Leading SA's Growing Edtech Ecosystem

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The following is a brief analysis of the ways in which the community of educational technology (edtech) practitioners, decision makers and influencers think, discuss, enact and make policies on digital technologies in the basic education system in South Africa (SA).

In combining a critical, retrospective view of the past 30 years of educational technology experience in basic education in SA with present knowledge, it proposes an approach that is sensitive to the fluidity of the edtech ecosystem globally and in SA. It demands a shift in the national discourse, design and delivery of edtech policy and practice, especially if the principles of inclusion, equity, ethics, redress and social justice are to be defended and prioritised.

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Background and Problem Statement

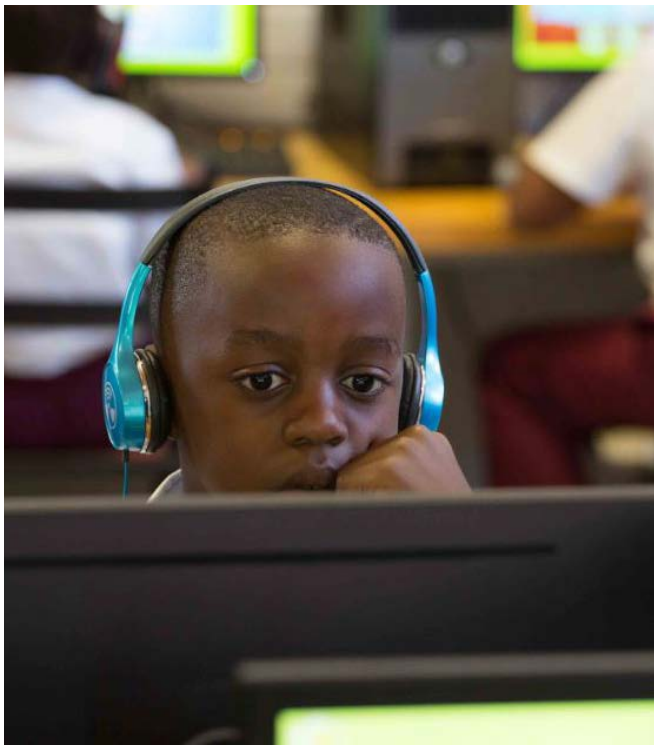
Since the dawn of SA's democracy in 1994, the SA basic education system made several, well-intended explorations into ways that learning quality and equity can be enabled by educational technologies. These range from investment in values-centred educational broadcasting via television and radio, to computer labs in schools, interactive white board in classrooms, laptops for teachers, tablets and mobile devices for learners, mobile learning applications, learning portals, educational chat platforms and more recently, on a small scale, the role of AI and generative AI in education. While many of these initiatives showed signs of success, there were also unviable and at times wasteful edtech initiatives.

There is a notable dearth of evidence that edtech initiatives enhance the way SA children learn in varying contexts of marginality;

- that they improve learning outcomes; and
- that they enable equity and efficiency in education systems.

The limited available evidence suggests that improved learning outcomes were achieved at project and micro levels, based on only a few evidence-based research monitoring and evaluation studies that led to pedagogical improvements in some classrooms, with limited numbers of learners and teachers in a limited number of schools. Many partially successful experiments, of which the ICT4RED is a well-designed, well-known example (Botha & Herselmann, 2015; DBE, 2024), have not been sustainable. Overall, national educational technology policies have failed to reach their intended goals and targets.

Policy-related large scale edtech interventions have consistently contended with layers of unanticipated, often overwhelming, system complexities: the entanglement of infrastructural, socio-economic, cultural, spatial, linguistic and educational disparities that conspire to challenge simplistic intervention designs, worsened by the call to redress the historical legacy of decades of apartheid's structural inequality. Added features of intersecting problems included system capacity constraints, poor techno-centric and procurement-centred programme design and tensions between commercial and educational interests. The latter continues under the influence of powerful impulses towards the commercialisation and privatisation of education systems worldwide. Edtech continues to be a catalyst for private tech companies to marketize schools, colleges, universities, curricula, content, teaching and cultures of learning. The United Nations Digital Compact (UN, 2024) and various frameworks adopted by international development agencies frame these challenges as collective assaults on public education systems, especially if the effects of technologies are added to the mix of wars, political turmoil, pandemics and climate emergencies.



At the heart of many of these inter-related problems lies constrained leadership capacity in the system to engage with the scale and complexity of the challenges. Thus, the aggregate edtech experience in South Africa dovetails with a growing global narrative that challenges underlying assumptions about their affordances to improve quality learning and teaching, about equity, social justice and efficiency in education, against the backdrop of a dire lack of conclusive evidence. In some respects, educational technologies have created more challenges and catalysed deeper inequalities (UNESCO 2023a & 2023b). Moreover, in many cases where evidence was available, they were often designed by commercial companies based on the promotion of educational technology products in schools to enable market formation (UNESCO, 2023a).

The COVID-19 pandemic reinforced prevailing structural and unequal learning loss, illuminated emergent intersecting vulnerabilities and exacerbated existing inequalities (Soudien & Reddy, 2022). The concomitant COVID moment also served as a catalyst for more rapid, widespread investment in digital learning which laid the foundations for the rise of AI in education. In SA, the public education system responded with a remote and digital learning (RDL) campaign, attempting to prioritise communities that were most in need of education support. In contrast, in the domain of private and independent schools, significant investments were underway to promote digital technologies at scale, including a mushrooming of private online schools.

This paints the complexity of the challenges as they emerged and continue to surface. To explore how to make sense of, make decisions about and explore strategies for action, the concept of edtech as a structurally unequal socio-technical ecosystem is offered as a basis for critical reflection.

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Edtech as an Unequal Socio-Technical Ecosystem

A socio-technical view suggests that technologies are not designed, created and consumed outside of societal influences and its unequal socio-economic, political, cultural and linguistic structures, symbols and systems. This perspective proposes that technologies are not neutral artefacts. Yet conceiving, designing and implementing technologies (including AI) as neutral artifacts is one of the enduring challenges in the national and global discourse on educational technologies.

The conceptual frame of this paper proposes that technologies are inherently unequal socio-technical ecosystems. Ecosystem refers to the networks of relationships within and between human and non-human actors that cohere around the design, development, deployment, use and consequences of educational technologies, including generative AI.

Engaging with edtech through an unequal socio-technical ecosystemic lens may shape the way we talk and think about edtech initiatives and how we can engage with their affordances and their (dis)affordances, risks and dangers. Importantly, the rapid rise of generative AI has shown that technologies are more than just 'tools': they are socio-technical systems increasingly embedded and embodied in every aspect of daily life, learning, work and play to the extent that they no longer exist as entities separate from humans and nature. This suggests that the boundaries between online, offline, analogue and digital are becoming progressively fluid and that relationships between humans, machines and nature are increasingly co-constitutive and synthetic; are constantly in flux; and their underlying machinations are invisible to users (Gulson, 2024; Roberts, 2021). Thus, a shift from thinking of technologies as static, independent, neutral tools is proposed. These changes require that we embrace and engage with the fluidity of technology systems, alive to the ways they surface both explicitly and subtly, with invisible forms of inequities, biases and relations of power in the distribution of agency between humans, machines and nature. Viewing edtech in this way requires a responsibility to explore inclusive, equitable, ethical, responsible, socially and environmentally just possibilities in edtech design and use.

Figure 1 illustrates the unequal edtech socio-technical ecosystem in SA via a macro, system-wide lens. It illuminates the interplay between critical macro-level policy and practical design elements, required implementation arrangements

underscored by guiding principles. The latter are clearly articulated in the e-Education Strategy of the DBE (DBE, 2024). Intentional about not including various layers that operate at meso and micro levels, it also does not include the wide spectrum of unequal learning contexts even though it can be applied across these contexts. It is also not situated along an edtech maturity continuum because of the need to reduce the complexity of the framework as we make sense of how edtech is emerging in SA.

