Technology based learning – an international perspective: development and evaluation of resources for health workers in sub-Saharan Africa

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by

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Abstract

Technology based learning – an international perspective: development and evaluation of resources for health workers in sub-Saharan Africa

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Introduction:
E-learning is a familiar feature of health worker education in developed countries and there is interest in its use in developing regions, including sub-Saharan Africa, to overcome health workers’ lack of access to information, learning and professional development opportunities. However, there is limited evidence to guide such developments. The issues are complex, more so due to the size and diversity of sub-Saharan Africa and its health workforce, and rapid technological progress.

Objectives:

- Understand issues affecting the development and implementation of e-learning for health workers in sub-Saharan Africa.
- Develop and pilot an e-learning resource in eye health.
- Evaluate its impact on clinical skills.

Methods:
Qualitative and quantitative methods were used to explore issues including infrastructure, skills, health systems, learners’ needs and preferences related to e-learning design, development and implementation. This was integrated with evidence from a study of patients’ journeys of care to develop a novel e-learning resource in eye health using a quality improvement approach. After piloting, the impact on medical students’ clinical skills was assessed using a ‘low stakes’ Objective Structured Clinical Examination in a randomised trial.

Results:
A holistic view of the current situation related to e-learning in sub-Saharan Africa was achieved. Piloting of the resource confirmed its broad acceptability and gave recommendations for final refinements and implementation. In the trial setting, students exposed to the resource demonstrated better clinical skills (mean scores: 71.6% and 68.4%, (p=0.048); pass rate 90.0% vs 64.5% (p = 0.032) with significant improvements for ‘differential diagnosis’ and ‘making a management plan’.

Conclusions:
E-learning can be successfully applied in sub-Saharan Africa and a quality improvement approach integrating research with resource development is proposed. From this experience, an algorithm for e-learning development is presented.
Acknowledgements and declaration

I declare the content of this thesis to be my own work, aside from the contributions listed below. I am extremely grateful to those who have helped, in various ways, with the work.

- **Chapter 4**: assistance with questionnaire collection was provided by Drs Caroline Williams¹, Sarah Yacomeni¹ and Emma Williams¹ (in the UK) and Dr Fiona Cresswell¹, Mr Ali Omar² and Mr Ali Rajab² (in Tanzania). KiSwahili translation of the questionnaire was undertaken by Mr Omar, Mr Rajab and Mrs Zainab Othman². Dr Emma Pitchforth³ provided support with the thematic analysis. Statistical advice was provided by Dr Jon Bankart¹.

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<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CD-ROM</td>
<td>Compact Disc - Read Only Memory</td>
</tr>
<tr>
<td>CME</td>
<td>Continuing Medical Education</td>
</tr>
<tr>
<td>COECSA</td>
<td>College of Ophthalmology of Eastern, Central and Southern Africa</td>
</tr>
<tr>
<td>CPD</td>
<td>Continuous Professional Development</td>
</tr>
<tr>
<td>DFID</td>
<td>Department for International Development (UK Government)</td>
</tr>
<tr>
<td>DVD</td>
<td>Digital Versatile Disc</td>
</tr>
<tr>
<td>DVD-ROM</td>
<td>Digital Versatile Disc - Read Only Memory</td>
</tr>
<tr>
<td>EACO</td>
<td>East Africa College of Ophthalmologists</td>
</tr>
<tr>
<td>ERIC</td>
<td>Education Resources Information Centre</td>
</tr>
<tr>
<td>GMC</td>
<td>General Medical Council</td>
</tr>
<tr>
<td>HIFA</td>
<td>Health Information for All</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
</tr>
<tr>
<td>IAPB</td>
<td>International Agency for Prevention of Blindness</td>
</tr>
<tr>
<td>ICO</td>
<td>International Council of Ophthalmology</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
</tr>
<tr>
<td>ITU</td>
<td>International Telecommunications Union</td>
</tr>
<tr>
<td>JCAHPO</td>
<td>Joint Commission on Allied Health Personnel in Ophthalmology</td>
</tr>
<tr>
<td>KCCO</td>
<td>Kilimanjaro Centre for Community Ophthalmology</td>
</tr>
<tr>
<td>KCMC</td>
<td>Kilimanjaro Christian Medical Centre</td>
</tr>
<tr>
<td>MDG</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>MOOC</td>
<td>Massive Open Online Course</td>
</tr>
<tr>
<td>MRCP</td>
<td>Membership of the Royal College of Physicians</td>
</tr>
<tr>
<td>OA</td>
<td>Ophthalmic Assistant</td>
</tr>
<tr>
<td>OCO</td>
<td>Ophthalmic Clinical Officer</td>
</tr>
<tr>
<td>OSCE</td>
<td>Objective Structured Clinical Examination</td>
</tr>
<tr>
<td>OSEA</td>
<td>Ophthalmic Society of East Africa</td>
</tr>
<tr>
<td>OTN</td>
<td>Ophthalmic Theatre Nurse</td>
</tr>
<tr>
<td>PACES</td>
<td>Practical Assessment of Clinical Examination Skills</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
</tr>
<tr>
<td>PDSA</td>
<td>Plan-Do-Study-Act</td>
</tr>
<tr>
<td>RCOphth</td>
<td>Royal College of Ophthalmologists</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomised Controlled Trial</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>--------------</td>
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<tr>
<td>SAFE</td>
<td>Surgery, Antibiotics, Facial and Environmental Hygiene</td>
</tr>
<tr>
<td>SDG</td>
<td>Sustainable Development Goals</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
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<td>UN</td>
<td>United Nations</td>
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<td>US</td>
<td>United States</td>
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<td>USA</td>
<td>United States of America</td>
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<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
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Publications, abstracts and presentations

