NATIONAL EDUCATION COLLABORATION TRUST

THE STATUS OF ICT IN EDUCATION IN SOUTH AFRICA

AND THE WAY FORWARD

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Acknowledgements

CONTENTS

ABBREVIATIONS

3M	micro, meso, macro
BYOD	bring your own device
CSIR	Council for Scientific and Industrial Research
DBE	Department of Basic Education
ICT	information and communications technology (refers to hardware and connectivity)
ICT4E	ICT for Education
ICT4RED	ICT for Rural Education Development
ICT-CFT	ICT Competency Framework for Teachers
NECT	National Education Collaboration Trust
NGO	non-governmental organisation
NIMB	Notions of learning, ICT in Education, Model for learning design, and Bloom's modified taxonomy framework
PED	provincial education department
SA-SAMS	South African School Administration and Management System
TPD	teacher professional development
UNESCO	United Nations Educational, Scientific and Cultural Organisation

FOREWORD

The National Education Collaboration Trust (NECT) is based on the principle that collaboration and focused effort by important role players increases the power of the nation to secure the changes that are urgently required to deliver good education to all children.

This project was initiated by the NECT to define the most effective approach to leveraging ICTs so as to improve learner outcomes and overcome some challenges that are known to exist in Basic Education. These challenges are identified in the DBE's Action Plan, the National Development Plan, and the White Paper on e-Education of 2004, and include:

- Identifying which teachers are in need of pedagogic assistance;
- Assessing educational outcomes objectively and on time;
- Giving teachers and learners new, 21st-century skills;
- Giving access to online communities of practice, and online content;
- Making learning more learner-focused, fresh, novel, and fun;
- Enabling self-learning and discovery;
- Promoting critical thinking and exposure to new ideas;
- Reducing administrative burdens, e.g. marking tests, reporting absences.

A study that examined at least 22 existing initiatives distilled the common wisdom and lessons learnt from those initiatives, as well as the findings of over 50 local and international studies. The study culminated in a number of recommendations, focusing on a value chain of 14 elements, to improve the impact of ICT in Education.

Concurrently, similar work has been done in other initiatives to examine similar questions. This report is intended to reflect on work done across a number of studies, including the NECT study referred to above, and to use the learning to define the status of ICT in Education in South Africa. It outlines the role of ICT in Education, reflects on best practice as well as on the current local status of ICT in Education, and then proceeds to define a desired status, as well as *pathways to progress* and *appropriate practice*. The latter two aspects were partly informed by the opinions of local practitioners in the field. This reflection on the status is intended to provide policy makers and practitioners with *a baseline from which to influence the state of practice* in the long run.

The NECT thanks everybody who shared their knowledge and experience in order to make this report possible, and particularly the DBE for its ongoing involvement and support.

Godwin Khosa

CEO
National Education Collaboration Trust
23 August 2016

EXECUTIVE SUMMARY

This document reflects on the status of information and communication technology (ICT) in education in South Africa, with the purpose of providing a baseline from which changes can be initiated, and progress measured. It integrates work done in a previous NECT study on existing e-Education initiatives (Ostrowick, 2016), work done by SAIDE to reflect on ICT in Education (Amory *et al*, 2015) and work done by the Council for Scientific and Industrial Research (CSIR) to inform provincial strategies for ICT in Education (Marais *et al*, 2016).

The key message of the report is as follows:

The role of technology in Education

ICT is relevant within education as a means of supporting a process of teaching and learning, and is best employed in support of a value creation process. It is not a focus in itself. In addition, technology has a separate and distinct role in enabling the business and administration of education.

Best practice and critical success factors

International best practice is to use technology as an enabler of the education process. Pedagogy and the role of the teacher are central. Critical success factors include that solutions must be tailored to the readiness of schools to adopt technology (there is no 'one-size-fits-all'), and must be designed with cognisance of resource constraints, and requirements for successful handover. A holistic view is essential, and must incorporate multiple dimensions in creating solutions, include multiple role players, and cater to multiple levels within the education system. Merely providing computer hardware and software is guaranteed to fail.

The current status

While strategy and policy exists, implementation is slow and capacity is limited. Objectives are not clear, and a strategy that is integrated across the system is lacking. Access to technology is limited and unequal across provinces and quintiles. In the absence of clear, integrative provincial strategies, progress is fragmented and driven by solution providers. Solutions are not cognisant of resource constraints. Significant room for improvement exists on seven different dimensions of the education system. System-wide change management needs to be prioritised, and ICT-enabled assessment needs consideration.

Pathways to progress

For long-term sustainability, the capacity of the education system to integrate ICTs in support of education needs to be developed. The focus should shift from learner performance to capacity development. A phased approach, with appropriate interim targets, needs to be taken. Progress should be measured against multiple criteria, and the focus should be on measuring the capacity of the system to integrate technology, and the capacity of teachers to incorporate technology into the process of teaching and learning. The following initiatives are key to making progress: ensuring strategic alignment for ICT integration at all levels of the education system; increasing the focus on pedagogy in

ICT initiatives; developing the skills, confidence and desire of teachers to integrate ICTs into teaching and learning; and focusing on sustainable interventions: moving from pilots to integrated solutions.

1   INTRODUCTION

The introduction of information and communications technology (ICT) in South African Education has been undertaken by various role players, often in a fragmented manner. The organisations involved in these initiatives range from non-governmental organisations (NGOs) and solution providers to research institutions, and provincial and national Departments of Education. While the Departments of Education mostly are (or should be) the long-term custodians of such efforts, a clear integrative strategic direction is often lacking. The recent Operation Phakisa initiative developed a national vision for ICT in Education, and defined six pillars around which this vision will be executed. The initiative is in its planning stages, and impact and execution still need to follow. This dual bottom-up and top-down approach, combined with the involvement of multiple role players and diverse objectives, leads to varying performance of the role of ICTs in Education.

The purpose of this document is to describe the current ***status of ICT in Education in South Africa***, with the aim of providing a baseline from which future activities could be influenced. To this end, three sources of information were integrated, namely:

1. ***A study of Existing e-Education initiatives (Ostrowick, 2016)***

   An NECT report aimed at providing a model to integrate ICTs into content delivery, pedagogy, and infrastructure, based on research to assess the solutions that are available in the country and elsewhere.

2. ***Rapid research on the use of ICT in Education (Amory et al, 2015)***

   Desktop research to enhance understanding of the role of ICT in Education, in support of Operation Phakisa.

3. ***Research by the CSIR***

   Research, reported in various documents, on the rollout of e-Education initiatives in the Eastern Cape and elsewhere, and reflections on current strategic approaches in Information and Communication Technology for Education (ICT4E) in South Africa.

In combination, the above research provides recent insights into the use of ICT in Education. It has a local as well as international perspective, and is rooted in theory as well as practice. As such, it was considered a valid basis from which to define the status of ICT in Education in South Africa. Where relevant, the report is informed by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) ICT Competency Framework for Teachers (ICT-CFT) (UNESCO, 2011).

This document reflects an integration of the above sources, augmented with interviews with local practitioners, where necessary. It is structured as follows: section 2 defines the role of technology in teaching, as a basis from which to position the objectives of ICT initiatives in this field. Section 3 reflects on current (local and international) best practice, and section 4 gives an indication of how current practice in South Africa is perceived. Section 5 outlines a 'pathway to progress', by suggesting feasible and relevant goals for ICT in Education in South Africa, as well as by indicating what initiatives, activities, and focus areas should start, stop, and continue, in order to attain these objectives

2 THE ROLE OF TECHNOLOGY IN EDUCATION

2.1 What is the role of technology in teaching and learning?

Overview

Technology for the sake of technology is unlikely to have any lasting impact on education. Various researchers advocate that technology needs to support an educational process in order to have the desired effect and not to detract from, or have an adverse effect on, educational outcomes. Reflection on the appropriate role of technology in teaching is therefore necessary, since it is instrumental in defining a clear objective, and, as such, in guiding both strategy at the macro level and tactics and implementation at the micro level.

Numerous models of teaching and learning exist, each describing different interpretations of how learners familiarise themselves with, adopt, and utilise new knowledge and skills. In essence, each of these describes a progression from familiarisation with new knowledge to competence in the use and application thereof.

Other models that outline the role that technology should play in the process of learning are listed below. These include Blooms taxonomy, as well as three technology-focused models, (see Table 1).

Model	Focus	Elements or dimensions
Bloom's taxonomy	Classify educational objectives Structure curricular activities	A progression from recalling facts to producing new and original work
TPACK framework	Emphasises key knowledge elements required for teaching with technology	Technological, pedagogical, and content knowledge, and overlaps between these
NIMB framework[1]	Describes the ways in which ICTs can be used in teaching and learning, based on integration of a number of models	The effect of notions of learning, ICT in Education, and models of learning design on the progression of learning as described by Bloom's taxonomy
UNESCO framework	Outlines the various dimensions of ICT competencies that a teacher needs to develop in order to teach with technology	Describes a teacher's development in terms of the ability to improve technology literacy, create knowledge, and deepen knowledge

[1] Notions of learning, ICT in Education, Model for learning design, and Bloom's modified taxonomy framework

Table 1 Models of integration of ICTs into teaching and learning

The key similarity in these models is that all describe a progression of teaching and learning. See, for example, the progression described by Bloom's taxonomy:

| remember | understand | apply | evaluate | create |

Figure 1   A progression of learning

The focus is then to identify and describe how ICTs are used in support of this progression of learning.

Implication

The key message from these models is therefore that ***ICT is relevant within education as a means of supporting a progression of learning***, and is best employed ***in support of a value creation process*** in teaching and learning. A random provision of access to ICTs within the classroom will not necessarily make a difference, and the aim of ***ICT in support of teaching and learning*** needs to be clearly defined.

For example, providing electronic access to learning material (e.g., through tablets that can source data from a local server) is as good as providing a textbook. However, in the absence of a teacher that takes learners through a process from remembering facts to using facts to create new knowledge, such a technological intervention would mostly deliver limited results.

Effective integration of technology into teaching and learning therefore means the utilisation of the appropriate technological tools at appropriate places in the learning progression to enhance a process that creates value in the learner's education, such as remembering, understanding, applying, evaluating, and creating (or any other process of learning that is relevant to the context).

Furthermore, this has ***implications for the way in which progress*** with the use of ICTs ***is*** defined and ***measured***. In each instance where technology is deployed, it is important that the objective is specifically defined relative to the role of technology in the educational process. For example, if a technology solution is aimed at providing access to teaching material, the use of material should be considered an indicator of success. Where the solution is aimed at enhancing the teacher's ability to integrate technology into problem solving, success can be determined by the extent to which technology is used in a lesson plan aimed at problem solving. The roll-out of technology per se does not necessarily lead to improved learner outcomes (Amory *et* al, 2015), and distracts from the focus of developing the systemic capacity to teach with technology.

2.2   What is the role of technology in education management?

Some perspectives

In addition to supporting the model of teaching and learning, ICT plays a role in support of the operation of the education system. This role is mostly transactional, and is aimed at enabling the education system to function effectively.

Examples of the application of ICT in this regard includes:

- Collecting management information such as learner records, teacher records, test results, etc.
- Automating management activities, e.g. preparing financial statements, developing school timetables, calculating and paying teachers' salaries.
- Reporting management information at various levels of the system i.e. the school headmaster, the district, the provincial department and the national department.

Implication

In addition to supporting teaching and learning, ICTs play a role in augmenting the business of delivering education (i.e., the transactions associated with enabling teaching and learning). This role needs to be recognised and ***planned for separately and explicitly***, and the ***implications for goal setting and progress measurement need to be clear*** and not confused with progress related to support for a model of teaching and learning.