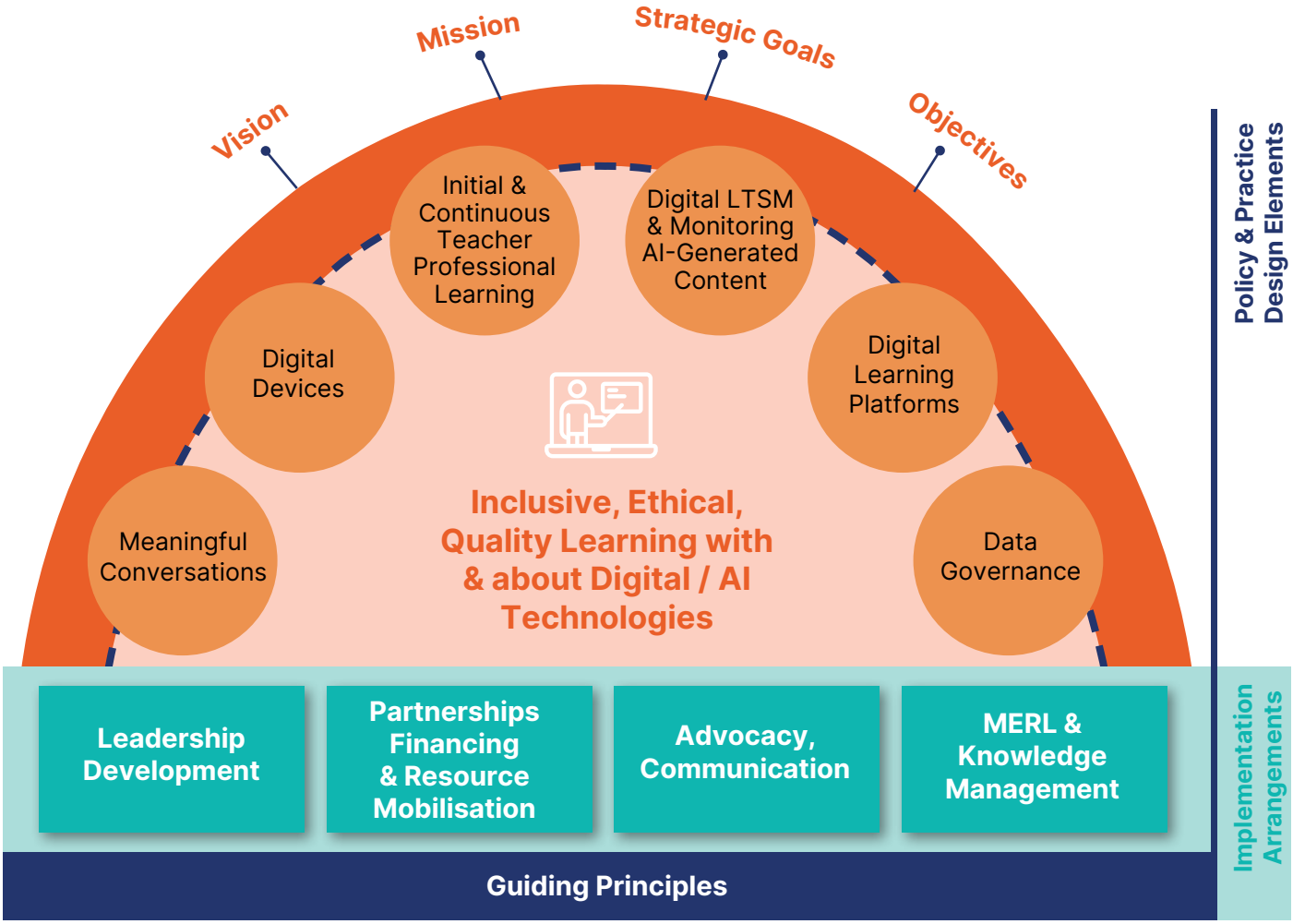


Figure 1. EdTech value chain for the SA basic education system

3

Learning At The Centre

What is the nature of the problem with digital learning?

The past 30 years' investment in edtech placed little emphasis on the pedagogies of digital learning and teaching despite the national preoccupation with learning challenges, especially at foundational level. Linking exploration with edtech to learning and teaching challenges, or 'backlogs', has been absent in much of the national discourse, with few exceptions. Instead, the national discourse has focused primarily on digital infrastructure access, teacher training on ICT integration and making digitised CAPS-aligned content accessible to as many learners and teachers as possible across various platforms. Many successes and failures occurred on this basis. However, this approach emphasised supply-side digital resourcing of the system rather than curriculum learning and teaching possibilities with technologies in marginalised schooling contexts.

Moreover, while there have been many debates in South Africa about the most appropriate learning strategies across various subjects and disciplines in the curricula, these debates have not featured in the national conversations on technology-enabled learning. Thus, the problem is the absence of conversations about whether and how South African children learn with technologies across contexts.

How learning with technologies are changing

Learning with technologies is a contested terrain. Dominant approaches to learning with technologies, including generative AI, have been criticised for drawing heavily on behaviourist pedagogies (Watters, 2021) that for many do not foster relevance, creativity and critical thinking among children compared to asset-based approaches to learning. Exploring how SA children learn or not with technologies in context has not featured in these debates as studies are based primarily on learning experiences in the Global North. Placing learning at the centre in SA edtech interventions is increasingly critical with the onset of generative AI where learning about and learning critically with AI is now urgent.

Placing learning at the centre opens the space to engage with claims about how AI enables personalised learning as well as with emerging insights offered by the learning sciences concerning application to edtech interventions in SA.

What have we achieved to date?

Table 1 overviews the digital learning policies and strategies that focus on learning, teaching, teacher professional development and youth skills.

Table 1. Edtech-related policies on learning, teaching, teacher professional development & skills

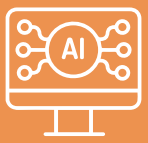
National Policy/ Strategy	Policy Prescriptions	Related National Programmes	Provincial Programmes Examples	Status as of 2024
2004 e Education White Paper	Aims to transform learning & teaching through ICTs; focus on digital access, TPD; e-content, & community engagement & system-wide targeted implementation	• Teacher Laptop Initiative • Ukufunda Virtual School • Connecting 147 DTDCs • DBE eCloud; Data-Driven Districts (DDD) • 2006 Feasibility Study	• Khanya Project • Gauteng Online • Internet Broadcast Project • ICT4RED	Still relevant conceptually: outdated tech; targets unmet;
2014 Operation Phakisa: ICTE	A presidential multi-pronged strategy for digital integration in basic: six focus areas: management systems, curriculum content, TPD, ICT infrastructure & connectivity	• National Edu Broadcast; • Foundational Digital Skills: Coding & Robotics Curriculum	WCED ePortal GDE IWB & AI festivals	Gave way to the development of an e-education strategy
2014-2024 e-Education Strategy	Comprehensive strategy with SWOT, best practice analysis, change management & phased implementation			Plan for adoption in 2024/2025
2021 Presidential Commission on 4IR Report	Emphasises investment in 4IR human capacity; mass 4IR skills development that nurtures nurturing emerging sectors like the digital,green, social, gig & creative economies	• Establishment of an AI Institute • Presidential Youth Employment Initiative	GDE IWB and AI festivals	Plan for adoption in 2024/2025
2020-21 National Digital & Future Skills (DFS) Strategy & Implementation Programme	Offers eight strategic elements for the development of DFS, including digital foundations in schools with strategic measures & actions	• Coding & Robotics curriculum in schools • NEMISA DFS for NEETs; Annual DFS conferences	Teacher Training in Coding & Robotics with PEDs	Ongoing, including Nov 2024 DFS National Conference
2023 National AI_ Discussion Document.pdf	Led by DCDT to engage national strategic stakeholders on an AI strategy	No references to national programmes in education		Still a draft for discussion

Table 1 confirms that SA has consistently been edtech policy- and framework-rich even though at present, some policy dimensions are outdated. Existing policies have guided in the rollout of digital infrastructure, teacher development and digital content via wide-ranging policy-supported interventions. However, with many policies not reaching their aspired goals, the national edtech system has also been policy implementation-poor. Where interventions have been successful, they have not been sustained, while others have not reached their intended goals, as shown in the 2024 e-Education Strategy. The absence of a national change leadership strategy is one factor contributing to a fragmented edtech ecosystem. This allows the system to be driven, in large part, by technology 'solution' providers who are unfamiliar with the complexities of learning and education system change in resource-challenged SA schooling contexts, as pointed out by Gent and Meyer (2016).

Currently, an increasingly diverse range of edtech interventions are underway, involving newly emerging actors, many of whom are not engaging with, or are running parallel to, the DBE and provincial education departments (PEDs). The reasons for this phenomenon are varied and complex, some of which are linked to rapid technological change, limited policy, insufficient regulatory guidance, trust deficits with existing education institutions and capacity constraints at the DBE for leading on the emerging edtech frontiers.

What strategies can we apply?

The national policy and leadership vacuum related to the rapid influence of generative AI and education will need to be addressed, albeit in limited ways given state capacity and fiscal constraints. Focusing available resources on augmenting the existing leadership and support capacity in the DBE and PEDs to engage, guide and support existing interventions and innovations underway is a pragmatic approach worth exploring.



