

DEVELOPING NEW INDICATORS TO DESCRIBE DIGITAL TECHNOLOGY INFRASTRUCTURE IN PRIMARY AND SECONDARY EDUCATION

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1 Introduction

1.1 Context

The paper presents a set of metrics for describing the digital technology infrastructure in the school sector. A range of metrics already exists, however these need updating to reflect the rapid changes in digital technology that have taken place. For example, mobile devices and cloud-based services have emerged and achieved significant penetration in the education sector over recent years. Education is also evolving within and beyond schools.

This paper examines the evolving nature of digital technology and the associated infrastructure to support learning of children and young people attending schools (i.e. primary and secondary) from both developed and developing countries in all regions. It also includes consideration of others who may be educated without attending a school campus. It recommends new (and/or modified) metrics to inform understanding of the digital technology provision in the school sector, which are also recommended for consideration by partnership agencies and organisations. While some definitions are provided in section 1.2 they are not definitive, serving only to clarify the term ICT as used in this paper. Other terms that are not defined include information literacy (see for example Fraillon, Schulz, Wolfram, & Ainley, 2013).

The paper has been commissioned by the UNESCO Institute for Statistics (UIS) as one of three background papers to advance the global data collection about digital technology use in education statistics in the post-2015 context. The 2014 review of the outcomes of the World Summit on the Information Society ([WSIS+10 2014](#)) is useful for this context.

Both digital technology and education are evolving at an increasingly rapid pace, both separately and together. For example, there have been significant developments in new digital technology platforms such as mobile technologies, cloud computing, social media, open educational resources (OERs), free and open-source software (FOSS), as well as the associated hardware (e.g. mobile phones, tablets, e-readers, interactive whiteboards). Opportunities and demands of globalisation and technology are fuelling transformations of educational practices and school infrastructure so quickly that international agencies and government Ministries are increasingly challenged to remain up to date in measuring the use and integration of digital technologies in education. The evolution of educational systems and digital technology also provide additional challenges to framing our perspectives, including the emergence of virtual and networked schools that share courses and programmes within countries and across regions (Davis, Eickelmann & Zaka, 2013). Finally, the very different contexts of school-age children and young people can be strongly influenced by their gender (Subrahmanian, 2007), including access to education and digital technology within and beyond school and home, which is highly influenced by considerations of what is acceptable within the multiple cultures within which children grow up today.

The paper also aims to examine amongst developing countries, the innovative use of digital technology to enhance learning across the curriculum including mobile computer labs (e.g. BRAC, a non-governmental organisation that is sometimes known as Bangladesh Rural Advancement Committee), the use of community tele-centres in an official capacity by educational authorities, as well as older, more traditional forms of technology-assisted instruction that use radio and television broadcasts as part of the regular school day or on an ad hoc basis. Digital technology resources and support provided to young people who attend school and the educational staff who work with them may also be relevant even when provided

by public and community libraries and community centres. This includes clubs that provide access to digital technology and technical support, as well as coaching to build digital literacy skills and skills for maintenance of digital technology devices and networks. Other forms of innovative use of digital technology to be explored and examined include interactive radio instruction (IRI).

The authors recognise that many of these topics cannot be addressed well without consideration of the topics that will be covered by the two complementary papers that focus on the ways in which digital technology is used (Gibson, Downie and Broadley In Preparation) and the preparation, professional development and ongoing support of educators and those who support them including leaders within schooling systems (Du Toit In Preparation). For example, a consortium of leading organisations in international development, health, nutrition and education recently stated in their review of educational technology

Several studies showed that increasing students' access to computers of itself has little discernible impact on teaching or learning practices. ...

The effective use of any learning technology is bound up in pedagogy, curriculum, purpose, roles and activities. If new technologies are introduced without changing any of the other aspects, nothing different is happening.

([Power 2014](#) p. 7 & p. 12).

[Kennisset's \(2014\)](#) annual 'four in balance reports' communicates this as an ongoing balancing process that is best driven by educational vision, supported by expertise, content and applications, with technology infrastructure as the fourth and last basic condition.

This paper considers digital technology infrastructure outside the school premises, acknowledging the additional challenges and issues that arise from learning through digital technology, sometimes at a distance. This leads us to recognise that a key factor will be to identify the fit of the digital technology for the purposes, often multiple purposes, of primary and secondary schooling.

To illustrate the complexity of schooling infrastructures and emerging trends, a range of vignettes (see Appendix 6.2) are used before making recommendations about new indicators.

1.2 Defining ICT

The term ICT is used differently across different contexts, often leading to confusion and miscommunication. For example, it has been used to refer to a specialist subject (learning about digital technology); to the use of digital technology across the curriculum (learning supported by digital technology); and to refer to hardware, software and associated digital technology infrastructure. Care should also be taken to distinguish it from learning in different locations communicated via digital technologies including telecommunications.

In order to avoid confusion, this paper will use the following terms, which we acknowledge are not the same as those previously adopted by UIS:

Digital technology - the technology infrastructure, including hardware and software.

ICT - the cross curricula use of digital technology to enhance learning.

Computing - an umbrella term to refer to subjects that are focused on teaching about digital technology and its use, including: Computer Science, Information Technology, and Digital Literacy.

Computer Science - is a scientific discipline, covering principles such as algorithms, data structures, computational thinking, programming, systems architecture, design, problem solving etc.

Digital literacy – is the ability to operate effectively as a citizen in the 21st century. It covers the following areas:

- Understanding the impact of new technologies on society, including the ways in which new technologies change disciplines (e.g. history, chemistry, English, etc.)
- Understanding the nature of digital identities and being able to manage your digital identities appropriately
- Being able to interact safely in a digital world (encompassing e-safety, cyber-bullying, data security, etc.)
- Being able to locate, organize, understand, evaluate, analyze and (re)present information and communicate using digital technology (including using dynamic and procedural representations – this can be viewed as 'the creative' making and doing aspects of using digital technology although many other aspects of the subject can also be creative).

Information Technology (IT) - the assembly, deployment, and configuration of digital systems to meet user needs for particular purposes. (Note that this is narrower than the use in industry, which generally encompasses Computer Science as well).

1.3 Some emerging trends

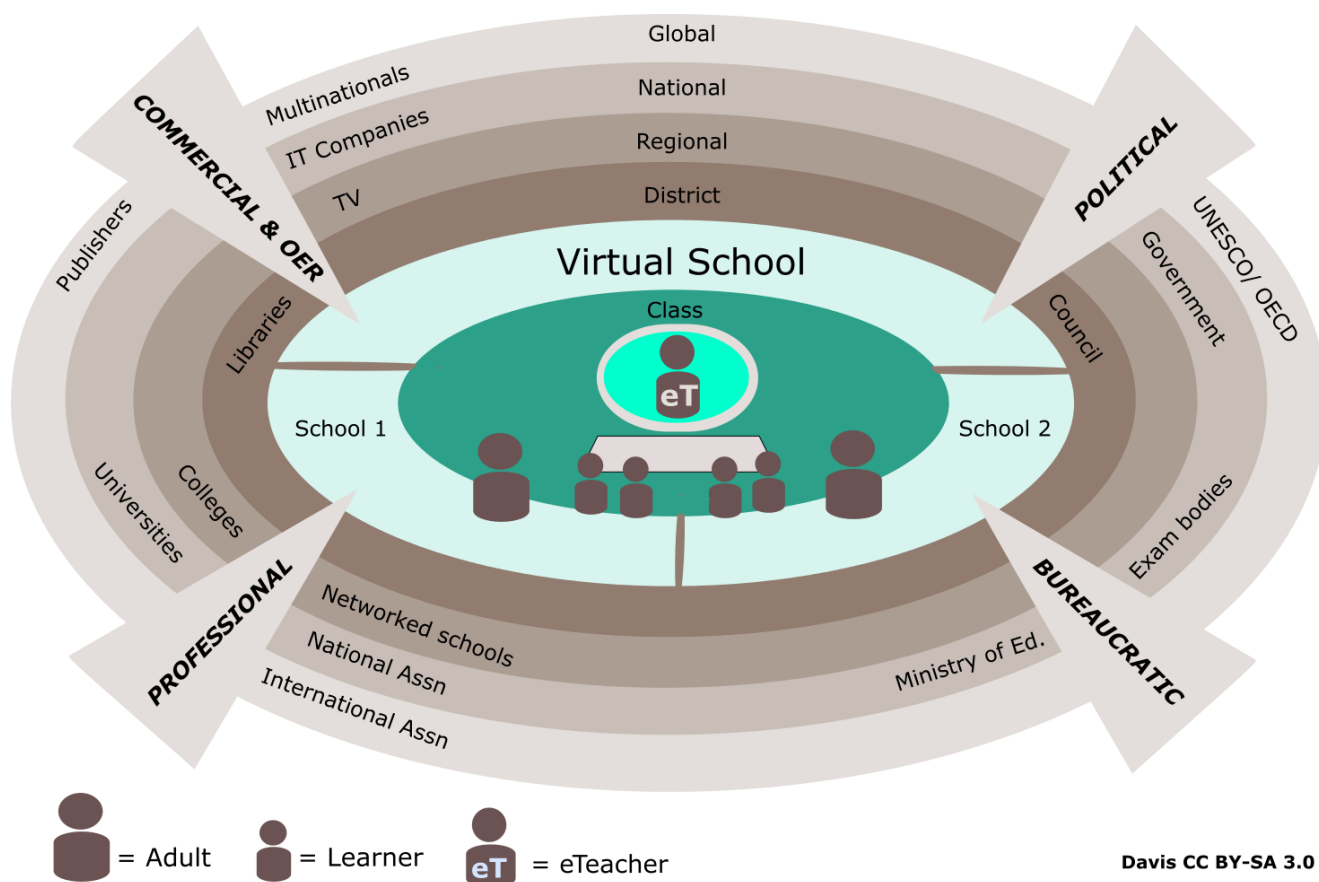
Both digital technology and educational systems are evolving rapidly and those changes stimulate further evolution and co-evolution with worldwide impacts (Davis, Eickelmann & Zaka 2013). Essentially it is collective actions globally that result in the societies of today. UNESCO's recent review of digital technology in schools across the Asian region describes a wide diversity of rapidly evolving educational ecosystems, many increasing the adoption of digital technology and some dropping back as they prioritise other aspects, including the employment of teachers (UIS, 2014a). In the interests of equity, which is an important part of post WSIS contexts, these diversities are best perceived in relation to the larger systemic contexts locally and globally. As Paul Gorski recommends, this paper presents indicators to assist in measurement of

digital inequities, not as individual phenomena, but as symptoms of larger systemic inequities. And we must challenge strategies for “closing” or “bridging” the digital divide that fail to consider digital inequities in this broader context.
(Gorski, 2009; p. 360)

Therefore the paper adopts Davis' (2008) arena of change with digital technologies in education to clarify the interaction between global and local educational ecologies on four main axes: political, bureaucratic, professional, and commercial (including FOSS and OER). Figure 1.3.A presents a recent version of the arena at the centre of which is a distant teacher viewed through digital technology by students located in different schools and/or homes. This virtual classroom is nested within larger ecologies of the school, the region, the nation as well as a global

perspective. Figure 1.3.A clarifies the need for indicators to move beyond the school level and to recognise the interfacing of digital technology and practices across participating organisations, including access to secure Virtual Learning Environments for educators who are not employed by a school (Davis 2014).

Figure 1.3.A Davis’ global arena of change with ICT in schooling showing a distant teacher working with students in at least two schools, as well as the ecosystems within which a teacher enabled by ICT is nested at the centre (developed from Davis, Eickelmann & Zaka 2013 p. 442)



The first major trend recognises the increasing importance of digital technology infrastructure that is not on the school premises, including the growth of state and nationwide provision of virtual learning environments. Korea’s award-winning ‘Cyber home school’ (UNESCO education award 2009) has been followed by others, such as Malaysia’s VLE [1BestariNet](#) (e.g. Vignette 4) that has a multi-lingual portal that aims to provide “an integrated platform for administrative, collaboration, teaching and learning activities which can be accessed by teachers, students and parents”. Teachers can access a Google dashboard to administer homework and other activities through the portal. Policies are set up to ensure compatible practices, such as adjustment to school firewalls to enable access to shared services that are not on the premises. Similarly cyber-safety and the healthy growth of digital citizens in schools and society have become a pressing issue (e.g. [UNESCO Bangkok 2014](#)) that is increasingly addressed with online services at national and global levels.

Regional services that make use of a limited digital technology infrastructure across a number of countries have also emerged to fit particular needs, for example, the [Exam Preparation Outreach Project \(EPOP\)](#) that provides an online portal for promising students, often in remote regions, who would like to attend university following their identification through Southeast Asian community organizations. Improving English language tuition may also take advantage of off-line digital technology such as the use of mobile phones as audio-visual tools in schools in Bangladesh (Vignette 1) and radio (Vignette 9).

Virtual school campuses have rarely been included in national metrics, with the exception of North America, and a number of Ministries and other agencies were unaware of the growth of digital technology-enabled distance education (Bacsich, Pepler, Phillips, Öström & Reynolds 2011; Davis 2012). The annual reviews of the growth of virtual schooling in North America have led to questions on funding and policy, including a U.S. federal report that attempted to classify virtual schools to inform national policy ([National Forum on Education Statistics 2006](#)). In contrast, Australasia has not seen the same rapid expansion with the evolution of nationwide correspondence schools slowly incorporating digital technology to fit their ecologies (e.g. Vignette 3). In the Pacific, as in other regions, a virtual school campus only becomes an option when the digital technology infrastructure improves; that occurred in 2014 in the Cook Islands with emergence of the [Cooks Online School - Te Kura Uira](#) to serve students in rural and remote schools on those Pacific islands.

Recent advances in solar power generation and deployment in schools and communities are improving access to more reliable power sources; it is hoped that the trend of increasingly affordable and reliable power sources for education will continue worldwide. However, caution is necessary, as digital technology infrastructure will compete for power with more essential infrastructure, such as toilets and basic lighting.

Digital technology resources are increasingly provided by public and community libraries and community centres to improve access in ways that support both children and adults, and their learning together. The digital technology infrastructure for displaced people such as refugees is also likely to be outside schools and linked to those who volunteer their aid (see Vignette 5). A move towards 'bring your own' (BYO), particularly iPads, Android tablets and mobile phones was identified as an emerging trend in the World Bank's 10 trends blog in 2012 (Trucano, Iglesias & Hawkins 2012). Such facilities may also travel to communities and schools in vans (e.g. Vignette 2) and on motorbikes.

For example, Bangladesh – with support from the non- governmental development organization, BRAC – introduced 17 mobile ICT laboratories containing laptop computers, cameras, multimedia projectors, etc. to cover 1,000 schools in remote areas (World Bank 2010). In contrast, Sri Lanka – through its Nensala Project – established over 700 rural tele-centres or “Nensalas”, which are managed and supervised by the Nensala Community Development Task Force to build ICT skills and impart ICT education in school curricula (Nensala 2013; World Bank 2010).

(UIS 2014a, p. 25)

Innovations to increase access to digital technology at home for educational purposes for those who cannot afford it are also common in fully developed countries (e.g. Vignette 3), including essential skills and safety training for parents and care givers. It is also important to note the increasing importance of digital technology infrastructure in teachers' homes as well as those who volunteer as educators, who often bring their own devices to support learning in schools and other contexts (e.g. Vignette 5). In developed countries the ratio of devices to students is

likely to increase above 1 to 1, with access to some school computers boosted by mobile phones and tablets such as the iPad. The digital technology expectations of schools also stimulate home ownership of devices and Internet access for both children and parents.

Hardware trends include an increasing range of digital devices with decreases in size, including tablets and wearable computers (e.g. in glasses). Tiny cheap computers such as the innovative Raspberry Pi have found a niche to improve the teaching of Computing, and can enable enthusiasts to recycle other parts including screens and keyboards. There are indications that the One laptop per Child (OLPC) movement will not continue, which would confirm that specialised educational hardware and related ICT infrastructure cannot be sustained by the education market alone. Improvement in the management of computer related waste is an increasing need and trend.

The 2014 K-12 Horizon reports for schools in Europe, the USA/world and international schools in Asia provide useful information on trends (Johnson, Adams Becker, Estrada, & Freeman 2014; Johnson, Adams Becker, Estrada, Freeman, Kampylis, Vuorikari, & Punie 2014; Johnson, Adams Becker, Estrada, & Freeman 2014; Johnson, Adams Becker, Cummins & Estrada 2014). Most noticeable are the trends increasing (a) adoption of Cloud computing and tablets, (b) mobile learning, and (c) personalized learning and access to remote facilities such as laboratories, with adoption for European schools predicted for 1, 2 and 5 years respectively.

Another trend relates to the increasing availability of digital content useful in education. Such content comes in many sizes and increasingly includes whole 'courses' that can be ported across learning management systems. The open courseware trend continues, sustained by educational outreach complemented with marketing (e.g. Massachusetts Institute of Technology (MIT) open courseware initiative in the USA). Access to such courses includes universities and consortia offering massive open online courses (MOOCs), which can complement secondary education and teacher training. A related trend is increasing use of OERs, which support customisation of courseware and other content. However, increasing access within diverse ecologies is likely to remain challenging for a number of reasons as noted in 2012 by the World Bank,

Sometimes part of open educational resources (OER) activities and/or taking advantage of various Creative Commons licenses, it is true that many such translation efforts are to transform educational content created in industrialized countries for use in developing countries, and that comparatively little efforts have been made to translate education materials created in the global 'South' for use in other developing countries (or indeed by countries anywhere). It is also true that translating and contextualizing content to meet local circumstances and needs are not the same thing. That said, what was once largely the domain of enthusiasts utilizing new digital tools to make available their own translations of (for example) Japanese comics and animation for wider audiences is becoming an activity that, while perhaps not mainstream, is of increasing relevance to learners in many countries.

[\(Trucano, Iglesias & Hawkins, 2012\)](#)

There are strategies that can enable better uptake, such as the successful Teacher Education in Sub Saharan Africa (TESSA) project that continues to involve many educators in Sub Saharan Africa to develop OERs and place them in a repository. Vignette 7 describes the embedding of TESSA OERs within initial teacher education in Nigeria to enable improvements in mentoring of beginning teachers. The increasing understanding of the complexity of OERs is likely to increase quality uptake over time. For example, Atenas and Havemann (2014) describe the key

principles of repositories of OERs that underlie open access for higher education and the 2012 Paris OER Declaration (UNESCO, 2012). They describe 10 indicators of quality repositories, while also recognising that the application of all ten is likely to be unrealistic and so choice will depend on the context, which is to say the choice will depend on the ecologies within which any repository is sited. The ten indicators are:

featured resources; user evaluation tools; peer review; authorship of the resources; keywords of the resources; use of standardised metadata; multilingualism of the repositories; inclusion of social media tools; specification of the creative commons license; availability of the source code or original files.

(Atenas & Havemann 2014 p. 9 Table 1 describes the metrics)

There are complex interactions between trends in digital technology infrastructure and the contexts where school-age children learn that are influenced by gender (Subrahmanian 2007) and culture, which complicate metrics and are likely to reduce the validity of the evidence gathered. For example, the very different behaviours in Western and Arabic classrooms described by Gamiel and Hazan (2014) suggest that it will be more challenging to interpret that data and to increase capability for self-managed and community support within classes and schools. Unlike the Jewish children who appeared to be empowered by their culture and the training provided in their school that enabled them to give patient respectful support to their elders (teachers) who had very few ICT skills, the Arab children supporting their elders within the different culture of their Madrassa schools culture were observed to have few constructive experiences “relative to the dominant experiences of disorientation and boredom” (Gamiel & Hazan 2014 p. 902). They concluded:

As research illuminates different patterns of interaction of children with the digital world and the influence of cultural codes on the widening of the gap between high-achieving and low-achieving pupils in the Arab sector (Abu-Asba, 2007), one cannot rule out the formation and expansion of a digital divide occasioned, for example, by the tendency among disempowered children to adopt a passive pattern as opposed to an active one (Selwyn, 2009).

(Gamiel & Hazan 2014 p. 903)

From another perspective, digital technology infrastructure to provide access to education may be more critical to women and children whose travel is restricted by cultural norms that must also include aspects of security that would not be expected or designed in by other cultures. This increasing complexity of the interactions between the digital technology infrastructure, curriculum, professional development and cultural dimensions is important to consider for reasons of equity advocated by Gorski (2009) as well as for post WSIS goals.

2. Methodology

Digital technology has been in use in schools for over thirty years, and significant sums of money have been invested in digital technology and its implementation during that time. Understandably therefore, governments, commercial organisations, and others interested in education have developed a range of metrics to describe the digital technology provision in schools in order to try to capture the range of digital technology strategies and their impacts.

This research builds upon those existing metrics and on examples of diverse practice across a wide range of contexts. Specifically this research involved four stages, plus an on-going review of relevant literature:

- The compilation of a series of vignettes and other sources of information that illustrate a wide range of contrasting digital technology strategies and practices and emerging trends in educational contexts for school age learners.
- A review of existing metrics related to digital technology and related infrastructure in schools, leading to a set of dimensions of practice, which aim to encapsulate their key features as abstractions, which should remain relevant irrespective of changes to specific technologies.
- Testing and refinement of the dimensions of practice against the vignettes and other sources of information to ensure they adequately describe and differentiate between the wide ranging digital technology and related infrastructure provisions and emerging trends across contexts.
- Review of the dimensions of practice by international experts on the UNESCO ICT in education technical advisory panel (TAP).

2.1 Vignettes

The vignettes (see Section 6.4) were selected to provide and illustrate a wide range of digital technology strategies and issues that relate to ICT infrastructure. They were drawn from a wide range of contexts and developed by authors who had experience of those contexts in most cases. Table 2.1.A provides an overview of the vignettes. The vignettes were not selected to illustrate the lead authors' views. Rather, our intention was to challenge current metrics while also promoting equity by including voices with experience of developing countries to assist the validity of our interpretation. All of the vignettes illustrate aspects relating to infrastructure, some also illustrate aspects of curriculum and professional development covered by the complementary papers (Gibson et al. In Preparation; Du Toit In Preparation).

This has resulted in diversity with a number of useful aspects:

- different regions including Asia, Africa, India, the Middle East and the Pacific;
- provision for learners and their teachers across the primary and secondary age ranges;
- urban and rural; community, work and home settings;
- state funded, public-private partnerships including aid contexts, and private education;
- school based and out of school provision;
- physical, virtual and blended settings and services;
- local, regional, national and global levels of provision.

