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How to cite:

Moon, Bob and Villet, Charmaine (2017). Can New Modes of Digital Learning Help Resolve the Teacher Crisis in Sub-Saharan Africa? *Journal of Learning for Development - JL4D*, 4(1) pp. 23–35.

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Version: Version of Record

Link(s) to article on publisher's website:

<http://jl4d.org/index.php/ejl4d/article/view/194>

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## Can New Modes of Digital Learning Help Resolve the Teacher Crisis in Sub-Saharan Africa?

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**Abstract:** Sub-Saharan Africa, more than any other part of the world, is experiencing a crisis in finding sufficiently qualified teachers to meet the needs of expanding school systems. The professional development support provided to serving teachers is also inadequate in most countries. The most recent data on learner outcomes has revealed a worrying picture of significant under-achievement across the region. This paper argues that the teacher education and training structures of the last century will never be able to meet urgent contemporary needs. Given population growth, especially among the young, large-scale expansion of the teaching force and the associated teacher education systems will be the norm through to the middle years of the century and beyond. In this context the paper argues for a significant policy shift to expand quality teacher education and professional support at scale through a more school-based and digitally supported network model of provision. Examples of current digital programmes within the region are considered as well as the new technologies that are emerging with relevance to teacher education. The paper suggests a three-phase process through which national governments might move in making the necessary changes in policy and practice.

**Keywords:** Teacher education, digital learning, Sub-Saharan Africa

### Analyzing the Challenge

The UNESCO Global Education Monitoring Report for 2016 'Education for people and planet: creating sustainable futures for all' makes salutary reading for those of us with a commitment to improving schooling in the world's low and middle income countries. Jeffrey Sachs, Special Adviser to the UN Secretary General on the 2015-2030 Sustainable Development Goals (SDGs) writes that 'the report should set off alarm bells around the world and lead to a historic scale up of actions' if the educational improvement sought is to be realized.

The report provides extensive detail of the problems now faced by education systems across the developing world, particularly in Sub-Saharan Africa. Central to the analysis is the persistently poor achievement of learners. In essence the core problem is that success in getting children in to school (the 'out of school' children have been cut by half since 2000) has not been matched by even modest levels of learning success. We will explore this in a little more detail but first we want to set out the framework of our argument, one advanced in a report for The Commonwealth of Learning (COL) that can be found at <http://oasis.col.org/handle/11599/2443>

We want to suggest that the quality of teachers is the key issue in seeking to improve the achievements of the growing number of children in our school systems. In one sense this is a rather obvious proposition but it is one that has not always been at the centre of policy development. The Millennium Development Goals failed to mention teachers. The SDGs do explicitly prioritize teachers



in suggesting that international co-operation will be needed to address the challenge of teacher recruitment, retention, education and training.

Simply stated, many countries cannot find sufficient teachers for expanding school systems. Equally, many countries do not have sufficient teacher training places even if the recruits could be found. Additionally, we know, although data on this is not easy to collect, that a large proportion of those completing teacher-training programmes choose not to enter teaching. The consequence is the contracting of large numbers of unqualified adults to take on the teacher role. These teachers receive limited, if any, professional support. In addition we know that qualified teachers in schools also need support and development. But professional development structures are few and far between, especially in the rural communities in which so many children are educated.

This situation presents an enormous challenge for teacher policy and practice. Many teacher divisions in Ministries of Education are overrun by the scale and nature of the crisis. Teacher education and training presents one of the most intractable problems. It is now clear that the systems for teacher preparation and support developed in the twentieth century are inadequate to meet the needs of the twenty first. Campus based training cannot respond to the scale of teacher need. The curriculum within such institutions is also often outdated and lacking a focus on effective classroom practice. In-service training systems, mostly based on the idea of taking teachers out of school on courses, can nowhere meet the scale required and, in any case, have been proven ineffective in changing and improving teacher practice.