There are a few examples of projects focusing on how digital technologies can support children's learning in their situated cultural and linguistic contexts in SA. Some of these have produced evidence to show how the learning in specific subjects in specific grades can improve under certain conditions in resource-challenged contexts (Roberts & Vanska, 2015). These projects serve as a strong foundation upon which to design and build future learning-centred edtech programmes.

New actors are emerging on the edtech landscape in SA, some of whom are experimenting with learning possibilities through AI-enabled technologies. This opens spaces for modest, targeted learning-centred edtech interventions by the DBE, PEDs and their social partners. These can include explorations into learning-centred programmes focused on:

- learning critically about AI;
- learning with AI;
- learning how AI can be redesigned for ethical, trustworthy, responsible and inclusive learning; and
- learning about the appropriate conditions for opting out and refusing to adopt AI.

4

Meaningful Connectivity

What is the nature of the connectivity challenges in education?

Since the adoption of the Telecommunications White Paper in 1996, the SA government has consistently aimed to provide under-served communities with physical access to quality internet connectivity. However, most policy goals have been hindered by limited success, unmet access targets, poor digital infrastructure planning, unsustainable cost models, theft and burglaries. Moreover, the Universal Services and Access Fund (USAF) and Universal Services and Access Agency of SA (USAASA) established to enable universal connectivity experienced institutional inertia. The high cost of data has restricted 'bring your own device' (BYOD) models and reinforced digital inequality, even though the zero-rating of DBE-vetted digital education data circumvented this challenge to some extent. Provincial governments, provincial education departments, districts and school governing bodies also implemented their own respective plans to promote internet access.

How connectivity architecture has been changing

Historically, the quest for universal access to internet connectivity, particularly in under-served communities, has focused primarily on access to physical internet infrastructure. But the concept of connectivity has evolved since then. The Department of Communication and Digital Technologies (DCDT) and the International Telecommunications Union (ITU) adopted the concept of meaningful connectivity which extends beyond only physical access into digital technologies. It embraces elements that make internet connectivity meaningful and valuable for individuals, families, communities, organisations and governments. It focuses attention on requirements for meaningful digital infrastructure access such as devices, internet connection options and a range of factors that enable safe, satisfying, enriching and productive online experiences that are affordable. The critical elements for meaningful connectivity are shown in Figure 2, which also differentiates between what each of these elements reflect when there is no connectivity, basic connectivity or meaningful connectivity. Thus, meaningful connectivity includes fast and reliable digital infrastructure, smart device ownership, advanced digital skills, meaningful content and services, along with safe navigation.

Stages of Connectivity	No Connectivity	Basic Connectivity	Meaningful Connectivity
Infrastructure	No Infrastructure	Signal Available	Fast and Reliable
Affordability	Too expensive	Affordable	Cheap
Device	No Device	Access to A Device	Ownership of a Smart device
Skills	No Skills	Basic Skills	Advanced Skills
Content	No Content	Some Content & Services	Meaningful Content & Services
Security & Safety	No Security	Security Infastructure	Safe Navigation

Figure 2. Levels of connectivity (BCG et al., 2021)

What have we achieved to date?

Table 2 provides an overview of connectivity-related policies, their associated national and provincial programmes and their status by 2024.

National Policy/ Strategy	Policy Prescriptions	Related National Programmes	Provincial Programmes Examples	Status as of 2024
2013 SA Connect: SA's Broadband Policy	National broadband initiative for universal access to broadband services for all prioritising underserviced areas	• Phase 1 connectivity to 970 govt facilities • GIGA SA School Mapping • Phase 2 launched in 2024	Digital Access Centres and Schools in partnership with municipalities WCG Mobile eCentres (2024)	Phase 2 under way to roll out to 5.2m households & existing 970 govt facilities including schools
2016 National Integrated ICT Policy White Paper	Digital literacy, infrastructure development, universal access, net neutrality, internet governance, environmental & consumer protection	The SA Connect emanated from this policy to enable universal access to ICT		
2024 National Policy on Data & Cloud linked to POPIA (2013) enforced in 2020	A regulatory framework to manage safe, trustworthy & ethical use of data via cloud technologies	• Data Driven Districts • DBE Cloud • PSET Cloud • SA SAMS	mySLDR (GDE) WCED ePortal	Adopted in March 2024: Existing projects can be mapped to the policy

Table 2. National policies that enable digital infrastructure access in schools

According to the GIGA Initiative, 15,700 out of 24 800 schools mapped are connected to the internet. Kemp (2023) shows that 27.7% of the South African population was still offline in 2023, which also means that 72.3% of the population did have internet access. Yet despite a steady increase in generalised access to internet connectivity in SA, the quality of internet access combined with related infrastructural disparities such as sustainable power solutions is an enduring challenge in education. Table 2. National policies that enable digital infrastructure access in schools.

15,700
schools connected to the internet

24,800
schools mapped

27.7%
of the South African population offline in 2023

72.3%
of the population with internet access

Strategies we can apply

The e-Education Strategy (2024) proposes a basic education network (BENET), a worthwhile pursuit provided it is backed by the required resources to sustain it. Here, learning the lessons from the SA National Research and Education Network (SANREN) as well as the experiences of NRENs across Africa would be an important consideration. In the UK, Poland and in several African countries, NRENs linked to universities have been able to share their infrastructure with clinics, libraries and schools in various communities. NREN backbones typically use points of presence (PoPs) located in cities and towns where adherent institutions are located.

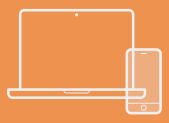
It may be worthwhile to explore sustainable connectivity innovations such as the TV White Spaces project in Ixopo, KZN, and community-based network models such as in Mankosi, Eastern Cape. These hold the promise of providing affordable, quality, sustainable connectivity to under-served communities which will need to be pursued and prioritised.

5

Digital Devices

What is the nature of the problem with digital devices in education?

Many strategies to sustain digital device and related infrastructure access in under-served communities have been attempted in SA: the idea of state support for device assembly plants in SA; negotiating lower costs of equipment and software with relevant private sector companies; providing refurbished devices within a technical support environment; and even promoting the establishment of job-creating, device refurbishment centres. Device access strategies have had mixed successes, similar to international experiences like the One Laptop Per Child Initiative (UNESCO, 2023; Ames, 2019).



Much of the available analysis suggests that often device rollout strategies centre on procurement and distribution of devices and related infrastructure and therefore often come up against broader infrastructure ecosystem challenges related to access to electricity, secure buildings, running water, sanitation and security. Moreover, device rollout strategies pay less attention to learning context, teacher development and the pedagogical integration of the digital devices. In addition, considerations for the technical support, operational, educational and financial sustainability and leadership required to sustain large scale edtech interventions were inadequate with the initial device rollout programmes (Gent & Meyer, 2016; Isaacs, 2015; Farrell, Isaacs & Trucano, 2007).

The e-Education Strategy (2024) acknowledges the learning experiences from the Khanya Project, Gauteng Online and ICT4RED which offer worthwhile lessons for the system on future edtech and device rollout programme designs.

How digital device architecture is changing

In the past, digital device access was conceived of as simply provisioning schools with computer labs. These have changed to mobile devices in the initial form of laptops, then tablets, mobile phones and now, increasingly smaller, wearable devices such as smart watches and smart sensors into wide-ranging physical materials in the form of the Internet of Things. In the face of technological convergence, devices are more fluid, embedded, embodied, connected and personalised. They are also acknowledged as increasingly invasive and extractive as data-driven technologies become integral to edtech ecosystems. Thus, when considering device rollout in schools, a host of complex issues converge and collide, requiring more cautious and considered thinking.

What we have achieved to date

At various moments over the 30-year period, the DBE and PEDs led successive policy-enabled large scale digital device access programmes in schools based on a spectrum of access modalities. These ranged from 1:1 access to customised tablets, mobile phones or laptops for learners and teachers to various shared device access models for use in classroom learning and teaching. The latter include device labs and interactive white boards and mobile projectors. The DBE e-Education Strategy (2024) provides a succinct analysis of South African, African and global device access initiatives that have been undertaken, their promising practices, limitations and critical lessons for future rollout attempts.

Much of the edtech discourse across the world remains preoccupied with promoting digital device access as a basis for enabling equitable quality learning, especially for the most under-resourced communities. Based on available Stats SA and related analyses, the majority of South Africans have access to some form of digital connectivity and device, even if they do not necessarily own devices.

The need for equitable access to devices for learners and teachers will likely continue in SA which points to the ongoing need for realistically achievable, workable, cost-effective, sustainable digital infrastructure models in ways that differentiate between commercial interests and educational interests.