Publications


Williams CD, Pitchforth E, O’Callaghan C. Computers, the internet and medical education in Africa. Medical Education. 2010;44:485-488


Abstracts related to this work


Maps of study area

Map (i): Political Map of Africa (showing Uganda and Tanzania, the countries in which field work was undertaken).\(^1\)
Map (ii): Political Map of Tanzania.
Map (iii): Political Map of Uganda.3 Since this map was drawn, Southern Sudan has been recognized internationally as an independent state (although its northern border with Sudan is still disputed – see map (i)).
1.1 Introduction

This review gives an overview of existing knowledge related to health worker education, access to information and information and communications technology (ICT) and the development and evaluation of e-learning in the context of sub-Saharan Africa. The scope is deliberately broad to reflect the importance of the context in which health workers practice and learn, the major themes in global health policy which influence them and the range of educational theory and methodological approaches that can be applied in this field of study. Relevant research from other developing regions is presented; and comparisons made with more economically developed countries (specifically the UK) to provide contrasts, highlight themes which are likely to impact on sub-Saharan Africa and underpin the comparative work presented in chapter 4.

The review is presented in seven themes:-

- Health and healthcare delivery,
- Use of technology,
- Insights from the educational literature,
- E-learning and educational technology,
- Health information and other learning opportunities,
- Quality improvement approaches,
- Research and evaluation in health worker education.

A summary, drawing together these themes, closes the chapter. Insights from this literature review, triangulated with the original research in chapter 3-5 are synthesised in chapter 6.
1.2 Methods

This is a narrative desk review of literature obtained from searches of medical, psychological and educational databases (MEDLINE, PsycINFO, PUBMED, Educational Resources Information Centre (ERIC), SCOPUS and Google Scholar), searches of institutional websites (World Health Organisation (WHO), United Nations (UN), World Bank, International Telecommunications Union (ITU), UK Department for International Development (DFID) and Health Information for All (HIFA)) for relevant ‘grey’ literature (unpublished, non-peer reviewed papers (such as policy and discussion papers) from the government and non-governmental sectors). Literature searches were originally performed in 2009 (excluding Google Scholar) and regularly updated until 2015 to capture more recent literature. Initial literature searches were performed for each of the themes listed in section 1.1. The process was iterative so that, when a further theme was identified from these primary searches, further specific searches were performed to provide additional depth (e.g. literature on the health workforce crisis prompted further searches on health worker productivity and motivation). Additional literature was identified by discussion with colleagues and other researchers.