3   BEST PRACTICE and CRITICAL SUCCESS FACTORS

3.1   Coordinating different levels of the system for success

The educational system functions at various levels, and drivers for the integration and uptake of ICTs are seated across all these levels. In addition to the formal education system, role players include external organisations, such as NGOs and solution providers, who are involved through the execution of projects or programs parallel to, and in some case integrated with, the education system.

This systems perspective is outlined in Figure 2 below, as developed for the ICT for Rural Education Development (ICT4RED) strategic analysis of provincial ICT integration (Marais *et al*, 2016). It provides a basis from which the system can be assessed from a macro, meso, and micro perspective (i.e., the 3M approach as outlined by Amory, 2015), as well as a means of recognising and defining best practice at the various levels.
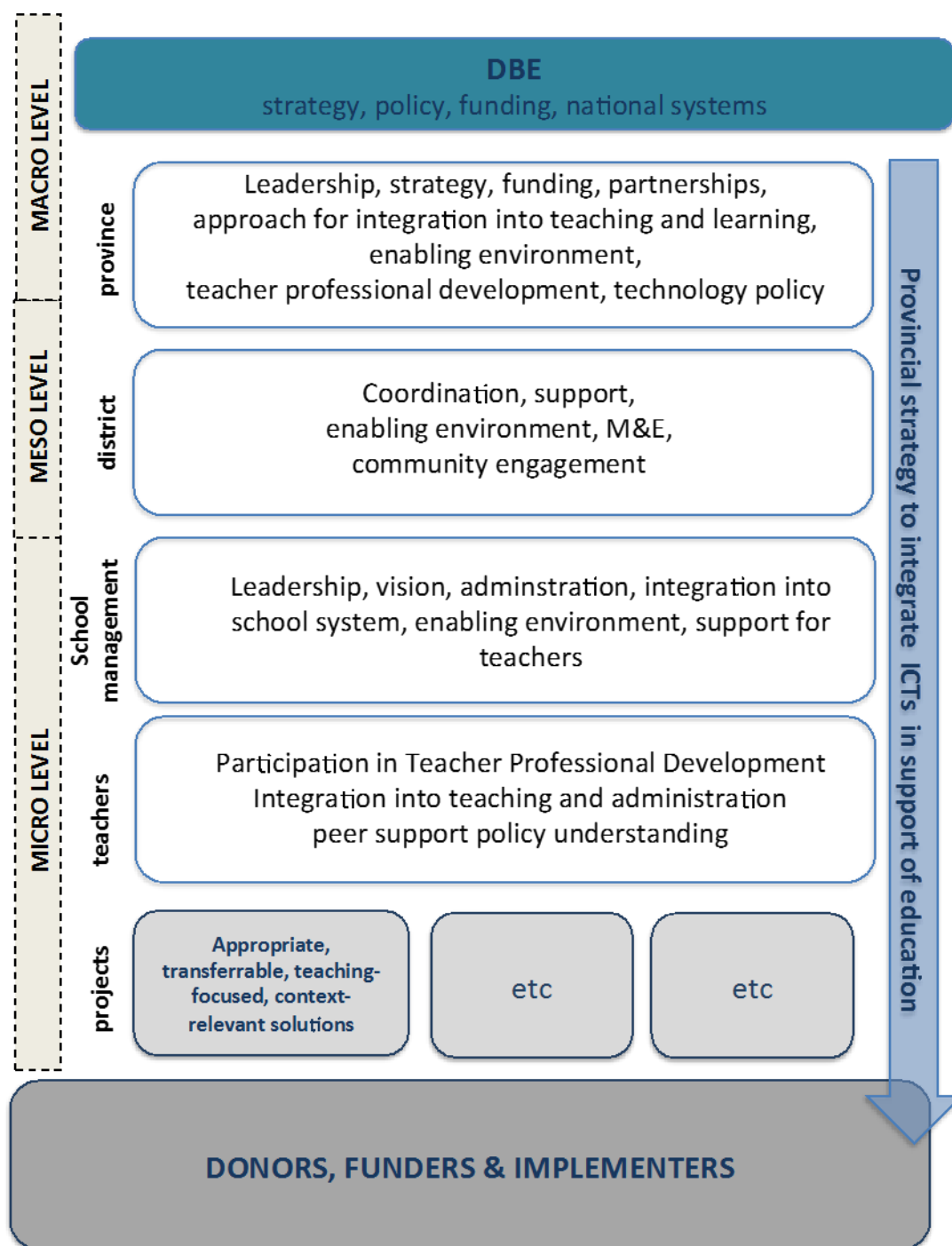
Figure 2   *Systems view on role players in ICT for Education, and their areas of focus*

This representation also provides the opportunity to reflect on whether activities are taking place at appropriate places in the system, and whether the goals are aligned and constraints are addressed. Also, it provides a framework against which to assess whether the varying levels are introducing constraints at other levels, or whether the levels are supporting each other by creating the appropriate enabling environment.

Based on two of the resource reports of this project (Amory, 2015 and Ostrowick, 2016), we identified current best practice and critical success factors at the various levels of the system. We consider **best practice (⌘)** for the purposes of this report as practices that have been

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identified as the most effective, based on extensive research and multiple studies. These were identified from the literature (i.e., from studies that concluded how and where success was best facilitated), as well as from local projects. Studies mostly included international cases (Amory, 2015 and Ostrowick, 2016).

In addition, we consider **critical success factors (☞)** as those aspects that practitioners have identified as critical to the success of a specific ICT implementation. They were identified from learning that has taken place across a number of projects, where participants learnt what worked and what did not. While there has not been sufficient research to generalise these success factors, it is nevertheless worth considering them in new implementations. These were mostly identified from local studies (Ostrowick, 2016).

Both best practice and critical success factors were identified across the various levels of the systems diagram, within their logical scope of influence.

The summary below integrates and extracts the key factors from these two sources (not referenced separately). More detail is available in the two reports.

MACRO LEVEL: provide leadership and facilitate integration

ICT integration: clear vision, strategy, and policy

Department of Basic Education

⌘ ICT integration in schools is successful when teacher professional development (TPD), ICT competence, developmental educational beliefs, and ICT vision and policy are in place in a school, and is unsuccessful when these factors are absent.[2]

Strategy for teacher professional development

⌘ TPD should be seen as a continuum from initial/pre-service training to continuous in-service training, and should be conceptualised as ongoing.[3]

Province

Strategy for ICT integration
⌘ Provinces with integrated strategies, or that are working towards integrated strategies, are the front-runners.
⌘ Provinces that are more successful understand not to use a one-size-fits-all strategy, but that are cognisant of variations in the ICT readiness of schools.
☞ Ownership of any ICT initiative by provincial leadership is critical for long-term success.
☞ Ongoing change management, across the organisational system, is critical for sustained uptake of ICTs in education.

Objectives

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[2] From a study of 53 Flemish schools (Amory, 2015)
[3] From HSRC policy dialogue workshop, 2014 (Amory, 2015)

⌘ The rollout of technology and associated resources in schools does not necessarily lead to improved teaching and learning outcomes.[4]

⌘ ICT has become an important aspect of teaching and learning in primary schools across the world, because of its potential to *improve the quality of learning*.[5]

Management and administration

⌘ Leadership and organisational culture are central to an effective ICT implementation plan, and management perceptions of ICT are a key determinant of the extent of adoption and integration into teaching and learning.[6]

Accountability

⌘ Projects that work best are those where there is clear accountability and frequent reporting of performance against targets.

Affordability

☞ The total cost of ownership approaches needs to be taken into account when budgeting for ICT solutions; once–off costing of current requirements inhibits sustainability.

☞ The hidden and long-term costs associated with donated technology need to be understood and budgeted for.

Defining the approach to ICT and pedagogy[7]

⌘ Technology is used in support of education, not as a primary tool by means of which to educate.

⌘ International practice predominantly uses ICT in support of participatory approaches as a means of learning.

⌘ ICTs are used to foster thinking skills; objectives range from remembering to knowledge creation; technology is used as a cognitive tool in this process.

⌘ The most commonly used international models are aligned with learning designs that support interactive and conversational approaches (i.e. teachers are central to learning, and students play an active role).

⌘ Drill-and-practice ICT tools support memorisation of information and development of skills.

⌘ ICT that is used to mediate learning fosters the higher order skills that are required for creativity.

☞ Templates should be provided to help teachers organise the use and development of cognitive ICT tools.

Strategy for teacher professional development

⌘ The development of attitudes, skill, and knowledge (both technical and pedagogical) of pre- and in-service teachers is a prerequisite for successful use of technology in the classroom.

⌘ The use of technology literacy programs can support the development of technical skills.

⌘ Scaffolded TPD opportunities should be provided to help teachers organise their use and development of cognitive ICT tools.

⌘ An appropriate technology integration framework should include technology skill development and pedagogical use of technology.

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[4] Various authors (Amory, 2015:13)

[5] Vanderline, Aesert & BRaak, 2015 (Quoted by Amory, 2015:25)

[6] Various studies, quoted by Amory (2015:8)

[7] The best practices listed here are derived from the NIMB framework developed by Amory (Amory, 2015:25)

⌘ Successful TPD initiatives that improved the use of ICT in teaching included: sessions of online collaborative group work, 12-week collaborative enquiry-based learning practices, and time spent on professional development activities.[8]

Technology

⌘ Higher learning gains are not necessarily dependent on lower student-to-device ratios; the key is professional development.

⌘ The balance of focus needs to be on TPD, not on technology.

☏ Complete solutions need to be designed; do not deliver end-user devices only.

☏ User-friendly, low-maintenance designs are important.

☏ Choices of technology need to be affordable and easy to access.

☏ Internet access is important in realising the full potential of ICT use in teaching and learning.

☏ Optimise the use of existing telecommunications infrastructure before investing in new infrastructure.

☏ Stable electricity supply is imperative.

☏ Almost zero-bandwidth solutions are needed in some rural areas.

Maintenance and technical support

☏ Solutions for ongoing maintenance and user support are critical, especially in rural areas.

Content

☏ Due to high bandwidth demand and high costs, video content and other bandwidth-intensive solutions are not necessarily appropriate to solutions in rural South Africa.

☏ Negotiate zero-rating of educational content with mobile service providers.

MESO LEVEL: create an enabling environment

District

Creating an enabling environment

⌘ A virtual community where teachers can share their successes provides good support.

☏ Ongoing capacity to support ICT initiatives in the district is critical.

☏ Ongoing support for teacher training initiatives is necessary.

☏ Community engagement is necessary.

MICRO LEVEL: create an enabling environment, learn and apply, design for the context

School management

Establish a vision and show leadership

⌘ School-related policies, such as an ICT plan, ICT support, and ICT training, have a significant effect on class use of ICT.

⌘ School leadership is the single most important factor determining whether ICT integration is successful.

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[8] Various authors, quoted by Amory (2015:27)

Ensure that it works

⌘ A well-funded, well-managed, and supported school ICT environment is the foundation needed to support teaching and learning with technology.

☾ On-site support is critical, for user advice as well as for technical issues.

☾ Security is critical.

☾ Provide for time for repetitive training of teachers, to ensure continuity.

Professional development

Teachers

⌘ Teachers need to learn technology integration strategies and must learn to support their students.

⌘ Teachers also need to understand the role of ICT in Education policy, curriculum, and assessment, and organisation and administration.

⌘ Models that incentivise teachers (e.g., through 'earn as you learn') work well.

☾ Teachers need to learn in a safe environment.

Collaboration

⌘ Sharing among teachers allows teachers to take ownership of technology and develop confidence.