What strategies can we apply?

Building on that which is already proposed in the e-Education Strategy (2024), the following are several proposals for consideration:

a. Promote a spectrum of device access models, including emerging affordable 'bring your own device' and 'bring your own data' (BYOD) and related models, to supply-side access via a range of digital learning labs that can include shared resource computing and 1:1 computing models. It is important to ensure that schools adopting BYOD approaches recognise that there are students and staff who cannot afford their own devices or data, and that they be compensated with the institutional provision of digital resources including devices and connectivity.

b. Invest in assistive technologies to support people who are differently abled with access to quality learning opportunities.

c. Consider a spectrum of connectivity and power solutions, from offline cached servers to Wi-Fi access, from solar powered to grid electricity solutions.

d. Negotiate digital inclusion rates, incentives and education data plans with prospective private sector partners. These will include the development of an incentive system in partnership with private providers for discounted access to connected digital devices for educational use, including payment schemes as part of BYOD and data models. This might mean negotiating for zero-rating of vetted digital content by network service providers of approved digital education content. Such a network of partners in support of meaningful connectivity for all education institutions can converge as a bandwidth coalition for education.

e. Partner with innovative start-ups and hubs to develop creative access solutions, applications and digital tools appropriate for schools in under-served communities in SA.

f. Ensure that all schools and education institutions have secure and reliable technical support systems in place to manage the use of digital technologies by staff and students.

g. Encourage all schools to adopt fair and responsible use policies as well as policies for the responsible re-use, recycling and disposal of end-of-life technologies. This could also involve partnerships with electronic waste management start-ups and small businesses.

h. Promote environmentally conscious procurement of technologies, safe and responsible technology disposal and e-waste management.

i. Raise awareness among learners and teachers of possibilities for access to digital resources at libraries, museums and district teacher development centres.

6

Initial & Continuous Teacher Professional Development (ICTPD)

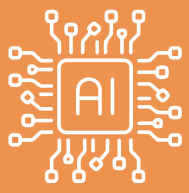
What is the nature of the problem with digital integration and teacher development?

One key challenge of many teacher development and training programmes on digital technologies is that they are rarely tailored to the disposition and conditions of teachers and the contexts in which they teach. For example, digital integration training programmes rarely incorporate strategies to teach with technologies in overcrowded or under-resourced classrooms, or in rural classrooms, or when teachers struggle to teach their respective subjects because of limited subject knowledge.

This may explain why numerous teacher training programmes on digital integration do not result in changes in teachers' digital practices which in turn limits the extent to which teacher practices, or lack thereof, improve learning and learning outcomes. The expansion of generative AI in education also raises new pedagogical, ethical and legal issues that must be included in teacher professional learning programmes.

How ICTPD systems are changing

Education is a diverse community: student teachers in initial teacher education, lecturers at teacher development institutions, in-service teachers in schools, subject advisors, curriculum writers and office-based educators. While diverse, these are all critical actors in the edtech ecosystem. Over the past 30 years, developing the capabilities of the teaching community to teach with technologies has focused primarily on short-term teacher training programmes that included basic digital literacy and use of digital technologies in classroom practice. This approach, however, overlooks the need to address the disposition of teachers, subject advisors and curriculum writers in their respective cultural, linguistic and social contexts; their need to grow their skills, knowledge, attitudes and values in their respective subjects; their pedagogical capabilities; their knowledge of technologies, including generative AI; and their knowledge of technology application in teaching practice and in personal and professional growth as a lifelong professional learning endeavour.



The rapid growth of generative AI also demands different roles of teachers as critical consumers and designers of AI technologies in ways that are safe, trustworthy, ethical and responsible; sensitivity to their teaching contexts and conditions of employment; and advancing their human rights and critical agency as individual professionals and as professional communities.

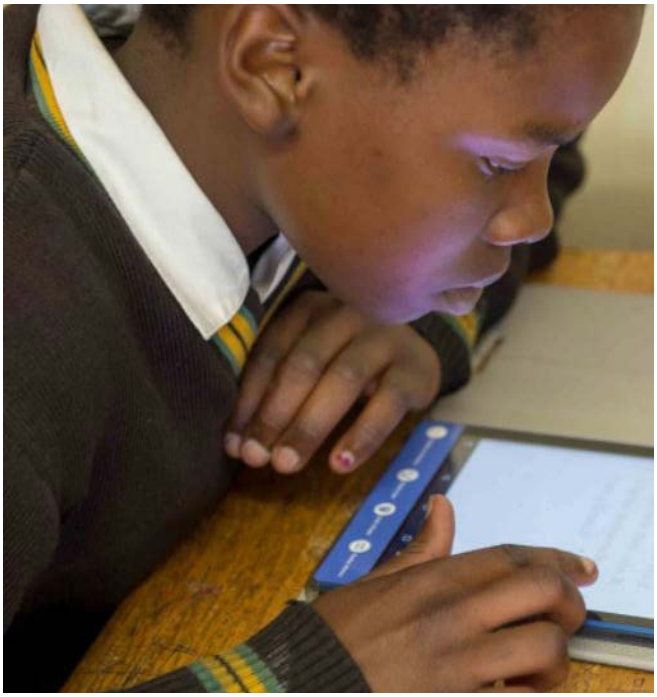
The latter are illuminated in the Education International and UNESCO (2024) Global Framework of Professional Teaching Standards; UNESCO's (2018) ICT Competency Framework for Teachers; UNESCO's (2024) AI Competency Framework for Teachers and the DBE's (2018) Professional Development Framework for Digital Learning, all of which spell out a systemic approach to continuing teacher professional learning pathways, professional learning communities and accessible formal and non-formal professional learning programmes that are quality assured, certified and accredited in collaboration with teachers and teacher unions.

What we have achieved to date

Many national DL programmes have focused on engaging teacher concerns with and their perceived phobia and resistance to technology adoption. Many of the numerous teacher development programmes focus on 'ICT-integration' in classroom teaching and in this way, large numbers of the 460 000 plus in-service teaching community have been 'trained'.

The DBE also adopted the Professional Development Framework for Digital Learning in 2018, a comprehensive guide to digital competencies for teachers in initial education and for in-service teachers. It focuses on professional growth, curriculum integration and leadership with technological pedagogical content knowledge (TPACK). Many courses have been developed aligned to this framework that have also been endorsed by SACE.

Many universities across SA have developed various programmes and courses on digital learning for student teachers in initial teacher education (ITE). The adoption of the Minimum Requirements for Teacher Education Qualifications (MRTEQ) aimed at ITE and the Professional Development Framework for Digital Learning provide frameworks to guide the teacher development community towards systematic, contextually relevant, pedagogically rich, digitally enabled professional learning pathways. Available evidence confirms that for teachers to teach optimally, they need consistent support systems: coaching, mentorship, peer-learning and peer coaching. Attempts at exploring virtual coaching have found mixed results, so this continues to be an approach worth exploring (see Celliers et al., 2021). These important lessons are finding fertile ground in the design of existing teacher development programmes.



What strategies can we apply?

Making sense of how teacher development is being designed and implemented with emerging technologies, including generative AI, within a burgeoning national edtech ecosystem can inform strategic roles for the DBE and its TD partners.

An important strategy for consideration is the way teachers are included in the design of teacher professional learning programmes and pathways to ensure relevancy to their personal and professional dispositions and teaching contexts.

Importantly too, designing programmes that develop teachers' critical capabilities and agency when adopting generative AI tools and technologies is urgent. Attempts at developing relevant human agency-centred programmes can be combined with attempts at upgrading existing teacher competency frameworks and professional standards that account for the influence of generative AI.

7

Digital LTSM And Generative AI

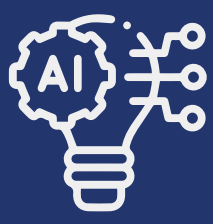
What is the nature of the problem with digital LTSM?

For many years, in light of shifts in curriculum policy, the basic education system has struggled to develop accessible learning and teaching support materials (LTSM) timeously and in sufficient quantities to reach all schools, classrooms, teachers and learners, particularly those in the most under-resourced communities. Moreover, the quality, relevance and accessibility of LTSM for learners and teachers across a wide range of cultural and linguistic contexts have been a pressing issue. Attempts to develop LTSM in digital formats have proven costly, have predominantly been made available in English, and have failed to cover the curriculum content for all subjects, grades and phases across the entire curriculum. Moreover, the use of digital LTSM formats is dependent on access to digital infrastructure, which is challenging in the face of the prevailing digital infrastructure inequality.