1.3 Health and healthcare delivery

E-learning materials are developed in the broader context of health needs and health service delivery. This section reviews the literature on disease burden, global health and development policy, health systems and human resources for health in sub-Saharan Africa. These issues form the context in which educational initiatives (including e-learning) can be used.
1.3.1 Global Health Challenges

1.3.1.1 Disease burden

Health services in sub-Saharan Africa face a dramatic challenge. The Global Burden of Disease Study (2010) and other reports highlight the scale of mortality, morbidity, loss of economic output and health service utilisation in the region:

- 76% of deaths in sub-Saharan Africa are attributable to communicable, nutritional, maternal and neonatal disease, underpinned by poverty and a lack of access to clean water and sanitation.
- HIV remains the leading cause of years of life lost and places a significant strain on health services and communities.
- A rising burden of non-communicable ('emerging') diseases (such as diabetes and cardiovascular disease) is also reported, underpinned by lifestyle, smoking and dietary changes amongst sections of the population; and presenting new challenges for health services in terms of prevention, chronic disease management and managing disability.

Further challenges are anticipated: population growth and ageing, climate change, desertification, antimicrobial resistance, and economic and political instability are all potential contributors. Epidemics (such as the recent Ebola outbreak in West Africa) and natural disasters place further strain on health services with limited capacity to plan and respond effectively. These issues reflect the likely priorities for health worker education in coming years.
1.3.1.2 Global health and development policy

In the aftermath of World War II, the United Nations (UN) Declaration of Human Rights (1948) enshrined:-

‘the right to a standard of living adequate for the health and well-being... including food, clothing, housing and medical care’.20

The political, philosophical and practical debate about how to address health and development for the world’s poor has continued ever since. This has culminated most recently in the United Nations Millennium Declaration21 and the Millennium Development Goals (MDGs), setting ambitious goals and targets for global health, education, development and poverty reduction to be achieved by 2015.21

Six MDG pledges are specifically health-related:22

- **Goal 1:** Eradicate extreme poverty and hunger
  (with targets on undernutrition and underweight children).
- **Goal 2:** Ensure environmental sustainability
  (with targets on access to water and sanitation).
- **Goal 4:** Reduce child mortality.
- **Goal 5:** Improve maternal health.
- **Goal 6:** Combat HIV/AIDS, malaria and other diseases.
- **Goal 8:** Develop a global partnership for development
  (with targets on sustainable access to affordable drugs).

The most recent MDG progress reports suggest that sub-Saharan Africa is unlikely to meet many of these goals and targets23 although it is argued that significant progress has been made in a number of areas.24 (Indeed, it may not even be possible to gather accurate data upon which to base such judgements).25 The debate about how policy will develop when the MDGs mature at the end 2015 is already underway26 including a
series of proposed Sustainable Development Goals developed by a working group of the UN General Assembly.\textsuperscript{27}

This policy framework shapes health workers’ practice and underpins investment by governments and donor bodies. Educational interventions need to recognise (and where appropriate, align) with this broader policy approach.

\textbf{1.3.1.3 Comprehensive and selective healthcare provision}

A central policy issue relates to how health services are provided within communities. This is relevant to educational interventions as it impacts their content, delivery and underlying philosophy.

In the immediate post-colonial era (1950s and 1960s), it was increasingly recognised that colonial health systems did not respond adequately to the needs of communities. This led to growing interest in more comprehensive, community-based approaches to health.\textsuperscript{28} This culminated in the Declaration of Alma-Ata (1978) which set out a vision of universal primary care, advocating a holistic and comprehensive approach to healthcare with health as a fundamental human right, and highlighting the importance of preventative health, responsiveness to local needs, community involvement, sustainability, social justice and international co-operation.\textsuperscript{29}

