change happened. The development of the framework involved three qualitative case studies to synthesise the key learnings of the ICT4RED initiative. Data were collected over a three-year period using both quantitative and qualitative research methods.

Lessons learnt

A number of key insights stand out from a rich and diverse data set:

- ICT application in rural education needs to be teacher-centered and teacher-driven.
- The supply of ICTs requires professional development for teachers for the effective uptake of the technology.
- Design for the sustainability and e-readiness of the system is essential. A modular implementation framework, combined with a readiness assessment and modelling tools, such as a total cost-of-ownership model, can facilitate

decision-making that is designed to fit the available resources in the education system, thus enabling sustainable and cost-effective rural education initiatives.

Each insight is discussed in more detail below.

Teachers first!

Teachers' early involvement in the design and implementation of ICT4RED was pivotal. Teachers needed to build confidence in using ICTs, which then supported their enthusiasm for the use of technology and their sense of ownership of the programme. In order to design pedagogically innovative class lessons using ICTs as a support tool, teachers require a deep understanding of the pedagogical tools as well as how to apply ICTs to support these tools. Consequently, professional development courses for teachers are an ideal platform to introduce educators to ICTs.

Education-focused vs technology-focused approaches

ICT4RED tailored the applied technology to the specific educational needs of the target schools. That is, the initiative assumed technology to be a tool in support of a larger educational endeavour. Only once the educational needs had been identified and appropriate pedagogical approaches decided on, was the relevant ICT – tablets, in this case – introduced. This ensured that educators did not perceive ICTs as isolated items, but realised the pedagogical potential of the technology to guide and support their teaching.

Design for sustainability and e-readiness of the system

ICTs for education are costly, and should be considered for use in the whole system for e-readiness owing to the many dependencies between appropriate teacher professional development, e-learning, infrastructure, ICT support resources, and overall management capability. ICT4RED adopted a total cost-of-ownership tool as a holistic method to guide decision-making in allocating investment and resources among the crucial components required for success.

Providing costly ICT equipment to schools can yield a sufficient return on investment only if the education system has sufficient resources for equipment maintenance and replacement. The system needs to have the organisational capacity and coordination to manage, support, and maintain the various elements of an intervention.

ICT4RED – A systems learning experience

The ICT4RED initiative successfully proved the feasibility of designing and implementing an advanced ICT solution in a resource-constrained environment in South Africa. The potential for adoption was demonstrated. The concept of sustainability was used to develop a view on what constitutes e-readiness of the system.

Provision needs to be made for new responsibilities for district officials and principals (along the whole command chain), as well as additional training and resources, so that they can manage and support teaching with technology as part of their daily tasks. The structures and implementation processes of the

provincial head office must be designed for the introduction and ongoing operations of cross-cutting initiatives such as ICT in education.

Support from the Department of Basic Education in terms of policy and budget allocation decision-making processes, together with the relevant provincial department to balance investment and resources, are among the crucial components required for success. Training on teaching with technology, content, management, ICT support, maintenance and replacement, and infrastructure are vital.

The successful integration of technology into schools has the potential to transform schools and the education system as a whole. Change will be sustained if the capacity of the education system to adopt and sustain change (i.e. the state of e-readiness) is understood and planned for, and if the intervention is absorbed into the strategic planning of the provincial and national education system.

Policy implications

The learning from ICT4RED informs the following generally addressed ICT4E policy topics:

Strategic considerations

Systemic support systems, guided by policies, are required to realise the potential for adoption of teaching with technology. Policy development at national and provincial level should not treat ICT in education as an addition to existing policies, but as an opportunity to enable e-readiness by integrating teaching with ICTs into all aspects of the educational policy framework.

Institutional considerations

Financial oversight by entities such as the National Treasury and relevant provincial treasuries should be designed to support systemic and sustainable changes to the education system. Policy should support of organisational mechanisms and processes that enable integration to facilitate the introduction of ICTs. Restructuring initiatives should consider the impact on the workload and hence the delivery capacity of district

officials, subject advisors and support structures.

Teaching

Curricula should be developed with the aim of ICT-enabled teaching and learning, and assessment approaches should be reformed to benefit from ICT-enablement. ICT-enabled teaching should form a key part of teacher professional development.

Technology

Financial budgeting and expenditure processes at provincial education level should be designed for the screening, introduction, and ongoing operational support of ICTs in education. Policy on asset management should take into account the requirement for a central resource allocation for asset maintenance, upgrades, and replacement.

Learning

Monitoring and evaluation policy should support a shift from measuring inputs and outputs to continuous learning and the improvement of initiatives in their specific context, so as to ensure sustained benefit.

Societal considerations

Traditional authorities in rural South Africa play an important role in terms of inclusion and safety of schools. Policy should aim to strengthen the capacity of school governing bodies to influence the active involvement of relevant players in creating a supportive environment for ICTs in schools.

Recommendations

The above policy implications take a systemic view on the integration of ICTs into the schooling system.

This should be informed by a rigorous decision-support process that will guide decision makers on the readiness of the school and the education system to adopt ICT interventions. It is pointless to design and deploy ICT-enabled

interventions that do not fit school readiness levels.

Integrating mobile technology into a resource-constrained environment to support teaching and learning has to be done by focusing on empowering teachers through professional development training courses before the technology is deployed.

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