The system is also challenged with the under-utilisation of available digital LTSM where digital infrastructure access is available. This has been attributed to a supply-side approach to digital LTSM which meant that their relevance and levels of use were impacted because they did not engage adequately with the learning realities of learners and teachers in under-resourced contexts. The lack of communication pertaining the availability of the digital LTSM on various platforms was an added challenge. Additional system level concerns relate to the high cost of producing proprietary digital content which the emergence of open education resources (OER) have addressed to some extent. Thus, the quest to reach quality-assured digital content in multiple modes in all subjects in ways that support curriculum learning and teaching in multiple languages – including sign language and Braille – is challenging. Evidently, these challenges are complex and multi-faceted and highlight pedagogical, subject (discipline), legal (copyright), economic, contextual and system level concerns.

How digital content architectures are changing

Historically, digital LTSM was conceived as 'digitising curriculum content' that needed to be distributed via various digital platforms. Digitising content referred to the idea that existing curriculum content was produced in print format and all that was necessary was that it be digitised in PDF format, for example, for efficient electronic distribution. This approach considered digital content as 'static content' and neglected to weigh the pedagogical underpinnings in the design or the use of interactive, gamified, culturally responsive curriculum content. The concept of digital content is shifting rapidly in the face of generative AI – with machine-generated synthetic multi-modal content in text, video, audio, image formats – which brings in new challenges related to education quality, accuracy and algorithmic bias that have profound legal and ethical implications. This shifting terrain catalysed by generative AI demands urgent attention in view of AI's growing adoption and risks and dangers posed.



What have we achieved?

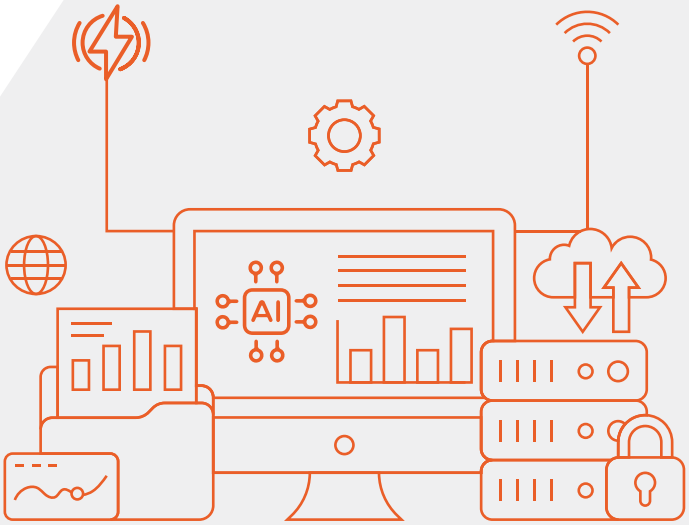
Significant strides have been made in mobilising a growing national stakeholder ecosystem involved in the design, production, distribution, use and evaluation of digital LTSMs that cover many of the 104 subjects across all grades in the current basic education curriculum. Digital LTSMs are increasingly available on a wide range of platforms in digital and non-digital formats, across various print or text, video, audio and image modalities. The onset of generative AI has been shifting the paradigm on digital multi-modal content generation, coinciding with the emergence of new role players in the digital education content space which the system must clarify and understand.

What strategies can we apply?

Drawing on experiences during the COVID-19 pandemic which involved mobilising the widest possible range of CAPS-aligned context providers and platforms, the e-Education Strategy (2024) can be augmented by understanding and engaging strategically with the burgeoning digital content ecosystem in education. New actors in the ecosystem can be engaged in ways that leverage their resources and guide the development of their resources in pedagogically and culturally relevant ways.

Monitoring the changes in the generative AI and OER space could be another area of strategic focus in view of budgetary constraints by leveraging the economic advantages offered by OER.

One area gaining attention relates to explorations into ways that generative AI can support the development of relevant, accurate, human-controlled LTSM in African languages. Such explorations can be combined with capacity development to make these investments worthwhile, especially if they also involve curriculum writers and subject advisors in the system, whose expertise can be leveraged but who also need support in their roles.



8

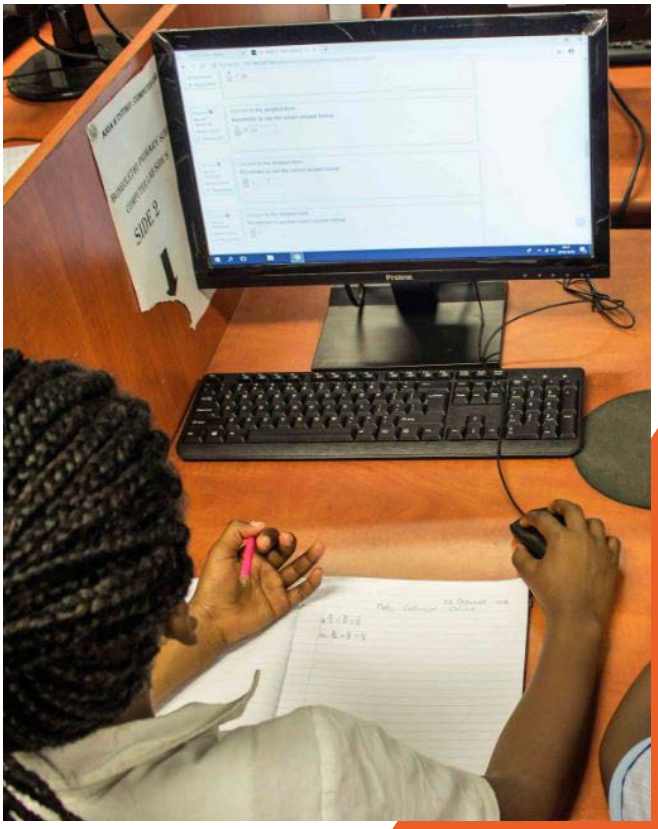
Digital Learning Platforms

What is the nature of the digital platform problem?

Another abiding feature of the edtech ecosystem over the past three decades is the increase in digital platforms that offer a variety of CAPS-aligned learning and teaching resources, applications and assessment tools. There is a growing number of available platforms that claim to reach many learners and teachers with CAPS-aligned content and learning opportunities. However, many of these platforms attract low numbers of users, particularly from marginalised schooling contexts. The limited adoption of existing digital learning platforms can be attributed to several intersecting factors, including a lack of access to the requisite digital infrastructure and to the meaningful connectivity required to access high-bandwidth video-formatted content. In addition, the lack of awareness of the availability of these platforms; the lack of cultural and linguistic relevance to the learning context of targeted learners and teachers; and the design of platforms based on better resourced contexts are three additional salient reasons for platform under-utilisation. And on top of all this, the platform landscape is changing swiftly in the face of generative AI, raising conceptual, legal and ethical concerns.

How digital learning platform architecture is changing

Generative AI is transforming digital learning platforms in a myriad of ways. This includes the automation of synthetic content creation in various formats that have the potential for play-based gamified learning to make learning more fun and interesting for learners, but which also pose risks and dangers with legal and ethical ramifications. Generative AI also enables platforms to manage wide ranging complex queries at scale and can deliver conversational responses. Some generative AI platforms can detect and manage harmful content by effectively analysing language and context and can assist in identifying deepfakes and misinformation. All these changes are not yet clearly understood and will require ongoing sense-making.



What have we achieved to date?

Over the past 30 years, numerous learning platforms have been designed for a wide range of resourcing contexts. While these began as education broadcast channels on both public and private platforms in educational TV and radio channels, they now also include a wide range of online chat platforms, mobile learning applications and interactive gamified platforms, some of which have successfully demonstrated improvement in curriculum learning and learning outcomes. During the COVID-19 pandemic, the DBE and NECT developed an approach for vetting many of these platforms in a campaign to enable access to digital resources in resource-challenged communities.

Key to the platform approach was the adoption of a spectrum of analogue to digital platforms, traditional technologies and emerging chat platforms such as WhatsApp. A salient feature of the pandemic period was the success with which the DBE facilitated the zero-rating of a wide range of vetted platforms. This laid the groundwork for many learners and teachers in under-resourced communities to access and use these platforms at zero cost to the end user. The contemporary platform landscape, however, is changing rapidly, requiring the development of more robust edtech platform strategies as part of the e-Education strategy of the DBE.

What strategies can we apply?

The rapid pace of change, referred to by some as the platformisation of education, demands ongoing awareness, sense-making and clarity of understanding how the landscape is evolving across the basic education system. Conducting horizon scans of existing and emerging digital learning platforms, their design, uptake, influence, risks and risk mitigation strategies would be an important part of the broader sense-making of the edtech ecosystem in SA.