However, the practicality of this comprehensive approach was quickly challenged; and a more selective approach advocated in the interests of making efficient use of limited funds, targeting specific diseases based on prevalence, health impact and availability of effective and affordable treatment.\textsuperscript{28,30,31} Two competing approaches therefore emerged, with different strengths and weaknesses, summarised in table 1a.\textsuperscript{28,31-37}
<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Comprehensive</td>
<td>Holistic care, based on needs identified by the community and provided with their full participation.</td>
<td>Difficult to measure/monitor success as a lever to donor support.</td>
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<tr>
<td><em>(horizontal, <em>bottom-up</em>)</em></td>
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<tr>
<td>Selective</td>
<td>Focus on evidence-based interventions for priority diseases, rapidly scalable, enables training, development and support for specific activities, measurable impacts.</td>
<td>Neglects local health priorities, removes decision-making from communities, does not specifically invest in infrastructure and human resources, risks pulling health workers in conflicting directions and reduces their autonomy to respond to local needs.</td>
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<tr>
<td><em>(vertical, <em>top-down</em>)</em></td>
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**Table 1a:** Comparing the advantages and disadvantages of comprehensive and selective healthcare provision in resource poor countries

Selective approaches were initially intended only as an interim step towards comprehensive health care, but this was quickly overtaken by political and economic considerations; and by the need to respond to the emergence of HIV/AIDS in the 1980s. As a result, despite evidence that health systems based on the primary health care approach deliver better outcomes, cost-effectiveness and patient satisfaction, there has been significant donor investment in disease-specific programmes and research has also tended to coalesce around disease- and intervention-specific foci. Indeed, a common criticism of the MDGs is their vertical focus. Furthermore, many vertical programmes use locally based health workers for delivery. This pulls health workers in conflicting directions, and reduces their autonomy to respond to the needs of the local community.

Recently, there has been renewed interest in the comprehensive primary care approach, driven by factors including the emergence of non-communicable diseases, evidence of health systems weaknesses, the development of community based health workers and a perception of limited progress towards achieving the MDGs through vertical programmes. There is also interest in bringing together the strengths of both approaches; including the development of ‘clusters’ of effective interventions for specific patient groups through programmes such as
WHO Integrated Management of Childhood Illness. In the context of e-learning, the outcome of this debate will shape the delivery of healthcare and, hence, the learning needs of health workers and the structure within which educational interventions are provided.

1.3.2 Health Systems

1.3.2.1 Definition

Health systems have been defined to include

‘all actors, organizations, institutions and resources whose primary purpose is to improve health’ and ‘to carry out four interlinked key functions: resource generation (investment and training), financing (collecting, pooling and purchasing), service delivery and stewardship (oversight).’

In the context of health systems, health worker education is a key responsibility of the health system and educational content should be relevant and responsive to the needs of the health system as a whole.

1.3.2.2 Health systems in sub-Saharan Africa

The state of health systems in sub-Saharan Africa is widely cited as a barrier to health, and to the achievement of the MDGs. Alongside a range of issues related to the front line health workforce (described in section 1.3.3), constraints have been identified at all levels of the health system, including:

- community awareness of health issues,
- accessibility of health services,
- supply of drugs and equipment,
• bureaucracy,
• corruption,
• weak leadership and planning.⁸,⁴⁹,⁵⁰

In developing educational interventions, it is necessary to be mindful of these weaknesses and the overall fragility of health systems; and to consider how educational interventions fit within this broader context and can contribute to wider health systems strengthening.

1.3.2.3 Healthcare providers

Health workers operate and receive educational input within a range of provider organisations (broadly ‘governmental’, ‘private’ and ‘private-not-for-profit’), each with its distinct ethos and culture. In addition to these ‘formal’ providers, sub-Saharan Africa has a large, broad ‘informal’ sector of traditional healers and unregulated private clinics. More information about these providers is given in table 1b.

The growth in the private and informal sector in sub-Saharan Africa has the potential to improve access to healthcare⁵¹,⁵² but also represents a regulatory challenge⁴⁷,⁵³,⁵⁴ and raises political and philosophical questions about how health services should be delivered.⁵⁵ There is particular debate about how informal providers should be integrated with the wider health system and hence given greater recognition, training and support to improve the quality of their services;⁵³,⁵⁶,⁵⁷ although such integration may be a difficult step for philosophical, legal and regulatory reasons.⁵⁵ Developing educational opportunities for these informal providers would be an important part of such a strategy to formally recognise and develop these informal providers.
Government

