

Broadband in Schools: Towards a Definition and Model of Broadband for South African Schools

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Abstract: South Africa is about to provide broadband internet connectivity to all schools in the country via the implementation of the national broadband policy. The challenge is to ensure a balance between the schools' demand-side usage and supply-side bandwidth provision, so that the large investment in infrastructure to schools is not wasted and, conversely, so that there is sufficient bandwidth to support the needs of schools. In order to inform the bandwidth implementation process, a bandwidth allocation model needs to be developed. Broadband models employed by other countries are not necessarily appropriate for South African schools. To support this objective, a definition for "broadband for South African schools" was developed, leading to a "Broadband in Schools Impact Framework" that identifies factors that need to be considered when providing broadband to South African schools. The framework gives guidance to implementation agencies and government policymakers to ensure that the investment in infrastructure leads to appropriate impact and outcomes within the education system, from an educational perspective, rather than from a technology perspective.

Keywords: definition of broadband, bandwidth in schools, ICT, technology, broadband, connectivity, SA Connect, broadband policy

1. Introduction

As specified in South Africa's National Development Plan, Information and Communication Technology (ICT) has become a critical aspect of life in the 21st century [1]. Rapid advances in ICT and expanding, high speed connectivity to the internet have made the world increasingly complex, inter-connected and knowledge-driven [1]. In a globalised economy with a high degree of competition between countries, the success of a nation depends on the quality of its workforce [2].

In a networked, always-on, evolving and growing world, it is imperative that the education system is able to harness ICT to produce a workforce that is fit for purpose. ICT has the potential to transform the education system in South Africa to be internationally competitive if implemented and managed appropriately and if combined with other educational improvement activities.

Typically, schools use ICT and connect to the internet for the following reasons:

1. To improve the efficiency and effectiveness of school administration, management and planning [2, 3];
2. To support the development of 21st century skills for both teachers and learners [4]. This includes the concepts of collaboration, critical thinking, creativity and comfort with technology (i.e. digital literacy, which is the ability to effectively use technology and navigate the digital world [2, 4]); and
3. To use technology as a tool for teaching, learning and collaboration [5]. Technology has the potential to enhance and modernise pedagogical models, both in the classroom and by extending reach beyond traditional brick-and-mortar boundaries [6].

The e-Education White Paper [7] of the Department of Basic Education (DBE), in addition, identifies technology as a tool to increase equity and access for resource-constrained and disadvantaged schools. Unfortunately a number of key challenges remain that inhibit the potential positive impact of new technologies on teaching and learning [6]. Foremost among these is the belief that educational challenges can be overcome simply by providing more and better devices and connectivity. The so-called Matthew Effect of educational technology holds that those most likely to benefit from the use of new technologies in educational settings are those who already enjoy privileges related to wealth, existing levels of education, and prior exposure to technology in other contexts [6]. Policies that neglect to consider this phenomenon may result in projects that exacerbate existing divides within an education system [6].

The fact that access to the internet is provided to a school, does not mean that the school has the capacity or skills to make full use of the technology [4]. There have been quick wins regarding administration and management systems, but integrating technology into a school in order to achieve learning transformation requires a complex set of changes that affect all areas of the education system. There are many activities that are needed to stimulate this “demand-side” of technology and internet connectivity in schools [2].

Regarding the “supply-side” provision of technology and connectivity infrastructure to schools, there are currently multiple interventions in progress in South Africa. Approximately 51% of schools are currently connected to the internet [3]. Connectivity is funded and provided as follows [3]:

1. Schools themselves through the annual budget allocations (sometimes subsidised by parents and other organisations);
2. Corporate Social Investments from the private sector;
3. Efforts by municipalities (e.g. Tshwane’s Project Isiswe) and state-owned entities (Sita, Sentech, etc.);
4. Research projects funded by various government departments (e.g. the Department of Science and Technology’s Technology for Rural Education project and the Broadband for All project, facilitated by the CSIR);
5. University outreach programmes;
6. The Universal Service and Access Agency of South Africa (USAASA);
7. Provincial Departments of Education (e.g. Western Cape and Gauteng);
8. The national Department of Basic Education (DBE);
9. The 2010 FIFA World Cup Legacy Fund via Telkom;
10. The Universal Service and Access Obligations imposed on the Network operators as one of the conditions linked to their operating licenses (ICASA); and
11. SA-Connect implementation by the Department of Telecommunications and Postal Services (DTPS)

Unfortunately, much of this connectivity is either inadequate or is not being fully utilised by the schools [3]. The SA-Connect initiative of DTPS is the vehicle for implementing South Africa’s Broadband Policy, and is starting to rollout connectivity to schools throughout the country [8]. Phase 1 of SA-Connect aims to provide broadband access of 10 Mbps to 4444 schools in 8 District Municipalities by the end of 2017. Targets increase incrementally towards 1Gbps to all schools by 2030 [8].