Learning to understand how the landscape is changing also demands a commitment to grow generative AI knowledge and skills within the DBE and among the PEDs. Part of this collective learning curve could include the development of appropriate system level strategies to respond to the changing landscape.

9

Data Governance

What is the nature of the data governance problem?

Data governance in the basic education system has historically focused on the lack of accurate data about learners, teachers and the limitations of existing system-related data. Education data have been notoriously incomplete and inconsistent. The absence of data coupled with the system's challenges with data quality have affected system efficiency. Moreover, the system invested in a few parallel, siloed data management systems designed on incompatible platforms that were not interoperable.

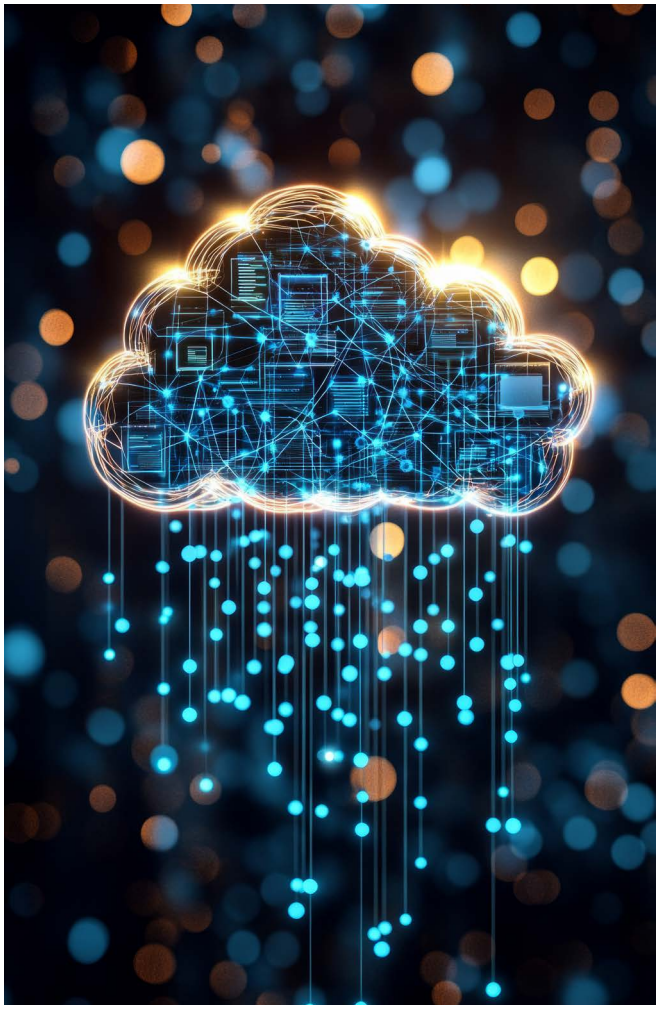
The onset of large data-driven language models and generative AI systems opened new vistas on how data is generated, used and stored and is surfacing wide-ranging challenges related to privacy protection, transparency and ethics.

How is the data governance landscape changing in education?

The integration of generative AI in education is catalysing dramatic change in data generation and governance, highlighting wide-ranging risks and concerns. Some risks include privacy and data security, particularly with vast quantities of sensitive personal data of legal minors as risks are posed by storing, processing and potentially exposing this data through unauthorised access or data breaches.

Many education stakeholders, including children, parents, guardians and teachers, are often unaware of how their data is used to train or operate generative AI models. Ensuring informed consent and communicating data usage policies are challenging, especially as generative AI systems may use data in complex, indirect ways that users do not understand.

Generative AI models can perpetuate and even deepen biases and discrimination that prevail in the training data, heightening risks related to equitable and inclusive learning outcomes. Issues of data ownership and data sovereignty of users and citizens; the accountability of unexplainable, opaque AI systems; and issues of ownership of intellectual property in the face of synthetically generated data by generative AI systems based on the intellectual property of others are additional concerns surfacing in conversations about data governance in education. These issues are complex. They demand stronger data governance frameworks in education to support responsible generative AI integration while ethically safeguarding privacy, equity, data sovereignty and accountability.

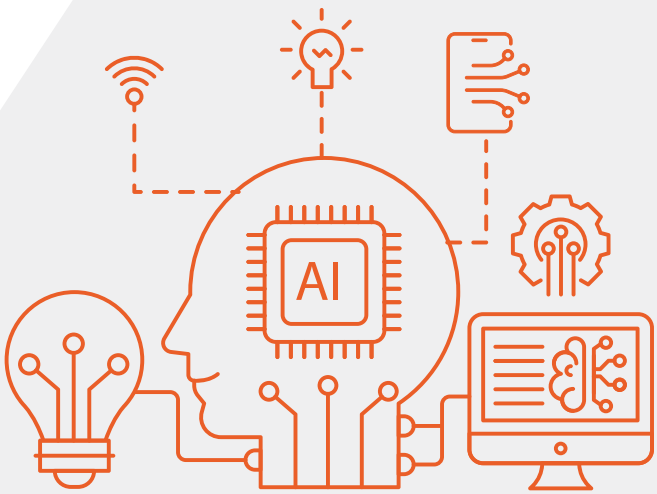


What have we achieved to date?

Table 2 on page 12 refers to the National Policy on Data & Cloud linked to POPIA (2013) which was enforced in 2020. These offer regulatory frameworks to manage safe, trustworthy and ethical use of data via cloud technologies. The DBE has also developed a successful programme on Data Driven Districts (DDD) and introduced an education management information system via SA SAMS which has been in operation for almost two decades. These provide a strong legal basis for engagement, raising awareness and creating strategies to circumvent data governance breaches and risks of generative AI.

What strategies can we apply?

The DBE's e-Education Strategy (2024) must consider the emerging complexities that generative AI will pose to the education system, key among which relates to synthetic governance of education data. Convening expert advisory groups to inform regulation and system guidelines may be an appropriate low-budget step, along with updating the DBE's e-Safety guidelines to include risks associated with generative AI.



10

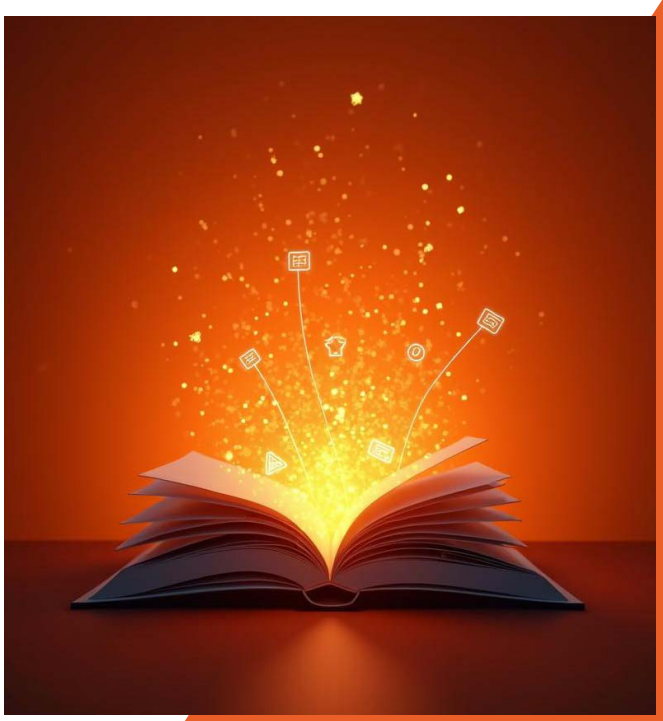
Leadership Development

What is the nature of the edtech leadership development problem?

One of the enduring challenges in the educational technology ecosystem in basic education is the sometimes severe organisational, financial and human resource capacity constraints that militate against the investment in edtech leadership development. A consequence of the lack of investment in leadership development is that the system struggles to manage education systems catalysed by increasingly powerful digital technologies and AI systems. While limited capacity exists in the DBE and within the PEDs, the edtech ecosystem is concomitantly growing its capabilities outside the mainstream public education system, among a burgeoning edtech start-up sector, among venture capitalists investing in startups and in universities and other tertiary institutions that are developing 21st century leadership programmes. Many of these initiatives involve individual department officials who, alongside office-based educators, invest in their personal and professional development on an ad hoc basis. Comprehensive investment in leadership development does not exist in an organised and structured way as a basis for upscaling and enlarging the capability of the system. The absence of an intentional, purposeful leadership development programme risks the overall capability of the basic education system to engage with the complexities of AI-powered changes in the system.

What capabilities are needed to lead in the era of generative AI and education?