⌘ Support from more knowledgeable colleagues and leaders is helpful.

Teachers and pedagogy

⌘ Successful practice based on participatory approaches supports outcomes that range from remembering facts to creating new knowledge with technology.

☾ Understanding the alignment between classroom activities and standards is vital.

Projects

Sustainability, affordability, and transfer

⌘ Projects that work best are those where there is sufficient accountability and reporting.

☾ Project goals need to be clear.

☾ An exit strategy is critical for every project: lines of accountability, roles, reporting, and transfer from the project stage to the 'business as usual' stage need to be clear. The intervention needs to be designed for sustainability, and the prerequisites for transfer need to be clear. In the 'business as usual' stage, a number of aspects need to be handled differently (including governance, reporting, and measurement.

☾ Community engagement is necessary and limits crime.

☾ Low-cost solutions that can be sustained by the relevant department are critical.

Project focus

⌘ Solutions with a focus on teacher development, not technology, are successful.

☾ A holistic, modular, customised solution that is adaptable and has the potential to work in various contexts is the most effective.

INTEGRATION ACROSS LEVELS: ensure alignment

☞ Management at the national and provincial (macro), district (meso), and school (micro) levels is required to maximise the use of ICT in line with national and local policies.

3.2 Summary

Critical success factors and best practice are outlined here for different levels of the system. Different role players need to coordinate and integrate actions to ensure the provincial- and nation-wide success of the system. The key best practices and critical success factors can be summarised as follows:

MACRO	***National and provincial*** ***Provide leadership and facilitate integration*** Leadership, vision, clear objectives, accountability, a strategy for ICT integration in support of pedagogy, a strategy for integrated teacher development, policy to ensure technology and content choices that are relevant to the context, enablement of other levels
MESO	***Province and district*** ***Create an enabling environment*** Capacity for support and enablement (teachers, technology, operations); community engagement; facilitate communities of practice
MICRO	***School management, teachers, projects*** ***Create an enabling environment, learn and apply, integrate with the context*** Create an enabling environment (systems, practices, scope for training); participate in appropriate professional development; learn from each other; develop and integrate context-specific, transferrable and affordable solutions; engage the community.
ACROSS	***All levels of the educational system*** ***Ensure alignment*** Ensure alignment from strategy through implementation. Align external stakeholders and ensure integration with the system before transfer of projects or programs. Also, recognise that different activities need to happen at different levels. Ensure that the right things are happening at the right places, in line with where the skills, scope and decision–making authority reside. For example, policies need to be developed and implemented to ensure that solutions are cognisant of the local realities; this needs to happen at the provincial rather than the national level. Furthermore, policies to ensure consistent standards need to be developed at national level, not provincial level.

Table 3   Summary of best practices and critical success factors

4   WHERE ARE WE NOW?

4.1   Current South African strategy and policy

We summarise the current policy environment in the form of policy documents, and list concerns expressed in recent dialogues (from Amory *et al* 2015), as well as from analysis of initiatives.

Policy environment	Concerns
Deployment of ICT to every school in South Africa, a full integration of ICT in the curricula and an e-skilled educator workforce—in order to improve the quality of education—defined collectively by the following documents: **National Education Policy Act (27/1996)** *The national policy framework for teacher education and development* **White paper 7 on e-education (1896/2004)** *Transforming Learning and Teaching through Information and Communication Technology* **Action plan to 2019** *Towards realisation of Schooling 2030.* **National integrated ICT Policy green paper** **Strategy for Information Technology in Education (DBE, 2001)**	*Policy dialogue on ICT in Education (2014)* Some progress in school administration and provision of teaching and learning BUT impact compromised due to *slow and uncoordinated implementation* *GDE study on e-maturity and e-readiness (2010)* *Unreliable connectivity, lack of leadership and vision of school administrators, lack of ICT skills of educators, limited learner access to ICTs are the major inhibitors to e-readiness*
Phakisa has six focus areas for the integration of ICT in Education: **management systems, curriculum content, TPD, ICT infrastructure, and connectivity**	• *Lack of a clear, context-sensitive definition of objectives* • *Lack of an integrative strategy* • *Clear prioritisation within the constraints of the budget* • *One-size-fits-all approach, that does not recognise the diversity of South African schools*

Table 4   Summary of policy environment of ICT in Education, and key concerns

In addition to the policies that are specific to ICT in Education, the implementation of ICT in schools is also influenced by the broader regulatory environment, including financial and administrative policies (e.g. the

Public Finance Management Act); government ICT and infrastructure policies (e.g., Policy of Free and Open Software Use for the South African Government; National Broadband policy); and other education-specific policies (e.g., The Guidelines Relating to Planning for Public School Infrastructure [DBE, 2012] and the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa 2011–2025 Technical Report [DBE & DHET, 2011]).

Specific to ICT in Education, general concerns are that (while the policy environment has been defined at a high level), the ***implementation is slow and uncoordinated***, and ***specific resources and capacity are insufficient to ensure successful implementation***.

Furthermore, the objectives with ICT in Education are defined in general terms, and do not translate into practical pathways towards an achievable goal. In practice, a number of initiatives ***are unclear about what they want to achieve*** (Ostrowick, 2016). In addition, many initiatives are still aimed at improving learner marks, but are ***unable to define a pathway*** moving from the current reality to future success.

Policy and strategy are defined at a high level, and do not extend across all levels of the education system. Furthermore, policy and strategy are not differentiated for context-specific solutions. Given this vacuum, ***leading provinces proceed to develop their own approaches***, independent of national initiatives. In addition, the implementation of ICT for Education, in the absence of clear guidelines and integrative strategies, is driven by solution provider objectives (Ostrowick, 2016, Marais *et al*, 2016). This results in fragmented implementation and the uncoordinated rollout of technology. A practice of '***perpetual piloting'*** results, leading to projects that cannot be supported in the long run.

4.2   Current practice

A framework for interpretation
Before describing current practice, we define dimensions within which it can be described. This in itself is a useful exercise, in the sense that it clarifies the various focus areas of studies and role players. Furthermore, it provides a focus for future intervention. Our analysis maps the focus areas of various role players, and seeks similar categories in terms of which to examine and discuss current local practice. The following approaches were mapped:

- ICT in e-Education white paper: 6 strategic objectives
- Phakisa focus areas
- NIMB framework (Amory *et al*, 2015)
- UNESCO ICT-CFT (model (UNESCO, 2011)
- NECT study of e-initiatives in education (Ostrowick, 2016)
- ICT4RED 12 components
- Comments from a roundtable discussion with practitioners

See Appendix B for a map of the dimensions of ICT that each of these role players consider to be significant. From this mapping we identified common dimensions that are addressed (either completely, or to some extent) by each of the role players. These dimensions are listed below, with an indication of which role player has a (at least partial) focus on the various categories.

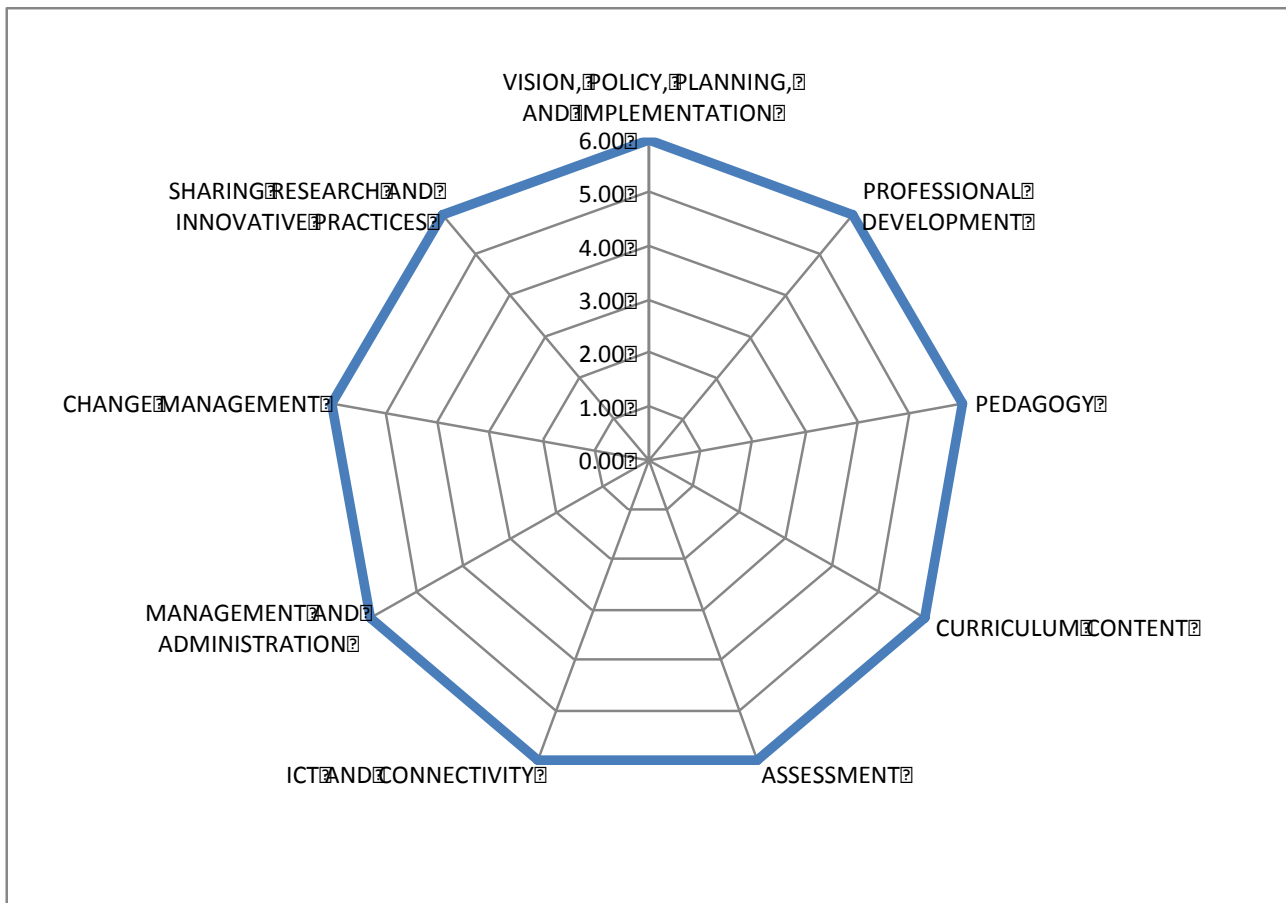| DIMENSION OF ICT IN EDUCATION	e-Education white paper strategic objectives	Phakisa focus areas	NIMB framework	UNESCO ICT-CFT	e-learning report	ICT4RED 12 components	Roundtable discussion
Vision, policy, planning, and implementation	✓			✓		✓	✓
Curriculum and content	✓	✓	✓	✓	✓	✓	
Assessment				✓			
Pedagogy				✓	✓		
Change management and leadership					✓	✓	
ICT	✓	✓	✓	✓	✓	✓	
Management and administration		✓	✓	✓	✓	✓	
Professional development	✓	✓	✓	✓	✓	✓	
Sharing research and innovative practices							✓

Table 5   *Summary of dimensions of ICT in Education, as defined by different initiatives*

NOTES:

- This analysis merely highlights the main focus areas or categories as defined by the various initiatives. Some categories may be implied within others, which may account for issues that are seemingly omitted.
- The NIMB framework already represents an integration of some of the other frameworks. All of these were again included, to allow for new categorisations.
- From this mapping, it is clear that ***Assessment*** does not emerge as a clear and separate focus area, except in the UNESCO framework, where it is highlighted as an ICT skill that needs to form part of a teacher's capability. Debates around the use of ICT in assessment include whether or not this intrudes on the teacher's capacity to add value to the process. However, ICTs have a role in automating mundane tasks associated with assessment (e.g., automated marking of multiple choice questions, as well as storing and analysis of results, where appropriate), thus leaving the teacher with more time to add value to the process of interpreting results and designing student-specific corrective interventions. Therefore, the role of ICT in assessment (as for other functions), needs to be clearly defined and designed for.
- Importantly, change management is only explicitly addressed as a key element in work that takes a bottom-up approach, such as the e-learning report and the ICT4RED 12 component model. Elements that

are addressed include ICT readiness, and integration into pedagogy for both teachers and learners. We categorise both stakeholder management and community engagement as elements of change management. The latter is a focus area of the e-education white paper. Furthermore, an integrated view of enabling change across all levels of the education system is not explicitly addressed by any of the frameworks. Change management is a key element and enabler of systemic change, and addressing this as a key focus area of ICT4E has the potential to unlock progress. It is therefore included in our framework.