Table 2.1.A Vignettes produced for UNESCO Institute for Statistics (UIS) with an indication of the relevance of the project for the themes of all three papers commissioned. (Note: Capitalised 'YES' indicates that the vignette describes the aspect directly)

| | Title | Lead Author | Infrastructure | Curriculum | Teacher Education |
|---|--|-----------------------------|----------------|------------|-------------------|
| 1 | Bangladesh: English in Action authentic video on mobile phones | Clare Woodward | YES | Yes | Yes |
| 2 | India: Integrated ICT school supplements in community centres | Amina Charania | YES | YES | YES |
| 3 | New Zealand's development of Ultrafast broadband in schools including the largest nationwide correspondence school | Niki Davis | YES | No | Yes |
| 4 | Malaysia's nation-wide VLE for schools | Hasniza Nordin & Niki Davis | YES | No | Yes |
| 5 | Jordan with Syrian refugees: Saturday programme for out of school refugee children 30 minutes from the border and war zone | Aleta Chowfin & Niki Davis | YES | Yes | Yes |
| 6 | Bangladesh: Multimedia classrooms creating OER | Clare Woodward | YES | YES | YES |
| 7 | Nigeria: Extending OER amongst trainee teachers using tablet technology | Fiona Henry | YES | No | YES |
| 8 | Africa: Solar-powered mobile school classrooms in Africa | Fiona Henry | YES | No | No |
| 9 | India and Africa: Community and interactive radio in schools and other places | Amina Charania | YES | No | Yes |

2.2 Existing indicators

The review of existing metrics drew on the following sources complemented by our ongoing literature review:

- Barbour, M. K., Brown, R., Waters, L. H., Hoey, R., Hunt, J. L., Kennedy, K., Ounsworth, C., Powell, A. & Trimm, T. (2011). *Online and blended learning: a survey of policy and practice of K-12 schools around the world*. Vienna (VA), USA: International Association for K-12 Online Learning. Retrieved from <http://files.eric.ed.gov/fulltext/ED537334.pdf>
- Becta (2006). *The Becta Review 2006: Evidence on the progress of ICT in education*. Coventry: Becta.
- BESA. (2012). *ICT in UK state schools: Provision and spending*. Full Report Volume 2. London: BESA.
- European Schoolnet. (2013). *Survey of schools: ICT in Education: benchmarking access, use and attitudes to technology in Europe's schools* (p. 163). Belgium: European Commission. Retrieved from <https://ec.europa.eu/digital-agenda/node/51275>
- Haddad, W. D. (2007a). *ICTs for Education: A reference handbook Part 1 Decision makers essentials*. Virginia, USA: Knowledge Enterprise, LLC. Retrieved from http://www.ictinedtoolkit.org/user/p_page.php?section_number=0 (accessed 15-Nov-2014)

- Kozma, R. (2011). *A framework for ICT policies to transform education*. In UNESCO *Transforming education: the power of ICT policies*. (19-36) Paris: UNESCO. Retrieved from <http://unesdoc.unesco.org/images/0021/002118/211842e.pdf>
- MMS Education. (2014). *2014 Results from the SIIA Vision K-20 Survey*. Washington, DC: Software & Information Industry Association. Retrieved from http://www.sii.net/visionk20/2014_VK20.pdf
- Mullis, I., Martin, M., Foy, P., & Arora, A. (2012). *TIMSS 2011 International results in mathematics*. Massachusetts: International Association for the Evaluation of Educational Achievement. Retrieved from <http://timssandpirls.bc.edu/timss2011/international-results-mathematics.html>
- Mullis, I., Martin, M., Foy, P., & Drucker, K. (2012). *PIRLS 2011 International Results in Reading*. Massachusetts: International Association for the Evaluation of Educational Achievement. Retrieved from <http://timssandpirls.bc.edu/pirls2011/international-results-pirls.html>
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- Roberts, S. (2010). *Partnership on measuring ICT for development: Core ICT indicators 2010*. Geneva: International Telecommunication Union
- Sankey, M., Carter, H., Marshall, S., Obexer, R., Russell, C., & Lawson, R. (2014). *Benchmarks for Technology Enhanced Learning*. Canberra, Australia: The Australian Council on Open, Distance and e-learning
- Twining, P. (2014a) *Redefining Education: 1:1 computing strategies in English schools*. In Sweeney, T. & Urban, S. (Eds) *Now IT's Personal: Proceedings of the Australian Computers in Education Conference 2014*. pp. 377-386 ACEC: Adelaide, Australia. Retrieved from <http://acec2014.acce.edu.au/program-glance>
- Twining, P. (2014b). *Digital technology trends*. Retrieved from http://edfutures.net/Digital_technology_trends
- UNESCO Institute for Statistics (UIS) (2009). *Guide to measuring information and communication technologies (ICT) in education*. Montréal, Québec, Canada: UNESCO. Retrieved from http://www.uis.unesco.org/Library/Documents/ICT_Guide_EN_v19_reprintwc.pdf
- UNESCO Institute for Statistics (UIS) (2014a). *ICT in education in Asia*. Retrieved from <http://www.uis.unesco.org/Communication/Documents/ICT-asia-en.pdf>
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2.3 Analysis to develop new indicators

The analysis was based on a model originally used on research into Tablet PCs in English schools (Twining et al. 2005) and subsequently on the 22 English Vital Studies (Twining 2014a) and 13 Australian Snapshot Studies (e.g. Clark, Twining & Chambers 2014; Fluck & Twining 2014; Jamieson-Proctor, Redmond, Zagami, Albion & Twining 2014; Newhouse, Lane, Cooper & Twining 2014). The approach involved meta-analysis across the case studies of digital technology strategies in schools, informed by the literature.

An adapted version of Wong and Blanford's (2002) Emergent Themes Analysis was used in order to identify consistent patterns across the data from the studies and practices reported in the literature. Themes emerged as dimensions, which encapsulated key features of the digital technology implementations in the form of abstractions that described and enabled comparison across contexts.

The starting point was an analysis of the existing metrics within the literature, including the dimensions of practice that had been developed by the Vital Studies and extended by the Snapshot Studies (see Figure 2.3.A).

Figure 2.3.A Dimensions of practice from the Vital and Snapshot Studies (EdFutures.net 2014)

| Impact | Support | | Extend | | | Transform | |
|---------------------|----------------------------|------------|---|-------------------------------------|-----------------------|-----------------------|----------------|
| Provision | Lab | Group sets | Class sets | 1:1 loan | 1:1 owned | BYOD | BYOT |
| What device | Desktop | | Laptop | Tablet | | Tablet + | |
| Network | Wired | | Wireless: closed | | | Wireless: controlled | Wireless: open |
| Funding | 'School' | | Subsidised | Hybrid | | Home | |
| Tech model | 'Learning technology' | | | | | Consumer devices | |
| Hosting | 'Local' Servers | | VLE | | Cloud | Cloud + | |
| Access | Internal | | External (staff) | | External (registered) | | Public |
| Management | ICT teachers | | Dedicated technology infrastructure team | | | Digital Leaders | Manage YOT |
| CPD | Formal CPD | | Informal CPD | | | Learning organisation | |
| Pupil role | Traditional class teaching | | | Independent & personalised learning | | | Pupils teach |
| Teacher role | Sage on the stage | | Collaborative resource designer & Guide on the side | | | | Co-learner |
| Vision | None | Technology | Apple pie | 21 st Century | | Educational | |

The analysis was then extended by testing the power of the emerging dimensions against the vignettes of practice that had been selected (see Appendix 6.2).

3 Data analysis - new indicators

Analysis of the existing indicators quickly highlighted a number of overarching aspects that they focused on. These have been used as major headings within this section. Sub-dimensions are then identified within each of these overarching themes.

3.1 Visions, strategies, curricula and teacher education

Educational vision

Whilst a government's (or school's) educational vision would normally be viewed as part of the pedagogical approach rather than an infrastructure issue, it is critical in that the vision frames the context for the development of the digital technology infrastructure. Specifically, there needs to be a clear educational vision, with associated digital technology strategies and policies. As Haddad (2007a p. 11) points out:

Technology is only a tool: no technology can fix a bad educational philosophy or compensate for bad practice. Therefore, educational choices have to be made first in terms of objectives, methodologies, and roles of teachers and students before decisions can be made about the appropriate ICT interventions.

Barbour et al. (2011) indicate that one of the five main challenges inhibiting the effective use of digital technology (specifically in their case online and blended learning) was a lack of governmental vision and leadership. Innovative and transformative approaches to education most often involve public and private funding to provide the initial infrastructure that is informed by a particular vision and related mission, including government funded initiatives (see for example Barbour 2014).

Kozma (2011 p. 27) identifies that "Educational policy-makers are in a unique position to bring about change". This reflects that policy makers set the overall vision and strategy for education. They are therefore critical to the effective implementation of ICT, which is perhaps why Sankey et al. (2014) provide eight benchmarks in higher education, all of which are targeted at those responsible for providing strategic leadership in technology enhanced learning.

Twining (2014b) developed a Vision dimension, the categories of which are summarised in Table 3.1.A. This dimension highlights the need for there to be a link between the educational vision and the digital technology strategy.

Table 3.1.A The categories on the Vision dimension (Twining 2014b)

| Category | Explanation |
|---------------------|---|
| None | There was no educational vision (or the head/principal couldn't articulate an educational vision) or there was a mismatch between the educational vision and the digital technology strategy. |
| Technology | The vision was clearly technology driven, e.g. To have a set of computers in every classroom; For every student to have their own mobile device. |
| Apple pie | The vision was aspirational but so vague as to be unhelpful in knowing what the school strategies should be. e.g. Every child will reach their full potential. |
| 21st Century | The vision was about preparing students to be 21st Century citizens and/or developing 21st Century skills. |
| Educational | A clearly educational vision, that was sufficiently specific to provide some guidance about appropriate educational strategies. |

Strategies

The key sources of indicators of ICT tend to focus at the level of digital technology strategy rather than vision. Such strategies are (or should be) encapsulated in policies (or other regulatory mechanisms). For example, the UIS questionnaire on ICT asks “Does your country have a national policy, plan, law or regulatory mechanism to promote and/or implement the integration of ICT in education?” (UIS, 2014b, p. B1).

The UIS (2014a, p. 9), building on Kozma’s earlier work, identified that

Policymakers are in a unique position to bring about change. This is illustrated in a study of 174 ICT-supported innovative classrooms in 28 countries (Kozma 2003). In 127 cases, there was an explicit connection between the innovation and national policies that promoted the use of ICT (Jones 2003). But while the introduction of ICT policy is necessary for change, it is not sufficient to result in its implementation or impact (Tyack and Cuban, 1995).

The European Schoolnet (2013) seems to endorse this view. They found that the existence of policies for ICT led to higher levels of use of digital technology across the curriculum so long as there were measures in place to support those policies. They implied that policies varied in terms of their degree of: scope (holistic); formalisation (written statements); precision; and focus (digital technology use in general, in teaching and learning, and/or in subjects). However, existence of a written policy may be less important than whether or not a policy (written or otherwise) is being enacted in practice. Thus, for example, while the Philippines has no written ICT policy, it does have three de facto policies operating in practice (Trucano 2014). Table 3.1.B suggests definitions of different categories on a new Policy dimension.

Table 3.1.B Categories on the new policy dimension

| Category | Explanation |
|------------------------|--|
| None | There is no digital technology policy or there is a policy that is not being implemented in practice. |
| General | A digital technology policy is being implemented, but it is not clearly linked to and supportive of the educational vision or teaching and learning, or the curriculum (including Computing) |
| Computing focus | A digital technology policy focused on Computing is being implemented, which is not clearly linked to and supportive of the school’s educational vision or teaching and learning in other subjects (across the curriculum) |
| ICT focus | A digital technology policy is being implemented, which is focused on supporting the school’s educational vision and explicitly links with teaching and learning, and the curriculum (going beyond Computing) |

A good indicator of whether or not a policy is being implemented might be the extent to which the policy is explicitly tied in to the accountability frameworks and processes in operation, such as a school inspection framework, or teacher certification and/or promotion criteria.

The literature and expert input from the UNESCO ICT in education TAP suggests that a range of different policies might be necessary, including policies related to:

- Funding, sustainability, maintenance of systems and technical support (e.g. Becta 2006; Haddad 2007a)
- Acceptable use, often focused on use of the Internet and social networking (e.g. European Schoolnet 2013; US DoE NCEC 2012c)
- Equality and/or equity (e.g. UIS 2014b)
- Disaster recovery (e.g. war, tsunami)

There are two other aspects of policy that seem particularly important, namely: Curricula, and Teacher Education.

Curricula

It seems reasonable to assume that the existence of a National Curriculum (or similar for a region, such as a state within a nation) that makes explicit reference to digital technology will impact on its uptake in schools. As noted in Section 1.2 of this report, one needs to differentiate between Computing (the specialist subject) and explicit reference to the use of digital technology as part of or to support learning in other subjects (defined as ICT in this paper). This is reflected, for example, in the proposed Australian national curriculum (ACARA 2014), which had both an explicit subject (called Digital Technologies) and a cross curricula strand (called ICT capability). Similarly, the UIS (2014a, p. 12) differentiates between: instruction in basic computer skills (or computing) and the use of digital technology “to teach other subjects to enhance or expand student learning opportunities.” National curriculum requirements in relation to Computing and/or ICT may vary in terms of the level or grade of education at which they apply and number of hours per week specified. This is reflected in specific questions in the latest UIS ICT questionnaire (UIS 2014b):

B.3 Does the education curriculum include a course on basic computer skills or computing?

B.4 Please indicate for which subjects and grades (all or some), recommendations exist to use ICTs to support teaching and/ or learning: Mathematics/Natural Sciences/Social Sciences/Reading, writing and literature/Foreign Languages

This aspect is more central to UNESCO paper 2, so will be left to that paper (Gibson et al., in preparation)

Teacher education and educational leadership development

There is strong evidence to suggest that the quality of teaching is a key factor in the learning outcomes that children achieve. The value of early and ongoing placement of student teachers in schools is well known in teacher education research. Whilst the issue of teacher education is the focus on another paper (Du Toit, In Preparation), teacher standards and requirements for Initial Teacher Education and the certification of qualified teachers is also an infrastructure issue. In addition, where services are developed for schools, such as an online portal where access is managed by individual schools to protect their children, then access for others involved in the educational system such as students in teacher education becomes an ICT infrastructure issue (Davis 2014).

Barbour (2014) notes that there is a need to focus on teacher training. The UIS (2014a, p. 7), building on UIS (2009), asks about the proportions of teachers with Computing qualifications (which the UIS refers to as ‘ICT-qualified teachers’) in schools and the proportions of teachers who have been trained in ICT (which UIS refers to as being able to teach using ICT). Similarly, UIS (2014b) also asks about the numbers of staff teaching digital technology related subjects as well as the numbers of teachers using various digital technologies to support teaching of other classroom subjects.

Finally, the development of school leadership to enable best use of the ICT infrastructure and its ongoing upkeep is a common issue in both developed (Schrum & Levin 2012) and developing countries (Trucano, Iglesias & Hawkins 2012).

This aspect is more central to UNESCO paper 3, so will be left to that paper (Du Toit In Preparation).

3.2 Environment

It is evident from the vignettes and the literature that the environments in which school age children are being educated are changing. The nine vignettes illustrate a range including multimedia centres or media labs in schools, community centres (some of which are mobile) and virtual learning environments that are accessed through the Cloud by the child's own mobile device.

Haddad (2007a) suggests that education in the future will need to change dramatically and quickly, and that there is a need to equip students to continue to learn “anytime, anywhere, on demand” (p. 4). Reflecting this view, Rix and Twining (2007) developed a typology of education systems, which aimed to recognise these changes and to “map the different forms of provision into a typology that will provide theorists, practitioners, users and policy-makers with a clear set of descriptors to explore current structures and to consider future developments” (Rix & Twining 2007 p. 329). This typology, which is summarized in Table 3.2.A, provides a set of high-level descriptors to enable one to differentiate between different forms of education provision. Twining et al. (2006), who were explicitly focused on the impact of digital technology on schools, extended this analysis, in the form of the eSIR Reference Statement (see Table 3.2.B).

Table 3.2.A Typologies of education systems (adapted from Rix & Twining 2007, p. 337)

| | Programme title | Programme length | Dominant educational approach | Degree of learner control | Opportunities to access setting | Age range | Regulation | Location |
|---------------|-----------------------------|-------------------------|--------------------------------------|----------------------------------|--|------------------|-------------------|-----------------|
| Type 1 | Alternative | Long or short term | Creative | High | Limited | Up to 18 | Systemic | Fixed sites |
| Type 2 | Last chance | Short term | Discipline | Low | Limited | Up to 18 | Systemic | Fixed sites |
| Type 3 | Remedial | Short term | Therapy | Low | Limited | Lifelong | Systemic | Fixed sites |
| Type 4 | Special | Long term | Therapy | Low | Limited | Up to 18 | Systemic | Fixed sites |
| Type 5 | Home | Long or short term | Creative | High | Limited | Up to 18 | Informal | Diverse sites |
| Type 6 | Selective | Long or short term | Traditional | Low | Limited | Up to 18 | Systemic | Fixed sites |
| Type 7 | Comprehensive | Long term | Traditional | Low | Open | Up to 18 | Systemic | Fixed sites |
| Type 8 | Schome (not school or home) | Long or short term | Creative | High | Open | Lifelong | Systemic | Diverse sites |
| Type 9 | Adult | Long or short term | Traditional | High | Limited | Post 18 | Systemic | Fixed sites |

Table 3.2.B Summary of the eSIR Reference Statement (First published under CC licence in Twining et al. 2006, p. 14)

| | |
|-------------|--|
| Aims | ‘Smarter learners better able to cope with changing contexts’ – focus on enhancing learning, motivation and lifelong learning as important elements of this. |
| Environment | The learning environment is the whole environment of the learner that is recognised as being relevant to the education system. It has two components: <ol style="list-style-type: none"> 1. The spatial environment – where learning takes place. 2. The temporal environment – when learning takes place. Both the spatial and temporal environments that are considered relevant to the education system will expand. In particular there will be greater emphasis placed on the home, working across physical settings and virtual settings, and extending ‘the school day’. This is all summed up in the phrase ‘anywhere/anytime learning’. |
| Actors | The ‘actors’ are people and/or organisations involved in supporting learning, including teachers, support staff, learners, learners’ peers, parents and employers. There will be an increase in the involvement and availability of actors owing to the facilities that ICT offers, especially in relation to interaction ‘at a distance’. In particular, greater emphasis will be placed on the role of parents. Collaboration will be a key element to this diversification of actors and environments. Learner choice, responsibility and control will become increasingly important as part of the ‘personalisation’ agenda. |
| Curriculum | The curriculum includes everything that learners learn. There will be a broadening of the curriculum both in the ‘subjects’ available and in learner choice. In particular, the curriculum is likely to offer more vocationally orientated options and will place a greater emphasis on ‘core skills’. |
| Support | The range and nature of support, which includes teaching, will increase and diversify as the environments, actors and curriculum expand. In particular, there will be an increase in learner choice about when, where and how learners are supported. |

Two aspects of the environment, that are particularly evident in the vignettes, relate to the degree of flexibility in when and where students learn, as illustrated in Table 3.2.C.

Table 3.2.C The spatial and temporal environments (based on Twining et al. 2006, p. 14 and Rix & Twining 2007, p. 337)

| | Spatial environment | Temporal environment |
|----------------|---|--|
| Fixed | Learners attend a fixed location for their schooling, which may be a physical or virtual location | Schooling happens at pre-determined times (e.g. from 7am to 2pm on Monday to Friday) |
| Diverse | Learners attend a range of different locations, which may be physical and/or virtual (Anywhere) | Schooling happens at a variable times (Anytime) |

Another aspect is the nature of the organisations providing the education, which is shifting from being schools (which provide a physical location and all of the services) through to online providers who are seen more as a service rather than an organisation or institution, and combinations of these. Indeed there is a blurring of boundaries, as physical schools buy in specific online services from other providers, and in turn offer their services to others. This is reflected in UIS's (2009) guidelines, which ask about the proportion of educational institutions offering ICT-enabled distance education programmes (ED33). The new Provider dimension was developed to address these trends.

Table 3.2.D Categories on the new provider dimension

| Category | Explanation |
|--------------------|---|
| None | There is no education provision |
| Community | Provides limited face to face teaching services e.g. after school computer club or community centre |
| Traditional | Provides a physical location that students attend and all teaching services e.g. a traditional school |
| Extended | Provides a physical location that students attend and some teaching services. Buys in some distance teaching (may also sell online teaching services to other providers) e.g. a school that buys in online teaching for specific subjects (because they lack the in-house expertise) |
| Virtual | Does not provide a physical location for students to attend. Provides online teaching services. e.g. a virtual school, which students may attend part-time or full-time |

The Nensala Project in Sri Lanka is an example of a Community provider: the project has established over 700 rural tele-centres or "Nensalas", which are managed and supervised by the Nensala Community Development Task Force to build ICT skills and impart ICT education in school curricula (UIS, 2014a).

3.3 Electricity supply

Whilst most sets of metrics related to digital technology in schools assume that electricity is available, UNESCO Institute for Statistics (2009, 2014a) and Roberts (2010) highlight that this may not be the case and use an associated metric:

- The proportion of schools with electricity (EDR1)

The reliability of electricity supply also has an impact on the usability of ICT for educational purposes. For example, in some locations schools or other centres have an electricity supply for part of the day or an ongoing supply that is frequently interrupted and experience surges of power as well as lack of power. Recent trends to increase solar power generation in the Pacific region indicate some success for the schools and their communities. Thus a metric describing the limitations of access and quality of the power source becomes relevant.

The UIS (2014a, p. 14) states that:

The integration of ICT into schools requires electricity (e.g. grid/mains connection, wind, water, solar or fuel-powered generator, etc.) that is regularly and readily available.

That is why collecting data about the proportion of schools that have a regular and reliable electrical supply is potentially a useful metric. This of course assumes that a school either has or does not have electricity, and ignores the fact that:

even if schools are connected to an electrical grid, in many countries power surges and brownouts are common in both rural and urban areas further impeding the reliable usage of ICT.
UIS (2014a, p. 14)

These features of the power supply may be related to their source, which might include: mains, generator, solar, wind, water, batteries, hand cranked, etc. However, the key dimensions are:

- **Duration:** None, Infrequent, Frequent, 100%
- **Reliability:** Unstable (Brownouts/Surges), Stable

In addition, the power supply needs to be accessible in the sense of being available in the places where it is needed throughout the school. Together the duration, reliability and accessibility determine the sufficiency of the electricity provision.

These might be represented as a new Electricity dimension (Table 3.3.A), which simplifies them in order to make data collection easier and increase its validity and reliability.

Table 3.3.A The new electricity dimension

| Category | Explanation |
|---------------------|---|
| None | There is no accessible electric power supply |
| Intermittent | There is an accessible electric power supply, but it is not available or reliable throughout the whole teaching day |
| Stable | There is an accessible electric power supply that is available and reliable throughout the whole teaching day |

3.4 Media type

Most sets of metrics assume a focus on digital technology, and more specifically computers and their associated infrastructure. UNESCO Institute for Statistics (2009) includes metrics related to the use of radio for instruction and television for instruction. Their specific metrics are:

- The proportion of schools with a radio used for educational purposes (ED1)
- The proportion of schools with a television used for educational purposes (ED2)

The UIS (2014a, pp. 29-30) reports the use of radio and television-assisted instruction (TAI):

Radio/community radio have been used successfully in Nepal (e.g. Radio Sagarmatha), Sri Lanka (e.g. Radio Kothmale) and Afghanistan (e.g. Educational Radio and Television) in creating innovative models for providing educational messages and creating community awareness (World Bank 2010). Similarly, radio broadcasting through the Education Broadcasting Unit (EBU) of the Samoa Broadcasting Corporation (SBC) has been used extensively to reach children in rural and remote areas (Samoa 2006).

TAI has also been used extensively, for instance, through dedicated educational channels (e.g. Gyan Darshan I & II in India, Nenasu in Sri Lanka, ERTV in Afghanistan, the Knowledge Channel (KCh) in the Philippines), through educational programming on existing television channels, or in the case of India, through private educational television channels (e.g. Toppers, Tata Sky Fun Learning, etc.) (World Bank 2010).

The use of television for distance education is not restricted to developing countries, as evidenced by a question in the US Department of Education Schools and Staffing Survey 2011-2012 (US Department of Education 2012a, National Centre for Education Statistics 2012b Question 17) which asks if schools offer distance learning courses “taught primarily via television, satellite, Internet or email”. In addition the TV channel may be broadcast on a public channel or narrowcast within a school or specific set of educational users for whom the station service is licensed.

At a superficial level the differences are between: Radio on/off air, TV on/off air, and computers with or without Internet access. This however ties the metric to specific technologies, which may change, as illustrated by Vignette 1 in section 6.4.1 in which a phone with SD card and external speaker is used to provide audio to support the learning of English, rather than using radio. Vignette 9 illustrates the role of community radio and the increasing use of mobile phones and other devices to provide some interactivity with the audience. Such interaction is also possible during live TV programming.

Haddad (2007a) highlights the benefits of radio and television for education, before going on to highlight that radio is limited to audio and that both are constrained because they follow a prearranged schedule, and offer no interactivity. This emphasises that fundamentally the issues here are not about the specific device being used (radio, television, or computer) but about the nature of the media being used and the degree of control and interactivity, as illustrated in Table 3.4.A.