In this context we argue that policy makers need to acknowledge that most teacher development will have to take place at the school level and that systems and structures need re-engineering to take account of this. Let us quickly add that we do not argue for the dismantling of campus based teacher education but rather we see it evolving to play a role in newly formed networks of school and teacher development. And we will go on to argue that the logistics of this approach will only work if access and interaction is facilitated through digital technologies and new modes of at scale open learning. Most countries in Sub-Saharan Africa, we suggest, need to radically review policy options in order to:

- expand initial teacher training through the provision of scaled-up outreach and digitally supported programmes
- develop similar strategies to ensure that unqualified and under qualified teachers in schools receive support to achieve appropriate qualification levels
- give strong policy priority to developing new structures of scaled-up, digitally supported, local and school based professional development programmes (with a strong focus on more effectively teaching the core learning skills of literacy and numeracy)

In the past different styles of open and distance learning were often used to fill the gaps in teacher education and training that face-to-face institutions could not meet. The nature and scale of need today, however, requires these approaches to be at the centre, not the periphery, of provision. And with the growing strength of digital technologies this can be achieved in ways previously not thought of. These new approaches are already well advanced in much of higher education. On-line teaching, not always thought of as open and distance learning, can be found in many high status universities across the world. Teacher education and training can draw on this wide experience and there are many interesting initiatives in Sub Saharan Africa that provide a direction for policy reform. Some of these we draw on below.

## **The Teacher and Learning Crisis in Many Sub-Saharan African Countries**

UNESCO's Institute of Statistics has estimated (UNESCO, 2015b) that globally the world will need to recruit 25.8 million extra teachers (equivalent to the population of Ghana) by 2030 to meet EFA targets: 3.2 million would be new posts and 22.6 million would be replacements for teachers retiring or leaving the profession. The 59 million children out of school in 2015 would require the recruitment of 2.7 million teachers, if pupil-teacher ratios did not exceed 40:1. According to the Institute's forecasts, 33 countries will not have enough teachers to achieve universal primary education (UPE) in 2030. Sub-Saharan Africa faces the biggest challenge of any major world region. For every 100 children beginning school in 2015 there will be 142 in 2030, and 2.2 million extra teaching posts will be needed to deal with the growth. At a conservative estimate, 3.9 million teachers will be required to replace those leaving the profession.

At present it is clear that the traditional structures for training teachers cannot keep pace with this expansion. In a third of countries less than 75% of teachers have the national standard qualification to become a teacher. In a majority of countries the percentage of unqualified or under-qualified teachers is growing. The UNESCO Institute report lists 32 countries globally where less than 75% of teachers have appropriate qualifications. Nineteen of these come from the Sub-Saharan Africa region, and, of the 18 countries with pupil-teacher ratios exceeding 40:1, all but one are in the same region.

Many countries have put in place policies to increase the supply of teachers but in most the rate of growth only just catches up with population needs by the latter part of the 2015-2030 period. Zambia, for example, has been increasing teacher recruitment by an average of 4% a year. Yet to achieve UPE the expansion would need to grow at 10%. At present recruitment levels the country will not have enough teachers in school until 2029. In other countries the problems are more challenging. The United Republic of Tanzania will continue to face a shortage of teachers even after 2030 if current trends continue. To achieve UPE by 2030 the country would have to recruit 4% more teachers each year compared to the current average growth rate of 3%.

Finding and educating sufficient teachers is an enormous challenge. Large-scale recruitment and training systems are going to be needed for most of this century. Equally of concern is the contemporary evidence about teacher knowledge and learner achievement in the region. The Institute for International Economic Studies (IIES) ([www.iies.su.se](http://www.iies.su.se)) working with the World Bank has been attempting to measure primary teacher effort, knowledge and skills in seven African countries making up 40% of the population of Sub-Saharan Africa. The initiative has been using Service Delivery Indicators that can be applied across different countries and contexts. A range of data is emerging. After three years primary public schooling many students lack the most basic elements of literacy and numeracy. Half of all the children assessed could not read the simplest of words. 70% could not read a basic sentence. A fifth of children could not recognise numbers, half of all children could not put numbers in order and three out of four could not do single digit subtraction. Teacher absenteeism is also identified in this research as a major issue. Many children are barely receiving half of the teaching time they are entitled to. (Bold et al 2016) Successive EFA Global Monitoring Reports, beginning with the 2005 report that specifically addressed issues of quality, provide further evidence on the problems of teacher knowledge and learner achievement. Only Ghana and South Africa of the Sub-Saharan countries are currently prepared to participate in the international assessments of education outcomes. Given the need to scale up provision and the imperative to make it more effective we argue that digitally supported school-based structures present the only feasible long-term policy option.