The dimensions addressed by our framework can be presented as follows:

Figure 3   *Dimensions of ICT in Education*

This representation reflects the dimensions of the NIMB framework, with the addition of a change management and research dimension.

What is the local status?

We summarise the local status in terms of the elements of the above framework, based on the three sources outlined in the introduction to this document. The various sources originated from various perspectives, and the level of detail and focus of the summary vary accordingly (for more detail on selected elements, as defined by the NECT e-initiatives report, see Appendix C).

Vision, policy, planning, and implementation

An overall integrated strategy vacuum leads to changes in the system that are directed by solution providers

The policy environment with respect to ICT in Education has been described in section 4.1, and the following conclusions were drawn, in terms of its current status:

- Strategy and policy has been defined, but implementation is limited and progress is slow.
- Objectives are defined at a high level, and are not context-specific.
- The pathway from the current status to a common objective is not clear.
- Gaps in policy and strategy result in an environment in which change is driven by solution providers.

Teacher professional development

A regulatory framework exists, but there is no evidence of the implementation of integration of ICT into TPD. Various role players independently facilitate TPD in practice, without alignment to a framework.

Key findings (from Amory, 2015) are as follows:

- A regulatory framework exists that allows for the integration of ICT in TPD, but evidence of progress with implementation does not exist.
- There is no national curriculum for TPD.
- TPD is driven by individual educational institutions and solution providers.
- There is a need to develop the capacity of districts to procure TPD services.
- TPD should be seen as a continuum of initial/pre-service to continuing/in-service training, and conceptualised as ongoing.

Pedagogy

Training and awareness is required to ensure that ICTs are integrated in support of pedagogy, in a phased manner.

A clear goal must be established, and teachers and learners must be guided to use ICTs in support of teaching and learning.

ICT in Education is often not approached from the perspective of being in support of a model of teaching and learning. Therefore, the progress from the introduction of ICT to its impact in terms of capacity to teach and learn with ICTs (and the eventual impact on learner performance) is not necessarily clearly understood and managed. In addition, objectives for ITCs are often aimed at improving learner marks. This places the focus on learner outcomes, and distracts from evaluating the capacity of the system to teach with ICTs, and to integrate ICTs in support of teaching and learning.

In addition to this inadequacy in terms of the conceptual point of departure, the integration of ICTs into teaching and learning encounters obstacles at classroom level (from Ostrowick, 2016):

- The value of incorporating ICTs is not always clear to teachers, and is not well addressed by programmes.
- Teachers have a slower uptake of ICTs than learners, and fear the change that is brought about.
- Teachers have different levels of knowledge of ICTs.
- Teachers lack confidence to use ICTs.

- While there are expected educational benefits, there are also concerns when exposing learners to technology in classrooms.

Curriculum content

There are vast amounts of content available, but the content is of varying quality and could benefit from curation and organisation. Content needs to be in support of the curriculum, and not the other way around.

The current status in terms of curriculum and content can be summarised as follows (from Amory, 2015, Ostrowick, 2016):

- Considerable content has been provided by the DBE.
- In general, large caches of (uncurated) content are available.
- The quality of the content, and the extent of curation, is a concern (not the availability).
- Content providers dictate the nature of content, which is not necessarily aligned with strategic objectives.
- Content is not always open source and sometimes requires licensing fees.
- Content provision is not a constraint, but the ability of teachers to engage with content and utilise it in support of teaching and learning is limited.

Assessment

The power of ICT appears to be under-utilised in assessment, and its role is undervalued. There has been limited research on this topic.

Amory (2015) observes the following:

- There is a dearth of information on ICT-supported assessment in South Africa.
- A 2006 study of assessment practices in 400 schools concluded that there was limited application of ICT for assessment, in spite of the fact that varied assessment practices, as well as widespread use of ICT, were in place in the schools under study.

ICT (i.e., hardware and connectivity)

Access to ICTs is limited, and unequally concentrated across provinces and quintiles.

Technology solutions need to be cognisant of resource constraints (e.g., bandwidth, cost) and local environments (e.g., lack of security).

Various studies and surveys culminated in the following definition of ICT infrastructure status (extent of access as well as technical aspects are discussed; the latter summarised from local studies [Ostrowick, 2016]):

	ASPECT	STATUS
EXTENT OF ACCESS	Access to computers for teaching and learning	15% of schools (KPMG, 2009)
		22.6% of schools have access to teaching and learning (Ostrowick, 2016)
		80% of Gauteng schools have a computer laboratory (Saide, 2010)–1-lesson-per-week learner access (Saide, 2010)
		Relatively high learner-–o-computer ratio in Gauteng (Amory, 2012)
		Quintile 5 schools better resourced in Gauteng (Amory, 2012)
		Access is currently mostly limited to Quintile 3 and higher (e-education plan, 2014)

STATUS OF TECHNOLOGY (Ostrowick, 2016, except if indicated differently)	Access to computers for administration	50.8% of schools have access to computers for administration (Ostrowick, 2016)
	Connectivity	Slow speeds and high costs contribute to slow uptake (DoE, 2004; Saide, 2010; HSRC, 2014)
	Hosting	Single online servers with limited usage Scalability not generally considered
	Upstream portals and onsite caches	Broadband unstable, expensive Most solutions not tested under large loads; most not scalable Large content basis without interactive features and curation procedures English only Not designed for non-digital-native (content not easy to navigate) Clarity about ownership and transfer of user-content required
	Broadband	Lack of connectivity in rural areas at broadband speed so as to enable the delivery of high-quality content
	Last-mile and LAN	Costs of WLANs are high Video requires high bandwidth Access to inappropriate sites needs to be controlled Limited range access points Concurrent user limits
	End-user devices	Security & cost are concerns Resistance to use by teachers Distractions & social networking Device loss & destruction
	Support and maintenance	Ongoing support costs are significant. This includes training, technology support, and device replacement. Complex and highly customised solutions are difficult and expensive to support. New people enter the system so ongoing training is required. A clear exit strategy is required that enables capacity building and transfer of the project to the Department of Education.

		Support structures need to be in place before equipment is delivered.

Table 6   *Status of ICT infrastructure, collated from various sources*

Partnerships are seen as useful in rolling out infrastructure, but are not adequately coordinated, and state-owned enterprises adopt duplicating and conflicting roles (Amory, 2015).

Management and Administration

At the level of schools and provinces, the following findings from local studies define the current status (Amory, 2015):

- There is a lack of integration of ICT into the organisational culture of schools and districts.
- School management teams make little use of ICT in execution of their responsibilities.
- Teachers and principals are isolated from district e-learning units, leading to superficial knowledge of e-education policy and incoherent actions.
- While the South African School Administration and Management System (SA-SAMS) has improved the capturing of data at school level, the functionality of the system is under-utilised: it is not web-enabled, which means data collection is costly and inefficient; accuracy and completeness of data is poor; staff at school and district levels have limited opportunities to access data on the system; and the reliability of the data is questioned.
- On-going technical and user support for SA-SAMS is lacking, resulting in schools choosing to use other systems, even when these are charged for.
- The Data Driven Districts project developed customised data collection processes, and lead to sustainable data collection, better defined ownership of data, and improved data quality.
- A number of change related aspects have been identified as crucial when introducing new innovations (change management, project support, and professional development opportunities).

The following were identified with respect to the management of ICT projects (Ostrowick, 2016):

- A focus on sustainability and ongoing support is required.
- Return on investment needs to be justified (outputs should justify costs), and appropriate monitoring and evaluation should be undertaken.

Change management

Change management is not seen as a key enabler across all levels of the education system. Where it is considered, a classroom view is taken, with a focus on acceptance by teachers and acceptable use by learners. A change management focus is required that permeates all levels of the hierarchy, is aligned to a common goal and that adopts holistic change management practices, beyond training.

Key aspects are as follows:

- Change management is not a key element of the introduction of ICT into teaching and learning. Where it is defined, it is interpreted as management of the adoption of ICTs into the classroom environment.
- A view on integration of the capacity to accommodate ICTs throughout the system is not incorporated. Different parts of the system do not coordinate to integrate new systems, and sufficient support is not provided for new innovations (see *Management and Administration)*
- Some projects provide for stakeholder management and community engagement. The latter is seen as a means of facilitating security (Ostrowick, 2016).   (see *Pedagogy* and *Management and Administration* above for more detail)

### *Sharing research and innovative practices*
There is significant room to define, undertake, and share good educational research that informs policy as well as what happens in the classroom.

Key aspects are as follows (from roundtable discussion):

- Research is required at university level that can inform policy and practice, and that is targeted at what the system needs.
- It should include innovative practice that happens inside a classroom
- There is a general lack of awareness among teachers and learners of what is possible
- A forum is required where the nature of good educational research (that goes beyond small interventions) is shared; teachers should be enabled to do their own research.
- Things should be shared and recognised as they are happening

What is the implication?
The current status provides significant room for coordination and streamlining, in order to improve the integration of ICT into education. A ***subjective*** assessment of the status, against the various dimensions, was obtained through a roundtable discussion as well as an online survey of the opinion of local practitioners. The average ratings are summarised below. For each dimension, a key constraint is listed.
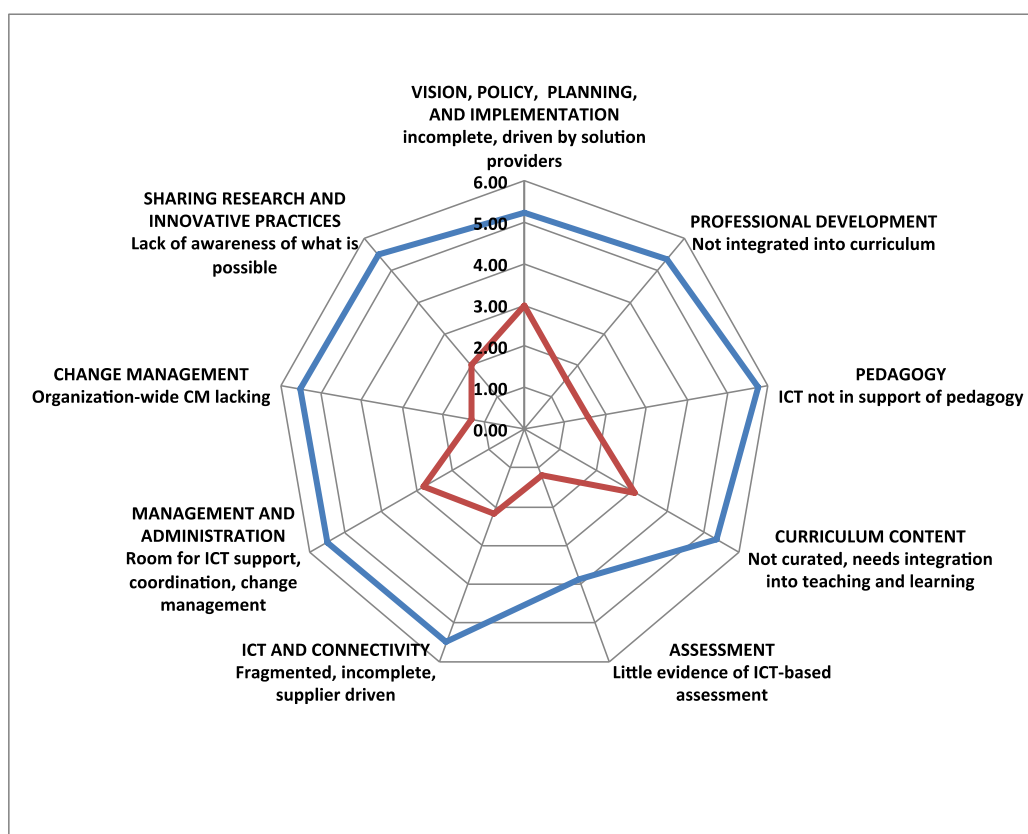
Figure 4 **Summary of key constraints per dimension**

From the above ratings, it is clear that all aspects (with the exception of ICT in assessment) are considered approximately equally important to the success of ICT in Education. Further, the current status falls significantly behind the ideal, with curriculum content and change management being key areas of concern. ICT in assessment, although deemed less important, is also lagging significantly.