Leadership competencies that an increasingly AI-infused education system demands include the need to develop a critical understanding of the capabilities and limitations of AI. Critical AI literacy will guide leaders in making informed choices about AI in education systems, choices that are appropriate and relevant for SA basic education. Education leaders will need to understand the ethical implications of generative AI, including issues related to data privacy, algorithmic discrimination and the potential for over-reliance on AI-driven content. Ethical stewardship involves setting policies to protect the privacy of learners and teachers and ensuring equitable access to safe, trustworthy AI resources. A range of related skills is needed, along with strong leadership capabilities, to make informed decisions about AI investments within the system. The current leadership at DBE and NECT could create a leadership development model on AI and education that relates to DBE and PED institutional contexts.



What have we achieved to date?

The DBE and NECT have hosted a range of leadership development programmes, including accredited courses at universities targeted at senior management in the DBE. These experiences provide rich insight on the designs of leadership programmes that work well in a DBE and PED context. One of these programmes, an ICT Leadership Short Learning Programme at the University of Johannesburg involving senior management across all nine provinces, had a 99% completion rate of 40 course participants in 2015. Many of these senior managers remain in the system and have applied the tools and strategies acquired in the course.

What leadership development strategies can we apply?

Investing in leadership development on AI and education needs to be prioritised. Strategies can include:

- hosting at least two national dialogues per annum;
- hosting seminars once a quarter; and
- designing a dedicated leadership programme in partnership with SA universities with senior management receiving accreditation upon completion.

11

Partnerships, Financing And Resource Mobilisation

What is the nature of the partnership, financing and resourcing problem?

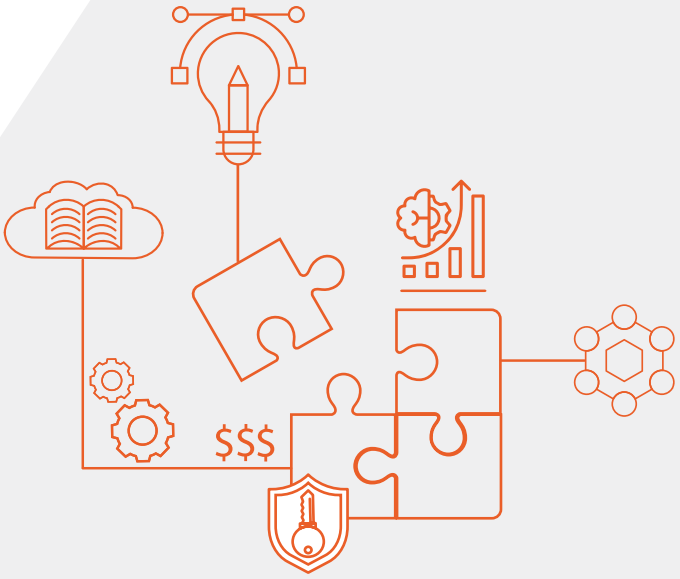
The basic education system is facing significant fiscal constraint challenges which risk the success of investment in digital learning, AI and education and the current process for developing an e-Education strategy in the DBE. An added challenge in the face of fiscal constraints is the duplication of resources and wasteful expenditure in edtech.

One way the system has managed to function with limited financial resources has been to engage in partnership development. But the partnership development experience in edtech has brought collaboration challenges with varying and sometimes conflicting interests among partners. Linked to some of these partnership development challenges is a pervasive trust deficit within the system that militates against investment by donor and private investor communities.

How is the partnership landscape changing in edtech?

The edtech stakeholder ecosystem in South Africa has always been fluid and dynamic. Over the past few years, new actors have emerged, especially in the form of venture capital and edtech start-up companies, many of which are also entangled within a global network of powerful technology companies, donors and development agencies.

SA has a growing philanthropic sector as well as a growing corporate social investment sector even though recently both sectors have shown signs of fatigue. But even so, many of these stakeholders and actors have young managers who are eager to learn. This provides potential opportunities for the DBE and its social partners to leverage.



What have we achieved to date?

In the edtech space, the DBE and NECT have extensive experience with partnership development across multiple stakeholders in civil society, the private sector, donors and philanthropic communities. This serves as leverage to improve existing relationships and can also help forge new partnerships with new actors on the horizon by drawing lessons from experiences of partnerships that have broken down.

What strategies can we apply?

Several strategies can be employed:

- streamlining existing resources,
- reducing duplication and wastage,
- reinvigorating existing partnerships and
- exploring possibilities for partnership development with new actors and role players.

However, partnership development and resource mobilisation incur transaction costs which are typically underestimated. The DBE, NECT and partners can prioritise partnership development and resource mobilisation by investing in human resource capacity dedicated specifically to partnership development.

12

Monitoring, Evaluation, Research & Learning (MERL) & Knowledge Management

What is the nature of the MERL and KM problem?

Only a handful of edtech projects and programmes have integrated research, monitoring and evaluation in their design and have contributed to the limited SA edtech evidence base. A limited evidence base results in poorly designed and ineffective edtech programmes. Unfortunately, the South African education system has extensive experience with interventions that lack a strong evidence foundation.

Moreover, the accumulated experience and insights from South Africa's edtech landscape have not been properly documented, structured or managed. The lack of a knowledge management system has also resulted in limited expertise in designing, implementing, researching and evaluating the edtech interventions.

How MERL and KM are changing

The growth of generative AI has opened new vistas in MERL and KM methodologies. New AI tools and technologies are available that offer wide-ranging affordances to support the efficient real-time integration of MERL in the design of edtech interventions.

What has been achieved to date?

Despite the limited evidence base, more edtech interventions are integrating MERL into their designs so the evidence base is growing while simultaneously tossing up questions about the nature of evidence and research in the current dynamic context. Some MERL research has been led by universities and think tanks who are investing in AI and education.

What strategies can be applied?

A more systematic engagement with South Africa's national innovation system and research community – both within academia and beyond, including emerging institutions like the National AI Institute – would be valuable. Developing a dedicated research and MERL (Monitoring, Evaluation, Research, and Learning) agenda for South Africa's edtech landscape should be a key priority.

13

Preparing For The Next Emergency: Lessons From The Covid-19 Pandemic

The emergency RDL intervention was designed as a supplementary support programme to complement the myriad of existing initiatives that were underway during the COVID-19 pandemic. It offered a spectrum of access points for learners living in household conditions of poverty as it was surmised that the poorest households would have a television and radio access; hence, the RDL programme included in its spectrum of offerings access to curriculum content for public broadcast television, free-to-air TV, free access to satellite TV negotiated with broadcasters, as well as mobile apps, WhatsApp-based communications and the mobilisation of a range of content from a wide range of possible role players. The main costs incurred went to oversight, leadership and management, content production, MERL integration and communication. The programme was partially successful over the three years in which it prevailed.

What did we achieve?

In the post-COVID environment, the challenges of learning backlogs remain a salient feature of the education landscape; many of the gains made by RDL during COVID have not been sustained. However, the design of the RDL holds rich lessons as the system must prepare for future shocks and crises like the COVID-19 pandemic.

What strategies do we need to apply?

As we consider the way forward for the national edtech ecosystem, we must think how existing developments can be leveraged to prepare the system for the next big crisis. Drawing on lessons from the SA experience and the evidence base of international experience within similar contexts is integral to next conversations on e-Education led by DBE and its partners.

14

Edtech Road Map Considerations

The following proposed road map serves to build on the recommended plan in the e-Education Strategy (2024).

It proposes interventions at two levels:

1. At a system-facing level by focusing on the role of the DBE as an orchestrator of the national edtech ecosystem through strategies that build trust, leadership and capabilities in the DBE and its state-based partners to guide the edtech discourse in the national system.

2. At the level of learners and teachers in selected schools through a bottom-up approach to edtech strategy design. Given the capacity constraints in the system, the focus must be on selected conditions of marginality and exclusion and on what is necessary to improve foundational learning in numeracy, literacy and digital literacy under these conditions.

Figure 3 provides an overview of key considerations for an edtech road map.