Table 3.4.A Media type

| | Broadcast | Recorded | Interactive |
|--------------------------------|------------------|--|------------------------|
| Audio | Radio | Cassette, mobile, digital recorder (e.g. iPod) | Interactive radio |
| Audio and moving images | TV | Video, mobile, digital recorder (e.g. iPod) | Interactive TV |
| Hypermedia | | Computer w/o Internet | Computer with Internet |

3.5 Access

A range of different indicators related to access to digital technology in schools are evident in the literature. These vary in sophistication, from metrics about expenditure or number of devices through to dimensions that integrate student to computer ratios with location. They also differ in their focus on access:

- in school and/or at home (e.g. Becta 2006; OECD 2011)
- during lessons and/or outside lesson times (e.g. Becta 2006)
- for members of the school and/or the wider community (e.g. US DoE NCES 2012c; UIS 2014a)

3.5.1 Expenditure

Barbour et al. (2011) argue that there has been a lack of funding to support online and blended learning, signaling the link between digital technology integration and expenditure. Expenditure on digital technology does provide a basic metric for the level of digital technology infrastructure, which has been used by organisations such as:

- the British Educational Suppliers Association in their annual review of ICT in schools (e.g. BESA 2012)

- the US Department of Education (e.g. US DoE NCES 2012c)
- UNESCO (e.g. UIS 2014b)

However, the relationship between spending and impact is at best tenuous (Twining 2002), which has led to the development of metrics based on the numbers of devices that are available for schooling. The rapid increase of Bring Your Own (BYO) device strategies adds complexity to expenditure metrics with the multiplicity of funding sources (see Section 3.8 Funding, below). Overall metrics based on expenditure at a high level are likely to be unhelpfully inaccurate due to their distance from the realities of implementation, except for an indication of a level of commitment from the funding bodies.

3.5.2 Availability of devices

UNESCO currently use indicators related to the number of schools in an area that use particular technologies:

- The proportion of schools with a radio used for educational purposes (UIS 2009, 2014b)
- The proportion of schools with a television used for educational purposes (UIS 2009, 2014b)
- The proportion of schools with computer-assisted instruction (UIS 2014a; UIS 2014b)

Most sets of indicators (including those from UNESCO) focus on within-school levels of provision. This may be in terms of the raw number of computers (e.g. US DoE NCES 2012c; UIS 2009, 2014b), which may be further broken down into those used for administrative/pedagogical purposes (e.g. UIS 2009, 2014b). Or they may use metrics related to staff or student access or adequacy of provision:

- Number of students who have never used a computer (OECD 2011)
- Number of students who have access to a computer at school (OECD 2011)
- The proportion of computers that are operational (European Schoolnet 2013)
- How much is your school's capacity to provide instruction affected by a shortage or inadequacy of computers for instruction (Mullis, Martin, Foy, & Arora 2012 p. 227; Mullis, Martin, Foy, & Drucker 2012 p. 151)
- Number of computers available during maths lessons (Mullis, Martin, Foy, & Arora 2012)
- Percentage of students who have computers available for reading lessons (Mullis, Martin, Foy, & Drucker 2012)
- Whether educators have access to a similar level of technology resources common for other professionals (MMS Education 2014)

As with metrics based on expenditure, it is difficult to find evidence of a clear relationship between these 'availability of device' indicators and use of digital technology or impact on learning outcomes. Indeed, some of the indicators may not adequately differentiate between contexts. For example, across the OECD countries in 2009 less than 1% of students had never used a computer and this did not help explain differences between contexts. A better set of indicators relates to the ratio of students per computer.

3.5.3 Student to computer ratios

The student to computer (or computer to student) ratio is one of the most common amongst existing indicators. The level of sophistication of the metric varies from simple metrics:

- Computer to student ratio (Becta 2006; OECD 2011)
- ED4bis: Learner to computer ratio (UIS 2009; UIS 2014a)

More complex measures recognise that not all computers in schools are available for pedagogical purposes:

- Ratio of students to computers available for instruction (Mullis, Martin, Foy, & Arora 2012; Mullis, Martin, Foy, & Drucker 2012)
- ED4: Learners-to-computer ratio in schools with computer-assisted instruction (for ISCED levels 1-3) (UIS 2009, p. 28)

“The learner-to-computer ratio (LCR) refers to the mean number of learners sharing a single computer available for pedagogical use in national, aggregate education systems” (UIS 2014a, p. 16)

And some recognise the challenge of knowing ‘what counts as a computer’:

- Students to Computer ratio - Computer includes desktop, laptop, netbook or tablet used for educational purposes, whether or not connected to the Internet (European Schoolnet, 2013)

Whilst many existing metrics use a simple ratio, specify bands of ratios go some way to address the misleading degree of accuracy indicated in such ratios. An example of such a banding is provided by Mullis, Martin, Foy and Arora (2012 p. 242-243) and Mullis, Martin, Foy and Drucker (2012 p. 158-159) who suggest the following bandings:

- 1 computer for 1-2 students
- 1 computer for 3-5 students
- 1 computer for 6 or more students
- No computers available

Whilst the UIS (2014a, p. 20) acknowledges that “The LCR is a system-wide indicator and does not reflect schools that do not use computers for pedagogical purposes”, UIS still argues that:

While the LCR indicator does not provide information on the intensity of computer usage, it may be considered as a proxy measure for the quality of computer-assisted instruction (CAI), since there is a relationship between LCR and individual learner time using computers.

(UIS 2014a, p. 16)

The UIS does recognise that this is only true where the LCR relates to computer available for pedagogical purposes. However, this seems to give too much weight to the LCR for two reasons. Firstly, what counts as a computer in the ratio is highly problematic. Should equal weight be given to new high spec desktop computers running the latest operating system as to old machines with much lower specifications? Should a desktop, laptop, tablet, or iPod touch all be given equal weight in compiling the ratio? Secondly, there is no clear relationship between the student computer ratio and the level of use in schools:

Anderson et al. (1979) reported that “the amount of computer resources in the school has no direct effect upon adoption or disadoption” (p. 243), however, the perceived availability of those computers was an important predictor. Thus, the key variable may not be the actual availability of resources but teachers’ perceptions of their ease of access to them.”

(cited in Twining 2002 p. 25)

This highlights the issue of where ‘computers’ are located within a school.

3.5.4 Location

Views on where digital technology should be located within schools vary across contexts. The UIS (2014a) notes that:

While many developing countries promote the establishment of computer laboratories in schools, the provision and location of computers in schools amongst developed countries is increasingly varied.

(UIS 2014a, p. 23)

Clearly where computers are located has implications for their accessibility and should be informed by curriculum and pedagogical objectives. Computers in labs are best suited to the teaching of Computing, whereas computers distributed around the school and other locations where learning takes place facilitates improved curriculum opportunities for ICT.

Existing indicators that refer to the location of computers include the following possible locations (within schools):

- labs, classrooms, clusters (Becta 2006)
- computers in classrooms, on wheels, in computer rooms or labs, or in libraries and teachers' rooms (Haddad 2007a)
- computer rooms, distributed (European Schoolnet 2013)

UIS (2014b, Section D) also refers to the location of devices (Computer laboratory), but seems to merge this with other qualitatively different dimensions (e.g. Local Area Network, website, Open Educational Resources).

The UIS (2014a, p. 22) suggests that

Establishing computer laboratories in schools is typically perceived to be a significant upgrade from classrooms with one desktop computer at the back of the room. Computer laboratories offer the promise of a learning environment with one device per child.

Whilst this is not necessarily the case, combining information about the student to computer ratio with location does help provide a richer picture of provision.

3.5.5 Models of digital technology provision for learning

The Vital Studies (Twining 2014a) resulted in 'the Provision dimension', which described the range of models of digital technology provision evident in 22 case study schools. This dimension was further refined to account for the 13 Snapshot Studies (Twining 2014c). Perhaps not surprisingly, given the focus in these studies on mobile technology strategies in schools in England and Australia, this dimension needed to be extended in order to describe digital technology provision in less affluent countries. The revised Provision dimension is shown in Table 3.5.5.A.

Table 3.5.5.A The revised provision dimension (based on Twining 2014a p. 430)

| Category | Explanation |
|-------------------|---|
| 1:Area | A single machine shared between two or more classes. It may be on a trolley so it can be moved between classes, or kept in a shared area. |
| 1:Class | A single machine allocated to each classroom, which would normally be kept in the classroom or a nearby location. This could include the provision of a computer for use with a data projector or Interactive Whiteboard. |
| Lab | Dedicated 'room' with desktop machines. Generally a timetabled or bookable resource for a whole class. This could be a mobile lab that is shared between schools (such as the BRAC digital technology labs in Bangladesh (World Bank 2010)). |
| Group sets | Clusters of desktop machines in a class, shared area or department, or sets of mobile devices on trolleys, or a mobile classroom, which are timetabled or bookable. |
| Class sets | Sets of mobile devices on trolleys or as part of a mobile classroom, sufficient for every child in a class to have a device, but which are shared with other classes/schools. |
| 1:1 loan | There is a mobile device for each student, which is not shared with anyone else. However, access is restricted in some way (e.g. students can only use them during lessons; students cannot install apps or upload personal music). |
| 1:1 owned | There is a mobile device for each student, which is not shared with anyone else. Irrespective of who actually owns the device each student perceives that they 'own' it because they can take the devices home and can customize it to some degree (e.g. install games, upload personal music). |
| BYO | Students are allowed to bring their own devices from home to use in school. There is no requirement to bring in a device or for each student to have a device (in contrast to 1:1), thus some students may not have their own device. |

In most cases, more than one model was evident in each of the Vital Studies. For example, Vital Study 16 had a range of provision, including: labs; group sets of PCs, laptops and iPads; class sets of laptops; and BYO. In a smaller number of cases, only one model was evident, such as Vital Study 7, a primary school in which the computer lab had been replaced by two class sets of Chromebooks on trolleys.

Perhaps surprisingly, 1 to 1 strategies, which might imply a high level of provision, whilst common in schools in Australia, are relatively uncommon in schools in the UK, and are a feature of provision in some developing countries (e.g. Peru). This is in part due to the One Laptop Per Child (OLPC) initiative, which

manufactures robust, durable and low- cost XO laptop computers specifically designed for children in developing countries to promote one-to- one computing. INTEL similarly manufactures the comparably-designed Classmate PC

(UIS 2014a, p. 19)

A shift towards 1:1 digital technology strategies almost inevitably involves a move towards mobile devices, which flags up the importance of the underpinning technology model.

3.6 Technology model

There are four inter-related aspects to the technology model: the types of devices being used; the locus of control over and management of the devices; the approach to technical support; and the provision of supporting technologies. Each of these is explored in turn.

3.6.1 Device type

Many existing digital technology indicators focus on the device type, often with an emphasis on mobile devices. For example:

- Becta (2006) looked at laptops, PDAs and mobile phones
- US DoE NCES (2012c Question 21) asks about the availability of laptops for use outside the media centre
- European Schoolnet (2013) consider patterns of computer provision, focusing on which devices (laptops, tablets, netbooks) are available
- MMS Education (2014) asks about the extent to which digital educational content can be accessed through multiple platforms, specifically including mobile devices.

Extending these existing indicators, Twining (2014b) developed a dimension, called 'What device' which included:

- Desktops
- Laptops, which included netbooks, Tablet PCs and Chromebooks
- Tablets, which included PDAs, iPods, iPads and tablets with other operating systems
- Tablet +, which recognised that no one device was adequate for all purposes and that with a move towards BYO strategies learners might have access to more than one device each.

Mobile phones tended to be banned in the Vital and Snapshot Studies and so were not included. However, it is clear that mobile phones play an important role in digital technology provision in many developing countries. As UIS (2014a) notes, in relation to existing UIS indicators:

While privately-owned mobile telephones are excluded from the current definition, mobile units are increasingly used by teachers in developing countries for both pedagogical and administrative purposes. As such, current statistics do not fully encompass the entire range of available capacity for telecommunications

(UIS 2014a, p. 15)

This is reinforced by Vignette 1 in section 6.4.1, which describes the use of mobile phones to support the teaching of English in classrooms in Bangladesh.

In recognition of this omission the 'What device' dimension was extended to create a new 'Device type' dimension, which is explained in Table 3.6.1.A. This also incorporates a new category that anticipates the emergence of wearable technology, which was flagged up in the Horizon report on international schools in Asia (Johnson, Adams, Becker, Cummins & Estrada 2014).

Although this dimension relates specifically to digital technology other than radio or television, it could be extended by adding a Radio and a Television category.

Table 3.6.1.A The new device type dimension (based on Twining 2014b)

| Category | Explanation |
|---------------------|--|
| Desktop | Devices are desktop computers sometimes known as Personal Computers (PCs). |
| Laptop | Devices in use are laptops, which include smaller Tablet computers as well as other fully sized computers with removable keyboards. |
| Mobile phone | Smartphones include any phone capable of playing audio and video, taking photographs, and connecting to the Internet (where available) |
| Tablet | Tablets include devices such as the iPad and Android hand held computers and other devices with a similar form factor. They have a touch sensitive screen. |
| Wearable | Wearable technology includes any ICT device which is worn by the learner, such as a smart-watch or Google Glasses,. |
| Tablet + | This category recognises that no one device is suitable for all purposes, and that learners and educators often have more than one device that they use (e.g. smartphone + laptop) |

At first glance this dimension does not account for what the UIS (2014a, p. 16) describes as “multi-seat computers or networked PCs, where users simultaneously operate from a single central processing unit (CPU) and server while possessing their own individual monitors and keyboards”. However, from a user perspective such devices are Desktops. Such networked computers do raise issues about networking and hosting within a school, which are explored in Section 3.7 on Connectivity, below. Similarly, from a user perspective, devices such as Chromebooks, which are designed to be adjusted to particular services (e.g. the Google Chrome web browser and other Cloud Apps), fit into the category Laptop.

With a move away from desktop computers there has been a shift in control and management of devices.

3.6.2 Device control and management

Traditionally schools have been responsible for the provision and thus control and management, of all the digital technology that is used in school. However, as became evident in the Vital Studies (Twining 2014a) the move towards the use of mobile devices, and specifically consumer devices such as iPads, has resulted in a shift in control and management of digital technology within schools. This resulted in the Control dimension (which was originally called the Technology model). However, this dimension did not fully account for some of the practices found in the vignettes. For example, where a mobile lab is shared between schools, such as illustrated by Vignette 1 in Section 6.4.1 in Bangladesh where control rests with the provider of the mobile classrooms or shared resources in a community centre (see Vignette 2 in India in Section 6.4.2). Similarly, the advent of networked and virtual schools brings the need to establish partnership agreements between multiple organisations that lay down the expectations for control and management. Examples of such arrangements can be seen for the nationwide Te Kura in New Zealand (see Vignette 3). Thus the Control dimension was revised to explicitly account for these scenarios. The resultant dimension is explained in Table 3.6.2.A.

Table 3.6.2.A The revised control dimension (based on Twining 2014a p. 432)

| Category | Explanation |
|----------------------------|---|
| School technology | All the digital technology and associated services are controlled and managed by the school and/or their agent who might be an external contractor. E.g. There is a standard 'desktop image' for each mobile device that the school configures. Alternatively, learners are directed to access digital technology and associated services are controlled and managed by a community centre or another school. |
| Consumer technology | Mobile devices (and related services) are managed by the users. E.g. The user controls the installation of apps and configuration of the device. |

It should be noted that legal ownership of a device does not necessarily give an indication about where the provision will fit within the Control dimension. Thus, most of the Vital Study schools retained a 'School technology' approach, even in some cases where the parents actually owned their children's mobile devices outright, as in Vital Study 18.

Control and management are closely linked to the approach to technical support.

3.6.3 Technical Support

Traditionally technical support has been seen as the domain of the school (and/or its sub-contractors). Thus, for example Becta (2006) see technical support and service provision as being the remit of teachers, in-house technical support, managed services and/or external consultants. Similarly, European Schoolnet (2013) identify technical support as being provided by teaching staff, school technicians, and/or external organisations. Although consideration of gender equity is relevant here, support to improve access for females and their opportunity to become technicians has been left to one of the two complementary papers (du Toit In Preparation).

The UIS (2014a, p. 23) suggests that digital technology support services, by which they seem to mean support provide by school staff or external providers, "will have an increasingly pivotal role for ensuring the sustainability of equipment and facilities and will be vital in the coordination, maintenance and overall viability of ICT in education efforts". This reflects the context in many developing countries where shifts towards BYO strategies are not commonplace. The Vital Studies, which took place in England, suggested that with a shift towards 1:1 owned and BYO strategies (see Table 3.5.5.A) there was a shift away from institutional responsibility for providing technical support and towards learners being responsible for the management and maintenance of their own technology. This resulted in the Technical Support dimension (Twining 2014a), which is explained in Table 3.6.3.A.

As already noted in relation to the Vital Studies, moving towards a BYO model (see Table 3.5.5.A) usually involved a shift towards Manage Your Own Technology (e.g. Vital Study 2 and Vignette 5). However, it was also evident in schools that had not moved to a 1:1 or BYO approach. For example, in Vital Study 8, a group of students (known as Digital Leaders) were responsible for managing 42 iPads that could be booked out by staff. They ensured that the iPads were returned to their standard configuration after use, delivered devices to classes, and helped their peers use the iPads during lessons, including how to share files.

Table 3.6.3.A The technical support dimension (based on Twining 2014a p. 432)

| Category | Explanation |
|------------------------|---|
| ICT teachers | The ICT teacher/coordinator is responsible for managing and supporting use of digital technology throughout the school, often with the assistance of a (part time) technician, teaching assistant, or external consultant. |
| Dedicated team | The school employs a dedicated digital technology team (e.g. network manager and technicians) and/or external contractor to provide technical support |
| Digital leaders | The school 'appoints' some students as Digital Leaders, who have roles in supporting the use of digital technology. This may include helping to manage equipment, supporting staff and students in using digital technology in lessons, providing input to professional development for staff, or a range of other roles. |
| Manage YOT | Staff and students become responsible for managing their own mobile devices. This might range from making sure that devices are charged overnight to having full responsibility for installing software and getting devices repaired (outside school). |

In many of the Vital and Snapshot Studies Digital Leaders provided technical support to assist teachers with using technology in the classroom. For example, they often set up the computer and data projector or Interactive Whiteboard for the teacher at the start of a lesson. There are links here with teacher professional development, and issues to do with gender and culture, which will be addressed in one of the complementary papers (see du Toit In Preparation). This brings us to the topic of supporting technologies.

3.6.4 Supporting technologies

Supporting technologies potentially include a wide range of resources. Existing metrics consider:

- Digital calculators (Mullis, Martin, Foy, & Arora 2012)
- Interactive Whiteboards (IWBs), digital cameras, data projectors, video conferencing facilities (Becta 2006)
- Digital Video Disc (DVD) player(s), Blu-ray disc player(s), or video cassette recorder(s), and technology to assist students and/or staff with disabilities (US DoE NCES 2012c)
- Data projectors, e-Readers, mobile phones, digital cameras and IWBs (European Schoolnet 2013)

As with metrics about access to computers, a range of indicators are used in relation to these supporting technologies, such as student per device ratios and the location of non-mobile devices such as IWBs (e.g. European Schoolnet 2013).

3.6.5 Assistive technologies

There is widespread recognition that students with disabilities and/or who have been labeled as having 'special needs' may be disadvantaged when it comes to education (e.g. UIS 2009) and may have limited access to digital technology (Haddad 2007b). Existing surveys tend to address this issue by asking questions in relation to 'persons with special needs', in the same way that they might ask questions in relation to gender. For example, the UIS questionnaire on ICT in education (UIS 2014b, p. 4) asks:

Do any of the existing ICT in education policies, plans and/or laws address equality and/or equity in favour of ... Gender, Poor groups, Rural areas, Persons with special needs, Minority, or Other?

3.7 Connectivity

As noted in earlier sections, one of the differentiators in computer provision is whether or not the devices are connected to the Internet. This is one aspect of connectivity, though in the context of developing countries a more fundamental question is about the availability of telecommunications more generally.

3.7.1 Telecommunications

Telecommunications is defined by UIS (2014b, p.14) as:

a fixed telephone line, cable connection, mobile phone or other sustainable communication technology that connects a school's terminal equipment to the public switched telephone network, or other telecommunication network,

Perhaps the main reason that telecommunications is important in schools is because it can provide access to the Internet, which helps explain why

In order to gauge national capacity to support the integration of ICT in education, measuring the share of educational institutions with electricity and a telephone communication facility provides basic information for policymakers to assess current gaps in infrastructure,

(UIS 2014a, p. 14)

The UIS (2009, p. 28) guidelines do suggest collecting data about telecommunications:

- ED3: Proportion of schools with a telephone communication facility

However, the UIS notes that due to the increasing use of teachers own mobile phones “current statistics do not fully encompass the entire range of available capacity for telecommunications” (UIS 2014a, p. 15). In addition, in this report on ICT education in Asia, the UIS identifies that

[In many Asian countries] telephone communication facilities are more or less universal wherever electricity is widespread. However, in Malaysia and Armenia, which have electricity in all schools, telephone communication facilities are just available in 88% and 80% of primary schools and 76% and 80% of secondary schools, respectively. In countries where electricity remains a challenge, telephone communication facilities are also typically less than universal.

(UIS 2014a, p. 16)

Historically, collecting data about telecommunications provided useful information about computer to computer connectivity, and more recently about access to the Internet. With a proliferation of different ways of connecting to the Internet and the overlap between provision of electricity and telephony, one could argue that if one is collecting data on the Electricity dimension (Table 3.3.A) there is likely to be little added value in also collecting data about telecommunications. In practice, a more useful differentiator of digital technology infrastructure is the level of Internet access.

3.7.2 Internet

Whilst the focus of this report is on the digital technology infrastructure in schools it is important to recognise that digital technology provision, including Internet access at home, is a key factor affecting the impact of digital technology on children's learning. That is why Becta (2006), OECD (2011 p. 148) and YOTS (Twining, Henry & Lewis 2014) have home Internet access as a focus.

The majority of other existing indicators focus on in-school Internet provision. Three different facets of Internet access are evident in these existing indicators:

1. The extent to which computers with Internet access are available to students for pedagogical purposes, for example:
 - ED6 Proportion of learners who have access to the Internet at school (UIS 2008, p. 37)
 - ED23 Proportion of schools with Internet-assisted instruction (UIS 2009, p. 55)
 - ED25 Ratio of learners-to-computer connected to Internet (UIS 2009, p. 57)
 - Proportion of computers for pedagogical purposes connected to the Internet (UIS 2014b, Table 5, Table 6)
 - ED27 Average number of computers connected to the Internet per educational institution (UIS 2009, p. 59)
 - The number of computers available in school that are connected to the Internet (OECD 2011, p. 148)
 - Of the computer workstations reported above, how many have access to the Internet? (US DoE NCES 2012c 18b)

2. The type of Internet connection
 - ED5: Proportion of schools with Internet access by type ... (UIS 2009, p. 36; UIS 2014a, p. 7)
 - Type of connection - ADSL, Cable, Fibre, Wireless, Satellite (European Schoolnet 2013)
 - Infrastructure of which with: fixed broadband Internet/Wireless broadband Internet/Narrowband Internet (UIS 2014b, Section D)

3. The speed (or more accurately bandwidth) of Internet connection
 - Internet connectivity and speed (Becta 2006)
 - No broadband, <2mbps, 2-5mbps, 5-10mbps, 10-30mbps, 30-100mbps, >100mbps (European Schoolnet 2013)
 - Up to 2 Mbit/s, Up to 10 Mbit/s, Up to 30 Mbit/s, Up to 100 Mbit/s, Up to 1 Gbit/s, At least 1 Gbit/s (OECD 2013 p. 29; OECD 2014 pp. 24-25)

Barbour et al. (2011 p. 15) recognised the need to consider whether Internet access was equitable. This indicates a problem with all of the above metrics, which is that knowing the bandwidth or knowing the number of machines connected to the Internet does not indicate the extent to which the provision meets the demands of the situation. MMS Education (2014) attempted to address this by asking about the adequacy of bandwidth provided for students. This leads to a new Internet access dimension (Table 3.7.2.A).