An interpretation of the discussion in this section, across the various dimensions, indicates that the integration of ICT in Education can benefit from alignment at various levels:

Vision, policy, planning, and implementation	Provincial initiatives need to be aligned with national policy.
	Objectives need to be clear and aligned within specific provincial contexts.
	Policy needs to optimise initiatives by service providers, and align hardware and software installations with policy objectives.
Professional development	ICT in Education needs to be integrated into the teaching curriculum, and TPD needs to be acknowledged accordingly.
Pedagogy	Strategies for the introduction of ICT need to be aligned with a clear model of support for ICT in teaching and learning.
Content	The form and structure of content needs to align with using ICT in teaching and learning

Assessment	The use of ICT in assessment needs to be included as an objective, and needs to be incorporated into teacher development.
ICT *(i.e., hardware and connectivity)*	The introduction of hardware by solution providers needs to be aligned with provincial standards, policies, and budget. Connectivity needs to be seen as a scarce resource, and an integrative strategy and user commitment is required to optimise its use from a technology and content perspective.
Management and administration	New initiatives need to be supported adequately and consistently, to ensure uptake.
Change management	Significant effort needs to be expended to align the entire system for change, and to accommodate ICT initiatives (across all levels, not only at direct interfaces of the user with the system).
Sharing research and innovative practices	Research that can influence policy and practice (at scale) needs to be actively pursued, and results should be shared and applied.

From the best practice described in section 3, as well as the status outlined here, a pathway is developed towards continuous development of the capacity of the system to support education. This is discussed in section 5 below.

5   PATHWAY TO PROGRESS

5.1   Where would we like to be?

What does achievable impact mean when ICT is used in support of education? According to UNESCO, the role of ICT in Education is to support the present-day 'knowledge society' (UNESCO, 2011):

- *To build workforces which have ICT skills to handle information and are reflective, creative and adept at problem-solving in order to generate knowledge*
- *To enable citizens to be knowledgeable and resourceful so they are able to manage their own lives effectively, and are able to lead full and satisfying lives*
- *To encourage all citizens to participate fully in society and influence the decisions which affect their lives and*
- *To foster cross-cultural understanding and the peaceful resolution of conflict.*

They define these social and economic goals as the focus of a country's education system, and indicate that teachers need to be equipped to fulfil these roles (UNESCO, 2011). The use of technology in teaching and learning therefore has a role that is removed from improving learner marks, and that has a broader impact in terms of preparing learners for participation in the knowledge economy.

This document outlines a landscape in which the change that is brought about by ICT in Education in South Africa is:

- Not clearly defined
- Driven by solution providers, and
- Not aligned with a detailed national and provincial strategy.

Furthermore, the pressure on 'fixing the education system' leads to a focus on pass rates and learner marks, and ICT is often seen as the silver bullet that will fix the system.

Based on the analysis in this document, as well as the current baseline from which the system is working and the need for a more holistic approach to ICT in Education, we define the following systemic objective:

> **The capacity of the education system needs to be developed to integrate ICTs in support of education.**

A strategic focus on systemic capacity has implications throughout the education system. It affects strategy, policy, design and implementation of interventions, as well as the way in which success is defined and measured. It calls for a differentiated approach to ICT interventions in schools tailored to the readiness of individual schools for the uptake of ICTs. Furthermore, it calls for alignment throughout the system, so that interventions can be integrated into the business of teaching and learning. Solution providers and donors need to be guided to design interventions that are aligned with the objectives of the system. Similarly, the various parts of the education system need to be aligned in support of the integration of ICT initiatives. Measurement of progress needs to be focused on measuring advances in systemic capacity before measuring changes in learner outcomes.

The remainder of this section describes a pathway towards progress, by defining the principles underlying a phased approach, identifying what needs to start, stop and continue at different levels of the system, and elaborating on approaches to measurement.

5.2 ICT in support of teaching and learning: a phased approach

Schools work within an educational system where multiple role players at multiple levels have the capacity to influence their access to, and use of, ICT. An approach to the integration of ICT in support of teaching and learning therefore needs to consider the education system as a whole, and the role of ICTs within the system.

At the system level, integration and alignment is required across levels of the hierarchy. This means that national strategy and policies need to be adopted and integrated into provincial strategies, which are differentiated for the specific challenges and conditions within each province.

The school environment is diverse, and there is a continuum from those schools that have no access to ICTs to those that have both the resources, and the capacity to use such resources. The intention is to meet each school where it is on this spectrum, and to create an environment within which they can progress towards the capacity to successfully integrate ICT teaching and learning. Furthermore, the intention is to show value for the investment that is made in the education system. For each school, the value will be different, and this needs to be recognised when progress is assessed. It needs to be possible for the school and province to integrate, use, and maintain the solutions. When an investment is made in an environment that cannot adopt or sustain it, scarce resources are wasted and the impact is diluted.

When designing a process to develop ICTs within the school environment, it is proposed that the following principles are adopted, based on the best practice and critical success factors outlined earlier:

- The readiness of different schools *for the integration of ICTs into teaching and learning* needs to be understood.
- Solutions need to be differentiated for schools with different needs and different levels of readiness.
- Adopt a phased approach in order to move from the current baseline to a future reality. This means that schools are met where they are, and competence is developed gradually and in line with progress.
- Be clear about the vision for ICT integration in each school. Measure progress for each school differently, and in line with its particular vision and goals.

5.3   What to stop, start, continue

In the context of bringing about systemic change, Amory (2015) quotes the 3M approach, which has been developed for rural poverty and natural resource management. It considers a system at the macro (in this case, national), meso (provincial and district) and micro (school) levels. Good practice for improvement of the system then includes that (Amory, 2015):

- Obstacles should first be removed at the micro (school) level;
- Policies and institutional activities should be aligned at the meso and macro levels; and
- Communities that are representative of all stakeholders should be built at all levels.

Given our analysis of the status, we consider the 3M approach when defining what should stop, start, and continue at the various levels of the system to bring about progress and sustained change. We outline activities for each of the dimensions of ICT in Education as outlined in section 4.

We inform the analysis with work done by Amory et al (2015), in which next steps at the various levels have been outlined for the various pillars of ICT in Education. We incorporate work done by Ostrowick (2016) on next steps for the various components of a value chain for the deployment of ICT initiatives. Further, we consider work that was done by Marais *et al* (2016) to assess the provincial status of ICT in Education and to make recommendations with respect to the development of provincial-level strategies. Finally, a roundtable discussion with a number of experts further informed the analysis.

The intention of the tables outlined below is to define a pathway to progress, based on our current understanding of the system. It informs activities ranging from strategic through tactical to operational. The pathway and the activities outlined here would change as the system progresses.

5.3.1 Vision, policy, planning, and implementation

STOP	• Do not consider ICTs as a (rapid) means of improving learner outcomes. • Do not design one-size-fits-all solutions. • Do not allow solution providers to dictate the change in the system by promoting their individual solutions. • Do not implement ICTs from within departmental silo's: cross-cutting strategies and project teams are required.
START	• Define a clear and coherent vision and strategy for the use of ICTs in support of teaching and learning that emphasize the role of teachers and pedagogy (national, provincial, school). • Define clearly the ICT in Education aspects that should be addressed by policy. • Define how policy should be used in practice (including the TPD policy); include a pedagogy rather than ICT focus. • Update the e-Education white paper. • Define for solution providers and donors how they should align with the integrated provincial strategy for the integration of ICT into education. • Find ways to use ICTs to ease the administrative load associated with teaching. • Understand school readiness, and implement solutions that are specific to a school's readiness to implement ICT in teaching and learning. • Develop the skills of district officials to assist schools with the implementation of their ICT policies and plans, and with integration of donor projects into the school environment. • Measure progress at multiple levels of the education system, and define different progress markers for schools at different levels of readiness.
CONTINUE	• Find innovative solutions and seek partnerships to fund and implement ICTs in support of teaching and learning.

5.3.2   Professional development

STOP	• Do not consider professional development with respect to ICTs as separate from overall TPD. • Do not allow solution providers to implement TPD activities that are not guided by provincial policies and that are not aligned with the national curriculum.
START	• Integrate competence with the use of ICTs in teaching and learning as part of the national TPD curriculum. • Shift TPD activities from training to teacher development. • Shift the focus of TPD activities from being device-driven to matching the device to what needs to happen in the classroom. • Ensure that teachers demonstrate their learning before earning TPD points. For service providers designing TPD programmes, provide guidelines that are aligned with a national curriculum and that are focused on provincial priorities. • Ensure that the curriculum is cognisant of best practice (e.g., based on the NIMB framework). • Ensure that the curriculum is endorsed through the SA Council of Educators (SACE) CPTD system, and allow for formal acknowledgement of participation. • Ensure that the pre-service Minimum Requirements for Teacher Education Qualifications is based on the same framework, and that it ensures that teachers are competent *learning with technology* practitioners. • Provide a curriculum for professional development for district officials and subject advisors. • Develop an ICT platform to support in-service TPD. • Facilitate informal teacher development activities by establishing communities of practice, and establish mechanisms to support these (e.g., social media platforms). • Design school management processes that allow for sufficient time to integrate ICTs into teaching and learning. • Require provincial and district officials to be competent in teaching with technology. Reflect this requirement in key performance indicators. • Recognise district officials, subject advisors, and teachers for participation in professional development activities.
CONTINUE	• Encourage teachers to participate in ICT-related TPD activities by recognising participation and endorsing progress (e.g., through 'earn as you learn' programs)

5.3.3   Pedagogy and curriculum content

STOP	• Do not make content available for passive use; encourage teachers (through TPD) to incorporate digital content actively into lesson plans.
START	• Support development of content that is in support of the integration of ICTs into teaching and learning (see NIMB framework for principles). • Align content with the curriculum, but then also extend content beyond the curriculum, and allow scope for teachers to innovate. • Support development of content that is cognisant of resource constraints, and that is aligned with local conditions (such as bandwidth and connectivity limitations). • Support and encourage development of content that allows for the use of different languages. • Support innovation in content development (e.g., use of gaming to engage people). • Use different types of technology for different content areas. • Focus on the curation of currently available content, rather than on development of excessive amounts of static, non-interactive content. • Focus on structuring of content, to enable teachers to manage the curriculum. • Support district officials to become competent in assisting teachers to use and adapt available material for their specific requirements, and within their local constraints. • Facilitate sharing of learning between schools through, for example, online communities of practice. • Recognise and celebrate success.
CONTINUE	• Develop partnerships for innovative solutions to context-specific content development, curation, adaptation, and use. • Invest in content development, and increase investment.