In order to provide broadband to schools, there is a need to define the concept of “broadband” in the context of schools. Currently, this has not been done in South Africa. This paper attempts to provide input into this definition, by taking the context of schools in South Africa into account, identifying best practice from elsewhere and linking this to South Africa’s broadband definition, as articulated in the South African Broadband Policy document [8].

2. Objectives

As can be seen by *Figure 1*, the objective is to ensure a balance between demand-side usage and supply-side bandwidth provision, so that the large investment in infrastructure to schools is not wasted and, conversely, so that there is sufficient bandwidth to support the needs of schools.

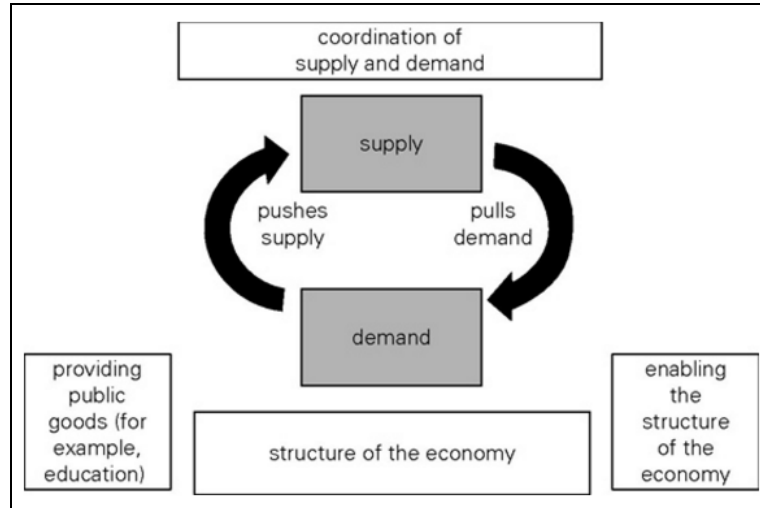


Figure 1: World Bank framework for Government Intervention to Facilitate Broadband Development [9]

All schools are different – they start from different expertise and experience levels, different levels of functionality and different contexts [10]. A single bandwidth provision model for all schools is therefore not appropriate in a bandwidth-constrained country where broadband is an expensive commodity [11]. Data released in a survey done by the SA Institute of Race Relations [11] indicates the average monthly cost of broadband in South Africa is more than 10 times higher than in the United Kingdom (UK). In comparison, it found that the UK enjoys a broadband speed that is five times higher. In addition, South Africa’s broadband speed is about a fifth of that of the United States (US) but its average monthly broadband cost is over five times as high. The average cost of broadband for a South African internet user is approximately R337 a month, versus the cost in the UK of about R36 a month. Not only are the UK and US’s services cheaper, but they are also faster and have a higher number of users [11].

The objective of this paper is to develop a definition and model for bandwidth provision to South African schools that leads to a better understanding of the challenges related to the coordination of supply and demand of bandwidth to schools.

The ultimate objective of this work is the eventual development of a bandwidth prediction model for schools in South Africa, which takes into account the unique context of each school. This will ensure that bandwidth provided to schools is affordable, accessible, effectively and appropriately used.

3. Methodology

This paper aims to provide input to the ultimate question “How much bandwidth does a school need in South Africa to adequately integrate technology into teaching and learning?” In order to address this question a scoping review was undertaken. According to Grant and Booth [12] scoping reviews assist a researcher to establish the current state of research in a particular subject area (broadband in this paper). Colquhoun et al. [13] define a scoping review as “a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesizing existing knowledge”. The scoping included the following databases: ACM digital library, IEEE Xplore, Scopus and ScienceDirect. This methodology allowed the researchers to do the following:

1. Developing a definition of broadband within the context of schools;
2. Using this definition to develop a model that identifies the various factors influencing the demand for connectivity; and
3. Highlighting areas that need to be focused on to ensure the education system (at national, provincial, district and school levels) is adequately prepared, ready and empowered to take full advantage of this broadband connectivity.