## **The Contemporary Take Up of Digital Learning**

There is a considerable history of applying open and distance learning (ODL) methods to teacher education in Sub-Saharan Africa (Moon 2000). Since the 1960s many countries have experimented with such programmes, mostly directed towards upgrading primary teacher qualifications. Specialist ODL institutions such as UNISA, in South Africa, The Open University of Tanzania and the National Teachers Institute of Nigeria have demonstrated a long-term commitment to teacher education. Long established universities (e.g., The University of Pretoria and the University of Namibia) are also developing new off-campus teacher education courses.

The design of such initiatives is usually built around four elements:

- Providing the resources through which students study.
- Building in-school and other support opportunities so crucial in a practice-focused course.
- Developing appropriate assessment arrangements.
- Creating robust quality assurance systems to monitor programme development.

There are a variety of texts that look in detail at the options for course development in relation to these four elements (Moon, Leach and Stevens, 2005). Most of these, however, were developed at a time when access to digital technologies was extremely limited. This is now changing:

- Core resources can be provided on already loaded tablets or on-line.
- Resources can be interactive and creatively designed.
- Support can be continuous and encourage peer interaction.
- Providers can keep much closer contact with schools.
- Data on student self-assessment and student progress can be more easily collected and used.
- Quality assurance systems, including student evaluations, can be collected and used more cost effectively and more quickly.

Alongside the digital adaption of existing courses we can also identify a range of interesting ways that digital technologies are enriching and reforming teacher education. Here are just a few examples.

Mindset Learn delivers curriculum-aligned eLearning content and materials over television and the Internet, for use by students, teachers, and parents in the classroom and at home. It aims to increase learning outcomes by providing up-to-date, accessible, and interactive learning experiences and has been developed in accordance with South Africa's Curriculum Assessment policy. All Mindset Learn content is free to view at [learn.mindset.co.za](http://learn.mindset.co.za) and <http://www.youtube.com/mindsetlearn>.

CoZa Cares Foundation has created a new library, Nolwazi, a digital repository of resources aligned with the South African primary school and high school curriculum including subject research and lesson planning. A significant proportion of Nolwazi's content has been sourced from practicing teachers

Open Learning Tank (OLT) is a platform that supports and builds knowledge around the use and reuse of resources and open source eLearning technologies to democratize access to quality academic resources in Sub-Saharan Africa. OLT's goal is to maximize the power of technology to improve teaching and learning and increase access to education for all.

Siyavula, a new resource bank premised on the idea that each individual should have access to pedagogic support relevant to their personal learning needs. Siyavula is a collaborative project seeded by the Shuttleworth Foundation, through which educators can create, share, and adapt freely accessible and openly licensed resources that are aligned to the school mathematics and science curricula. Unlike the vast majority of material, which is under a traditional, restrictive copyright licence, Siyavula material can be adapted to ensure cultural relevance or refreshed without incurring costs.

CyberSmart Africa has developed a digital learning platform that can deliver learning resources in Sub-Saharan Africa areas that have no electricity. This works through an all-in-one mobile device that contains a solar panel, solar rechargeable batteries, a projector with interactive whiteboard capabilities, speakers powerful enough for classroom use, 3D capability, cooling fans and a dust filtration system. Developed with support from US Aid the technology which is provided with resources and teacher training has already shown signs of successful impact in classrooms in Senegal ([www.cybersmartafrica.org](http://www.cybersmartafrica.org)).

These are important initiatives. Our main argument, however, is that we now need to think about the ways in which these innovations can be assimilated into the mainstream of policy and practice. We want to suggest that coming to grips with scale is a crucial issue. For many years to come rapid, large-scale expansion of teacher education systems will be necessary. Digital technologies offer the opportunities to expand at scale whilst ensuring equitable access and engagement of teachers wherever they are located.

## **OERs and MOOCs**

Two of the most interesting developments that have arisen from the development of digital technologies are the Open Educational Resource (OER) movement and the advent of Massive Open Online Courses, commonly known as MOOCs.