All publicly run health facilities, although countries vary in how institutions are funded: with free-access, user fee and (less commonly) insurance based models operating in different countries.\textsuperscript{49,52,58,59}

Problems reported in government facilities include a lack of staff, drugs and facilities, poor accessibility and informal payments to health workers.\textsuperscript{49,50,60}

Private

A range of organisations – large and small – run on a commercial basis by companies, groups of professionals and individuals.\textsuperscript{53}

Private providers have increased in prevalence in recent years, due to rising incomes and the limited capacity of government services to meet expectations.\textsuperscript{49} Private provision can result in a lack of preventative focus; and financially motivated over- and under-treatment.\textsuperscript{50-52}

Private not-for-profit

Non-governmental, missionary and other charitable organisations providing services on a ‘not-for-profit’ basis\textsuperscript{59,61-63} including small-scale insurance based services.\textsuperscript{64}

Informal

A wide-range of providers such as drug sellers, traditional healers and unregistered private clinics. These practitioners lack formal training, registration and regulation and generally take payment for services directly from patients.\textsuperscript{65}

Informal providers are more accessible and hospitable than formal health services, especially in poor communities\textsuperscript{11,47,51,53,55,65} although concerns about quality of care (including the illegal sale of prescription medicines by drug-sellers) are highlighted.\textsuperscript{65}

<table>
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<tr>
<th>Table 1b: Providers of health services in sub-Saharan Africa</th>
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There are also many links between the private, government and private-not-for-profit sectors: many government and private-not-for-profit hospitals operate private wards; and health workers often combine work in the government or not-for-profit sector with private activities (sometimes at the expense of their government work).\textsuperscript{47,53} The significant influence of private and non-governmental providers, in attracting health workers away from the public sector and rural areas towards towns and cities\textsuperscript{66-71} and its impact on the design and implementation of educational interventions, is discussed below.
1.3.3 The Health Workforce

WHO highlights the fundamental importance of human resources within the health system and defines human resources for health as:-

‘the different kinds of clinical and non-clinical staff who make each individual and public health intervention happen.’

1.3.3.1 Health workforce crisis

The dramatic shortage of health professionals in sub-Saharan Africa has been termed the ‘Health Workforce Crisis’. In 2006, it was estimated that 36 of 46 countries across Africa faced shortages of doctors, nurses and midwives totalling 817,992 workers. In sub-Saharan Africa alone, a total shortfall of 792,000 has been projected for 2015 (based on similar assumptions) with shortages in 31 of 39 countries. To meet this demand would require a 140% increase over current health worker numbers.

Three broad areas of action have been proposed in response to the crisis:

- Building training capacity (including developing the appropriate skill-mix),
- Improving productivity,
- Preventing attrition.

Educational interventions are relevant to all three strands of this strategy.
Building training capacity

Training capacity can be developed either by expanding existing institutions or establishing new institutions.72 Both approaches have budgetary, infra-structure and teaching capacity implications; and it is necessary to consider the quality of training as well as the number of trainees.74 E-learning and technology are felt by many training institutions to have a role in building training capacity48 although a note of caution is sounded about a lack of infra-structure75 and limited evidence of effectiveness.48

Attention is also needed to the overall skill mix of the health workforce.66,74,76 Some have proposed a shift from training doctors towards a greater proportion of nursing/midwifery cadres on grounds of cost-effectiveness77 and this is part of a wider debate on ‘task-shifting’ and developing new cadres of health worker, discussed below. Developing educational materials which are appropriate in the context of task-shifting and new cadres is important.

Medical training

In 2010, 169 medical schools were identified across sub-Saharan Africa, producing 10,000 -11,000 graduates per year. Class sizes are typically smaller than in other regions, with 39% of schools having annual class sizes of 100 or less.74

- Small class sizes suggest that there is scope for expansion within existing medical schools.78 Indeed, this is already taking place: 76% of schools report that they have expanded training places within the last five years and 45% report that they plan to do so within the next five years.75

- The number of institutions is also expanding, with 33 new medical schools established in sub-Saharan Africa between 2000-2009, including 13 private institutions (of which 6 are private-for-profit).75,78 The growth of private institutions brings new focus to the challenges of governance and accreditation.79
E-learning may be a useful means of improving the quality of education as institutions enlarge and teacher/student ratios increase.