4. Broadband in the Context of Schools

The ITU defines broadband in general as a transmission speed of 1.5 to 2 Mbps [3]. The *Broadband Commission for Digital Development* believes that "high-speed, high-capacity broadband connections to the Internet are an essential element in modern society, conferring broad social and economic benefits". The challenge of specifying a transmission speed to the definition is that broadband bandwidth becomes a moving target as technology and infrastructure evolves at a rapid pace.

Without broadband infrastructure and services, developing countries risk exclusion from participation in the burgeoning global digital economy [2]. The Commission also argues that broadband internet presents more teaching and learning digital opportunities due to its greater capacity to carry information at higher speeds. Such digital educational opportunities include audio and video streaming, educational gaming and live virtual tutoring [2].

The South African Broadband Policy was approved by Cabinet towards the end of 2013. This contains, among other things, the South African definition of Broadband that is not linked to a particular speed but to the ability that broadband provides to users [8]:

"Broadband is always-on connectivity, where users can access the most demanding interactive content to meet their needs in real time. It's enabled by a high-end ICT platform with the potential to enhance the variety, utility and value of services and applications offered by a wide range of providers to the benefit of diverse users and communities across all sectors of the economy."[2]

The US defines speeds per school, i.e. "by the 2014-2015 school year, schools have at least 100 megabits per second of connectivity to the external Internet for every 1,000 students and/or staff member"[7]. Critics note that such measures ignore the potential importance of prudent bandwidth management and optimization at the local level (the school and the district) [7]. There is also criticism that this kind of definition could be driven by commercial interests, with companies benefiting from increased bandwidth to schools.

The UK's broadband to schools model uses 2 Mbps per learner as a baseline for connectivity per school, but allows for 1 in 10 devices being active during peak demand. Thus a school of 1600 learners, where 400 learners have connected devices, would need bandwidth of $400 \times 2/10$, which equates to 80 Mbps. Average growth in school usage of the internet in the UK has been estimated as 30% per annum and this is built into the model [12].

There is a need to define broadband in schools for the South African context, in ways that support internationally accepted norms and standards and link to the South African broadband definition. The definition should focus on "always on" and "high capacity" as supported by the Broadband Commission [2] and the "ability" that broadband provides users. The definition should speak to the level of readiness of schools to make optimum use of the bandwidth, particularly for teaching and learning purposes. The concept of an "ecosystem", which includes both supply and demand aspects of broadband connectivity should also be supported. Based on these criteria, the following definition of *Broadband for South African Schools* is suggested:

"Broadband for schools is an ecosystem of always-on, high capacity and high quality networks, services, content and applications that are extensively used by skilled and confident users at schools in order to reach educational goals."

5. Factors Influencing Broadband Usage in Schools

A “Broadband for Schools Impact Framework” (see Figure 2) was developed, based on the “Broadband for South African Schools” definition, the “demand” and “supply” focus of the World Bank framework for Government Intervention to Facilitate Broadband Development [9], the ICT4RED 12 Component Model [4] and the ICT Development Index (IDI) conceptual framework developed by the International Telecommunications Union (ITU) [3].