The impact of OERs is growing in higher education globally. The impetus came from a project at the Massachusetts Institute of Technology (MIT) to make all course resources freely available through an Open Courseware project ([www.ocw.mit.edu](http://www.ocw.mit.edu)). This began in 2002 and now covers more than 2,000 MIT courses

In Sub-Saharan Africa there are two substantive OER initiatives that have been taken up by teacher education institutions. The first is the Teacher Education in Sub-Saharan Africa (TESSA) programme. TESSA is a consortium of universities and organizations representing more than ten countries on the continent that also draws on the technological expertise of the UK Open University. The consortium, in the early years of the century, identified the need for high quality classroom-focused resources to promote more active pedagogic approaches in the primary school sector. The consortium has subsequently developed a wide range of modular and unit-based resources addressing the key areas of the primary curriculum. All the study units involve classroom-based activities that are then monitored and assessed through a range of strategies. The TESSA model is, so far, unique in presenting the resources in multi-lingual versions: Arabic, English, French and Kiswahili (see [www.tessafrica.net](http://www.tessafrica.net)).

All these resources are freely available for use by anyone and that includes the permission to freely adapt the resources in ways necessary to the local contexts. An independent evaluation of TESSA, carried out by African experts said the following about the programme:

Interaction with, and use of, TESSA OER has had a significant impact on the identity and practices of teacher educators and a profound impact on those of teacher-learners. It has fused theory and practice; shifted perceptions from teacher as “know it all” to “teacher as facilitator of learning”; and greatly enhanced the relevance of pupils’ learning experiences. The materials have been used in creative ways to meet the real needs of teachers and learners.

TESSA is a highly successful project, achieving its aims at scale. This has immense implications and promise for all teacher education in SSA.

(Hartley & Barasa, 2012)

A second example of OERs for teacher education is the OER Africa site that is coordinated by SAIDE ([www.oerafrica.org](http://www.oerafrica.org)) A number of projects have associated OERs that are freely available. These include the following:

- The University of Fort Hare’s B Prim Ed was a high-quality programme for in-service Eastern Cape teachers that ran from 1998 to 2006. OER Africa then digitised their excellent materials and made them available online for everyone to enjoy.
- The ACEMaths Project aiming to pilot a collaborative process for the selection, adaptation and use of OER materials for teacher education programmes in South Africa.
- The SAIDE Teacher Education Series covering a range of topics central to the teacher education process.

The African Virtual University, based in Nairobi ([www.avu.org](http://www.avu.org)) has also been developing a range of teacher education resources, involving, like TESSA, a consortium of countries and institutions.

Asha Kanwar, the President of COL sees OERs as having the potential to help transform education by involving all kinds of stakeholders in participating, collaborating, creating and sharing knowledge, by encouraging consumers to become the producers of knowledge and by enabling harnessing the wealth of tacit knowledge across the globe to address the great development challenges of the age (Kanwar, 2011).

In a very short time OERs appear to have captured the imagination of educators, including teacher-educators, across the world. Systemic integration into the work of higher education and other organizations appears to be on the immediate horizon.

The second digital initiative that is relevant to teacher educators is the Massive Open Online Courses or MOOC developments. These are usually short courses using online resources and communication to meet as wide an audience as possible. Stanford University in the USA was early into MOOCs – in 2011 it offered a course on Artificial Intelligence that reached 160,000 teachers. A number of consortia, among them Future Learn ([www.futurelearn.com](http://www.futurelearn.com)), have been established to exploit the potential of MOOC. France has created an Open Classrooms site ([www.openclassrooms.com](http://www.openclassrooms.com)) to make MOOCs (mostly in French but, increasingly, other languages) accessible to all. The Open Classrooms slogan is ‘Des Professeurs brillant et des élèves géniaux’ (Bright Teachers, Great Students).

MOOCs have created considerable controversy. Detractors question quality and completion rates. Supporters point to accessibility and the sheer richness of resources available. MOOCs now come in many formats, from those with a fairly traditional teaching model to new forms of digital capabilities (Nanfuto, 2013).

Debate about MOOCs will be on-going as higher and professional education begins to integrate digital modes of working into mainstream practice. There are, as yet, few examples across higher

education or professional education in Sub-Saharan Africa (Escher et al, 2014). The African Virtual University is exploring the possibilities of MOOC developments. Some US private organizations have also begun to explore possibilities. Coursera is one of the largest and best known MOOC providers (the two others with this sort of reach are Udacity and edX) Coursera, with support from the World Bank, is planning a new pilot initiative in Tanzania to offer MOOCs as part of a broader initiative to help equip students with employment-relevant IT skills. The MOOC phenomenon is attracting considerable private investment. One report has estimated that the global market is estimated to grow from US\$ 1.83 million in 2015 to US\$ 8.5 billion by 2020, at an estimated compound growth rate of 36% (Research and Markets, 2016). Adoption of device-based computing, rapid increases in connectivity and the emergence of online and collaborative learning (including the personalization of technology) are seen as some of the prominent factors driving the adoption of MOOC platform and services.