5.3.4   Assessment

STOP	• Do not consider automated assessment tools as a 'nice to have' – consider their roles in improving the efficiency of the teaching process.
START	• Guide teachers in the appropriate use of ICTs in formative and summative assessment; assessment for learning and assessment of learning (through TPD). • Be clear about, and communicate, the benefits of the use of ICTs in assessments. • In the absence of a national system, explore partnerships with solution providers and donors for the implementation of school-based ICT assessment systems. • Investigate more innovative assessment systems. • Incorporate the implementation and use of reliable systems to support the use of ICT in formative and summative assessment as part of the management objectives of the school. • Support school management teams in their use of ICTs for assessment purposes. • Support district officials to fulfil the above role at the school level. • Assist teachers in integrating automated assessment strategies into their assessment plans.
CONTINUE	• Find innovative ways to use ICTs to reduce the administrative burden of teaching, of which assessment is one. • Promote and support the role of the teacher in designing assessment exercises, analysing results, and developing learner development plans.

5.3.5 ICT and Management & Administration

STOP	• Do not support the implementation of technology solutions in isolation, without appropriate support, teacher development, etc. (focus on holistic, integrated solutions). • Do not allow the implementation of solutions that do not have a clear exit strategy and sustainability plan. • Do not accept ICT donations without understanding the long-term implications. • Do not accept or support one-size-fits-all solutions.
START	• Repair and maintain ICT infrastructure at provincial and district offices. • Be specific about how technology should be selected. This should be done in accordance with specific principles of technology selection for ICT in Education initiatives. These could include an approach to connectivity; technology selection policies that are localised and fit with resource constraints; availability of support capacity, etc. See Ostrowick (2016) and Amory *et al* (2015) for specific recommendations, also summarised in Appendices C and D. • Be clear about the acceptable nature and design of (donor) solutions, to ensure that they are suited to the specific local conditions and constraints, and are in the long run affordable, can be integrated into the education system, and can be supported over time. • Be clear about the reasons for technology guidelines, relative to the objectives with ICT integration in Education in the province. For example, a motivation for a LAN needs to be linked to the use of networked content in lesson plans, etc. • Develop a clear understanding of the diversity of schools in the province, with respect to their readiness for the implementation of ICTs. • Develop solutions that are school-specific and that match readiness. • Recognise the global trend towards mobile technology, and develop solutions accordingly • Develop the ICT support capacities of the province, to be able to support all schools (e.g., technology support, maintenance, etc.) • Develop the capacity of the district to support the school with ICT integration plans. • Support school management in their understanding of their own ICT readiness and the development of a school-specific ICT integration plan (include ICTs in administration). • For each school, develop an implementation plan, based on readiness and local constraints. • Seek opportunities to use ICTs to improve school administration, and include these in the implementation plan. • Dictate to donors what 'gifts' are acceptable, within the context of the school's technology plan. • Interact with the community with respect to the implementation of new initiatives. • Seek partnerships for the strengthening of the ICT infrastructure and school-based ICT capacity of the province.
CONTINUE	• Find innovative ways of developing the local capacity for technology support in schools that are difficult to reach, e.g. by allowing learners to participate in support activities. • Link schools with shared resources in the district, and enable the use thereof to support their ICT capacity (e.g. shared resource centres, etc.)

5.3.6 Change management

STOP	• Do not see change management as something that is only associated with the school-level implementation of ICTs – consider the change that is required across all hierarchies of the educational system. • Do not allow the implementation of ICT initiatives that are not accompanied by a holistic change management plan. • Do not see change management as a course: it is a process that needs to be implemented at all levels of the organisation. • Do not use hierarchical positions to enforce change; this leads to passive resistance and, ultimately, failure.
START	• Prioritise change management as a critical success factor for ICT implementations. • Promote change management as a holistic activity that includes structures, systems, processes, and human capacity development. • Provincial change management plans should address change management in terms of a number of dimensions, including changes that are required in the organisation of the province; leadership development at provincial, district, and school level; communication; readiness assessment; training with respect to management of change; mentorship, adoption and response to feedback, etc. • Change management should cut across organisational structures, since cooperation between different levels and departments is often key to success. • Develop the district capacity to facilitate and enable change (take an organisational, process, and people view). • Guide schools in the adoption of change management plans.
CONTINUE	• Develop capacity for change management within the system, but expand this across all levels (i.e., beyond learner and teacher level).

5.3.7 Sharing research and innovative practices

STOP	• Do not conduct research that is not applicable to what the system needs, and that cannot affect systemic change and improvement.
START	• Conduct research that can inform policy and practice in an integrated manner. • Include research about what is happening in the classroom. • Create awareness of research, research outputs, and ways in which it can be applied in practice. • Define 'good' education research, and create awareness. • Enable teachers to conduct their own research, by including in TPD training that develops their classroom research skills. • Create educational spaces where teachers can talk about what they do, what works and what does not work. • Share research as it is happening. • Share and disseminate positive news.
CONTINUE	• Conduct research that focuses on systemic improvements.

5.4   How to measure progress?

The research is clear on the fact that measurement of learner outcomes as a means of assessing the impact of ICTs on teaching and learning is not appropriate, and could even be detrimental. Given the overall goal of developing the systemic capacity to adopt ICTs, we propose a measurement approach at multiple levels that reflects progress against multiple objectives, all of which define a systemic growth path.

In essence, we want to be able to reflect on the **status of ICT in Education**. We suggest that this implies a measurement framework that is based on the following principles:

- Measure progress along **a path towards impact**, rather than impact alone.
- **Measure progress** for different provinces, districts, and schools **differently.**
- Measure access to ICTs in teaching and learning that are **appropriate for a specific environment.**
- Measure use of ICTs relative to their support for teaching and learning (i.e., **how ICTs are used** in the classroom, rather than whether they are used).
- **Measure teachers' capacity** to teach with ICTs before measuring learner outcomes.
- Measure the **system's capacity to sustain** the use of ICTs in schools (i.e., access to ongoing funding, technical support capacity, etc.).
- At a provincial level, include measures of progress against objectives other than improved learner marks (e.g., retention of learners in rural schools, etc.).

Heeks (2014) proposes a useful (and now often-cited) value chain for the adoption of ICT for development. It is based on an outcomes chain, and outlines a progression from precursors through to development impacts, while highlighting enablers and constraints along the process:
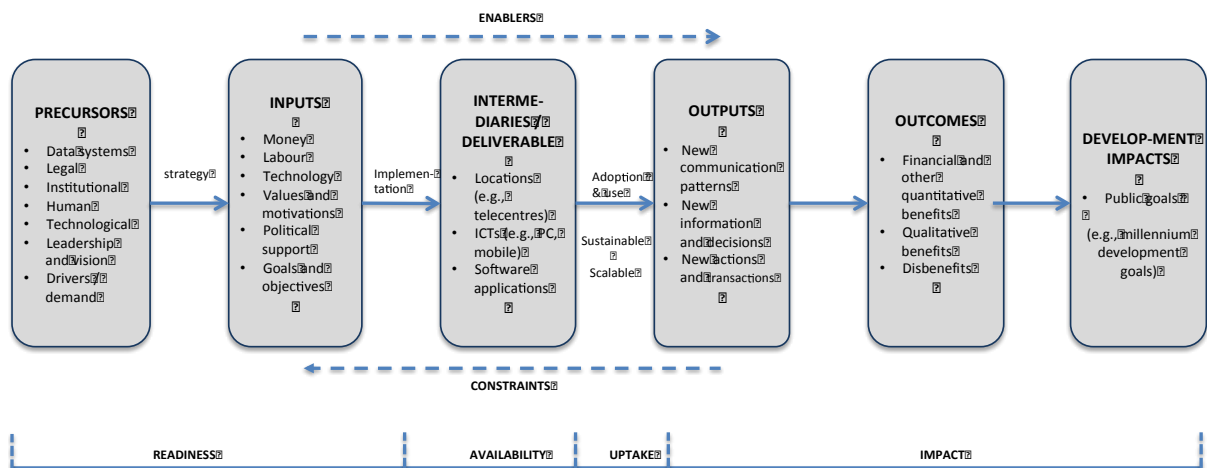

Figure 5   *The ICT4D value chain (redrawn from Heeks, 2014)*

In the context of measuring ICT in Education in South Africa, the relevance of the value chain is in highlighting various aspects that could be considered when reflecting on progress. The progression from inputs to development impacts provides elements of a pathway towards impact. With this in

mind, and given our objective of enhancing systemic capacity, the following measurement framework is proposed:[9]

Where?	What to measure?	Why?
NATIONAL	***Extent of access*** • Who (which provinces, quintiles, districts) have access to what (connectivity, devices, teacher development, content, etc.) • Who is providing access?	• Budget allocation and shared (national) resource development decisions • Policies to align resource provision with objectives, ensure quality
	Extent of use • How well are resources used, or which are under-utilised? (infrastructure, training, etc.)	• Development of shared support programs (technology, training, etc.) • Resource allocation decisions
	What are we getting right? • Who is doing what well?	• Defining and sharing best practice, across provinces
PROVINCE	***Extent of access*** • As above, within province • What is happening in the province, that is not within the provincial education department (PED) development plan?	• Provincial resource development decisions • Integration of solution providers within provincial plans
	Extent of use What are resources used for? (e.g., how are teachers using technology?)	• Support programs to ensure appropriate use • Development of an enabling environment (technology support, training, security) • Remove disablers
	Capacity to integrate Capacity of teachers to teach with technology Capacity of learners to learn with technology Capacity of district officials to support teaching with technology Capacity of province to provide technical support	• Ensure that enablers are in place to ensure functional ICT access and ICT competence of teachers and learners
	Progress against multiple goals, for example: School migration patterns	• Ensure that a holistic set of objectives is reached

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9 Numerous measurement frameworks could be developed. This proposed framework is intended as a baseline from which to report on the status of ICT in Education in South Africa, as well as to inform decision-making at various levels. It is open for debate and discussion.

DISTRICT	**What are we getting right?** Who is doing what well?	• **Share good practice across districts** • **Develop enabling environment (communities of practice, etc.)**
SCHOOL	**Extent of use** What are obstacles to use? • What are enablers of use?	• Ensure an enabling environment
	Impact What is changing? What is perceived as success?	• Understand impact • Support success
PROJECT	**Alignment** In how many projects are planning and implementation aligned with provincial policies? Are exit strategies in place? How many projects are successful? What are critical success factors?	• Ensure alignment • Ensure integration and sustainability • Learn from successes

6 CONCLUSION AND SUMMARY

This report integrates learning from three sources to highlight the role of ICT in Education: best practice and critical success factors; the current status; and pathways to progress. A systems view was taken, and recommendations were made at different levels.

The message that emerges from the three sources is clear:

Role of technology, best practice, and critical success factors

• ICT is relevant within education as a means of supporting a process of teaching and learning, and is best employed in support of a value creation process. It is not a focus in itself.

- International best practice is to use technology as an enabler of the education process. Pedagogy and the role of the teacher are central.
- Critical success factors include that solutions must be tailored to the readiness of schools to adopt technology (no one-size-fits-all), and must be designed with cognisance of resource constraints and a plan for successful handover. Solutions must be designed to address multiple aspects. Technology drops are guaranteed to fail.