Table 3.7.2.A The new Internet access dimension

| Category | Explanation |
|---|---|
| No bandwidth < 0.01 MbpspS* | There is no Internet connection Less than 0.01 Mbps per student e.g. a 512K connection shared between 50 students, or a 2Mbit connection shared between 201 students |
| 0.01 to < 0.05 MbpspS | Between 0.01 and 0.049 Mbps per student – equivalent to a 2Mb connection shared between 20 to 200 students or a 10Mbps shared between 100 to 1000 students |
| 0.05 to < 0.1 MbpspS | Between 0.05 and 0.099 Mbps per student |
| 0.1 to < 0.2 MbpspS | Between 0.1 and 0.199 Mbps per student |
| 0.2 to < 0.5 MbpspS | Between 0.2 and 0.49 Mbps per student |
| 0.5 to < 1 MbpspS | Between 0.5 and 0.9 Mbps per student |
| 1 or more MbpspS | 1 or more Mbps per student e.g. A 1 gigabyte per second connection shared between up to 1000 students |

* MbpspS = Mbits per second per student (Mbps per student), regarding the overall bandwidth reliably accessible to students divided by the total number of students

An assumption implicit within the above dimension is that the Internet connection is reliable and stable.

In some countries schools operate a shift system, with different cohorts of students coming in to school at different times. In calculating the bandwidth per student it seems appropriate to use the number of students per cohort (i.e. who are potentially using the Internet at any one time), providing that all cohorts receive equitable access. The same is true for community centres and homes serving as educational sites.

As with existing metrics, the focus in the new Internet access dimension is on download speed. Clearly in a context in which students are creators as well as consumers of digital materials then upload speeds are also important. It is likely that storage for learners and their teachers will also become an increasing issue, particularly for those who adopt Cloud services.

The degree to which students have access to the Internet depends not only on the bandwidth into the school, but also the nature of the school network, which can be split into Network type and Network access.

3.7.3 Network type

A range of different ways is used in existing metrics to deal with the issues of the type of network within a school:

1. Is there one or more networks? (e.g. Haddad 2007a; UIS 2014b)
2. Is there a network for management and/or curriculum purposes? (Becta 2006)
3. Is the network wired or wireless? (e.g. Becta 2006; Haddad 2007a)

The European Schoolnet (2013) and UIS (2014b) looked at connectedness in terms of whether there was a local area network (LAN), a school website, or other online provision. However, Twining (2014a) divided these into separate dimensions in order to separate out different aspects of the infrastructure, which he called the Network dimension and the Hosting dimension (see Section 3.7.5 below). Twining's (2014a) Network dimension focused on the nature of the network available to students, and extended the existing metrics by distinguishing between closed, controlled and open wireless networks. This is re-named here as the Network type dimension (see Table 3.3.3.A). A potential criticism of this dimension is that it does not seem to address peer-to-peer networking, which was raised by Haddad (2007a) as one type of network. However, the Network type dimension focuses on the fundamental nature of the network from a user perspective rather than the underpinning technology being used to provide that network.

Table 3.7.3.A The network type dimension (based on Twining 2014a p. 430)

| Category | Explanation |
|----------------------------|--|
| None | No network, including local area network (LAN) |
| Wired | A hard-wired network, which provides access to the Internet and school servers and services (e.g. shared folders). |
| Closed wireless | A wireless network, which provides access to the Internet and school servers and services. Only school devices can access the wireless network. |
| Controlled wireless | A wireless network, which provides access to the Internet and may provide access to school servers and services. Only devices that have been registered with the school can access the wireless network. |
| Open wireless | A wireless network, which provides access to the Internet. Any device can connect; login may be required using a Username and Password. |

Most of the Vital Study schools had a mixture of hard-wired and wireless networks, often having a Closed wireless network for staff use and a Controlled or Open wireless network for student use. In Vital Study 17 the school had a separate Controlled wireless network for staff and an Open wireless network for student BYO use. However, the BYO network had been disabled, which therefore required students who had brought in their own devices to use their own 3G mobile phone connections that the school could not monitor or filter.

As noted above, the nature of the school network involves both Network Type and Network Access.

3.7.4 Network Access

The importance of the extent to which students can access the school network is evident in many of the existing indicators. Providing wireless connectivity potentially increases the extent to which the network is accessible to students. However, this depends upon how the wireless network is configured. Thus, MMS Education (2014) asks about whether access to the (wireless) network is ubiquitous (Question 16) and reliable (Question 17). Similarly Becta (2006) considers where the school network can be accessed from, including considering access from outside the school. However, there are few existing indicators that help distinguish between different levels of access to wireless networks within a school. Table 3.7.4.A shows a new dimension, called Network Access, which addresses this critical question.

Table 3.7.4.A The new network access dimension

| Category | Explanation |
|----------------------------|--|
| None | No network access available |
| Wired – partial | Wired network is available in some of the teaching and learning areas |
| Wired – full | Wired networking is available in all of the teaching and learning areas |
| Wireless – limited | Wireless networking is available in some teaching and learning areas |
| Wireless – internal | Wireless networking is available in all internal teaching and learning areas (it may also be available in some outside areas) |
| Wireless complete | Wireless networking is available throughout the entire school, including all internal and external teaching and learning areas |

One limitation with this new Network Access dimension is that it does not address the question of who has access to the network. Twining (2014a) developed a dimension called Access (see Table 3.7.4.B), which looked at both where the school network was accessible from and who could access it. However, the focus of this dimension was on who could login to access school systems and information (e.g. curriculum resources, students' work) and where they could login from, rather than the extent to which the school network was accessible per se.

Table 3.7.4.B The access dimension (based on Twining 2014a p. 431)

| Category | Explanation |
|------------------------------|--|
| None | No access to server based systems for school system and information |
| Internal | Access is only available from within the school |
| External – staff | Staff can login via the Internet. Other people (e.g. students) can only access school systems and information from within the school |
| External - registered | Anyone (e.g. staff, students, parents) who has a username and password can login over the Internet |
| Public | Anyone can access non-confidential school information, for example curriculum materials or students work, over the Internet |

All the Vital Study schools had public websites, because this was a statutory requirement in England. However, some schools went much further than the basic obligation to provide information about the school, and provided access to curriculum materials and/or student work over the Internet. In most cases, such material was only accessible to registered users such as parents (e.g. Vital Study 7). Several schools had open student blogs (e.g. Vital Case Studies 4, 7 & 13). Whilst a small number published teaching materials, for example, Vital Study 3 shared ‘courses’ on Apple Computer’s Cloud service originally set up for universities called iTunesU.

The challenges of increasing equitable access for learners nationwide and supporting their schools to adopt and manage access and computer networks are illustrated in Vignette 3 in New Zealand and Vignette 4 in Malaysia. The New Zealand vignette also raises the issue of access for educators of teachers, including those involved in initial teacher education, who require access even though they are not employed in schools (Davis 2014).

The Access and Network Type dimensions hint at another important aspect of the digital technology infrastructure, which relates to the nature of the services that are available over the school network, which might be thought of in terms of hosting of services.

3.7.5 Hosting

Many of the existing metrics address issues about the types of services that schools provide and/or have access to over their networks. These include:

- Management Information Systems (MIS) and/or digital enterprise systems (e.g. MMS Education 2014 Questions 28 & 29)
- Virtual Learning Environments (VLEs) (e.g. European Schoolnet 2013)
- Interoperable learning platforms and management information systems (Becta 2006)
- School websites (ED31) (e.g. UIS 2009, p. 63 ; European Schoolnet 2013; UIS 2014b, Section D)
- Student and/or teacher blogs (ED32) (e.g. UIS 2009, p. 64)
- External email addresses for teachers/students (European Schoolnet 2013)
- Educational resources (MMS Education 2014 Question 15) or open educational resources (UIS 2014b, Section D), which include regional or national learning networks (such as the National Grids for Learning in the UK)

Twining (2014a) developed a Hosting dimension (Table 3.7.5.A), which encapsulates many of these elements. It also recognised the shift from local hosting of services to Cloud based provision, which was evident in the Vital Studies.

Table 3.7.5.A The hosting dimension (based on Twining 2014a p. 431)

| Category | Explanation |
|----------------------|--|
| None | No server based services used by the school. |
| Local servers | The school has its own physical servers, which provide shared folders and other services (e.g. management information system MIS). |
| Website | The school has a website which can be accessed over the LAN and/or Internet. |
| VLE | The school has a virtual learning environment (VLE), which could be accessed by staff, students and sometimes parents. Logging on to the network provided access to the VLE. |
| Cloud | The school uses a VLE that is hosted ‘in the cloud’ (i.e. by some other provider) and may require a separate login from the school’s network(s). |
| Cloud + | The school uses a range of services hosted ‘in the cloud’, which require separate logins from the school network and allow staff and students to mix and match the services they use to meet their needs (i.e. not constrained to one learning platform) |

Vignette 1 provides an illustration where little or no Internet or mobile connectivity was deliberately designed and communication was replaced by provision of memory cards. Vital Study 12 for example was assessed as “Cloud +” because it had a VLE (called Frog) and used a wide range of other cloud based services including: Google Drive (for document sharing), RealSmart (learning environment including electronic portfolio and self-assessment tools), Vimeo and YouTube (for video sharing), Flickr (photo sharing), SoundCloud (audio sharing of podcasts), Issuu (publishing prospectus and newsletters), CoverItLive (sharing live events), Wordpress (school website), and Weebly (web site building tool). Vignette 4 describes Malaysia’s nation-wide VLE for schools (Frog) that also includes access to other tools similar to those in the Vital Study 12. However, that vignette also indicates that there are challenges in engaging teachers and students in these novel environments.

Many of these categories on the Hosting dimension relate to the provision of access to resources to support learning. Related to this is the question of how much control the school has over which resources students can access. This is a particular concern in relation to students’ access to material on the Internet.

3.7.6 Filtering and User Login

One of the ways in which education providers manage students’ access to material on the Internet is through filtering. Whilst this does not feature extensively in the existing metrics on digital technology infrastructure, it is hinted at by MMS Education (2014) who ask about ‘security tools’, although their focus seems to be on data protection and privacy rather than preventing students accessing ‘inappropriate content’. Table 3.7.6.A suggests a new Filtering dimension. However, in practice this metric may be more appropriate to include within the paper on pedagogical approaches and the ways in which digital technologies are used (Gibson et al. In preparation) rather than this one on infrastructure.

Table 3.7.6.A The new filtering dimension

| Category | Explanation |
|--------------------|---|
| None | There is no filtering of web content that students can access from within the school |
| School | Access to the Internet is filtered from within the school and the school has full control over the filter settings |
| Partnership | Access to the Internet is filtered from within the school. Although an external agency manages the filter, the school can request changes to the settings |
| External | Access to the Internet is filtered from within the school, and an external agency has full control over the filter settings |

Gaining access to networked services, whether they are local servers or cloud based, requires users to have unique identifiers. This also allows individual user’s network activity to be monitored, although the accuracy of such data is challenged in Vignette 4. In some countries students are provided with unique identifiers. In others single sign on protocols have been established, which enable users to access multiple different services (e.g. Cloud based services) with a need to only log into one of the services. Therefore there is also scope for developing a set of metrics related to user login and security.

3.8 Funding

Section 3.5.1, which dealt with the level of expenditure of digital technology, noted that the increase in Bring Your Own (BYO) strategies in schools has complicated any metrics related to overall expenditure. The UIS (2009 p. 28) included a metric that addressed the BYO issue:

ED28: Proportion of student-owned computers available for pedagogical purposes (e.g. UIS 2009, p. 60)

Similarly, Your Own Technology Survey (YOTS) (Twining, Henry & Lewis 2014) helps schools collect data about the Internet-enabled mobile devices that their students have access to at home, and whether they would be allowed (by their parents/caregivers), able, and willing to bring them in to use in school every day.

The existing indicators in the literature do not capture the full range of alternative funding models that are emerging in schools. Twining (2014a) developed a Funding dimension, which has been extended here to account for external agencies providing funding (Table 3.8.A).

Table 3.8.A The revised funding dimension (adapted from Twining 2014a p. 432)

| Category | Explanation |
|------------------------|---|
| External agency | Funding might be provided as part of a national initiative or charitable donation. |
| School funded | The school pays for all the digital technology used in the school. |
| Subsidised | Parents make a (voluntary) contribution towards the cost of digital technology that is used in the school, often in the form of monthly payments over several years. |
| Hybrid | Parents make a (voluntary) contribution towards the cost of a mobile device, or if they already have a suitable device at home then their child brings that device to school. |
| Home | Parents buy a mobile device that is used in school. |

In all cases the school provides the networking infrastructure and some computers. These might be for specialist purposes, for general use, and/or for students' whose parents do not pay towards digital technology provision. For example, Vital Study 18 offered a hybrid model in which parents could either pay a monthly donation towards the cost of an iPad tablet computer provided by the school, or provide their own iPad for their child to use. Support was also provided for parents who couldn't afford either option. In Vital Study 18 all parents agreed to 'on-site management of the device', even if they owned it outright.

BYO approaches are also relevant for adults who act as teachers or teaching aids. Vignette 5 illustrates BYOD by such adults working with refugee students in a Saturday programme for out of school students. Similarly teachers may bring their own devices to school and/or contribute to the cost of their own laptop and other devices. Du Toit (In Preparation) discusses the importance of this for teacher professional development.

3.9 Digital content

Haddad (2007a p. 12) claimed that "ICT-enhanced instructional content is one of the most forgotten areas, but evidently the most crucial component." Whilst those in the U.K. or USA might claim that there is an abundance of high quality educational content on the Internet, this is not the case in many countries, especially in the developing world, either because English is not the language used in education and/or because culturally relevant content is not available. UIS (2014a) agrees that effective indicators of digital technology provision need to deal with provision of content, and indeed many of the existing metrics do so. For example:

- Becta (2006) considered ease of locating content, level of provision by subject, number of priced products, and the quality of digital resources (though no metrics were provided for establishing quality)
- UIS (2009) included indicators related specifically to content (ED24 Proportion of educational institutions owning licence for or subscribing to scientific digital libraries (p. 56); ED24bis Proportion of educational institutions owning licence for or subscribing to virtual experiment laboratories) (p. 56)

as well as to computer and Internet assisted instruction, which involves the use of content (ED22 Proportion of schools with computer-assisted instruction (p. 54); ED23 Proportion of schools with Internet-assisted instruction(p. 55))

- Barbour et al. (2011) raise the issue of equitable access to resources for online learning
- Mullis, Martin, Foy, and Arora (2012 p. 227) asked “How much is your school’s capacity to provide instruction affected by a shortage or inadequacy of ... Computer software for mathematics instruction?”
- Mullis, Martin, Foy, and Drucker (2012 p. 151) asked “How much is your school’s capacity to provide instruction affected by a shortage or inadequacy of ...Computer software for reading instruction?”
- US DoE NCE (2012c) has questions about access to online licensed databases (Questions 19 & 20), total holding and expenditure on specific and ALL information resources (Questions 25 & 26)
- UIS (2014b, Section D) deals with open educational resources (as part of a broader question about digital technology infrastructure)
- MMS Education (2014) focuses almost entirely on the provision of digital resources and their use, including: multimedia instructional materials, simulations, adaptive digital curriculum, digital educational content online, and online courses

In contrast, the Vital and Snapshot Studies suggested that this focus on content reflected a traditional approach to the implementation of digital technology in schools. The evidence from those 35 case studies suggested that as schools (in England and Australia) integrated the use of mobile devices the focus shifted from using them to deliver curriculum content (e.g. I need an app to teach about Flags), to using them as study aids that support students in carrying out research (e.g. finding information, taking notes), to them becoming multimedia creation tools (e.g. creating hypermedia representations), and ultimately tools to facilitate reflection and peer-assessment (e.g. recording yourself doing something and then review it and/or get a peer to give feedback on it). This suggests a potentially useful new Tool dimension (Table 3.9.A). This is strongly linked with pedagogy and how digital technology is used and thus not a main focus for this paper.

Several of the vignettes illustrate the relevance of pedagogies that deploy digital technology in such a way as to support the creation of digital content: rural Indian students create content in Vignette 2; multimedia is created in Bangladesh classrooms in Vignette 6 and the OERs produced by the TESSA project are deployed in teacher training in Vignette 7. Some of these approaches challenge the traditional approach to schooling so success is also strongly related to professional development.

Table 3.9.A The new tool dimension

| Category | Explanation |
|-----------------------|--|
| Delivery | Digital technology is used to present content to students |
| Research | Digital technology is used to support students in carrying out research, e.g. searching the Internet, taking notes |
| Creation | Digital technology is used as a multimedia creation tool by students |
| Meta-cognitive | Digital technology is used to support students in reflecting on their own understanding, skills or attributes and/or to support peer-peer assessment |

The last category on the new Tool dimension includes peer-peer assessment, which is a pedagogical tool. Using digital technology for summative assessment raises important issues relating to infrastructure.

3.10 Assessment

There is a growing move towards digital technology enabled assessment in schools, particularly summative assessment in developed countries. Thus, for example,

- On-screen testing has been used for some PISA tests (specifically around digital literacy) and will be used on all PISA tests from 2015
- Finland is developing Digabi as a replacement for high stakes paper-based examinations in schools
- An examination board in Northern Ireland (CCA) use on-screen assessment for one of their general qualifications (A levels)
- One of the larger examination boards in England (AQA) have trialled on-screen assessment for science GCSEs
- Tasmania has moved to on-screen testing for its end of school computing exams
- The USA is moving towards on-screen testing for its new Common Core curriculum
- Online assessment has been used to inform instruction for some years in New Zealand, e.g. eASTTLE (“e-asTTle is an online assessment tool, developed to assess students’ achievement and progress in reading, mathematics, writing, and in pānui, pāngarau and tuhituhi.” <http://e-asTTle.tki.org.nz/>) The New Zealand Government announced in 2014 that it is also preparing to move in this direction for summative examinations.
- Countries such as Lithuania, Slovenia and Georgia use on-screen assessment for their school leaving exams

The importance of this area is not adequately reflected in the existing metrics, most of which fail to mention assessment or only do so in passing. It is mentioned in SITES (2006 as reported in UNESCO 2009 p. 18) which talks about the availability of ICT software, including assessment tools. MMS Education (2014) place much greater emphasis on assessment, in that they have several metrics related to it, including:

- 21 Computer-based assessments are used to inform instruction.
- 22 Online assessments are used to inform instruction.
- 23 Assessments measure students' technology skills and competencies.
- 33 Information systems track student performance for decision-making.

Whilst the UIS (2014a) identifies assessment as an issue related to pedagogy and learning, assessment is also an important infrastructure issue, because of the importance of the regulatory regime, which is linked to policies (see Section 3.1) and the demands that digital technology-enabled testing places on the infrastructure in schools. Indeed, major barriers to digital technology-enabled assessment in schools include:

- insufficient computers (particularly where time sensitive terminal exams are favoured over ‘when-ready’ assessment)
- poor Internet access in schools, particularly unreliable and/or of insufficient bandwidth
- inadequate or unreliable server and networking infrastructure in schools
- lack of competence of staff to manage the digital technology required of high stakes on-screen assessment

Collecting data about the percentage of students who take digital technology-enabled high stakes summative assessments (e.g. school leaving exams, assessments leading to national certification) would provide a good indication of the level of digital technology available for use in schools. Table 3.10.A illustrates variables that might usefully be included in such a metric:

Table 3.10.A An embryonic (summative) assessment dimension

| Subject | Age at which nationally controlled summative assessments take place | | | |
|-------------------------|---|----------------------|-------------------|----------------------|
| | <Insert age here> | | <Insert age here> | |
| | Total students | % assessed digitally | Total students | % assessed digitally |
| Language (e.g. English) | | | | |
| Maths | | | | |
| Science | | | | |
| Computing | | | | |
| History/Geography | | | | |
| <Add subjects here> | | | | |

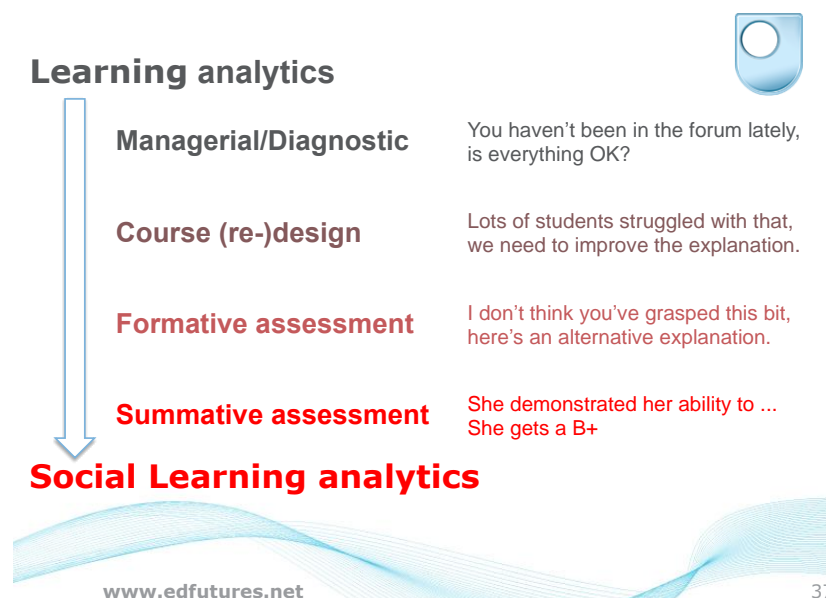
Summative assessment is critical because it acts as a driver of practice. Formative assessment, whilst less important in accountability terms is more critical in enhancing learning. The extent to which schools are able to make use of student data for formative assessment purposes depends in part upon their Management Information Systems (MISs).

3.11 Management Information Systems (MIS)

Management Information Systems were first used to track key data on students within one or more schools including enrollment and attendance. They evolved to network this data with other organisations including Ministries of Education and to inform school planning at local, regional and national levels.

As in other sectors, there has been an explosion of data available to schools and MISs have evolved to varying extents to support additional analyses. In particular, there is a growing emphasis on using student work for formative assessment purposes. Whilst not prevalent in schools at present, it seems likely that techniques that make use of 'big data' will become increasingly important in education. Thus social learning analytics using data from the school's virtual learning environments and wider Cloud based interactions are likely to become important components of MISs in the future (Figure 3.11.A summarises the difference between learning analytics and social learning analytics).

Figure 3.11.A Comparison of learning and social learning analytics (Twining 2014d with permission)



The OECD (2010) carried out a survey of ‘educational information and feedback systems’ which looked at: Goals of the system; Data model; Coverage and frequency of collection; Data linkages; Data quality processes; Data Access / Privacy; Comparison possibilities; Instructional Support, Collaboration and Professional Development; Accountability; Extendable Platform; and Other aspects. Their first focal area, Goals of the system, best captures the sort of changing trends in MIS use in schools, and has been used as the basis for a new MIS dimension, which is presented in Table 3.11.B.

Table 3.11.B The new MIS dimension (based on OECD 2010)

| Category | Explanation |
|-------------------------------------|---|
| No MIS | There is no management information system (MIS) |
| Administrative MIS | There is a MIS, which is used to manage administrative data, e.g. pupil enrollment, attendance, budget info, etc. |
| Teaching MIS | There is a MIS, which is used to support teachers’ preparation, planning and analysis of summative assessment data |
| Learning MIS | There is a MIS, which is used to support students’ learning by providing them with access to their own assessment data |
| Analytic MIS | There is a MIS, which analyses ‘big data’ to highlight students at risk and/or those who would benefit from additional support |
| Social learning analytic MIS | There is a MIS, which analyses ‘big data’ to provide summative and/or formative feedback on students’ performance and characteristics, e.g. related to knowledge age skills such as leadership, learning to learn, real problem solving, collaboration and networking |

4. Recommendations and conclusions

The analysis of existing indicators and their testing against the case studies and vignettes led to a set of key themes, each of which in turn had one or more associated dimensions of practice. These suggest new indicators for describing digital technology infrastructures in the school sector. The new indicators are intended to provide abstractions that reflect the changing digital technology strategies in education systems for school age learners, which capture the key 'essence' of these developments without being tied to specific technologies.