There do appear to be important opportunities for teacher educators in the evolution of OERs and MOOCs. Teacher education, including post pre-service, operates at large scale in most education systems. A technology designed for working at scale offers the potential to reach out to teachers in ways previously not possible. In addition, a large number of online digital teacher professional development sites are emerging, sometimes involving university staff. There is some evidence that teachers are using social media, such as Facebook, for the informal exchange of ideas. There are international examples of this moving into quite elaborate structures. 'Teach Meet' in the UK is a range of informal and online meetings of teachers outside any formal governmental or regional authority jurisdiction. TeachMeet events usually have input from well-known educationalists, many of whom work in universities. EdCamps in the USA (Marcinek, 2014) represents a similar development as do the TESSA clubs at OLA College in Ghana.

There are a range of innovations close to widespread adoption that could be of great significance for teacher education. OERs now have a significant foothold in teacher education provision. MOOCs will appear soon, as they already have done in India. Key questions for policy-makers and providers follow from this. What elements in teacher education are appropriate for large-scale online provision? How are these courses mediated at the local (institutional) and school level? Does an infrastructure for course development need creating? What knowledge and skill development is necessary to put such systems into place? Do governments or regional authorities lead in the incorporation of digital technologies into large-scale teacher education provision? Or do governments/ regional authorities facilitate (through financing and regulatory flexibility) organizations such as universities, NGOs and private companies stepping up to this task? Whether the term MOOC is used or not there is the need for very large-scale programmes for teachers across most of Sub-Saharan Africa and the experience and debates around MOOCs can contribute to this process.

## **The Future of Digital Applications in Teacher Education**

In identifying trends in digital learning that could be incorporated into the design of teacher education programmes we draw on the very useful work of the New Media Consortium Horizon Report on Higher Education produced as part of the EDUCAUSE programme in 2015 (Johnson, Adams Becker, Estrada, & Freeman, 2015). The report lists a number of technologies that could have a significant impact on education generally. Six of these technologies appear to be particularly relevant to teacher education; bring your own device (BYOD), flipped classrooms, makerspaces, wearable technologies, adaptive learning technologies, and the Internet of Things.



BYOD and flipped classroom are now at the near-adoption phase. BYOD refers to the practice of people bringing their own laptops, tablet, or smart phone and connecting to the different institutional networks they use. One of the obstacles to taking up online and digital technologies has been the cost and upkeep of equipment. This is now disappearing as devices such as tablets and increasingly sophisticated mobile telephones become a part of everyone's everyday toolkit. This is true in Sub-Saharan Africa given the astonishing growth in mobile telephony. Teacher education planning and policy will be in a position to exploit these new modes of accessibility.

The flipped classroom is an application that is in the adoption phase. The aim is to shift ownership of learning from the teacher to the student. The flipped classroom uses technologies (including BYOD) to make ideas about blended and inquiry-based learning easier to implement. Essentially students study content through videos, simulations and other online multi-media resources prior to engaging in virtual or face-to-face workshops where the focus is much more on interaction with other students, debate and discussion rather than 'listening to' a tutor.

Makerspaces and wearable technologies have an adoption timeline of two to three years from 2016. In makerspaces, the worlds of design and engineering begin to have significant influence over the educational environment. Proponents of makerspaces for education highlight the benefits of engaging learners in creative, higher-order problem solving through hands-on design, construction, and iteration. New technologies such as 3D printers and 3D modeling web-based applications become part of the tool set for those working in the makerspaces. In a sense, makerspaces are a more open-ended flipped classroom. It would be possible, for example, to think about a makerspace in which science teachers, teacher educators and leading scientists collaborated to develop to develop teacher knowledge and skills.