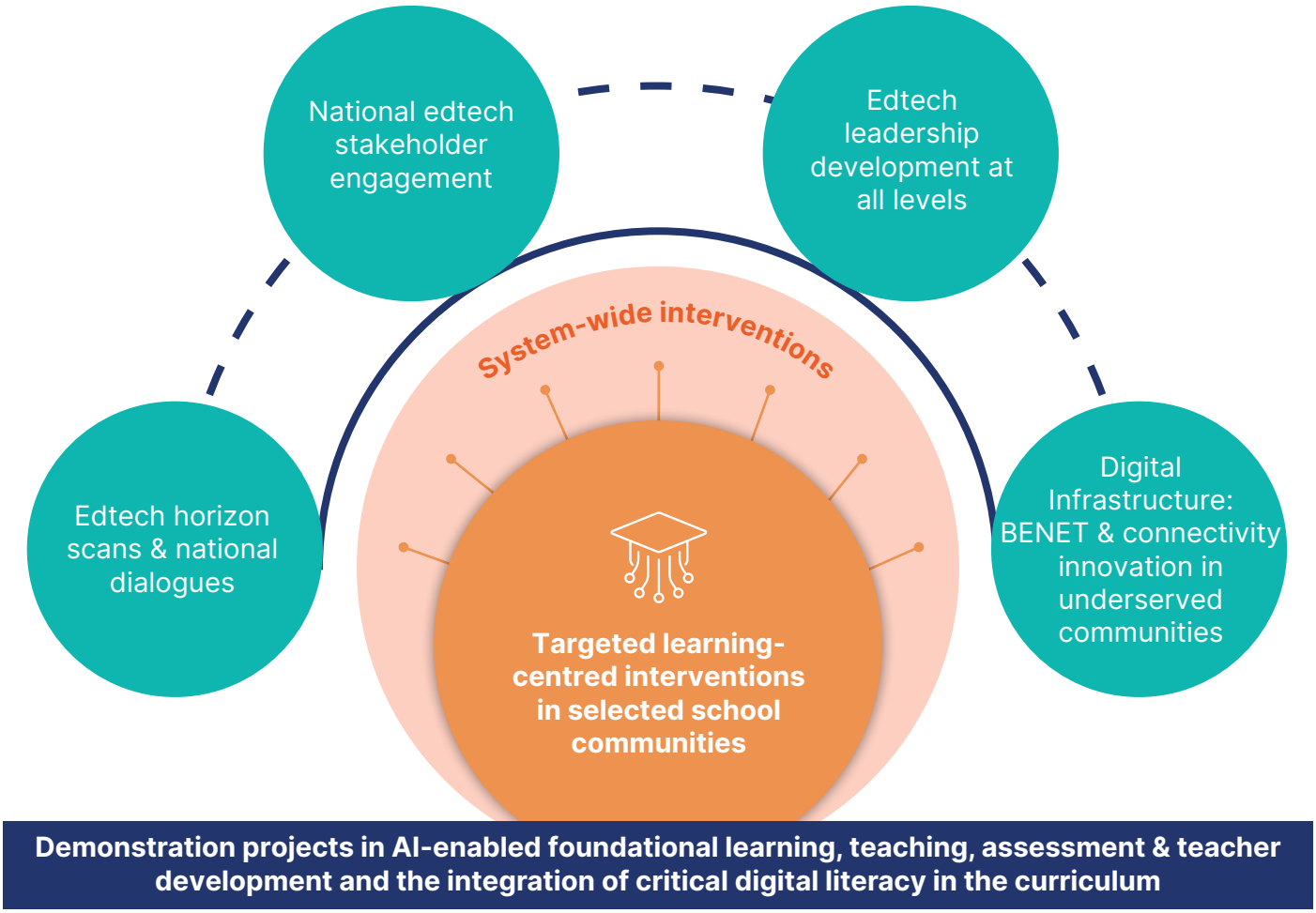


Figure 3. Proposed strategies for an edtech road map

Figure 3 proposes a modest approach to edtech integration towards progressive system change. At a system-facing level, it proposes that the DBE and partners focus attention on leadership development, making sense of the edtech landscape and developing strategic partnerships for improving digital infrastructure access for learning via the proposed BENET project in the e-Education Strategy.

At a system facing level, the road map could include:

1 **Generate an initial modest plan for edtech leadership development in generative AI and education among leading officials in the DBE, PEDs and districts**

The design of such a leadership development programme can draw on successes and failures of past leadership development attempts. The attention will need to be on enabling collective understanding of how the existing approaches in the DBE and PEDs may now be irrelevant in view of rapid changes in algorithmic technologies; strategies must focus on defending the inclusion and equity objectives of education as a public good. Such a programme can leverage global and local experts and institutional systems in a structured, systematic way, integrating monitoring and evaluation in its design to ensure system learning from the process. An initial six month blended learning programme may be realistic and achievable.

2 **Develop a plan to monitor developments on the edtech landscape in South Africa, including how new 'market' entrants are emerging.**

Such a plan can include the development of a **national observatory based on regular landscape scans**. These can serve to appreciate the key stakeholders, the programmes they are implementing and how these programmes are supporting learners, teachers and education communities. These can also serve to guide and support the various actors and networks within the edtech ecosystem and clarify the role of the DBE in leading and navigating such an emergent ecosystem.

3 **Develop strategies to leverage the dynamism of the broader edtech ecosystem.**

This can be achieved by strategically convening various stakeholders and engaging in regular action-oriented conversations wherein the DBE and PEDs can explore ways to support, guide and vet the work that is currently emerging in the system.

4 **Work with the Department of Communications & Digital Technologies (DCDT) and Department of Science and Innovation (DSI) to deliver on the SA Connect mandate for universal quality connectivity for all.**

The DCDT recently launched phase 2 of the SA Connect plan to reach five million households with quality connectivity and extend access to the existing 970 government sites, including schools in under-served communities. A whole government approach to addressing inequality in digital infrastructure access is required to support school level access to quality internet connectivity, particularly in under-served communities. It will also be imperative to extend the current explorations into alternative, low-cost sustainable connectivity models such as TV white spaces led by the DSI and the CSIR to schools in rural areas. These can go a long way in laying the foundation for children, teachers, parents and guardians in these communities to access education resources. Universal access to connectivity must be addressed alongside a strategy for digital device access under budgetary constraints. Exploring strategies adopted by the PEDs and the Remote and Digital Learning Programme of the DBE/NECT that combined a spectrum of technology access modalities would be worthy of further exploration.

Through 'bottom-up', learning-centred, user-centred design approaches, the following can be included in the road map:

5 **Design and deliver modest targeted edtech interventions that focus on inclusive, equitable learning, teaching and teacher development in foundational learning: literacy and numeracy in African languages.**

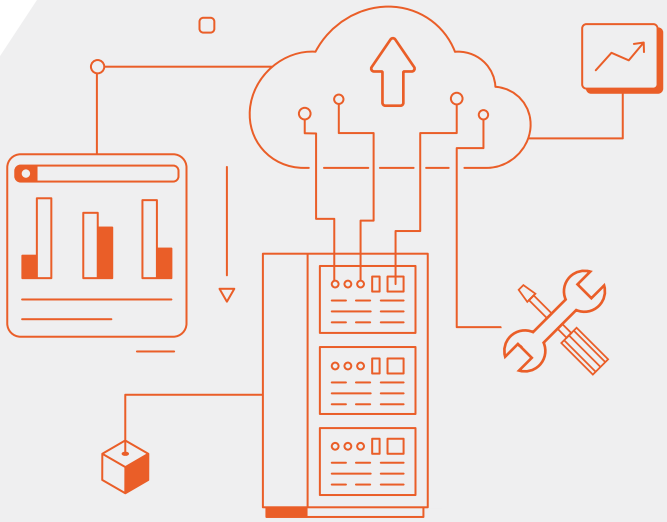
The jury is still out on the value of edtech for learning, teaching and teacher development. In the meantime, the dominant discourse remains hype-centred about the ways in which AI, generative AI and 4IR can revolutionise education. What is absent from the SA landscape are robust edtech interventions that can enlarge and strengthen our evidence base for understanding how edtech can enable foundational learning in mother-tongue based bilingual education. We can draw on existing programmes that may be underway as well as past intervention designs in the early grade literacy and numeracy space. Digital technologies can be integrated in existing designs or the enhanced design of early grade literacy and numeracy projects for the purpose of system learning about their value, their risks and even their dangers. These will need to be designed and implemented from a safe, ethical, equity and inclusion perspective.

6 **Work with existing partners to design the integration of critical digital (including AI) literacy in the curriculum at the foundation phase.**

The e-Education strategy identifies this area as a strategic intervention which aligns with similar approaches in countries globally. Again, the adopted approach can focus on schools, learners, teachers and school communities situated in resource-challenged conditions.

7 **Hire the services of technical assistants (TAs)**

who are familiar with the educational, pedagogical, organisational, strategic and operational requirements for edtech interventions within the particular complexities of SA's education system. Two to three TAs who combine technical, educational, strategic and operational expertise hired for an initial two year period, extendable to a five year period, would be a worthwhile investment in the system's human capacity.



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