It is important to recognise that the dimensions of practice presented in this paper are designed to assist in describing the digital technology infrastructure. They are neutral in the sense that they avoid indicating what 'good practice' might look like at a school, regional or national level. This reflects the fact that what is deemed 'good' in one context or ecology is often inappropriate in another and that interlinked educational ecologies evolve (see Figure 1.3.A and Davis et al. 2013). Thus the dimensions of practice provide ways of describing, and thus comparing infrastructure across contexts rather than evaluating its quality.

The adoption of Cloud based digital technologies has accelerated evolution away from the measures in the previous UIS ICT in education questionnaire (UIS 2014b). This has resulted in the increasing interdependence of the dimensions as well as spreading of control across the interacting ecologies beyond the school campus and region in some cases. For example Google sites are a global phenomenon and also one service within the regional infrastructure of some regions (see the Malaysian Vignette 4).

It is also important to note that the practice within any one school may span more than one category on some of the dimensions. For example, in relation to the revised Device Type Dimension (Table 3.6.1.A) students within one school may have access to both Desktops and Laptops. Thus the description of a school's provision is likely to be in the form of a pattern of provision and a trajectory in relation to each dimension (e.g. evolving from Desktops (Device Type) in Labs (Provision) towards 1:1 owned (Provision) Tablets (Device Type)). The pattern within and across dimensions provides a rich picture for each school at any one point in time. For those wishing to describe the digital technology strategy in individual schools we recommend using as many of the dimensions set out in Section 3 as possible.

Whilst all of the metrics are designed specifically to operate at the level of a school or other institution, some of them, such as the Policy and Electricity dimensions, may also be used / adapted to describe provision across schools, for example at a regional or national level.

In this section suggestions are made about the most useful dimensions to use at the national level, with an indication of how they might be adapted and how they relate to the existing sections of the UIS ICT in education questionnaire (UIS 2014b). However, further work will be needed to convert these metrics into instruments for collecting data (which is beyond the remit of this paper). There may, for example, be issues related to infrastructure that relate to characteristics of learners (e.g. gender; disability) and/or schools (e.g. urban/rural; state funded/private funded) which may impact on how data are collected. Such factors are also beyond the scope of this paper.

The selection of dimensions, and their organisation in this section, is informed by Laurillard (2012). She argues for the importance of drivers in education and the need to focus teachers and senior leaders on the most useful direction of travel, as well as enablers that can make that developmental 'travel' possible. Figure 4.A provides a diagrammatic representation of some of the key drivers and enablers in education identified by Laurillard (2012). Some of these drivers and enablers, such as 'Teacher professional development', 'Communities of practice', and 'Student needs and skills' fall outside the remit of this paper. They are being addressed in the two complementary papers also commissioned by UIS (Gibson et al., In preparation; Du Toit, In preparation).

Figure 4.A Drivers and enablers in education (based on Laurillard 2012 p. 75)

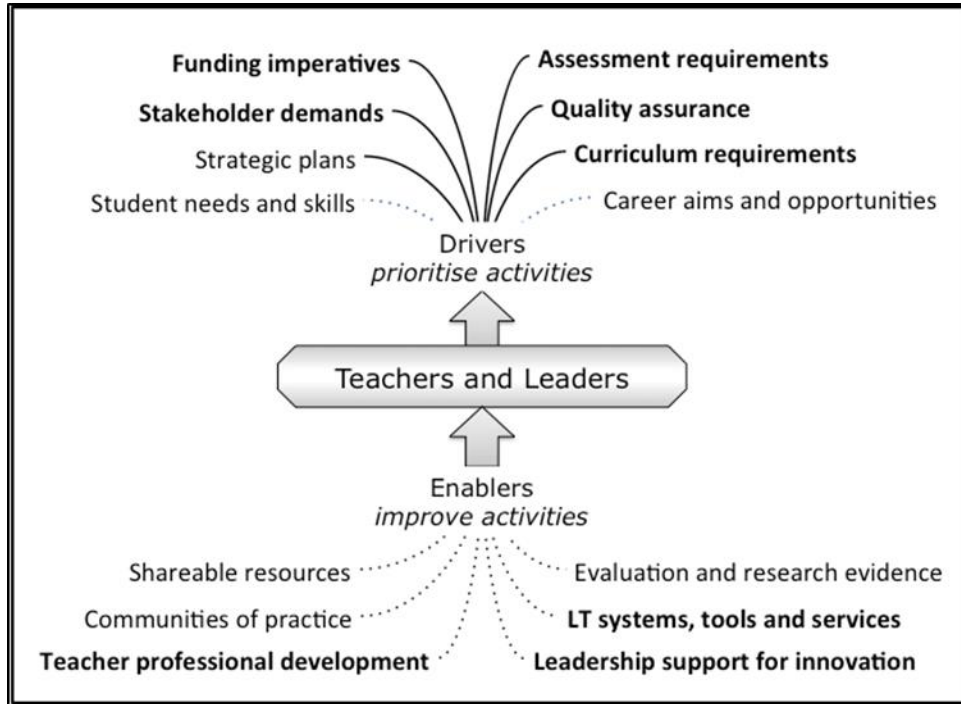
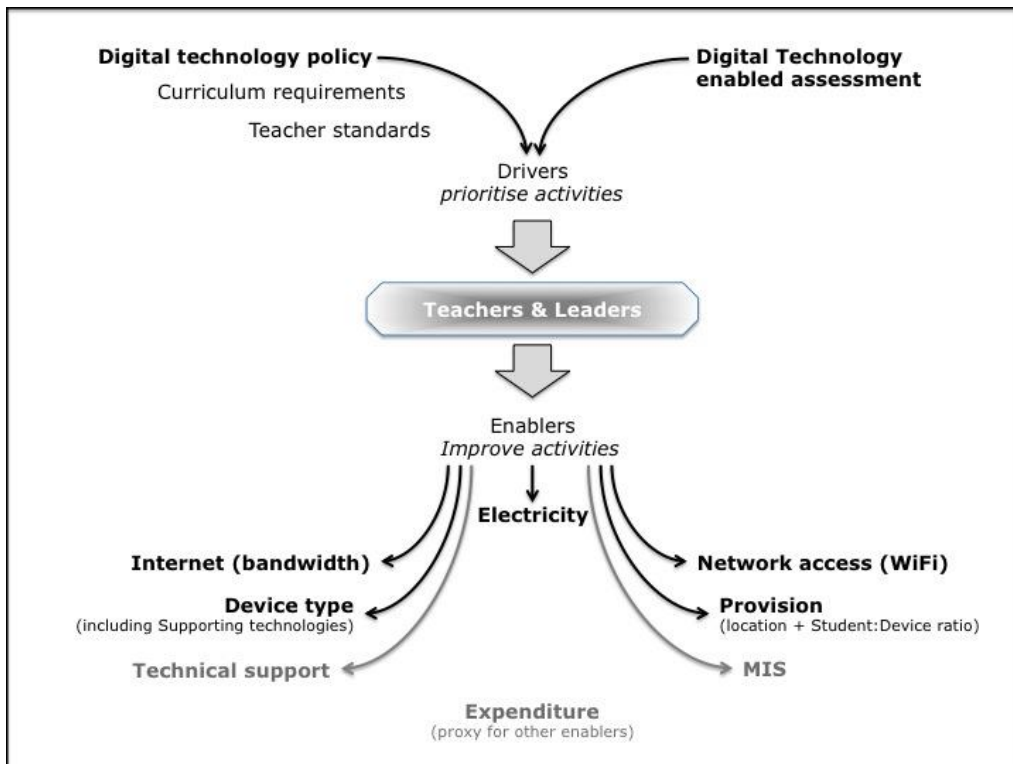


Figure 4.B provides a summary of the 12 dimensions that are recommended for use at a national level in the remainder of this section, organised into those that drive adoption and those that enable teachers and their leaders to change. Some (in bold) are likely to have greater impact and so are designated as high priority for educational systems wishing to promote adoption.

Figure 4.B Recommended dimensions for ICT infrastructure metrics at a national level



Although not designed into the following indicators we also recommend that, where possible, metrics are adjusted in a way so that data can become disaggregated by gender. Currently being gender unaware recommendations are at level zero on the UN-SWAP scale (UNESCO 2013) and relevant metrics should ideally be redesigned to move to the top level which “is gender-transformative as it relates to discriminatory policies and practices and affects change for the betterment of life for all”. This is discussed in du Toit (In Preparation).

4.1 Indicators related to visions and strategies (high priority)

Whilst education vision has been noted as being critical, we recommend focusing on how that vision is encapsulated in policy. Section B of the current UIS ICT in education questionnaire (UIS 2014b) has questions about the existence of national policies, plans, laws and regulatory mechanisms related to digital technology in education. However, the mere existence of a policy is not sufficient, it needs to be implemented and it would be useful to have some indication of the focus of the policy. Possible questions are illustrated in Questions 4.1.A and 4.1.B

Question 4.1.A First Policy Question (based on the Policy dimension in Table 3.1.B)

| | | |
|--|--------------------------|-------------|
| Indicate which of the following best describes your country’s digital technology policy | | |
| There is no digital technology policy | <input type="checkbox"/> | Finish |
| There is a digital technology policy | <input type="checkbox"/> | Go to 4.1.B |
| There is a digital technology policy focused on Computing | <input type="checkbox"/> | Go to 4.1.B |
| There is a digital technology policy focused on enhancing teaching and learning across the curriculum (going beyond Computing) | <input type="checkbox"/> | Go to 4.1.B |

Question 4.1.B Second Policy Question (based on the Policy dimension in Table 3.1.B)

| | |
|--|--------------------------|
| Indicate all of the following that apply to your country’s digital technology policy | |
| The policy is tied to the quality assurance criteria for schools | <input type="checkbox"/> |
| The policy is tied to the criteria for teacher certification | <input type="checkbox"/> |
| The policy is linked to promotion criteria for teachers | <input type="checkbox"/> |

As noted in Section 3.1.1 policies regarding national/regional curricula and teacher education are important, and questions relating to these should also be developed. However that has been left for the respective papers on digital technology use (Gibson et al. In preparation) and teacher education (Du Toit In preparation).

4.2 Indicators related to assessment (high priority)

Assessment is both an infrastructure and pedagogical issue so collecting data about the extent to which digital technology-enabled summative assessment is used in schools will provide an indication of the level of digital technology provision (and pedagogical approach).

The current UIS ICT in education questionnaire (UIS 2014b) does not contain any questions about digital technology-enabled assessment.

Question 4.2.A (based on Table 3.10.A) presents an early version of an assessment question that is likely to be further developed in conjunction with the paper on curriculum (Gibson et al., in preparation).

Question 4.2.A Assessment question (based on the embryonic assessment dimension Table 3.10.A)

Indicate the number of students at each level of education who took high stakes assessments in each of the subjects listed and the percentage of those students for whom those high stakes assessments were digital technology-enabled (e.g. involved use of digital technology, rather than being paper based)

| | Lower Secondary | | Upper Secondary | |
|-------------------------|-------------------------|----------------------|-------------------------|----------------------|
| | Total taking assessment | % assessed digitally | Total taking assessment | % assessed digitally |
| Language (e.g. English) | | | | |
| Maths | | | | |
| Science | | | | |
| Computing | | | | |
| History/Geography | | | | |
| <Add subjects here> | | | | |
| <Add subjects here> | | | | |

4.3 Indicators related to electricity supply (high priority)

Given that having electricity is a pre-requisite for being able to use digital technology this is an important baseline metric. The current UIS ICT in education questionnaire (UIS 2014b) includes a question about the number of educational institutions that have electricity. However, it is not clear whether this only includes schools that have a constant, stable power supply throughout the school. The recommended dimension incorporates these elements (as shown in Table 3.3.A) and could be posed as Question 4.3.A.

Question 4.3.A Power question (based on the electricity dimension Table 3.3.A)

Indicate the total number of educational institutions that fit into each of the following categories

| | Computer lab(s) | ... some other teaching areas | ... all teaching areas |
|---|----------------------|-------------------------------|------------------------|
| Have no power supply. | <input type="text"/> | | |
| Have an intermittent power supply in... | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Have a constant power supply in ... | <input type="text"/> | <input type="text"/> | <input type="text"/> |

4.4 Indicators related to connectivity (high priority)

Internet access is an important enabler in education. Whilst Section 3.7 outlines a wider range of dimensions related to connectivity we recommend focusing on two of these, namely the new Internet access dimension (Table 3.7.2.A) and the new Network Access dimension (Table 3.7.4.A).

The current UIS ICT in education questionnaire (UIS 2014b) asks a range of questions related to connectivity (in Section D). We suggest that these are replaced with new questions, which focus on bandwidth per student (rather than how Internet connectivity is provided) and on network access within schools.

4.4.1 Internet access

As indicated in Section 3.7.2, using the bandwidth available per students is more informative than the bandwidth per school. It is recommended that the number of students be based on the number enrolled in each cohort (e.g. where the school has a shift system with half the students attending in the morning and half in the afternoon the number of attending in each shift would be used), provided that they have equal access. The assumption is that the Internet connection is reliable and available throughout the school day. Question 4.4.1.A suggests a possible framing of the question.

Question 4.4.1.A Internet access question based on the new Internet access dimension Table 3.7.2.A)

Indicate the total number of educational institutions that fit into each of the following categories

| | Primary | Lower Secondary | Upper Secondary |
|---|--------------------------|--------------------------|--------------------------|
| There is no Internet connection | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| The Internet connection provides ... | | | |
| less than 0.01Mbps per student (e.g. a 512K connection shared between 50 students, or a 2Mbit connection shared between 201 students) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| between 0.01 and 0.049 Mbps per student (e.g. a 2Mb connection shared between 20 to 200 students or a 10Mbps shared between 100 to 1000 students) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| between 0.05 and 0.099 Mbps per student | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| between 0.1 and 0.199 Mbps per student | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| between 0.2 and 0.49 Mbps per student | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| between 0.5 and 0.9 Mbps per student | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1 or more Mbps per student (e.g. A 1 gigabyte per second connection shared between up to 1000 students) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4.4.2 Network access

No matter how high the bandwidth per student into the school it is only useful if the students can actually access it when they are working. That means that the Network Access dimension (Table 3.7.4.A) also needs to be used. Question 4.4.2.A suggests a possible framing of a question based on the new Network Access dimension.

Question 4.4.2.A Network access question (based on the new Network access dimension Table 3.7.4.A)

| Indicate the total number of educational institutions that fit into each of the following categories | | | |
|--|----------------------|----------------------|----------------------|
| | Primary | Lower Secondary | Upper Secondary |
| No network in the teaching and learning areas | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Wired network is available in some of the teaching and learning areas | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Wired networking is available in all of the teaching and learning areas | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Wireless networking is available in some teaching and learning areas | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Wireless networking is available in all teaching and learning areas | <input type="text"/> | <input type="text"/> | <input type="text"/> |

Consideration of a measure of teacher access on campus and at home may also be recommended in conjunction with du Toit (In Preparation).

4.5 Indicators related to access to devices (high priority)

Clearly a critical aspect of the digital technology infrastructure within a school relates to the access that students have to computers and related devices. Just as bandwidth into a school is of no value if there is not adequate networking, bandwidth and networking are of no value where there aren't adequate devices to connect to the network. As explained in Section 3.5, access to devices includes aspects relating to the numbers of devices relative to the numbers of students, the location of those devices, and the types of devices. At the school level a combination of the Provision and Device Type dimensions gives a rich picture of access to devices. It is recommended that these replace the items in Sections D and E of the existing UIS ICT in education questionnaire (UIS 2014b) that ask about access to devices.

4.5.1 Indicators based on the provision dimension

It is difficult to convert the Provision dimension to work at a national level, because any one school may span more than one category. We therefore suggest questions based on a modified version of the Provision dimension (Question 4.5.1.A) plus a student to computer ratio.

It is recommended that the student to computer ratio include all functional desktops, laptops, and tablets that are less than four years old and are available for student use.

Question 4.5.1.A Device provision question (based on the Provision dimension Table 3.5.5.A)

Indicate the total number of educational institutions that provide the following forms of digital technology for use in learning and teaching. (Note: institutions should be counted multiple times where they have more than one form of provision)

| | Primary | Lower Secondary | Upper Secondary |
|--------------------------|----------------------|----------------------|----------------------|
| Computer labs | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Devices in classrooms | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Loan sets of devices | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| 1 to 1 provision | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Bring Your Own provision | <input type="text"/> | <input type="text"/> | <input type="text"/> |

4.5.2 Indicators based on the Device Type dimension

As with many of the other dimensions, the Device Type dimension needs adaptation to work at the national level. In addition, particularly in areas where there are relatively low levels of digital technology access, it would be useful to capture data about a wider range of devices, including radios and TVs (which were discussed in Section 3.4), and digital cameras, data projectors and Interactive Whiteboards (which were discussed in Section 3.6.4). Similarly, it is recommended that assistive technologies are added to improve equity and inclusion.

Question 4.5.2.A Device type provision question (based on the device type dimension Table 3.6.1.A)

Indicate the **total number** of each type of device:
(do not double count across levels of education):

| | Primary | Lower Secondary | Upper Secondary |
|--|----------------------|----------------------|----------------------|
| Radios | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| TVs | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Assistive technologies | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Digital cameras | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Data projectors and/or Interactive Whiteboards | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Desktop computers | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Laptop computers (including Tablet PCs, Chromebooks, and other mobile devices with an integral keyboard) | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Tablets | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Other devices (specify) | <input type="text"/> | <input type="text"/> | <input type="text"/> |

Given the growing importance of mobile phones (e.g. Vignette 1) it could be useful to prompt regarding the pedagogical applications of mobile phones under 'Other devices (specify)' or to include it as a category in its own right.

4.6 Other indicators

4.6.1 Technical support (Medium priority)

Within traditional models of digital technology provision in schools technical support is critical, as without it the digital technology infrastructure soon fails. With shifts towards BYO approaches there has been a shift towards parents/students taking responsibility for maintaining devices, though there is still a need for schools to install and maintain the network infrastructure, specialist equipment and devices for those students who do not have adequate support at home.

Section D of the current UIS ICT in education questionnaire (UIS 2014b) asks about the number of schools that provide ICT support services. Question 4.6.1.A refines this, based on the Technical Support dimension (Table 3.6.3.a).

Question 4.6.1.A Technical support question (based on the technical support dimension Table 3.6.3.A)

Indicate the total number of educational institutions that utilise the following model of technical support: (Note, institutions should be counted multiple times where they have more than one form of provision. For example a school may have support provided by a teacher, a part time technician, students)

| | Primary | Lower Secondary | Upper Secondary |
|--|----------------------|----------------------|----------------------|
| There is no technical support | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| A teacher provides technical support | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| A part time technician, teaching assistant, or external consultant provides technical support | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| A dedicated digital technology team (e.g. network manager and technicians) and/or external contractor provide technical support | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| The school 'appoints' students as Digital Leaders to support the use of digital technology | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Students manage their own devices | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Other (please specify) | <input type="text"/> | <input type="text"/> | <input type="text"/> |

As noted earlier it would be particularly relevant to adapt this question to become gender specific (see also du Toit In Preparation).

4.6.2 Management Information Systems (medium priority)

As schools make increasing use of digital technology, the amount of data that they can access will increase. MISs will therefore become of growing importance to them, and will become a useful differentiator. As MISs become more embedded and sophisticated they will also (potentially) make it easier for central agencies to collect accurate data about provision within their schools.

Section A of the current UIS ICT in education questionnaire (UIS 2014b) asks about the sources of information used to fill in the questionnaire. It does not ask about MIS provision or use in schools. Question 4.6.2.A, which is based on the MIS dimension (Table 3.11.B), aims to address this omission.

Question 4.6.2.A MIS question (based on the MIS dimension Table 3.11.B)

Indicate the total number of educational institutions that use the following:
 (Note, institutions should be counted multiple times where they have more than one form of provision):

| | Primary | Lower Secondary | Upper Secondary |
|---|--------------------------|--------------------------|--------------------------|
| There is no management information system (MIS) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| There is an MIS, which is used to manage administrative data (e.g. pupil enrollment, attendance, budget info, etc.) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| There is an MIS, which is used to support teachers' preparation, planning and analysis of summative assessment data | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| There is an MIS, which is used to support students' learning by providing them with access to their own assessment data | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| There is an MIS, which analyses 'big data' to highlight students at risk or who would benefit from additional support | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| There is an MIS, which analyses 'big data' to provide summative (and/or formative) feedback on students' performance and characteristics | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Other (please specify) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4.6.3 Expenditure (low priority)

As explained in Section 3.5.1, expenditure is a very problematic metric, both because it is difficult to collect accurate data about the expenditure on digital technology in schools and because the critical issues are more to do with what digital technology is provided and how it is used. As funding models change the usefulness of having data about government/institutional expenditure of digital technology will also decrease. However, we recommend that the existing questions on expenditure from the UIS ICT in education questionnaire (UIS 2014b) are retained at this stage. It is recommended that an additional question is included to gather data about the digital technology funding models used in schools, based on the Funding dimension (Table 3.8.A).

Question 4.6.3.A Funding question (based on the funding dimension Table 3.8.A)

Indicate the total number of educational institutions that use the following model for funding their digital technology provision:

(A school may be counted more than once if it uses a range of different sources of funding)

| | Primary | Lower Secondary | Upper Secondary |
|---|----------------------|----------------------|----------------------|
| National initiative or charitable donation | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| The school's own budget | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Parents make a contribution towards the cost of digital technology that is used in the school | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Parents provide a mobile device for their child to use in school | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Other (please specify) | <input type="text"/> | <input type="text"/> | <input type="text"/> |

A similar question could be asked about the funding of provision of technology for teacher use to fit with recommendations by du Toit (In Preparation).

4.6.4 Indicators related to the environment (Low Priority)

The environments in which school age learners are educated have been noted as changing and becoming more diverse, including the opportunity to learn online for all or part of a distance course and/or have support from a distant teacher. The key indicator here is about the nature of providers (Table 3.2.D), although these data would be difficult to collect at a national level. A simplified question might be:

How many students have the opportunity to learn online?

4.6.5 Indicators related to digital content (Low Priority)

In Section 3.9 it was argued that as the use of mobile devices became embedded within schools there tended to be a shift away from a focus on using digital technology to deliver content and towards its use by students to create content and support reflection and peer-assessment (see the new Tool dimension Table 3.9.A). However, we recognize the importance that many countries still place on digital content and the growing focus on Open Educational Resources (OERs).

The most appropriate metrics in relation to digital content relate to the extent to which high quality digital content exists to support teaching of the school curriculum at each level, and what licensing agreements are in place, and hence the cost of accessing those resources. This suggests three key questions for further development in association with the curriculum paper (Gibson et al. In Preparation):

- At each level, what proportion of the curriculum is covered by high quality digital materials?
- What level of investment is planned to develop high quality digital content aligned with the curriculum?
- How much does it cost, per student, to access those materials?

4.7 Cautions

The purpose of this paper is to recommend and discuss metrics that can be used to describe and compare digital technology infrastructure in the school sector in line with UNESCO's goals of equity because, as the declaration from the international forum following up on outcomes ten years after the World Summit on the Information Society declared:

Infrastructure is central in achieving the goal of digital inclusion, enabling universal, sustainable, ubiquitous and affordable access to ICTs by all, taking into account relevant solutions already in place in developing countries and countries with economies in transition, to provide sustainable connectivity to and access for rural, remote and marginalized areas at national and regional levels.

(WSIS + 10 2014 p. 35)

Having undertaken a comprehensive synthesis of literature to inform discussions at the World Summit in 2005, including consideration of ICT infrastructure for schools, Davis and Carlsen (2004 p. 10) came to a conclusion that still stands today:

Although this comprehensive synthesis supports the expansion of literacy in the twenty-first century to include critical and cultural aspects of ICT, it finds that operational skills of ICT may be taught more effectively in vocational education. Research into the use of ICT to enhance educational attainment is complex, suggesting the need for complex and systemic engineering with extensive access to ICT for students and their teachers within and beyond education. However, there is clear evidence of the successful application of ICT to increase access to education, such as in rural areas. ICT to increase access for special educational needs is also indicated. However, these applications of ICT to enhance access also require systematic and systemic engineering, involving many partners, including teachers, who would do well to gain an understanding of their complementary motivations to invest in ICT, so that they may work in harmony.