**Nursing and midwifery training**

26,000 nurses and midwives were trained in sub-Saharan Africa in 2008\(^7\) (insufficient to replace the number leaving the professions);\(^7\) and an estimated 288 schools of nursing and midwifery were operating in sub-Saharan Africa in 2006 (although this is based on incomplete data and seems very likely to be an under-estimate).\(^7\)

**Task shifting and sharing**

Task shifting/sharing is defined as

>‘delegating tasks to existing or new cadres with either less training or narrowly tailored training.’\(^8\)

This approach has been widely adopted as a response to health worker shortages in sub-Saharan Africa. Task shifting can involve the movement of tasks:-

- **from more to less specialised members of the same cadre** (e.g. from specialist physicians to general practitioners),
- **from one cadre to another** (e.g. from doctor to nurse),
- **from a traditional cadre** (e.g. doctor, nurse, midwife) to a **new cadre** (see below),
- **from a qualified health worker to a trained lay-person** (e.g. from a nurse to a community health worker (see below)),
- **from trained workers to patients and the community.**\(^7,8\)
The alternative term – ‘task sharing’ - emphasises the need for mutual support amongst cadres within the health system\textsuperscript{79,84} although professional resistance to task-shifting from existing professional cadres is well-recognised.\textsuperscript{72,85,86}

Examples of task-shifting are reported in many areas of practice, including anti-retroviral treatment for HIV and maternal, child and infant health.\textsuperscript{7,50,83,87-90}
Proponents argue that, as well as being a short-term ‘crisis’ solution, task shifting has the potential to bring about greater community empowerment and revive primary health care services.\textsuperscript{44,82} Challenges include ensuring appropriate training, supervision, management and policy recognition; legislative constraints and obtaining better evidence of effectiveness and impact in terms of quality of care, cost and patient outcomes.\textsuperscript{50,70,72,80,84,89,91,92}

\textit{Developing new cadres}

One example of ‘task-shifting’ is the development of new cadres of locally qualified health workers, known as ‘mid-level health workers’ (or (perhaps inappropriately) ‘substitute’ health workers).\textsuperscript{82,85} These are:-

\begin{quote}

‘health cadres who have been trained for shorter periods, require lower entry educational qualifications, to whom are delegated functions and tasks normally performed by more established health professionals with higher qualifications.’ \textsuperscript{85}

\end{quote}

Whilst ‘mid-level’ workers are not new, with examples dating back at least 35 years,\textsuperscript{93} there has been a recent increased drive to develop these cadres.\textsuperscript{85} In many cases, mid-level health workers work independently (unsupervised by traditional cadres).\textsuperscript{89,94}

Mid-level cadres have typically developed at Individual country level so that qualifications and experience are only recognised within a specific country.\textsuperscript{89,94} One potential advantage of this approach is that they are less internationally mobile and
their skills therefore more likely to be retained within country. This also means that nomenclature varies so that different levels of seniority are implied by the same job-title in different countries.

Recent studies highlight the potential of mid-level workers to perform at similar levels to traditional cadres in areas including HIV, obstetric care, child health and mental health, and to increase the efficiency of health service delivery, although there are competing reports of unsatisfactory performance attributed to deficiencies in training, supervision and human resource management.

There is consensus that, where they are used, mid-level workers need learning opportunities and supervision, to allow them to function effectively.

**Deputisation**

Shortages of health workers and staff absence lead to informal ‘acting upwards’ whereby staff (such as nursing auxiliaries) undertake tasks for which they are not trained or qualified. This has been reported from Uganda, Tanzania and Malawi and highlighted by WHO in the context of maternal and newborn health. This practice is not officially endorsed, recognised or regulated but these unqualified staff perceive that they have a role in ‘coping’ within a fragile health system and it seems likely that ‘deputisation’ is a widespread phenomenon.

From an educational perspective, these unqualified staff are keen to receive more training to help them undertake their ‘deputising’ role; although similarly to informal providers (see section 1.3.2.3), there is debate about the extent to which such informal deputisation should be recognised within the health system.
Improving productivity

Productivity is defined as:-

‘Producing the maximum effective health services and health outcomes possible, given the existing stock of health workers; reducing waste of staff time or skills.’