In the two- to three-year adoption frame the possibility of incorporating wearable technology into our teaching and learning strategies can also be identified. The far too infrequent and clumsy tradition of lesson observations could be conceived in quite different terms as this technology becomes more common. These technologies could lead to a stronger and deeper discourse around practice. Ethical issues will need addressing but we are close to the point when low cost universal observation of student teachers and teachers could become commonplace.

A longer, four- to five-year time scale is envisaged for widespread adoption of adaptive learning technologies and the Internet of Things. Adaptive learning technologies refer to software and online platforms that adjust to individual students needs as they learn. Adaptive learning is a sophisticated data-driven, and in some cases non-linear, approach to instruction and remediation. It adjusts to a learner's interactions and demonstrated performance level, and subsequently anticipates what types of content and resources learners need at a specific moment in time to make progress (see <http://educationgrowthadvisors.com/gatesfoundation>).

There are two levels to adaptive learning technologies – the first platform reacts to individual user data and adapts instructional media accordingly, while the second leverages aggregate data across a large sample of learners for insights into the design and adaptation of curricula. These sophisticated technologies might have important implications for how to understand and judge quality and performance in the classroom. These technologies open up some fascinating prospects for research-focused university-school programs. If, for example, teachers had more detailed profiles of individual or group learning, the question remains how could this be pedagogically deployed.

Finally, there is the Internet of Things, a network of connected objects that link the physical world with the world of information through the web. Learners carrying such devices can benefit from a

host of inter-disciplinary information. One example is learners exploring an urban or rural landscape who could call on architectural, political, or biological lenses in order to understand what they see. The teacher in the classroom should be able to use the same technology in drawing ready-for-purpose resources for individual or collective use.

Describing such future scenarios can quickly look dated, not the least because the six overlapping technologies we have identified at this moment in time will be disrupted by interaction with each other and through the arrival of even newer applications. The point, however, is the rather simple one that the technologies now exist to fuse the worlds of university, teacher educator, teachers and schools in ways hitherto impossible. Exploiting this to give greater value to the teacher educator task seems essential. Most significantly the sort of curriculum development that would be associated with the exploitation of these new forms of technology are equally applicable in campus-based or school-based, distant provision. The evidence thus far suggests that students working through a blended online and face-to-face model are stimulated by the quality of the resources being used as well as the personal and collective autonomies that this engenders.

Take-up of these forms of technology go beyond the realm of teacher education. (See Willcox et al 2016) Innovative uses of digital learning are now widespread and, as noted already, are significantly impacting higher education and professional training in the public and private sectors. In an important sense taking the opportunities offered by blending in digital learning to teacher education is not a futuristic ambition. Many of the technologies are already there. But it does need systematic governmental and institutional planning to ensure that structures are in place, key staff well trained and resources available. At national, regional and institutional levels such planning will now need to go beyond the promulgation of new technology policy statements (of which there are many) to more detailed and creative mapping out of new modes of provision. This will almost certainly require more collaboration between the different levels of government and the different types of teacher education provider than has hitherto been the case.

## **Phasing in Digital Reforms to Teacher Education**

Below we suggest three phases of adoption of digital learning in teacher education that are likely to occur. These are generic phases that will certainly vary from one context to another. They could function, however, as markers for policy development at national, regional or institutional levels within any education system:

- Phase 1: teacher education systems as they are today with some digital development.
- Phase 2: full exploitation of existing technologies when access becomes nearly universal.
- Phase 3: incorporation of a future range of digital affordances relevant to teacher education.

It is important to note that each of these levels envisages some form of hub and network structure through which these new models would function. Such hubs in one sense already exist. A university, a regional education authority and some private companies are playing such a role in terms of surrounding schools and teachers. In this context, however, a hub becomes a much more explicit part of any digital network. The hub might manage different forums supporting the exchange of ideas, it might act as the repository of pre-selected OERs or showcase the way local teachers have produced new resources or re-interpreted existing OERs. There will be more than one model of how a hub would function or facilitate but it would be essential to allowing the network to become established and evolve (Anamuah-Mensah, Banks, Moon, & Wolfenden, 2013).

### **Phase 1: 2016-20**

For campus-based pre-service courses it is now possible to envisage that in most contexts students will have access to online resources and digital communications. The planned integration of good quality OERs (such as TESSA or OER Africa) could enrich teaching, particularly that focused on practical classroom understanding. Such resources could also be used for structured practicum activities.