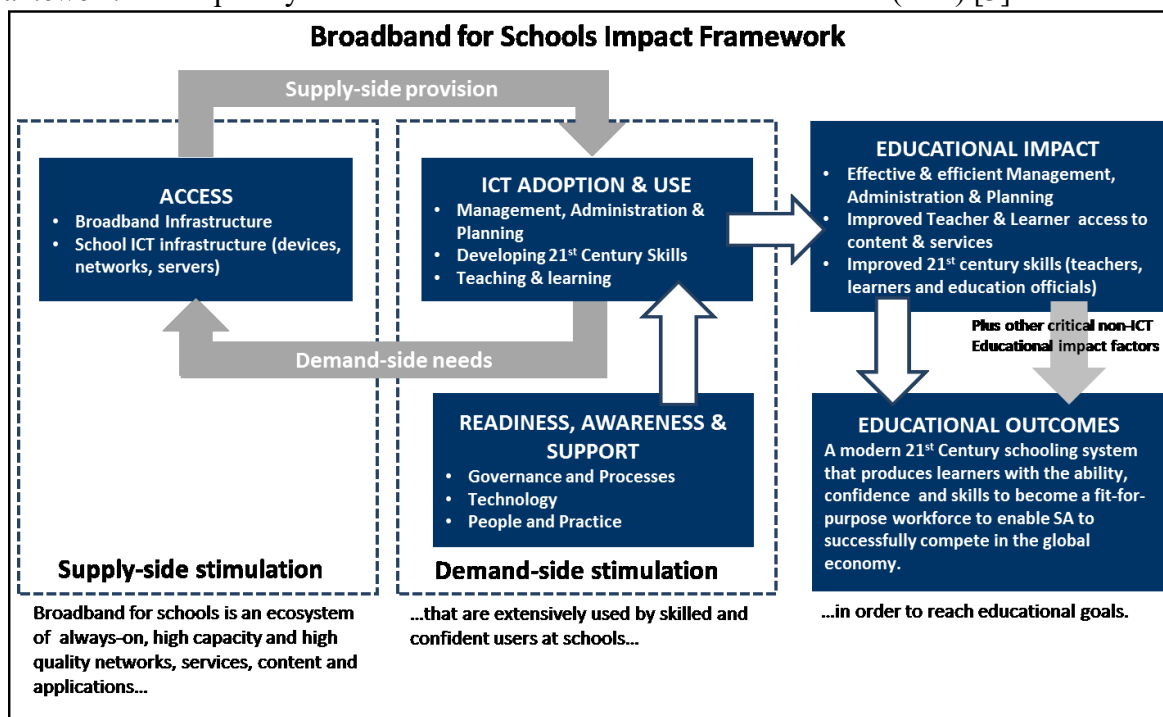


Figure 2: Broadband for Schools Impact Framework (adapted from 3, 4, 9)

The main focus areas of the Framework are as follows:

- ACCESS** is predominantly infrastructure and technology-oriented, but also includes ICT services (e.g. a provincial/national help-desk), content (e.g. access to cloud-based content repositories and/or local content servers) and applications (e.g. access to Microsoft’s Office365 or Google for Education cloud services, etc.). In the context of SA-Connect, this includes the broadband infrastructure being rolled out to schools in Phase 1. Phase 2 of SA-Connect will also include some end-user devices. This “**Supply-side provision**” should support the “**Demand-side needs**”. The challenge is to provide a cost-effective, pragmatic solution that takes into account the current situation in schools whilst supporting aspirational needs and scalability for the future.
- ICT ADOPTION & USE** includes the willingness to use ICT, the types of ICT usage and activities in schools and the frequency and intensity of use. As a school becomes more adept and confident in integrating technology into everyday practice, usage intensity is expected to grow, leading to an escalation of “**Demand-side needs**” which should result in increasing “**Supply-side provision**”.
- READINESS, AWARENESS AND SUPPORT** is necessary in order to stimulate, support and influence the rate of **ICT Adoption & Use**.
- EDUCATIONAL IMPACT** with regards to ICT integration in the education system should result in:
 - Effective and efficient Management, Administration and Planning;
 - Improved Teacher and Learner access to content and services; and
 - Improved 21st century skills (teachers, learners and education officials)
- The following **EDUCATIONAL OUTCOMES** should be achieved:

“A modern 21st Century schooling system that produces learners with the knowledge, ability, confidence and skills to become a fit-for-purpose workforce to enable SA to successfully compete in the global economy.”

Note that this educational outcome is linked to the education challenges in a modern world as proposed by the Broadband Commission [2]. There is a need for the DBE to clearly define the outcomes for South Africa’s education system, taking into account the requirements of an Information Society and Knowledge Economy. It is also not only dependent on ICT, but on many other critical non-ICT educational impact factors (such as leadership in schools, teacher subject knowledge, etc.)