Key challenges

- While strategy and policy exists, implementation is slow and capacity is limited. Objectives are not clear, and an integrated strategy across the system is lacking.
- Access to technology is limited and unequal across provinces and quintiles. In the absence of clear, integrative provincial strategies, progress is fragmented and driven by solution providers.
- Significant room for improvement exists in seven different dimensions of the education system. System-wide change management needs to be prioritised, and ICT-enabled assessment needs consideration.

Pathways to progress

- For long-term sustainability, the capacity of the education system to integrate ICTs in support of education needs to be developed. The focus should shift from learner performance to capacity development.
- A phased approach, with appropriate interim targets, needs to be taken.
- Progress should be measured against multiple criteria, and the focus should be on measuring the capacity of the system to integrate technology, and the capacity of teachers to incorporate technology into the process of teaching and learning.
- The following initiatives are key to making progress:
  - Ensure strategic alignment for ICT integration at all levels of the education system;
  - Increase the focus on pedagogy in ICT initiatives;
  - Develop the skills, confidence and desire of teachers to integrate ICTs into teaching and learning; and
  - Focus on sustainable interventions: move from pilots to integrated solutions.

This report serves as a basis for discussion on appropriate direction within the education system. It provides guidelines at multiple levels, to inform strategic, tactical, and operational decision-making. Critical next steps are a clear statement (or re-statement) of the national objective in terms of systemic capacity development, and the development of integrated provincial strategies.

REFERENCES

Amory, A. 2016. *Personal communication, May 2016.*

Amory, A., Rahiman, F., and Mhlanga, E. 2015. *Rapid research on the use of ICT in Education*. South African Institute for Distance Education, RFP-15/1116. August 2015.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., and Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals*. Handbook I: Cognitive domain. New York: David McKay Company.

Heeks, R. (2014). ICT4D 2016: New Priorities for ICT4D Policy, Practice and WSIS in a Post-2015 World. Manchester Centre for Development Informatics Working Paper 59. http://www.seed.manchester.ac.uk/medialibrary/IDPM/working_papers/di/di_wp59.pdf ISBN: 978-1-905469-87-1.

Marais, M.A., Meyer, I.A., Dlamini, S., Ford, M., and Roux, J.P. 2016. Guidelines for a provincial strategy for the integration of teaching, learning, and ICT. Pretoria: CSIR Meraka Institute project report.

Ostrowick, J. 2016. *A study of existing e-Education initiatives*. NECT internal report, vsn. 17, February 2016.

UNESCO, 2011. *UNESCO* ICT competency framework for teachers. Paris: UNESCO.

APPENDIX A: MODELS OF TECHNOLOGY IN EDUCATION

A significant body of literature emphasises that ICTs need to be used in support of teaching and learning. The models outlined below reflect different perspectives on this support role of ICTs. A brief overview is given of the intent of each model. Common to most of the models is their reflection of education as a progression through which learners develop increasingly advanced skills.

Bloom's taxonomy

A full version of this model, which was aimed at classifying educational objectives, was first published in 1956 (Bloom *et al*, 1956). This commonly used model is applied to structure curricular activities.
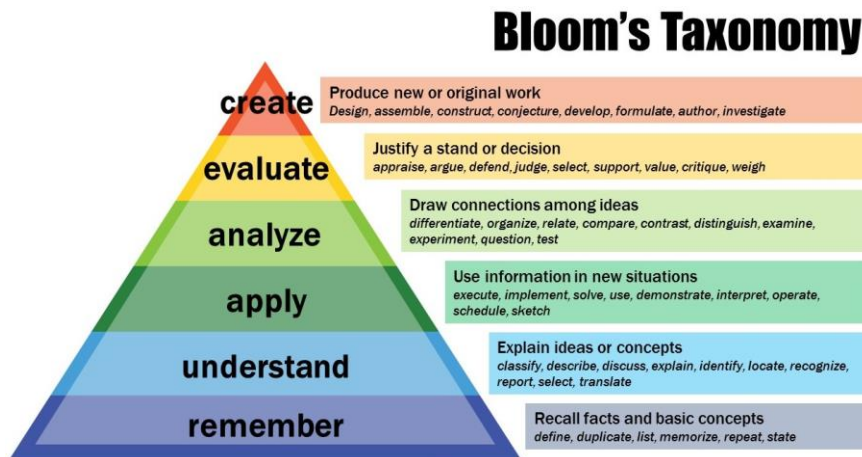

Image source:

https://cft.vanderbilt.edu/wp-content/uploads/sites/59/Bloomtaxonomy-e1445435495371.jpg

Figure A.1   Bloom's taxonomy

Similar to most other models, it defines a progression from assimilation of information, to using information to create new knowledge. Recent variations have included 'flipping' this model, to a version in which creating, evaluating, and analysing forms the basis of learning, from which the other levels are derived (Ostrowick, 2016).

The TPACK framework

This framework emphasizes the key knowledge elements that are required for effective integration of technology into teaching, as is highlighted below.

Image source: http://www.edtechcoaching.org/wp-content/uploads/2013/11/tpack.jpg

Figure A.2   The TPACK framework

While some researchers have pointed to its complexity and the extent of knowledge that is required for its effective use, others have outlined that it has assisted teachers to align theoretical and practical ideas, and has guided the integration of technology into teaching and learning (Amory, 2015).

From a practical perspective, it reinforces the view that a number of issues need to be considered when introducing technology into teaching and learning, and that these issues relate to the integration with pedagogy, rather than to a focus on technology.

NIMB framework

Amory *et al* (2015) defined a conceptual framework against which to evaluate the use of ICT in Education. This framework integrated different models (amongst others, Bloom's taxonomy), to define a model that can be used to describe the ways in which ICTs are used in teaching and learning.

The dependent variable is represented by the following modified version of Bloom's taxonomy.

Figure A.3   NIMB framework (dependent variable)

The independent variables include *notions of learning, ICT in Education*, and *model for learning design*, and are structured into the following progressions:

Independent variable	Progression		
Notions of learning	Acquisition →	participation	→ contribution
ICT in Education	Instructive →	cognitive	→ mediative
Models for learning design	Reproductive → interactive → conversational → transformative		

Table A.1   NIMB framework (independent variables)

In the above table, the variables are explained as follows:

Notions of learning (the way in which people learn):

- Acquisition: obtaining knowledge through information processing in an individual mind
- Participation: learning takes place between the individual and others in a community of practice
- Contribution: contributing to collaborative practices of humanity for individual and community transformation

ICT in Education (how ICT is used in learning)

- Instructive approaches: teachers integrate technology in a passive and teacher-centred manner (teaching from technology);
- Cognitive approaches: the use of technology as a 'mind tool' (e.g., use of technology to represent authentic contexts and activities in learning—learning with technology)
- Mediative approaches: the use of technology to mediate the construction of knowledge (e.g., use of tools to solve problems)

Models for learning design

- Reproductive: learn and reproduce information
- Interactive: learn by interacting with subject content
- Conversational: interactions between practice and theory; includes acquisition, inquiry, discussion, practice, collaboration and reproduction
- Transformative: Use of authentic tasks in teaching and learning, with designs that have real-world relevance, are ill-defined and complex, provide opportunities to examine ideas from different perspectives, are integrated across subject areas, etc. (e.g., adventure games)

In this context, the NIMB model then analysed and contextualised literature about current international applications of ICT in teaching and learning relative to these variables. The following conclusions were made with respect to the international use of ICT in teaching and learning (see shading in the table above):

- A participatory approach is predominantly used as notion of learning,
- Technology is predominantly used as cognitive tool in education, and
- ICT is predominantly used to support interactive and conversational approaches to learning design.

UNESCO framework

This framework outlines the various dimensions of ICT competencies that a teacher needs to develop in order to teach with technology (also referred to as the aspects of a teacher's work related to ICT). In line with the other models, it outlines a progression, in this case representing three successive stages of a teacher's development:
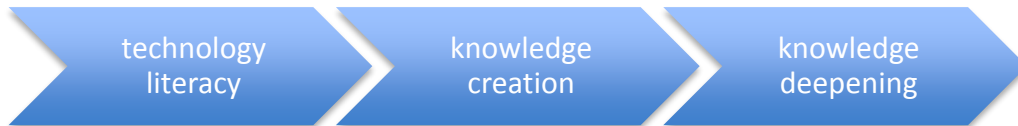

Figure A.4   *UNESCO framework: teacher development*

The model sees ICT in Education as a means of enabling social and economic development, and therefore includes a policy component as a dimension that needs to be understood and integrated. The model comprises the following:
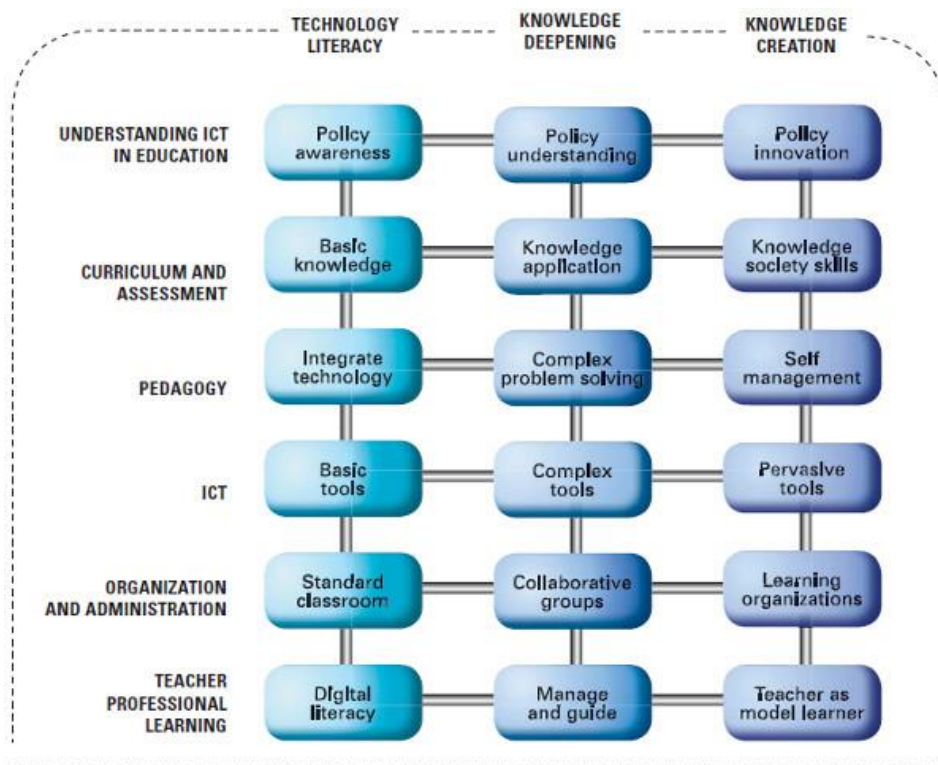
Figure A.5   *UNESCO framework* (UNESCO, 2011)

APPENDIX B: DIMENSIONS OF ICT IN EDUCATION

Integrated framework	ICT e-Education white paper: 6 Strategic Objectives	Phakisa focus areas	Saide: NIMB framework (Amory *et al,* 2015)	UNESCO (ICT-CFT)	e-learning report (Ostrowick, 2016)	ICT4RED 12 components
Vision, policy, planning	Research & Development			Understanding ICT in Education		Research & Policy
Curriculum and content	Electronic content resource development and distribution	Curriculum content	Curriculum Content	Curriculum	Content	Content
Assessment				and assessment		
Pedagogy				Pedagogy		
Change management and leadership	Community Engagement				Change management: Training and integration into pedagogy for teachers Integration into learning for learners ICT readiness	Change leadership and management Stakeholder engagement Community engagement

					Community ownership and engagement	
ICT (i.e., hardware and connectivity)	Access to ICT Infrastructure Connectivity	ICT infrastructure Connectivity	ICT infrastructure & connectivity	ICT	Hosting Upstream portals and onsite caches Broadband delivery Last-mile connectivity and LAN End-user devices or access Ongoing support and maintenance	School ICT infrastructure, Network, Operations management
Management and administration		Management systems	Management of systems	Organisation and Administration	Monitoring and evaluation	Project management Communication Monitoring and Evaluation
Professional development	ICT for professional development, management, teaching and learning	Teacher professional development	Teacher professional development	Teacher professional learning		Teacher professional development

Table B.1 Mapping of focus areas of various studies onto a single framework

APPENDIX C: SUMMARY OF SOME FINDINGS OF THE E-LEARNING REPORT

The NECT e-learning report summarised its recommendations according to a value chain, comprising 14 different elements. These are listed below. Following that is a summary of some of the concerns and recommendations related to the ICT dimensions as described in section 4.