It is possible that inappropriate pressure may be placed on some governments and leaders of other organizations to adopt digital infrastructure to keep pace with global changes. The authors urge resistance to such pressures and instead prompt leaders at all levels to continue to address the local and regional and national visions for schooling and then plan to develop and maintain relevant and robust digital technology infrastructure for schooling. Davis' ecological perspective illustrated by Figure 1.3.A aims to clarify the complexity of the interacting ecologies such that the digital infrastructure for students in a class interacts with that of other classes in the school and homes of the students and teachers and increasingly with regional, national and global dimensions. The nine vignettes collected for this report to challenge the metrics provide further illustrations (see Section 6.4).

Current evidence from the vignettes and other sources already discussed confirms that care continues to be needed in the interpretation of data provided by parties with a vested interest in the outcomes. This reflects Cuban's (2001 p. 120) criticism of surveys, which he said "are essentially self-reports and so are prone to inflation and selective memory". The issue of respondents inflating their responses on surveys about digital technology in schools was also raised by Twining (2002), and illustrated in relation to data collected by the English government. This reinforces the need to exercise caution in how data are collected and interpreted against the proposed new indicators.

However, it is clear that countries, agencies and other organisations will use the data that UNESCO collects for purposes of comparison and benchmarking. Caution is recommended. The value of these metrics lies as much in the highlighting of a necessary range of aspects of digital technology infrastructure and the interrelated nature of many of these aspects, as in the accuracy of data that is published. It is notable that data gathered through national governmental agencies is likely to ignore millions of children who are not attending school and we hope that by raising that aspect UNESCO and others will be encouraged to find a way to overcome the challenges and include those students in the future.

4.8 Concluding remarks

This paper has discussed the evolving nature of digital technology in schooling and the associated infrastructure to support the schooling of children and young people in many regions of the world. Unusually, it has also included out of school experiences and the needs of many students who are challenged to attend a local school on a regular basis, including refugees and the communities who support them.

The production of this lengthy paper has included significant discussion with a wide range of people before, during and after the technical advisory meeting in Paris in December 2014. The authors would like to acknowledge the contributions of those who wrote and validated the vignettes that have been used to challenge our metrics, to identify issues, and to improve their applicability (see appendix 6.2). In addition, the authors have benefited from engaging with the authors of the two complementary papers commissioned at the same time (Gibson et al. In Preparation; du Toit In Preparation). We all agree that the value of digital technology and related infrastructure depends on the fit between that infrastructure and the educational vision, and on how the technology is used in practice. Ultimately this is about the quality of the educators in all systems of schooling. Therefore, our concluding recommendation is for future metrics to encompass all parts of the schooling system by including institutions that prepare future teachers as well as schools.

5. References

Note: While the literature cited in vignettes in Appendix 6.2 is not included here, it is referenced at the end of each vignette.

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6. Appendices

6.1 Biographies of the authors

Peter Twining is a Professor of Education (Futures) at the Open University and Co-Editor In Chief of [Computers & Education](#). He was the Director of Vital Professional Development, a £9.4million English Department for Education funded programme to support practitioners in enhancing their teaching *about* and *with* digital technology. Peter has been a primary school teacher, the Head of Department of Education at the Open University and the Co-Director of the Centre for Research in Education and Educational Technology. His career has focused on issues to do with the management of educational change and enhancing education, informed by understandings of learning and the potentials of digital technology.

Niki Davis, University of Canterbury Distinguished Professor of e-Learning, is recognized internationally as a leading expert in information and communication technologies in education. Leadership positions have included centre for research and development in e-learning; President of the Society of Information Technology in Teacher Education, the UK association for Information Technology in Teacher Education and the New Zealand association for open flexible and distance learning (DEANZ); Chair of educational research for the International Federation of Information Processing; leader within [EduSummit](#)s, and editor-in-chief of academic refereed journals including Information Technology for Teacher Education, and the [Journal of Open Flexible and Distance Learning](#).

Amina Charania is a Senior Program Officer with Sir Dorabji Tata Trusts, which is one of the biggest philanthropies in India. She designs, recommends and manages education projects aiming to improve quality of education at elementary schools and for adolescents. Amina leads the [Integrated approach to Technology in Education \(ITE\) initiative](#), which is spread across 12 projects in rural India and urban slums to improve learning process and inculcate authentic, analytical, digital citizenship and other 21st century skills. Previously Amina was a research assistant on the USA federal project Teacher Education Goes into Virtual Schooling.

Aleta Chowfin is studying for a Masters in the University of Canterbury while she also works as a teacher. In 2014, while she was a teacher in an international school in Jordan, she volunteered to be the lead teacher in the Saturday school for Syrian refugees in Jordan described in vignette 5. She has also taught in schools in New Zealand and Bangladesh.

Fiona Henry is a Lecturer of Education at The Open University (UK). She has extensive experience in designing and developing new technologies, resources and tools to support teaching and learning, particularly in STEM subjects. A former maths teacher, Fiona is currently part of TESSA (Teacher Education in sub-Saharan Africa), an international research and development initiative aiming to improve the quality of, and access to, teacher education in sub-Saharan Africa. She leads on the strategic use of mobile technologies to embed and extend the use of, and widen access to, OERs (Open Educational Resources) amongst teacher-educators in projects in Nigeria and Ghana. Previously Fiona was the Lecturer on Vital Professional Development, a £9.4million English Department for Education funded programme to support practitioners in enhancing their teaching about and with digital technology.

Hasniza Nordin is a teacher educator in the Universiti Utara Malaysia (UUM) who recently completed a PhD supervised by Niki Davis that described the changes in future teachers' knowledge of ICT in teaching following teaching practice in schools in New Zealand and Malaysia. The comparison discovered some of the issues relating to the measurement of ICT in education.

Clare Woodward is a Lecturer in International Teacher Education at The Open University (UK). She has extensive experience in teaching English and teacher education in a development context. Clare is currently working on [English in Action](#), an award winning £50 million UK Department for International Development (DfID) funded project, and leads on developing mediated authentic video delivered on

accessible mobile technology for teacher professional development at scale. She has also worked as a project manager in widening participation in the UK, developing and delivering ICT and social network solutions to upskill and support adults in economically and socially disadvantaged communities.

6.2 Vignettes

As introduced in Section 2.1 nine vignettes were gathered with the support of additional authors to challenge the metrics. Case studies were also applied from the VITAL research in the UK (Twining 2014a) and Snapshot Studies in Australia (Twining 2014c; may be accessed at <http://EdFutures.net>).

Table 2.1.A provides an overview of vignettes produced for this paper with an indication of the relevance of the project for the themes of all three papers commissioned, including Gibson et al. (In Preparation) and du Toit (In Preparation). It is repeated below for convenience.

Table 2.1.A Vignettes produced for UIS with an indication of the relevance of the project for the themes of all three papers commissioned. (Note: YES in capitals indicates that the vignette describes the aspect directly, whereas Yes indicates that it was indirect. Table also appears in section 2.1.)

| | Title | Lead Author | Infrastructure | Curriculum | Teacher Education |
|---|--|-----------------------------|-----------------------|-------------------|--------------------------|
| 1 | Bangladesh: English in Action authentic video on mobile phones | Clare Woodward | YES | Yes | Yes |
| 2 | India: Integrated ICT school supplements in community centres | Amina Charania | YES | YES | YES |
| 3 | New Zealand's development of Ultrafast broadband in schools including the largest nationwide correspondence school | Niki Davis | YES | No | Yes |
| 4 | Malaysia's nation-wide VLE for schools | Hasniza Nordin & Niki Davis | YES | No | Yes |
| 5 | Jordan with Syrian refugees: Saturday programme for out of school refugee children 30 minutes from the border and war zone | Aleta Chowfin & Niki Davis | YES | Yes | Yes |
| 6 | Bangladesh: Multimedia classrooms creating OER | Clare Woodward | YES | YES | YES |
| 7 | Nigeria: Extending OER amongst trainee teachers using tablet technology | Fiona Henry | YES | No | YES |
| 8 | Africa: Solar-powered mobile school classrooms in Africa | Fiona Henry | YES | No | No |
| 9 | India and Africa: Community and interactive radio in schools and other places | Amina Charania | YES | No | Yes |

6.2.1 Bangladesh: English in Action authentic video on mobile phones

Provided by: Clare Woodward

Country: Bangladesh

Age range supported: primary & secondary

Overview of the context

English in Action (EIA) is a programme requested by the Government of Bangladesh in response to the poor English language skills of the population. The project's purpose is 'to increase significantly the number of people able to communicate in English to levels that enable them to participate fully in economic and social activities and opportunities'.

EIA is a nine-year project funded by the UK Department for International Development (DfID) with the following partners: BMB Mott MacDonald, the Open University (OU), the BBC World Service Trust (BBC WST), Friends in Village Development Bangladesh (FIVDB), and the Underprivileged Children's Education Project (UCEP). EIA is involved at primary and secondary level in the government school system, as well as in non-formal settings through UCEP and FIVDB schools. It has also targeted a mass adult audience through the BBC WST's EIA products.

In Bangladesh, outside urban areas, many schools, particularly primary, still do not have reliable access to electricity, and very few indeed have access to the Internet. However, the penetration of the mobile phone has been rapid, rising from below 1 million subscribers in 2001, to almost 116 million in February 2014. Thus, teachers are generally very familiar with using a mobile phone. EIA maximizes this familiarity by uploading all multimedia materials onto an SD card, which is accessed off-line through an affordable mobile phone. Teachers receive their phone, SD card and speakers at upazilla (local district) teacher meetings set up by the EIA project. Here the SD cards are inserted in the phones and teachers are given a brief orientation session on navigating the materials on the phone and connecting the speaker. Following this brief training session on how to access the SD card materials, teachers in general have had minimal problems in using them. In each upazilla around 12 schools at primary and/or secondary level participate in the EIA project. Teachers work in pairs in their schools and if there are any issues they first try and resolve it together or with teachers from the other schools participating in EIA in the area. If this is not possible, an EIA Field Coordinator based in each of the 8 divisions within Bangladesh is available to assist either by phone or face to face.

Digital memory (SD) cards are available for the mobile phones of primary and secondary teachers. Each card contains 3 folders:

Folder 1: Teacher Professional Development consisting of mediated authentic video (MAV). This comprises a set of units focusing on a communicative approach to the teaching of English. Each unit is made up of authentic classroom video using local teachers in their own classrooms introduced and deconstructed by a Bangladeshi video narrator or guide who provides pedagogic expertise in the local language and in English. These units also contain unscripted video of groups of local teachers discussing aspects of English language teaching and classroom practice, as well as audio files of classroom language to help teachers develop their own English in the classroom.

Folder 2: English Language for Teachers (EL4T): a set of audio files for teachers to help them develop their own English language skills.

Folder 3: audio files of dialogues, poems and stories taken directly from the National English textbook, English for Today, Classes 1 – 10, to give the children (and teachers) access to recordings of clear and

accurate English. There are also extra files of songs and other audio that teachers may find useful for use in their classroom. All recordings are made using local Bangladeshi voices.

Use of technology in the classroom

Prior to the use of this technology, the only way the students could hear English spoken was through their teachers, who frequently had poor pronunciation themselves. Now students have access to clear English spoken by Bangladeshi actors.

The teacher selects an audio file from Folder 3 on his/her mobile phone which corresponds to the lesson currently being taught from the *English for Today* textbook. The phone is then plugged into the speaker which sits on a desk either at the front or in the middle of the room. As many schools do not have a reliable electricity source in the classroom, the speaker is often charged away from the school/class and brought into the classroom with a full battery.

The teacher prepares the students for listening by engaging them in a pre-listening activity to practice the target vocabulary, for example. The students are then given a task to complete while listening and the audio file is played. In Folder 1 on the SD card, the teacher can access material for teacher professional development (TPD) on how to use audio files in the classroom, with video examples of appropriate activities before, during and after the class listen to the audio. Research undertaken on the project has found that students are highly motivated by these audio files and related activities.

Description of digital technology being used:

SD memory card, mobile phone, rechargeable speaker: EIA decided on the Nokia C1 01 phone with 4 GB memory size of micro SD card and portable speakers at a cost of 60 UK pounds per teacher. This cost was covered by the project at first, but in the later phase (2014 - 2017) teachers will be requested to provide their own phones, and the Government of Bangladesh will provide speakers. There is already evidence that schools currently not included in EIA are purchasing their own speakers and copying the SD cards to use both in the classroom and for the professional development of their teachers.

Any other useful info about the context:

EIA operates across the whole of Bangladesh at both primary and secondary government schools. By April 2014 the project had worked with 12,500 teachers and almost a million students. There was change in many teachers' classroom practices according to the EIA web site (<http://www.eiabd.com/eia/index.php/abouts/about-eia>),

Changing Classroom Practices

In schools, The EIA programme introduces new English language teaching and learning activities to teachers and students across Bangladesh. By April 2014, more than 12,500 teachers and almost a million students have been reached by the programme. By 2017, we aim to reach 76,500 teachers and over 10 million students.

We work within the Government of Bangladesh systems. We involve Upazila staff in field level monitoring, and many of our lead teachers are Master Trainers from the formal Government teacher development programmes; and we work closely with Government Education Offices.

Direct feedback from beneficiaries is positive

95 percent of surveyed teachers reported that EIA had helped them improve their own language skills and 90% feels EIA has an impact on the way they teach.

Research finding shows, when teachers changes their practice and students experience the difference, from near zero, over 90% of their talk is now in English in the classroom. And, with this new opportunity to speak and practise English, students are learning more. When tested on

an international 12 grade scale, within 12 months: 54% of primary students improved a whole grade; and 38% of secondary students improved a whole grade.

...

It was another good day for English in Action in October 2014 when a paper on 'The potential of mobile phones to transform teacher development' won the Gold Medal for Best Practice Award at the Asian Association of Open Universities (AAOU) conference in Hong Kong.

The paper, authored by The Open University, UK colleagues Chris Walsh, Clare Woodward, Prithvi Shrestha and Mike Solly (2014), analysed the futures thinking process involved in delivering teacher professional development through audio and video delivered on affordable mobile phones.

Author

Clare Woodward is a Lecturer in International Teacher Education at The Open University (UK). She has extensive experience in teaching English and teacher education in a development context. Clare is currently working on [English in Action](#), an award winning £50 million UK Department for International Development (DfID) funded project, and leads on developing mediated authentic video delivered on accessible mobile technology for teacher professional development at scale. She has also worked as a project manager in widening participation in the UK, developing and delivering ICT and social network solutions to upskill and support adults in economically and socially disadvantaged communities.

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6.2.2 India: Integrated ICT School supplements in community centres

Provided by: Amina Chariana

Country: India

Age range supported: primary, secondary

Overview of the context:

Integrated approach to Technology in Education (ITE) is an initiative of the Tata Trusts in twelve mostly rural locations in Eastern India. This approach is a pedagogical framework to improve teaching and learning processes and foster authentic and project based learning for the older children and adolescents in some of the most underprivileged geographies in India. Teacher capacity building is central to this project where the teachers of the learning centres are trained to design activities to integrate student use of technology based on the curriculum. Students, mostly first time computer users, create learning artefacts such as charts with recent data on topics such as weather (e.g. weather charts), agricultural production (e.g. jute in India), or population density in different cities. The most colourful ones are the videos and multimedia projects on national heroes, historic monuments or a foreign city such as London. All the projects assigned are carefully selected by the teachers and match with the curriculum and lessons currently taught in the school.

The ITE initiative was started in 2012, in a remote region of East India; at Kandi subdivision of Murshidabad district, neighbouring the Bangladesh border. The main occupation in this region is daily wage labour and agriculture; women are involved in Katha embroidery work. ITE was layered on four learning centres where teachers primarily enforced rote learning of content to pass school exams for middle school and higher secondary students. In the first phase ITE was in mainly in learning centres, with a few extensions in the neighbourhood government schools. In 2013 ITE was also layered on additional locations associated with rural madrasa schools, urban slums of the Muslim minority, and remote Kora and Santhali tribal villages. In a second phase starting in 2015, ITE will also be situated inside government schools.

A majority of the students within this ITE programme go to government schools and also attend the learning centres as a before or after school programme. Most of these students have seen computers at their schools, but they would not have used them, although the students in tribal and madrasa projects are less likely to have seen a computer. The parents in these areas may have never seen a computer and may only have a vague idea of its usage. Although schools under the ICT in education scheme for secondary schools are supposed to have desktop computers and a computer teacher, these students do not get the chance to use computers because they are either missing, not in functioning condition, or are restricted to the teaching of technical skills and applications. Some of the state textbooks also have dedicated subject on computers that includes illustrations of CPU, monitor and computer hard drive and other parts, but the students may not actually get an opportunity to use the computer. Some of the other schemes found in the schools of the ITE programme have CD based content and multimedia. However, the students simply become recipient of the content or sometimes, as observed in one of the locations, this CD based content was simply projected in the computer lab to the whole class by teachers.

The ITE programme has become very popular in the absence of other opportunities that enable students to make projects using videos, pictures, Internet resources. Some of the new Tata Trusts projects have a wait list for students wishing to enrol. Some of the visible impacts that are included in evaluation measures include increased in attendance at the centres and increased interest in schooling and curriculum. Interviews with parents and older adolescents plus attendance tracking have clearly indicated that it has brought the disengaged and truant children (known as procrastinators) back to learning in school. The teachers at the learning centres are equally motivated to have their students use ICT to create projects and use Internet. Although subtle, the teachers now turn to their students for support to learn some of the technical skills. The approach has brought the activity centre approach to the forefront in the projects which otherwise were heavily geared toward rote learning. The teachers

have also started to adapt the approach to let children continue with projects during vacations. These children produce videos with the objective of social impact on a variety of topics, such as pollution, the value of water conservation, child labour and, most popular, alcoholism and smoking tobacco. This ITE activity emphasises authentic and creative aspects and directly integrates value for the community with citizenship education.

Finally it is useful to note that the popularity of the ICT in the after school centres has generated demand for the regional government to provide ICT infrastructure on the campus of the schools in the region. Therefore, the next phase will include the Tata Trusts working with the teachers, schools and district education authorities to integrate ITE approach inside the public schools. The ICT infrastructure will become available both in the schools and in the after school centres.

Infrastructure and device

Each of the Mursihidabad learning centres have an ITE lab with about eight computers, speakers, one digital camera, Internet connection (using dongles), and a web camera. The classrooms are very small and crowded with about 35 to 50 students with a minimum student to computer ratio of 2 to 1. The digital technologies are powered by a generator running on diesel. The ITE phase 1 pilot budget was small and did not include an electricity generator, its running cost, speakers and web cameras all of which are now in place and part of the ITE infrastructure. These additional items were added later when funding permitted. Tablet computers are not considered to be a substitute for laptops or desktops because the focus of ITE is on student created projects. A tablet computer is difficult to share and awkward for detailed work. In future, if the budget permits, one tablet with keyboard per student may become an option.

Based on the learning and sharing of the pilot, most of the projects starting in 2013, decided to go for laptops. It was easier to carry it from one centre to another for more access; it also fulfilled the need for power storage. One of the projects in Assam learning centres used keyboards attached to laptops, because the laptop keyboard is delicate and these students (mostly first time users) press the keys very hard. In addition, the external keyboard is less susceptible to soiling and dust than the laptop keyboard. Securing the computers from theft has been a challenge for villages in the Assam project, which is also the main reason for computers going missing from schools in these villages. In this project, the teacher carries the laptop home to guard against theft. Insurance for laptops becomes an additional challenge, because there are very few companies that insure laptops from theft when the laptop is in a location other (e.g. a teacher's home) than the primary registered location (e.g. the after school centre).

Student to computer ratio: Most of the projects have 3:1 student to computer ratio. Some of the projects have very few computers and have tried different scheduling to reduce the number of students per computer to at least a ratio of 3:1. In addition it is useful to note that, except for the tribal settings, most of the urban and a madrasa projects use single gender grouping.

Software used: The first phase of ITE required students to create spreadsheets, videos, digital stories, multimedia software. Most use Microsoft Office or Open Office. The second phase has also introduced SCRATCH (a computer programming language used for teaching in Computer Science) for problem based learning and programming-critical thinking, and Skype software for connected learners over the Internet and practicing English conversational skills.

Emerging trends:

Internet towers: The dongles and broadband Internet service used for connectivity are not always reliable and have restricted usage. One of the aims of the programme is to spread digital citizenship in the communities it serves; a concept similar to the traditional telecentres. Recently, with the help of a foundation (Digital Empowerment Foundation), wireless towers have been sanctioned by the Trust, which will be plugged in to serve the three rural locations. These low cost towers cost about 400,000 Rupees, and based on the select plans, will give Wi-Fi connectivity ranging from 400 meters to five

kilometres. A pre-mapping is done to survey the area terrain upon which these towers are set and the required phone connectivity. The Digital Empowerment Foundation then trains the local youth to maintain the Internet towers.

Solar power: The diesel or gas used to run generators go a long way, but the running costs of fuel are high and make it difficult to sustain. Although there are various solar options available in India, a sustainable and cheaper solution has yet to be explored.

Low cost computers: For sustainability reasons, low cost computer options need to be explored. A model customized from the original Raspberry pie was tested for its usability with children at one of the urban ITE centres. However, teachers' feedback and children's usage data and feedback rejected this low cost model. Such experiments to find a low cost effective version will continue when opportunities arise. In addition mobile devices are another area that will be explored as BYOD, which students may use for Internet surfing and gathering resources for their projects when their BYOD devices are connected to the Wi-Fi at the centres.

ITE mobile centre in a van: Suchana is one of the organizations implementing ITE. It works with Santhal and Kora tribal children on early literacy and learning improvement. When they adopted ITE, children and the neighbouring schools responded very well, but there were children in remote interior pockets who could not reach these centres. Therefore an ITE van was supported by the Trust. This van reaches the Kora and Santhali tribal children in the remote pockets twice a week. It carries charged up laptops, solar lanterns, digital cameras, Internet dongles, and also books. In this ITE programme the teachers drive the ITE van, which is a novelty in India, especially tribal India. Figure 6.2.B shows the first tribal woman to drive a van in the region, which was an additional equitable outcome of the ITE mobile centre in a van. A typical scene would include the children and adolescents waiting eagerly for the van and, as soon as it stops, they would quickly unload the laptops to use in the open space or community centre and, in a very short time, start making their ITE projects. Figure 6.2.C shows the children at using ICT at night with the solar lanterns lighting them

Figure 6.2.2.A Children in a remote tribal village at work on their ITE projects lit by solar lanterns (with permission from Rhul Bose).



Figure 6.2.2.B The first tribal woman to drive in this remote region; she is driving the ITE van (with permission from Rhul Bose).



Author

Amina Charania is a Senior Programme Officer with Sir Dorabji Tata Trusts, which is one of the biggest philanthropies in India. She designs, recommends and manages education projects aiming to improve quality of education at elementary schools and for adolescents. Amina leads the [Integrated approach to Technology in Education \(ITE\)](#), which is spread across 12 projects in rural India and urban slums to improve learning processes and inculcate authentic, analytical, digital citizenship and other 21st century skills. While studying for her PhD in the USA, Amina was a research assistant on the USA federal project 'Teacher Education Goes into Virtual Schooling' led by Niki Davis.

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6.2.3 New Zealand's development of Ultrafast broadband in schools including the largest nationwide school

Provided by: Niki Davis

Country: Aotearoa New Zealand

Age range supported: early childhood, primary, secondary, adult

Overview of the context

The government of Aotearoa New Zealand is on target to have Ultra Fast Broadband (UFB) Internet service in 98% of all schools by 2016, using fibre optic complemented with satellite for remote areas including remote high country and offshore islands. The UFB in schools initiative is funded by the ministries responsible for education and economy. In addition to Internet provision, it includes support to rewire schools (LAN and wireless) and provide an educational portal to a nationwide [Network for Learning](#) for secure web browsing and an increasing range of ministry, public and commercial/OER services. An earlier overview of policies and practices in education in New Zealand provided by Brown and Chamberlin (2009) describes the background for this innovation.