6. Areas Needed to Ensure Demand-Side Stimulation

There are many activities under **READINESS, AWARENESS AND SUPPORT** in the model, that should be undertaken to ensure demand-side stimulation, as captured in the ICT4RED 12 Component Framework [4]:

1. Governance and Processes (lead, learn and manage):

- **Clear Ownership and Accountability:** This is major indicator of success and is needed across the whole education ecosystem, at all levels [10].
- **Monitoring and Evaluation:** An M&E plan is needed in order to measure and analyse multiple educational areas (e.g. continuous development of teachers and officials, use of technology in schools and bandwidth utilization on an ongoing basis) [4, 10]
- **Policy:** Revamping of policies is needed on national, provincial and school levels. Development of new policies and updates of existing need to stay in step with expanded ICT use in the South African school system [4, 10]
- **Management Structures, Systems & Processes:** Once technology has been integrated into schooling, it is not “business as usual”. True integration is a paradigm shift in how teaching and learning happens. It is critical that the structures, systems and processes are redesigned for a 21st century schooling environment [10].

2. Technology (use, implement and operate):

- **Content and Curriculum:** Additional digital content linked to the curriculum will need to be developed, in ways that are norms- and standards-based to make provision for multiple types of devices (e.g. smartphones/tablets/laptops/new technologies that don’t yet exist) and multiple modes of access (e.g. cloud vs local) [4]
- **Operations:** It is critical that adequate and efficient operations management processes are instituted across the system. Issues around power need to be attended to – schools need access to reliable, stable power, it is not sufficient to check whether a school is connected to the grid or not [4]. In addition, the safety of learners and the security of devices need to be considered. Device and bandwidth management will be needed at all schools.

3. People and Practice (prepare, develop and change):

- **Professional Development:** Initial professional development of leadership, managers, education officials and teachers needs to be undertaken, so that schools are able to effectively, efficiently and confidently utilize ICTs for teaching and learning. Although this includes digital literacy skills, the most critical skills are knowing how to “teach with technology” (teachers) and pedagogical and content support to schools (district officials) [4, 10]. Professional Development should be ongoing, as new technologies emerge and as teachers and district officials become more competent in utilizing technology to achieve their goals [14; 15]
- **Change Leadership & Management:** In order to truly integrate technology to support management, administration and teaching and learning in the educational system, it is critical that change management is comprehensively addressed, beyond exposing people

to courses. Leadership and support for change needs to be driven from the top and needs to permeate every corner of the education system [14].

- **Community Engagement:** Communities, particularly learners, parents and School Governing Bodies need to be consulted and kept informed, not only during initial rollouts, but also throughout ongoing decision-making activities (e.g. bandwidth management policies, safety and security policies, when/whether to introduce new device policies, etc.) [4]
- **Advocacy and Communication:** These are important activities as part of awareness-creation in order to get buy-in across the system (learners, teachers, parents, education officials). Each target group needs to understand the value of technology and what their roles and responsibilities are regarding technology in schools [4].

7. Conclusions

The development of a definition and model for Broadband in Schools in South Africa will ensure implementers and policymakers are better able to identify and measure the aims and objectives of providing broadband connectivity to schools, allocate roles and responsibilities to all the stakeholders and to better plan for implementations of ICT in schools. For example, for improved technology uptake, it is necessary to ensure that infrastructure rollout plans dovetail with the training and development of teachers and education officials and the expected rollout of connectivity infrastructure, ICT equipment and devices to schools.

Planning and preparation beyond the narrow confines of technology deployments, are vital. There is a need for Implementation Readiness assessments prior to infrastructure deployment [10; 15]. This will ensure that the appropriate activities are undertaken at all levels of the system in order to ensure the best chance of ongoing sustainability and success. Examples include setting up support structures at provincial levels (e.g. a technology help desk), ensuring change management activities are undertaken, professional development takes place (of teachers and education officials) and new organisational structures and processes are provided for (e.g. making provision for the cross-cutting nature of ICT; streamlining budgeting processes; developing strategies for additional applications of ICTs, such as online assessments and management dashboards; bandwidth and technology utilisation measurement and upgrade/downgrade policies; development of ICT support technician models; etc.)

In preparing for ICT integration in schools, the whole education ecosystem needs to be prepared. If the demand-side activities do not receive priority focus, then the large investment in infrastructure will be wasted. In many vulnerable and resource-constrained schools, the additional responsibility of managing technology in addition to managing day-to-day teaching and learning activities, could result in additional challenges and possibly negatively affect learning outcomes [4].

Further work is needed in understanding the use of technology, bandwidth utilisation and adoption patterns in South African schools that are already connected, in order to develop a baseline for expected bandwidth utilisation in schools across the country.

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