C.1   Summary of findings

Element 1:	Content	Open formats, Creative Commons, DRM-free, multi-lingual, CAPS-aligned.
Element 2:	Hosting	The hosted solution should employ load-balancing and should be scalable.
Element 3:	Caches	Centralised curated content to be sent downstream to appliance-like servers.
Element 4:	Broadband	We should supply broadband at least to the caches at schools (Element 3) as well as, at least, to principals and teachers. 3G is easiest to deploy.
Element 5:	Last-mile and LAN	Provide Wi-Fi on-site.
Element 6:	End-user Devices	Bring your own device (BYOD at home, maybe tablets for learners, teacher tablets.
Element 7:	ICT readiness	The following elements should be seen as 'entry criteria' into the programme: Secure buildings, electrical supply, availability of 3G, proximity to a road, school principal leadership, district and PED support structures present, and school staff willingness.
Element 8:	Change management: Teachers	Phased gradual introduction of components is better, starting with change management. Training teachers so that they meaningfully feel that the ICTs are valuable and useful and hence voluntarily continue to use them. Social and health support
Element 9:	Change management: Learners	Learners do not always know how to use ICTs to learn (OECD). Provide a course covering: sourcing of online content, referencing, plagiarism, fact-checking, intelligent browsing, critical thinking, and how to produce documents.
Element 10:	M&E	ROI is the issue — outputs should justify the cost of the initiative. Monitor usage, monitor uptake, monitor learner outcomes, and sustained engagement
Element 11:	Support and Maintenance	Offset costs against other budget items. Sustainability. Ongoing costs include: training, equipment replacement/upgrade, bandwidth, and support (School Champions). Simple solutions are more scalable and sustainable. Engage stakeholders

Element 12:	Community	Buy-in and support, SMME up-skilling, creating opportunities
Element 13:	Project Management	Necessary for sustainability and ongoing support.
Element 14:	Stakeholder Engagement	Identified stakeholder list is available.

C.2   Concerns and recommendations, as per ICT dimensions

Vision, policy, planning

An overall policy vacuum leads to change and performance that is directed by solution providers.

Element	Concerns	Recommendations
Theory of change	Solution providers drive installation of hardware, in the absence of a clear theory of change.	Develop measurable indicators at six levels of an outcomes chain (problem identification, inputs, intermediate and final outcomes, change).

Curriculum and content

Content can benefit from curation and organisation. ICT needs to be in support of curriculum, not the other way around.

Element	Concerns	Recommendations
Content: Open formats, Creative Commons, DRM-free, multi-lingual, CAPS-aligned	• Large caches with unstructured content • Outdated, not mobile-aware • Over-focus on PDFs • Large size of multimedia items (videos) inhibit use	• Easy to use, share, customise • Open formats • DRM free • Multi-lingual • Good quality • Local content • CAPS aligned

Pedagogy

Training is required to ensure that ICTs are integrated into pedagogy, in a phased manner. Teachers and learners must be guided to use ICTs in support of teaching and learning.

Change management:

Teachers
Phased gradual introduction of components is better, starting with change management. Training teachers so that they meaningfully feel that the ICTs are valuable and useful and hence voluntarily continue to use them. Social and health support.

Learners
Learners do not always know how to use ICTs to learn (OECD). Provide a course covering: sourcing of online content, referencing, plagiarism, fact-checking, intelligent browsing, critical thinking, and how to produce documents.

Element	Concerns	Recommendations
Change management: training and integration into pedagogy for teachers	• *The value of incorporating ICTs is not always clear to teachers, and is not well addressed by programmes* • *Teachers have a slower uptake of ICTs than learners, and fear the change that is brought about* • *Teachers have different levels of knowledge of ICTs* • *Teachers lack confidence to use ICTs*	• *Teachers should be shown why ICTs are valuable* • *First teach use of ICTs in a safe space, preferably face-to-face* • *Incentivise training* • *Subject-specific pedagogy should follow* • *Teachers should be taught on integrating ICTs into pedagogy in pre-service training* • *Training should recognise teacher's time restrictions* • *Teachers' skill level should be assessed before training is introduced* • *A national research initiative into best-practices around ICT in Education should be established*
Change management: Integration into learning for learners	• *There are expected educational benefits as well as concerns when exposing learners to technology in classrooms*	• *Use a phased approach to integrate ICTs into learning* • *Applications should be selected in support of learning*

Change readiness, management and leadership
Schools need to be assessed for readiness—there is no 'one-size-fits-all'. Change management needs to take a systems perspective, including integration into all levels of the educational organisation.

ICT readiness

The following elements should be seen as 'entry criteria' into the programme: Secure buildings, electrical supply, availability of 3G, proximity to a road, school principal leadership, district and PED support structures present, and school staff willingness.

Element	Concerns	Recommendations
Change management: ICT Readiness	• *Schools with poor infrastructure do not see ICTs as a priority* • *School's priorities are not ICT related* • *A limited percentage of schools have already-existing ICTs – which is an indicator of (poor) ICT readiness* • *ICTs are resisted, because there is not clarity at school level of the expected use and impact thereof* • *A variety of aspects hinder readiness and deployment of ICTs, ranging from leadership to infrastructure (electricity, broadband, procedures, etc.)*	• *Assess ICT readiness before implementation – there is no one-size-fits-all* • *Have schools tender to participate in ICT programmes, to ensure commitment*
People readiness	• *Change management needs and requirements should be understood*	*Install ICTs where the following are in place:*
Process readiness	• *Processes are affected by ICT introduction, and need to be identified and managed*	• *Leadership and willingness* • *District and PED support structures* • *Willing staff*
Technology readiness	• *Power supply and security critical to deployment*	• *Asset management and tracking* • *Security, electricity, access roads*
Community	• *Community involvement is essential for security* • *Community social challenges could be partly addressed though ICT-enabled solutions* • *Teacher depression and demotivation is part of the community problem*	• *Buy-in and support* • *SMME up-skilling, creating opportunities* • *Community support tools could be included in the ICT solution* • *Communities should be allowed to access the online learning resources*
Stakeholder engagement		
Integration into pedagogy for teachers and learners	*See 'pedagogy'*	

ICT

Technology solutions need to be designed with awareness of cost constraints, limited connectivity, intermittent electricity supply, security considerations and challenging support environments.

Hosting

The hosted solution should employ load-balancing and should be scalable.

Caches

Centralised curated content to be sent downstream to appliance-like servers.

Broadband.

We should supply broadband at least to the caches at schools (Element 3) as well as, at least, to principals and teachers. 3G is easiest to deploy.

Last-mile and LAN

Provide Wi-Fi on-site.

End-user Devices

BYOD at home, maybe tablets for learners, teacher tablets.

Support and Maintenance

Offset costs against other budget items. Sustainability. Ongoing costs include: training, equipment replacement/upgrade, bandwidth, and support (School Champions). Simple solutions are more scalable and sustainable. Engage stakeholders.

Element	Concerns	Recommendations
Hosting	• Single online servers with limited usage • Scalability not generally considered	• Load-balancing • Scalability • Virtual machines
Upstream portals and onsite caches	• Broadband unstable, expensive • Most solutions not tested under large loads; most not scalable • Large content basis without interactive features and curation procedures • English only • Not designed for non-digital-native • Clarity about ownership and transfer of user-content required • Browser incompatibility	• Centralised curated content to be sent downstream to appliance-like servers • Desirable features: • CAPS requirements fulfilled • Provide virtual learning environment • Include people-management and communication tools, M&E • Calendar and scheduling systems • User-friendly interface • (see report for more detail)
4.Broadband	• Lack of connectivity in rural areas at broadband speed so as to enable the delivery of high-quality content.	• Supply broadband at least to caches at schools • At least to teachers and principals • 3G easiest to deploy

Last-mile and LAN	• Costs of WLANs are high • Video requires high bandwidth • Access to inappropriate sites need to be controlled • Limited range access points • Concurrent user limits.	• Provide Wi-Fi on site, linked to LAN • WLAN should be able to support large files • Minimise video size • Use caching and proxying • Distribute smaller, affordable AP's
End-user devices	• Security • Cost • Resistance to use by teachers • Distractions & social networking • Device loss & destruction	Traditional computer labs no longer relevant Tablet solutions (with charging stations) for primary schools Aim for 1:1 solutions Negotiate affordable sourcing Allow BYOD at high schools Teacher tablets, earn-to-learn model Maybe learner tablets
Support and maintenance	• Ongoing support costs are significant. This includes training, technology support, and device replacement. • Complex and highly customised solutions are difficult and expensive to support. • New people enter the system; ongoing training is required. • A clear exit strategy is required. • Support structures need to be in place before equipment is delivered.	• Financial and technical support, district and provincial support and ongoing training and usage are critical. • Design simple, easy-to-support solutions that require minimum intervention and training. • Plan and budget for initial as well as ongoing elements (maintenance, training, technical support, equipment rollover). • The PED requires a dedicated department to provide ongoing capacity and skills in support of e-learning.

Management and systems

Project Management
Necessary for sustainability and ongoing support.

M&E
Return on investment is the issue: outputs should justify the cost of the initiative. Monitor usage, monitor uptake, monitor learner outcomes, and sustained engagement.

Teacher professional development
Teacher development needs to comprise pre-service and in-service training. Training needs to focus on the use of ICTs in support of teaching and learning, and needs to be negotiated with the Department of Higher Education and Training.

Change management:

Teachers

Phased gradual introduction of components is better, starting with change management. Training teachers so that they meaningfully feel that the ICTs are valuable and useful and hence voluntarily continue to use them. Social and health support. (For details, see Pedagogy)

APPENDIX D: PRINCIPLES FOR DESIGN NATIONAL ICT INFRASTRUCTURE

The following principles are outlined by Amory *et al* (2015:32-33) n terms of the design of a national system:

- Every school needs at least a single connection to the educational wide area network.
- Different school contexts necessitate different models of connectivity to the education wide area network.
- All teachers and learners should make use of technology in order to be ICT literate and to use technology as a cognitive tool to support learning.
- Security of the system must be considered from a number of perspectives. Some 'clients' require read and write privileges, while others only require read privileges.
- The design, implementation, and management of the education wide area network should make use of the most recent architecture to support future development but should be built according to internationally agreed standards.
- Interfaces used by meso- and micro-levels should not require additional licencing, specific software or hardware.
- Bi-directional flow of data to support national objectives and local initiatives and management should be part of the specification.
- Use should be made of a change management system to implement the local and national management systems.