This vignette focuses on the educational services provided by the largest school in the country that was established to extend access to education. It is New Zealand's largest provider of primary and secondary education,

“The Correspondence School (Te Kura) was set up in 1922 to provide education at primary school level for 83 students living in remote areas. Seven years later it expanded to cater for secondary school students. Since then the school has grown and developed to meet the changing demands placed on it as its role in the education sector has evolved over time... In 2014 Te Kura had a cumulative roll of close to 25,000 with around 13,000 students enrolled at any one time. Te Kura students are very diverse. Along with students who are geographically isolated, itinerant or living overseas, our full-time students also include those who have been alienated or excluded from a face-to-face school, those who have been referred by Special Education, young parents and students who have been referred by Child, Youth and Family. Together, these students make up 51 per cent of our full-time roll.”

(Te Kura, 2015: p. 4)

It has not been directly included in UFB, so that its ICT infrastructure and interconnections with others provides a particularly useful illustration on variations of school ICT infrastructure. In common with other correspondence schools courses were previously delivered via a set of around 10 booklets (some accompanied by kits) sent out from the central warehouse by post at intervals regulated by the individual student's submission of assignments to a teacher for marking and feedback. This is rapidly evolving as indicated in strategic plans and reports, including reviews by the national Education Review Office (2013).

Description of digital technology being used

Te Kura uses an online teaching and learning environment (OTLE, a LMS known as 'Desire to Learn' sourced from Canada) and a largely bespoke student management system (sourced from South Africa), with continued upgrading to the capability and connectivity of these two major systems to meet online learning requirements and ensure that the OTLE offers an engaging experience for students and teachers. In 2015 the guidelines given to students and parents who are looking at options for purchasing a device or deciding whether an existing device will be suitable are provided on its web site as follows.

A suitable device must enable the student to:

- access the internet and Te Kura's OTLE (via a web browser)
- create audio and video recordings, as well as still images

- create and edit documents, including spreadsheets and presentations (using PowerPoint or Prezi for example).

A laptop or desktop computer, netbook, or tablet PC (also known as a Smart PC) will provide students with a comprehensive learning tool which can be used to create and share content

(Te Kura web site <http://www.tekura.school.nz>)

In the first stage of its online learning strategy, the school undertook digitisation of its senior examination (National Certificate of Educational Achievement, NCEA) course learning resources by making booklets into PDF files, which became available to download as PDF files through the OTLE. In 2015, all the secondary dual students will be required to access all NCEA materials through the OTLE. ERO has noted the benefits of this and other online strategies as follows,

“Some recent developments have made the curriculum more responsive to the needs of its diverse student groups. Digitising resources means that some students can access the resource immediately rather than waiting for the paper resources. Increasing numbers of subject teachers are developing online teaching and learning programmes that enable students to share ideas and work, and get more immediate feedback from teachers and peers.”

(ERO, 2013: p. 7)

Additional ICT includes a free phone number, email, Skype video conference and FOSS (e.g. Prezi presentation software).

Learning Activities

Most students study at their own pace, although students in a range of courses may study in the same location at times. Those dual enrolled in a school or other centre have a supervisor and study area, such as the recent redesign of Roxborough Area School (a rural school covering primary and secondary education) to facilitate this student centre-learning (Barbour, Wenmoth & Davis 2011: p. 34). Sick children are also enrolled in one of three Health Schools, which have a well-equipped drop in centre and equipment for loan, including laptop computers. Full time students are supported by a learning advisor in addition to their course teachers.

“Learning advisors work with students to develop a learning programme based on the student’s interests and abilities and to provide ongoing support and encouragement to each student. During 2015 learning advisors will expand the ways they communicate with their students to include conducting online advisories and as well as periodic face to face meetings. These ‘advisories’ or learning sessions will represent the student’s basic or home ‘learning group’”

(Te Kura, 2015: p. 22).

Many varieties of partnership are important to Te Kura with well worked out arrangements. For example, ERO reported,

“Where schools or other providers give high levels of support for dual-enrolled students, better outcomes have been achieved. Te Kura has developed a revised service agreement with schools and other providers using the dual-enrolment pathways for 2013. This makes it clear that the provider is responsible for supervising students and providing a properly resourced learning environment, including broadband, to support digital delivery. Relationship coordinators now provide better liaison between the provider and Te Kura.”

(ERO, 2015: p. 7)

Partnerships are also developing to improve the ICT infrastructure for individual students. In 2014 Te Kura began to develop partnerships with services working to increase equity (e.g. Computers in Homes see below) to source devices and connectivity for students who need assistance.

The potential for ICT infrastructure to hamper development should also be noted. The ERO (2013) report noted that implementation of new ICT infrastructure can hamper progress, as follows, “While Te Kura

has maintained development in line with its strategic plan, overall progress in some areas has been affected by major work to implement a new electronic student management system (SMS)” (ERO, 2013: p. 3).

Finally, it is useful to note the Te Kura is planning to deliver professional development for its teachers though its own infrastructure:

“Professional learning for teachers. Te Kura’s Learning and Development strategy in 2015, supports the school’s approach to Education 3.0 and the development of online learning resources. We will evaluate the strategy to identify changes to enhance teaching pedagogy, leadership training, and specialist and support staff training. Just as we increasingly deliver teaching and learning via the OTLE, so too we expect to deliver this teacher professional development via the OTLE.”

(Te Kura, 2015: p. 23)

Any other useful info about the context

The [Computers in Homes](#) initiative is one of the means that Te Kura and other schools can use to increase access. Interestingly that initiative has developed to include careful preparation of parents to supervise their children. In 2015 Computers in Homes has a trial of smaller tablet computers alongside the refurbished laptops and desktops that it began with. According to its web site, “The programme works via low decile schools, to help families in greatest need to use the Internet, email and basic computer skills in their everyday lives, to enhance their performance at school and at work.”

Te Kura is not the only way in which students can learn at a distance. Given the challenges of covering enough of the subjects offered in the secondary curriculum and the shortage of primary teachers who are able to teach the indigenous Maori language, rural schools have developed partnership arrangements led by an e-principal, within which one teacher in one of the public schools teaches a class of students who are dispersed across a number of schools. The ICT used to enable this networked schooling often includes regular videoconference sessions plus student self-paced learning with other resources including a text book and additional activities in a Learning Management System. The teachers and students use their home and their school’s ICT infrastructure plus video conference and LMS services provided nationally by the Ministry of Education Virtual Learning Network. In this way,

“Schools also collaborate to provide distance learning in a number of connected school networks using infrastructure provided nationally at no cost to schools. The Ministry of Education currently provides and supports a variety of e-learning tools (e.g., video-conferencing bridge, a learning management system [Moodle], an e-portfolio system [Mahara], and streaming video services [eTV], an online community and course brokerage website [VLN], and the suite of tools on the MoE “software for learning” website). Similarly, the Ministry of Education also provides brokerage services for the existing VLN e-learning clusters to allow clusters with excess capacity to enrol students from other clusters. The only aspect of the national coordination portion of this organisational structure is the online course repository.”

(Barbour & Wenmoth 2013 p. 14).

Author

[Niki Davis](#), University of Canterbury Distinguished Professor of e-Learning, is recognized internationally as a leading expert in information and communication technologies in education. Leadership positions have included centre for research and development in e-learning; President of the *Society of Information Technology in Teacher Education*, the UK association for *Information Technology in Teacher Education* and the New Zealand association for open flexible and distance learning (DEANZ); Chair of educational research for the *International Federation of Information Processing*; leader within [EduSummit](#)s, and editor-in-chief of academic refereed journals including *Information Technology for Teacher Education*, and the [Journal of Open Flexible and Distance Learning](#).

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6.2.4 Malaysia's nation-wide VLE for schools

Provided by: Hasniza Nordin and Niki Davis

Country: Malaysia

Age range supported: Primary, Secondary

Overview of the context:

Malaysia aims to reach its Vision 2020 to develop the intellectual, spiritual, emotional, and physical dimensions in learners (Ministry of Education Malaysia 2012a). The Malaysian education system comprises three levels: pre-school, primary and secondary schooling, and tertiary education (Ministry of Education Malaysia 2012a). Malaysia has three major ethnic groups (Malay, Chinese and Indian) and the Malay language (Bahasa Malaysia) is the official language of the country and the medium of instruction at Malay national schools and public universities. The Chinese national schools and Tamil national schools use Chinese and Tamil languages respectively. The Malaysian education system is highly centralized with a 'top-down' approach in which each school follows the same curriculum, policies and teaching programmes.

In 1997, the Ministry of Education conceptualised the vision of the Malaysian Smart School (Ministry of Education Malaysia 1998; Ya'acob, Mozd Nor & Azman 2005). The Ministry's transformation plan stated in the Malaysia Education Blueprint (2013 - 2025) planned to enhance ICT in education (Ministry of Education Malaysia 2012b). The vision is to transform education in Malaysia as well as to bridge the digital divide between urban and rural students by providing quality Internet-enabled education to all schools throughout Malaysia. The main focus is to enhance basic ICT infrastructure by providing a platform for networking and learning through a Virtual Learning Environment (VLE) called "1BestariNet". This initiative aims to equip 10,000 primary and secondary schools across the country with 4G Internet access and the VLE (see 1BestariNet multi-lingual portal <https://www.yes.my/v3/1bestarinet.do>).

According to a recent UNESCO Institute of Statistics report, Malaysia has a mixed approach to the location of computers for computer assisted instruction, which "is universal in schools but laboratories have been established in 66% and 91% of primary and secondary schools, respectively." (UIS 2014a: 25). The learner to computer ratio was reported to be 13:1 with almost universal fixed broadband Internet connectivity in Malaysian schools.

Description of digital technology in use

The Malaysian government's nationwide 1BestariNet project is in partnership with technology service provider YTL Communications Sdn Bhd and schools. The vision described on the web site is of transforming education by providing quality, Internet-enabled education to Malaysians (students, teachers and parents). The Virtual Learning Environment (VLE) (specifically a software platform called Frog, see <http://www.frogasia.com/v3/what-is-frog/>) is an integrated platform available in all schools nationwide with high-speed 4G mobile Internet for administration, collaboration, teaching and learning activities. Files and data are stored in the Cloud. In addition, the Frog VLE is integrated with powerful educational tools and content partners, including Google Apps for Education and the Khan Academy (Ministry of Education Malaysia, 2012b). Access to the VLE is managed by schools with a personal 'keyID' including password (given to teachers, students and parents).

The phased roll-out of the Frog VLE started in December 2011. In March 2012, 351 schools nationwide were selected to become a VLE Champion School, so that the leaders would become a reference centre to support other schools with similar planning and implementation to improve the sustainability of VLE usage.

As part of this initiative, the Ministry has also deployed Chromebooks for teaching and learning to enable better access to the Cloud (Ministry of Education Malaysia, 2013). The Chromebooks provision that started in March 2013 has the aim to supply ICT facilities in mobile computer a lab containing about 40

Chromebooks in each school. (A Chromebook is a small computer that has been designed to make good use of Google software including Google sites for schools.)

Example of VLE activities in a VLE Champion School

Teachers must log into the VLE system with their own unique name and password (called a keyID) before they can access anything. The main or home page provides labelled icons that link to a wide range of services including tools and support: Email, calendar, assignments, a bookshelf, web browser, Google sites, etc. All the teachers have file space (called sites) that contains folders in which files are placed. The individual teacher or an administrator may add new categories to the existing categories that include Academic, Non-Academic, Templates, and Other.

Figure 6.2.4.A illustrates this with a screen capture showing a folder for the subject of Computing (SUBJET KOMPUTER) and a second screen in Figure 6.2.4.B shows one file open with a labelled image of computer system. That file was uploaded into the folder created for the subject of Computer Studies by a relatively expert teacher of computing.

Figure 6.2.4.A A screen shot of a folder created in the VLE by a Malaysian teacher of computing for her students studying computing (KOMPUTER).

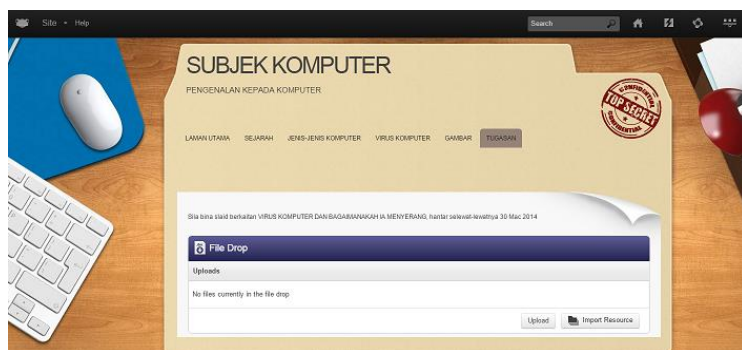


Figure 6.2.4.B A screen shot of a resource that a Malaysian teacher of computing placed in a folder in the VLE for her students to access (a labelled diagram of a computer system).



On the 1bestarinet.net web site promotional videos illustrate more activities. For example, a teacher of English used email after her students had left her secondary school classroom to set them language exercises for homework; the students were then shown accessing in the VLE to do that homework after school. Another video showed the same English teacher recommending to her male colleague to use the VLE notices of a school fair to raise money, rather than the old fashioned approach of printing out notices to deliver by hand.

There is also a support section that is accessible from the main home page called 'Learn Centre' for teachers, students, parents and administrators. This includes professional development opportunities for teachers, in which they may collaborate, and sharing their resource and web sites.

One of the criteria for the Key Performance Index for the implementation of Frog VLE in schools is to have students log in to the system for 30 minutes weekly. However, that is a challenge for schools given that some issues have yet to be resolved, including the speed of loading information over the Internet at some locations, the ICT skills of teachers, and their knowledge of the system (Abdullah, Mohamed Noh, Nik Yusuff & Mansor 2013). Most teachers in Malaysia have moderate knowledge and skills when it comes to the use of ICT (Alazam et al. 2012; Mahmud & Ismail 2010). Research into the experience of students in initial teacher training being prepared to teach with ICT in Malaysian schools provides some detail on the challenges experienced by them during their practicum in secondary schools (Nordin 2014). Given these experiences, it would not be surprising to find that more ongoing support is necessary, both technical and pedagogical.

Authors

Hasniza Nordin is a teacher educator in the Universiti Utara Malaysia (UUM) who recently completed a PhD supervised by Niki Davis (Nordin 2014), which described the changes in future teachers' knowledge of ICT in teaching following teaching practice in schools in New Zealand and Malaysia. This comparison discovered some of the issues relating to the measurement of ICT in education and the value of the practicum to increase ICT knowledge and skills.

Niki Davis, University of Canterbury Distinguished Professor of e-Learning, is recognized internationally as a leading expert in information and communication technologies in education. Leadership positions have included centre for research and development in e-learning; President of the Society of Information Technology in Teacher Education, the UK association for Information Technology in Teacher Education and the New Zealand association for open flexible and distance learning (DEANZ); Chair of educational research for the International Federation of Information Processing; leader within EduSummITs, and editor-in-chief of academic refereed journals including Information Technology for Teacher Education, and the Journal of Open Flexible and Distance Learning.

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6.2.5 Saturday programme for out of school refugee children 30 minutes from the border and war zone

Provided by: Aleta Chowfin and Niki Davis

Country: Jordan with Syrian refugees

Age range supported: Primary, Secondary

Overview of the context:

Opportunities for schooling for refugee children can emerge because of willingness of volunteers combined with community needs and aid organisations' recognition of the link between education and health etc.

Most Jordanian public schools and other schools set up to serve international students have are equipped ICT labs and are beginning to integrate it through the curriculum (UIS 2013). Jordanian and International schools, with their ability to support training and development, are willing to link with the local organisations to support the Syrian refugee children by building learning communities with them (UIS/UNICEF 2015).

However, not all refugee children can attend a school and so less formal means have also developed to provide educational opportunities and build the capacity to help refugee children (re)engage with schooling on a regular basis, which includes Saturday programmes run by volunteers. By the end of 2014, around 40% of the hundreds of thousands of Syrian children in Jordan were not in school. The need for informal and innovative learning opportunities is needed in this and other locations (UNHCR 2013a).

The United Nations Refugee Agency (UNHCR) (2014) report "No Lost Generation" revealed that organisations are looking at innovative ways to provide education to two million Syrian refugee children displaced within and around the neighbouring countries due to the Syrian war. Refugee children develop resilience and fortitude through intentional education and sometimes the refugee families place a higher value on education than the humanitarian aid providers (UNHCR 2001). Mathews (2008) finds that there is a desire to resume normalcy and the children aspire to have a better life as quickly as possible.

Therefore, educational programmes are increasingly being recognised as an essential backbone for the welfare and future of refugee children. Education helps to provide a consistency to their otherwise erratic life. As the Syrian war progressed, there was an influx of refugees and some of them settled outside of the camps. These refugees have to find resources, housing and food alongside of education for their children. This Saturday programme serves some of these children who do not live in a refugee camp.

The programme and its vision for digital technology

The aim of the Oasis Syrian Children's Programme is to use digital technology, people resources and time to build learning capacity and self-esteem in the refugee children. For most young children this is the only educational organisation that they will have ever attended. In 2014 the Saturday programme of the Oasis Syrian Children's Programme ran for two hours each Saturday in a four room building. It was set up with 60 Syrian refugee children and their families, in Mafraq, Jordan, and it continues to grow. The desire was to provide a future and a hope through an innovative education programme to develop the whole child, using a combination of digital media (YouTube videos, movie clips), music and puppets. This safe learning environment was established to enable the children to overcome the trauma and displacement they have experienced in a way that addressed their education from a holistic perspective.

The digital technology strategy

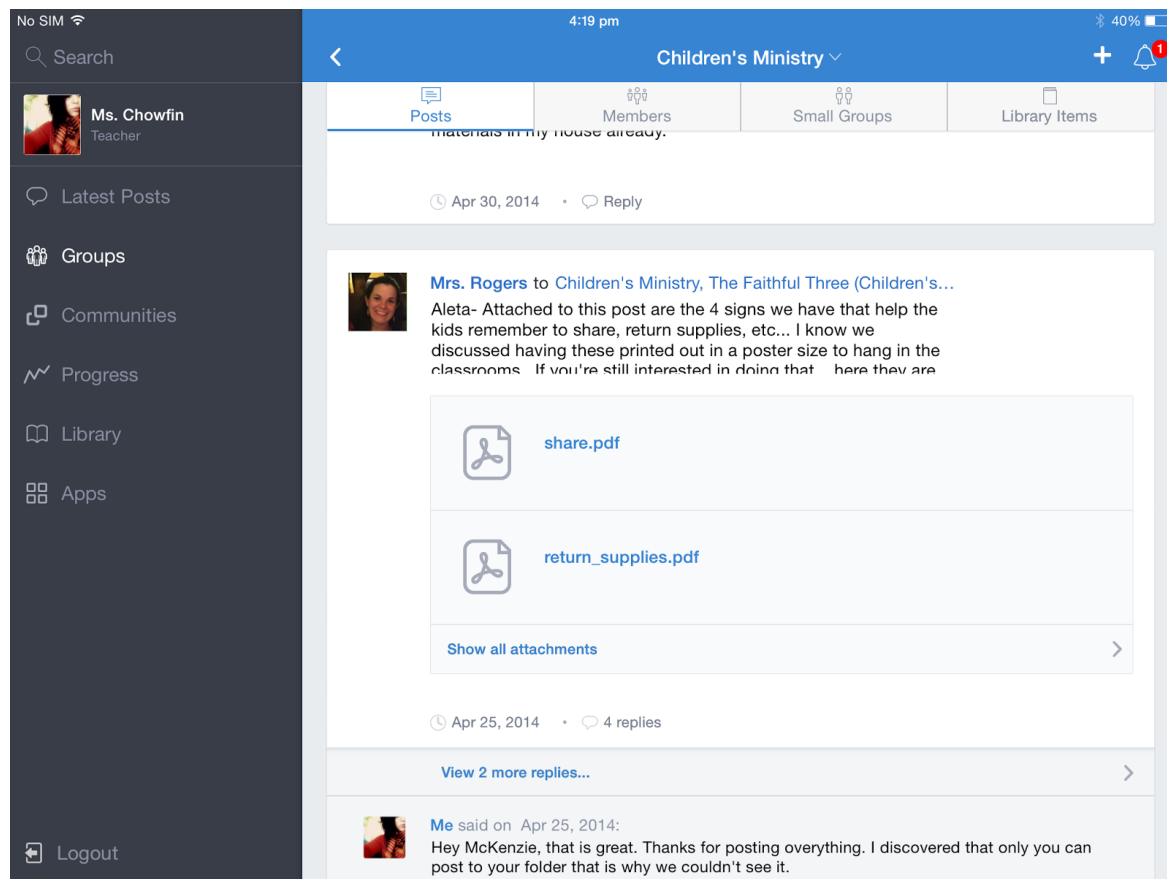
The strategy that evolved applied ICT in the following ways:

- A lead teacher recruited volunteers and set up a system (online and face to face) to support planning of activities, including the use of Edmodo and other Cloud based resources for planning and also with links to the resources used on Saturdays.
- A teacher with ICT knowledge and skills from international school (the lead author) assisted a local Jordanian couple to set up a projector, a working computer and an Internet connection at the premises.
- Volunteers (local and international) used personal digital devices, including their own and others that belonged to the programme leaders. For example, on one Saturday the devices included one iPad, one Macbook Pro (use for multiple purpose including briefing volunteers and in overcoming language barriers) plus three iPhones (only used for recording songs, playing YouTube videos, and tracking learning with snapshots of the classroom). Figure 6.2.5.A shows a volunteer using her own device with refugee children in the Saturday programme.
- The local youth recruited as volunteers were trained and scaffolded to help lead the programme and mentor the refugee children; and to assist in the monitoring and development of the programme by collecting digital and written artefacts. For example, to take photographs to record attendance and activities each Saturday.
- In addition, fundraising was ongoing to fund purchase of new and used digital technologies including tablets, smart phones and computers.
- Over time the ICT was further developed so that group leaders could use a free site in the Cloud (Google Group) to register their group of refugee students and to monitor their progress. They stored learning videos, music, pictures and personal stories.
- The leaders also used the Google Group to communicate and share resources, as shown in Figures 6.2.5.B and C.

Figure 6.2.5.A A volunteer using her personal smart phone with refugees at the Saturday programme (with permission).



Figure 6.2.5.B Screenshot from the author's iPad showing the Saturday programme's Google Group. Mrs Rogers tells Ms. Cowfin in an online message that she has attached the images of the 4 signs used to prompt children to remember to return supplies etc. (Chowfin's screenshot with permission)



During 2013-2014, the Saturday programme progressed through three phases. Phase 1 was a pilot programme for 60 children that strategies and resources were piloted. In phase 2 there were revisions and the programme expanded to 80 children with increased monitoring of engagement and outcomes. Phase 3 increased to include over 100 children with revisions, monitoring and setting up of an online network for resources in the Cloud based Google Group and Facebook messaging. Towards the end of the calendar year in phase 3, after the end of the term when many university students left the area, volunteer numbers reduced and this proved challenging (Bristow Hood, Personal Communication).

Activities varied within and across the Saturdays. In 2014 a typical Saturday session started with time for sharing a digital or verbal story, followed by a few songs on YouTube projected using a computer connected to an amplifier and speakers. An alternative activity for the start was to commence with a puppet show around the day's theme, and where 6 songs were projected from the computer by the local Jordanian couple. Afterwards, the children broke up into four groups based on their ages.

Figure 6.2.5.C Screenshot from the author’s iPad showing the sign used to prompt children to remember to return pencils. (Chowfin’s screenshot with permission)



It took five months to train the children to find their places and settle down for a quiet learning time when children were provided with colour pencils and crayons at a shared table. They were also provided with visual cues to share the resources and the story was reviewed using visual or digital resources (personal iPads). Once the children were finished with their activity they were able to draw their own picture and take it home. They were reminded to return the crayons with images such as that in Figure 6.2.5.B. The session ended with a final review of the whole session that took place in the groups after everyone had been provided with a snack and a drink.