The use of online forums to promote the exchange of ideas can be encouraged. Some institutions will incorporate online reporting of student projects and research into course provision. There may also be opportunities for providing tutor to mentor/supervising teacher communication through email or other forms of digital communications (Facebook for example).

### **Phase 2: 2018-2022**

For campus-based provision, the main gains from Phase 1 will be online access to students and teachers in schools; the opportunity will now exist for rethinking practice supervision. Although some personal visits will continue, digital observations and digital collaboration with school mentors will be possible.

For school-based programmes, universal access offers significant advantages in terms of potential scale of take up and quality of provision; teachers following upgrading courses will have full access to a range of OERs that providers (or providing 'hubs') will organize. There is a range of topics in teacher education that might be taught through international MOOC-style provision (examples might include the mathematics or science subject content knowledge required by primary teachers). The teachers following these upgrading courses could have access to the forums and resources created for students in the campus-based model; with universal access it is possible to envisage the building of a shared virtual resource centre serving campus and school-based programmes

### **Phase 3: 2020 Onwards**

Phase 3 builds on the systems and structures of Phase 2 but integrates new applications into the educating and training processes. In this scenario all students and teachers will have their own devices and broadband access. Wearable technology will permit practice observation to take place at any time. There will inevitably be concerns about 'spy in the cab' type of privacy intrusions. New protocols will need to be developed with appropriate consultation. The use of flipped classrooms will become commonplace. In teacher education programmes it might be possible to imagine a virtual group of campus-based pre-service students and some serving teachers in upgrading or CPD programmes. Tutors working across the programme might have identified a task, issue or problem (examples could include the achievements of girls in lower secondary mathematics or the parental role in learning to read at the primary phase). Students and teachers study a range of online resources prior to becoming involved in discussions that lead to some investigatory activities at the school level

### **Building a Research Agenda around New Modes of Teacher Education**

The development of digital technologies in teacher education, particularly the potential to scale up and improve the quality of education and training, provides fascinating opportunities for the researcher and evaluator:

- How does teacher education sit within the national and local systems of education? What are the determinants that impact teacher education? How do they relate to each other? What structure of determinants seems most likely to prove effective?
- How is it possible to ascertain and monitor effectively the flow of need for pre-service and upgrading programmes? What balance of provision would give a guarantee of education and training for all teachers?
- What is the scale of need for effective CPD programmes; how could this realistically be provided and who should do so? Is there a need for a stronger role for public and private universities in the professional development of teachers and how might universities provide for this?
- What are the varying profiles of teachers needing to go through upgrading programmes? What is their prior experience?
- How can teacher educators make their pedagogic practice more effective in providing digitally enhanced programmes. What are the future education and training needs for teacher educators?
- Can we monitor the progress of students and teachers to having universal broadband access? What are the barriers and how can these be overcome?
- What governance structures, at all levels, effectively encourage the move to universal access?
- What governance structures at all levels promote equitable access to education and training for teachers?
- What are the most effective combination of elements in blended programmes of pre-service, upgrading and CPD? How are digital technologies effectively integrated into such programmes?
- How are OERs best created for teacher education programmes? What are the means by which OERs might be versioned for local context? What contribution can the private sector make?
- How effective are MOOCs within teacher education programmes?
- Within blended programs of teacher education what are the most effective combinations of school-based, online and personal tutor visit support? What are the implications for costs and administration of alternative scenario support?
- Is it possible to develop research and development instruments that robustly trace the impact of CPD on learner rather than teacher outcomes?
- How can programmes successfully help promote the professional values in teachers that would indicate a purposeful and effective education system?

This set of questions is illustrative of the sort of profile that could be given to research and evaluation around new modes of teacher education. There has been work in this area but it dates quickly and research projects rarely show any progression in creating new knowledge and understanding. There is perhaps a need for legitimate organizations to take a lead in mapping out the field and overseeing research progress. The newly established African Deans of Education Forum (ADEF) might have a role, as would international organizations such as the World Bank, COL and the international aid agencies. The UNESCO Task Force on Teachers could give a stronger focus to this. The Sustainable Development Goals (particularly SDG 4 C) seek to encourage international cooperation around

teacher supply and education. The reform of policy and practice in all forms of teacher education must surely be a priority? Embracing digital technologies and drawing on the experience in higher education generally ought, we feel, to be central to this process.

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