Figure 6.2.5.D Refugee children and volunteers enjoy a puppet show at the Saturday programme

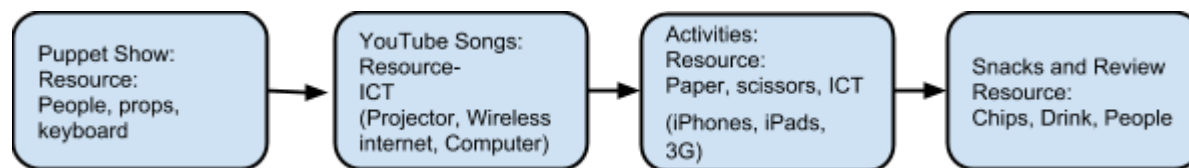


For example, one particular Saturday session lasted one and a half hours and was run by a team of 11 volunteers for 65 children. The children spoke Syrian Arabic, which is similar to the Jordanian Arabic and the local couple and four volunteers were able to communicate well with them. The other seven volunteers used media, in the form of a digital story on an iPad or smart phone and other visual cues to engage the children.

A laptop computer was used to link to the network (pay per go) through an additional device plugged into the laptop and three of the volunteers had a smartphone with 3G internet. In addition two iPads with 3G network were used for communication.

This particular Saturday began with a puppet show (see Figure 6.2.5.D) that progressed into songs supported by ICT, followed by a quiet group time drawing pictures and ending with a snack and review. The diagram in Figure 6.2.5.E was used to plan and communicate the activities among all the volunteers and it also lists the resources needed for each activity.

Figure 6.2.5.E A diagram showing the sequence of four activities for one particular Saturday morning, including the necessary resources. This was used for planning and also briefing volunteers.



Additional collaborative educational endeavours to support refugees

The Zaatari and Arzaq camps have a myriad of initiatives being run by humanitarian aid organisations (UNHCR 2015), and the Ministry of Education in Jordan, to meet the educational and emotional needs of the children. However some of the innovative initiatives are being provided by local faith based organisations. Unfortunately these are often not tracked.

The AAJ School after school programme (in Zarqa) is based on the Saturday programme described above, informed by phase 1. This school has the space to open its doors, for an afternoon shift, to about 500 refugee children. In future, the aim is to set up a learning environment where digital technology can provide the majority of the learning in the safe environment off the school premises.

ICT also enables gathering of data on the extent of activities and related challenges. The [Facebook ICT site](#) called ‘The Syrian <Out Of School> Service’ is a collaboration between UNESCO, Jordanian Ministry of Education and Department of Statistics. It aims to collect basic data of the Syrian Refugees’ education profile in Jordan. This collection of data can inform and strengthen education planning and management and it will also help to improve designs and develop interventions to support the education aspirations of the youth. This project will also strengthen capacities in education planning and management in Jordan by upgrading the Ministry of Education electronic management information system (EMIS) through the implementation of the following sub-system or module to be integrated to the main MoE #OpenEMIS solution.”

UNESCO Institute of Statistics and UNICEF’s (2015) report provides further details on children who are not able to access School, including many refugee children worldwide.

Key Findings

At the start of 2015 the total number of Syrian refugee children in Jordan was 324,534 out of which only 177,600 are receiving any kind of formal or informal education (UNICEF 2015, <http://www.unicef.org/appeals/syrianrefugees.html>; <https://magic.piktochart.com/output/4585268-syrian-children-in-camps-in-jo>). A formal school runs alongside of kindergartens and Child Friendly Spaces in each of the four camps (Zaa’tari, Arzaq, Emirati and King Abdullah Park).

There is evidence that teachers have been provided with training through the Queen Rania Teacher Academy (QRTA), in 2013, when the aim was to allow ICT to filter through as the teachers deliver lessons. However, the first author had not been able to track any evidence of lessons with ICT in the camps. Teacher training has been in collaboration with World Vision, Service Civil International, Norwegian Refugee Council, UNICEF and other agencies. The British Council has provided informal training to teachers. UNESCO alongside QRTA has worked with about 2000 Jordanian teachers. In summary,

- Out of the 80% children living outside the refugee camps, 40% do not have the opportunity to attend school. Providing consistency and routines can establish a safe learning environment for these refugee children. This is why learning opportunities outside school are needed.
- These informal education programmes benefit from an ICT infrastructure.

- The teachers and support staff, as well as other volunteers, are valuable resources who build learning relationships with the children. An important ICT infrastructure that already exists for these educational programmes outside schools can utilise the volunteers' own digital devices, some with personal internet connectivity, preferably in addition to other equipment.
- Collaborative partnerships between institutions and private citizens can provide learning spaces with an ICT infrastructure of digital resources connected to the Cloud.

The lead author

Aleta Chowfin is studying for a Masters in the University of Canterbury while she also works as a teacher. In 2014 while she was a teacher in an international school in Jordan, she volunteered to be the lead teacher in the Saturday programme for Syrian refugees in Jordan described in this vignette. She has also taught in New Zealand and Bangladesh.

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6.4.6 Bangladesh: Multimedia classrooms creating OER

Provided by: Clare Woodward

Country: Bangladesh

Age range supported: Secondary

Overview of the context

UNESCO has been providing support to the Bangladesh Ministry of Education in preparing the 'ICT in Education Master Plan 2012-2021'.

Objectives of the use of ICT in Education are:

- developing teaching-learning environment
- developing professional and ICT skills of teachers
- improving standards of teaching/learning materials
- building up skilled human resources
- ensuring of transparency accountability and efficiency in educational management
- creating accessibility of education resources at the doorsteps of the common people
- ensuring participation of persons concerned in the education sector

However there are some key constraints in the application of ICT for education in Bangladesh as follows:

- High cost of Internet
- Poor ICT infrastructure outside main urban centres
- Lack of qualified teachers and shortage of ICT trained teachers

One of the aims in the Master Plan for both primary and secondary sectors is the “establishment of a multi-media classroom with 1 laptop, 1 multi-media projector/LCD screen and Internet connection at each educational institution for the use of ICT in education.” The government has stated that each school should have a substitute power source where there is no regular power supply.

Description of digital technology being used

The Access to Information (A2i, see <http://www.a2i.pmo.gov.bd/content/multimedia-class-room>) initiative funded by the Prime Minister's office in Bangladesh is establishing Multimedia Classrooms in secondary schools, training teachers on making ICT aided educational content on hard-to-grasp topics and make electronic versions of text books available in primary and secondary levels including technical, vocational and Madrasa institutions.

By 2015, A2i will have introduced Multimedia Classrooms in 500 secondary schools, using one laptop with an Internet connection and a multimedia projector per classroom.

4,500 teachers from these schools have been trained through its 'Teacher-led Digital Content Development' programme in which teachers learn to develop and present digital content for their classrooms, using materials found on the Internet and simple presentation software. Teachers also share the content they have developed on an education Blog.

To increase the availability of school textbooks, the development of e-books or electronic version of textbooks for primary and secondary levels including technical, vocational and madrasah is also underway (see <http://www.ebook.gov.bd>). 300+ e-books for primary and secondary levels have been created so far and uploaded on the website with options like search and text enlargement. Anyone is able to download them or read online free-of-cost from anywhere.

Any other useful info about the context

Implemented through pilots in partnership with government and private organizations, these initiatives have largely been successful and are now being scaled up through various Government of Bangladesh projects and partnerships. There is an evaluation report for this United Nations Development Programme (UNDP) A2i programme in Bangladesh for the period of October 2006 to June 2011 (see Minges, Raihan & Raina 2011) that supports this vignette.

Author

Clare Woodward is a Lecturer in International Teacher Education at The Open University (UK). She has extensive experience in teaching English and teacher education in a development context. Clare is currently working on [English in Action](#), an award winning £50 million UK Department for International Development (DfID) funded project, and leads on developing mediated authentic video delivered on accessible mobile technology for teacher professional development at scale. She has also worked as a project manager in widening participation in the UK, developing and delivering ICT and social network solutions to upskill and support adults in economically and socially disadvantaged communities.

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6.2.7 Extending the use of Open Educational Resources amongst trainee teacher in Nigeria using tablet technology

Provided by: Fiona Henry

Country: Nigeria

Age range supported: primary, secondary, adult

Overview of the context

It is estimated that to address the United Nation's Millennium Development Goal (MDG) target of universal primary education by 2015 that an additional 1.1 million teachers are required across Sub-Saharan Africa (SSA) (UNESCO 2011). The scale of the challenge cannot be underestimated. The Teacher Education in Sub-Saharan Africa (TESSA) research and development network was set up in 2005 in direct response to this need and aims to improve the quality of, and access to, teacher education in Sub-Saharan Africa (see <http://www.tessaafrica.net>).

The TESSA consortium of African and international institutions focused on the creation of a bank of Open Educational Resources (OER), a modular and flexible toolkit designed to support school-based teacher professional development. The bank includes materials to enhance and develop teaching and focus on developing teachers' classroom practice in the key curriculum areas of literacy and life skills. This vignette looks at a strand of the *Researching Pedagogical Change with TESSA: Sustainability and Scale* research project, funded by the Hewlett Foundation, which took place in partnership with the National Teacher's Institute in Nigeria in 2013-14. The National Teacher's Institute (NTI) is a distance education institution that provides initial teacher education, post qualification professional development and what they describe as 'teacher upgrading' for existing practitioners with little or no formal qualification or training (The Open University 2011). The NTI was established in 1976 and has been part of the TESSA consortium since its inception in 2005.

In 2007 Nigeria's Ministry of Education founded their first ICT department (FME 2007a) and published their ten year strategic plan in which the ICT focus was on enhancing efficiency in educational management systems and building computer laboratories in schools across the country (FME 2007b). The plan highlighted the need for more practical training of teachers in technology, setting a target of 100 per cent computer literacy. More recently, the 2012 National Information Communication Technology (ICT) Policy highlights the need for a sustained programme to build a critical mass of ICT skilled personnel in Nigeria (Ministry of Communication Technology 2012). Much of the actual provision of ICT and training in schools has left to private organisations, NGOs or multi-national companies. For example,

- MTN, the mobile phone provider, has provided a number of further and higher education institutions with computers, providing access to educational resources by creating digital libraries.
- A virtual library project through which Higher Education Institutions gain access a large range of journals and articles, primarily by Nigerian academics, online. The project has been part-funded by The Nigerian Universities Commission (Aluede 2013).

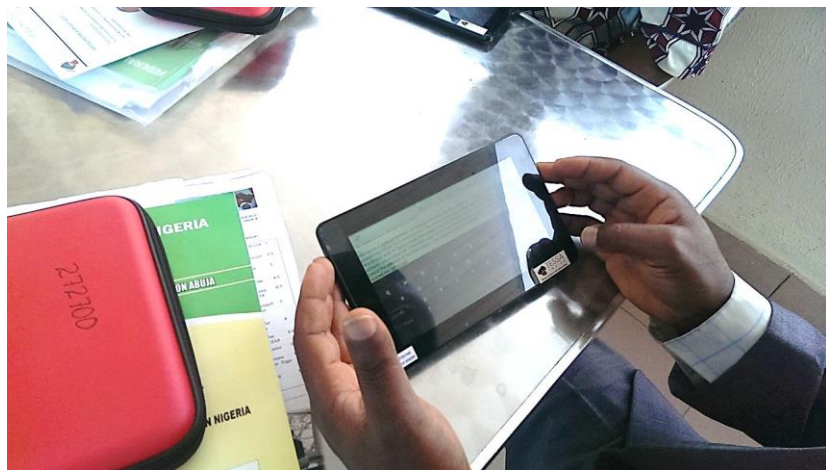
Description of digital technology being used

The Nigeria TESSA pilot project focused on embedding and extending the use of the TESSA OER materials amongst teachers. This was to be achieved by providing Teaching Practice Supervisors, NTI teacher-educators responsible for supporting trainee teachers and carrying out school visits and classroom-observations, with tablet computers pre-loaded with the complete set of TESSA materials for use during school-visits.

The tablets (see Figure 7.4.7.A) used were selected based on a number of criteria, including affordability (budget constraints limited the total cost of per tablet including peripherals to approximately UK £95), robustness, battery life and the availability of appropriate apps to support the project goals including an

Adobe software format PDF reader and editor and an integrated multi-media note taking tool. The tablet selected was the Android-based Sumvision Cyclone Voyager, costing approximately UK £75 at the time of purchase (September 2013). Hard-case protective covers were also provided.

Figure 6.4.7.A Sumvision Cyclone Voyager tablet and cover in use in the TESSA workshop (with permission - photograph supplied by Fiona Henry)



Thirty experienced teaching practice supervisors, with basic ICT competence and prior knowledge of the TESSA materials, were selected to take part in the pilot project. The project commenced with a workshop in which the participants were trained in the use of the tablet and how it could be used to support the professional development of the teachers they worked with.

The full library of TESSA materials was made accessible through a freely available PDF reader app (Foxit PDF) pre-loaded onto the tablets. Workshop participants were trained in the use of Evernote, an app in which notes, photos, audio and video recording taken during classroom observations could be combined into a single record of the visit using a template provided by the project team. The records could be shared amongst supervisors, the wider NTI organisation and the TESSA project team for further analysis via an Internet connection available at NTI centres. The NTI operates through a network of six regional, 37 state offices and 327 study centres throughout the country. Regional and state offices are equipped with V-SAT satellite broadband, with study centres having a limited number of functional desktop or laptop computers with either wired or wireless Internet connections.

Learning Activities

One of the challenges the project aimed to address was how to shift the focus of the role teaching practice Supervisor, which had typically involved addressing issues such as attendance, standards of dress and hand writing, towards something more akin to mentoring into the profession of teaching. The audio and visual recording tools on the tablet enabled the Supervisors to highlight aspects of pedagogy and classroom practice that could be used to support discussions with trainee teachers following a lesson observation. Discussions could be immediately linked to an appropriate TESSA OER to support further professional development. Participants reported a marked change in the nature of their school visits:

“I also record our discussions...and I can see things in a different dimension now. I show the teachers the pictures that I take then we can discuss them”

S Ayuba, Teaching Practice Supervisor, Kaduna

“It helps me to be a better mentor – I can elaborate more. It is so much better for me and my teachers”

P Kalu, Teaching Practice Supervisor, Kaduna

Any other useful info about the context

Access to Wi-Fi amongst project participants is limited, with all TP supervisors being reliant on Internet access via their local NTI centre, which could be up to five hours away by bus. Similarly a consistent electricity supply cannot be relied upon, even in urban centres. Data about the Internet availability in education contexts is limited; however according to data collected by the Telecommunication Development Sector (ITU-D) 73% of the population have mobile phone subscriptions and 38% of individuals have some access to the Internet (ITU 2014). Significant investment over 2014 may see this change. Over 400 Internet service providers have been licensed by the Nigerian government, alongside a large number of Internet exchange and gateway operators (Financial Times 2014).

A proposed follow up project has sought to address some of these issues by providing Internet access via a robust mobile hub. The BRCK (www.brck.com) is a robust wireless modem/router, designed to be used in challenging conditions. Designed and tested in Kenya, it has an extended battery life and built in fail-safes to cope with surges and cut-outs in electricity supply. It can be used with or without a SIM digital communications card (a build-on global SIM is included), can broadcast a shareable Wi-Fi signal and includes an external GSM antenna port.

Author

Fiona Henry is a Lecturer of Education at The Open University (UK). She has extensive experience in designing and developing new technologies, resources and tools to support teaching and learning, particularly in STEM subjects. A former maths teacher, Fiona is currently part of TESSA (Teacher Education in sub-Saharan Africa), an international research and development initiative aiming to improve the quality of, and access to, teacher education in sub-Saharan Africa. She leads on the strategic use of mobile technologies to embed and extend the use of, and widen access to, OERs (Open Educational Resources) amongst teacher-educators in projects in Nigeria and Ghana. Previously Fiona was the Lecturer on Vital Professional Development, a £9.4million UK Department of Education funded programme to support practitioners in enhancing their teaching about and with digital technology.

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6.2.8 Africa: Solar-powered mobile schools

Provided by: Fiona Henry

Countries: South Africa, Kenya, Nigeria, Senegal and Sudan

Age range supported: primary, secondary, adult

Overview of the context

As part of its Digital Villages community initiative, Samsung Electronics has partnered with governments across five African Nations to provide comprehensive support to improve health standard, enhance educational opportunities and boost employability amongst the populace.

According to Samsung (see <http://global.samsungtomorrow.com/?p=29286>), the typical village ICT infrastructure that they provide consists of a number of solar-powered elements:

- An Internet School
- Tele-Medical Centre
- Generator
- Health Centre
- Lanterns

The initiative is targeted at areas in which electricity supplies are unreliable or non-existent. Samsung have set a target of reaching 2.5 million learners across the continent by the end of 2015.

Description of digital technology being used

The programme is focused on the deployment and creation of ICT infrastructure. The Internet schools are created from re-purposed shipping containers, making them relatively transportable. The 12m long space allows for classes of between 20 and 25 students, and each comes equipped with a large 50 inch interactive whiteboard, solar-powered notebooks, tablets and cameras. All devices can connect to the Internet via wireless broadband. Photovoltaic solar panels affixed to the container roof provide up to nine hours of electricity a day, and charge using both visible and UV light, meaning overcast weather does not impede their usefulness. The robust panels are made of rubber, rather than plastic, improving their durability during transport and in harsh conditions. As well as providing Internet access, a local central server stores educational resources that can be accessed by teachers and students alike.

Learning Activities

The Internet schools can essentially be viewed as mobile ICT suites, from which a teacher and class full of students can access online resources. In some locales, localised teaching and learning resources have been provided by partner organisations and pre-loaded onto the computers and server.

Training provided by partner organisations encourages the use of collaboration between teachers and learning using video conferencing capabilities. According to reports, teachers are further encouraged and supported to use technology with their standard curriculum. In Kenya, the Institute of Curriculum Developments has worked with Samsung in the development of ICT-enriched content aligned with the official school curriculum.

Author

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Lecturer on Vital Professional Development, a £9.4million UK Department of Education funded programme to support practitioners in enhancing their teaching about and with digital technology.

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6.2.9 India and Africa: Radio in communities and schools

Provided by: Amina Charania

Countries/ Region: India, Africa

Age range supported: primary, secondary, adult

Overview of the context

“Community radio is a medium that gives voice to the voiceless that serves as the mouthpiece of the marginalized and is at the heart of communication and democratic processes within societies” (UNESCO 2001). Community radio started in 1947 in Bolivia and Colombia as miners’ and peasants’ radio respectively. Community radio can be locally owned and therefore remains popular in both developing and developed nations. In the developed nations, it is most popular to non-Internet users, in the developing countries compared to television relay, radio offers cheaper, faster and therefore the most localized version of community interaction over a specified geography.

Besides spreading awareness and information areas of governance, health and politics, these community stations have also been a useful tool for schooling and learning over the years. Community radio occurs more often in rural and remote interior areas where awareness and sensitization remains a key task for improving social indicators. It has been used to spread awareness of the importance of education and for dissemination of local events relevant to education to keep the community of parents connected and children motivated to attend and learn at schools. The illustrations below provide a range of examples of community radio in education in order to illustrate its value within the developing world.

Radios educating the unreachable

Five very brief illustrations of community radio to reach students to have little or no access to school are,

- The radio programme called Nakaseke was provided on community radio in a rural district 75 kilometres from Kampala in Uganda, Africa, is an educational channel whereby the local teachers and community members motivate community through dialogue and competitions to improve literacy rates and performance at school.
- A community radio broadcasts to a remote village district of Ghatshila in Jharkhand where members of the community are mostly employed as shepherds, potters and masons. These people largely own the community radio station, begin with an initiative supported by UNICEF. In the evening the radio has stimulated greater engagement including discussion of issues relevant to their lives, writing and preparing music. There is no easy access to schools in these villages, and therefore access to schooling and making schools functional remain important topics to be discussed over the radio with other villages in the district.
- In Bhutan due to low literacy rates and low electric grid coverage, radio remains a popular mode for communication mostly to inform, educate, and entertain the citizen of Bhutan. One of the weekly education programmes is called ‘Education calling Teachers’ which aims to spread awareness of new and innovative teaching techniques. In 2000, UNESCO prompted the practice of Radio Browsing where listeners ask experts to surf the Internet on their behalf and transmit information that provides answers to their requests.
- Radio Education for Afghan Children (REACH) broadcasts educational programmes to children as a supplementary education opportunity. These children have difficulty accessing schools regularly, so REACH keep them interested in learning by broadcasting interesting and thought provoking programmes in science, social studies and mathematics. It remains a big challenge to make these educational opportunities engaging without teacher or other learning resources to support the children. There are also programmes for youth and adults concentrating on life skills, safety and adjustment after civil wars; also on the role of women in Afghan society. The content of the radio programming is decided by experts in collaboration with local parents and youth.

- An example of radio for education used in an urban context is the Galli Galli Sim Sim (n.d.) Radiophone project in a suburb of India's capital. Here the radio is used for migrant workers' children who have migrated for work with their families from their villages to the metropolitan area. These children often remain outside the reach of a regular school. Galli galli simi sim broadcasts educational content and songs for these children as a way of providing limited non-formal education.
- Recently a USAID-funded initiative called 'Advancing Youth Project in Liberia' has brought learning to homes in the ebola infected area through community radio. Students tune in regularly as if for a regular classes. They take notes and stay connected with schooling and literacy skills, which they had acquired with a lot of effort. They are also supported to improve their own and family knowledge of health, including strategies related to ebola.

An example of radio within schools

Besides community radios being an out-of school for non-formal settings, some places such as Karnataka in India have used it within school spaces. In partnership with Education Development Centre (EDC) committees, a radio programme has been integrated within the school time table. In this case, a distant teacher conducts activities for primary children facilitated by the face to face local teacher. These activities fit within the curriculum and mostly cover the English language as a subject or as the medium of instruction. Thus it helps to fill a gap in the local teachers' proficiency in using English language in the classroom and at the same time models an activity-based pedagogy. These pre-recorded lessons are replayed on fixed days that have been assigned in the school time table within the specified region or block. The teacher gathers children in circle; otherwise children would be sitting in rows. Each activity is narrated very clearly on the radio. Activities include a poem, a song, and/or interaction with the fellow student. The classroom teacher prompts children through gestures and participates with the children. The radio instructor pauses often to allow children finish the particular activity or to allow them to repeat lines in songs and poems. The children are very engaged in these activities and look forward to radio class which breaks the monotony of sitting in rows; children get to move around, sing and interact with each other. The sound effects, clarity of language and the synchronous nature of radio draw children and teachers to focus diligently on the radio activities.

Trends and technologies deployed

Setting up a community radio station includes a range of equipment and expense that can be beyond the resources of a remote community. Radio guidelines such as those provided for a 'Studio Facility Comprising of 1 On-Air cum Production' by Agricoop in India indicates the costs (see <http://agricoop.nic.in/radiocguidelines.pdf>).

Over the years, the stringent licensing norms in many countries have been made more flexible to increase access to this radio programming in the communities. With electricity still a luxury in many parts of the developing countries, radio serves as a viable alternative to television. In addition, with increasing access mass access to mobile phones including remote areas, radio has become interactive and also accessible to individuals and homes and as a BYOD in schools. The person bringing the device may be a teacher, student or community member.

The physical configuration for the use of radio has also changed, from large boxes to small transistors and more recently within mobile phones. This has influenced the nature of physical settings, its content and use. For example, the increasing accessibility of radios and their reduction in size changes the ways in which they can be used. Radio programmes which had been attended in large gatherings, mostly after work, are now listened to by smaller groups and individuals such as those within a family unit, a shop or workplace. In addition, most mobile phones have radio as a plug-in, so that radios are used increasingly as an individual device. They may also be used with speakers for groups, including classes.

Many radio programmes, including community radio, have adopted an Interactive Radio style that uses mobile phones (audio and/or texting) to enable two way interactions during the radio programmes.

Author

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