Productivity has a significant impact on overall health system performance with widespread evidence of sub-optimal productivity amongst health workers in sub-Saharan Africa:-

- in rural dispensaries and health centres in southern Tanzania, nurses were estimated to be productive for 59% of their time, with absentee rates of 39% and 44% for clinical and nursing staff respectively;
- another study from Tanzania (across urban and rural areas) gave an average productivity of 58% (with only 38% of time spent on patient care);
- in rural health units in Cameroon, only 27% of health workers’ time was spent on productive, health related activities.

Productivity can be conceptualised in terms of:-

- ‘staff productivity’
  (the proportion of time spent on service related activities),
- ‘service productivity’
  (the proportion of productive time spent on priority tasks).

This highlights the importance of ensuring both that health workers are engaged in service-related activities, and that this activity is prioritised and focused appropriately. Reports of absenteeism, unexplained breaks and waiting for patients contribute to reduced ‘staff productivity’; whilst inappropriate use of clinical staff for non-clinical
duties (such as report writing, administration and collection of equipment)\textsuperscript{63,86} reduces ‘service’ productivity.

Productivity gains could partially offset health worker shortages in sub-Saharan Africa.\textsuperscript{63,72} For example, ambitious but realistic reforms in Tanzania have the potential to increase staff productivity to 67\% and service productivity to 80\%.\textsuperscript{109} Other reports have estimated potential staff-productivity gains of 26\% (in Tanzania) and 35\% (in Chad).\textsuperscript{63,107}

Many influences on health worker productivity have been reported and these can be divided into three broad groups.

- knowledge and skills,
- motivation, and
- work environment.\textsuperscript{92}

These factors are influenced by ‘levers’, some of which are amenable to e-learning and other educational interventions. These levers relate to the job itself (e.g. effective supervision (see below)), support system (e.g. access to information and communication) and work environment (e.g. promoting lifelong learning).\textsuperscript{72}

Studies of productivity also highlight potential pitfalls in implementing educational interventions: staff training is a common reason for absence from duty (accounting for 46\% of absence for clinical staff and 33\% for nursing staff in a study from Tanzania);\textsuperscript{63} educational programmes for health workers are often poorly co-ordinated and this increases the workload for remaining staff;\textsuperscript{86,104} and providing training without follow-up has only a limited effect on quality of care and productivity.\textsuperscript{110} These issues provide a challenge to those developing and implementing educational interventions.
**Supervision**

Despite acceptance that supervision can improve productivity,\(^{72,87,110-112}\) the quality of health worker supervision in sub-Saharan Africa is often poor\(^ {63,92,103,113}\) and there is limited evidence to guide the development of effective supervision programmes.\(^ {91,114}\)

Common criticisms of current methods of supervision include infrequent visits, unhelpful focus on data gathering and an unsupportive, disrespectful or unsympathetic approach from supervisors.\(^ {63,91,92,102,104}\) Cultural factors also influence engagement, with some health workers in Tanzania, for example, believing that supervision is for ‘weaker’ staff.\(^ {115}\) Effective supervision should be a regular occurrence and provided in a respectful and ‘supportive’ manner allowing opportunity for listening, problem solving and feedback.\(^ {48,72,87,112}\)

Continuing education and professional development are important aspects of supervision, but is more effective when it is:-

- interactive,
- focused on specific, real-life problems, and
- delivered using multiple methods.\(^ {72,111,112}\)

It has been argued that technology provides a possible tool to support supervision programmes.\(^ {48,57}\) However, this needs to be tailored to reflect the work situation, background of the health workers involved, cultural beliefs and previous experience.\(^ {91,111}\) Several authors have argued that education needs to be combined with other supervision strategies to improve long term effectiveness: including addressing occupational safety (reducing accidents and injuries), strengthening health systems and improving communication.\(^ {57,86,92,112}\)
Motivation and the ‘know-do’ gap

Health worker motivation is closely linked to productivity; and de-motivation is a common finding amongst the health workforce in sub-Saharan Africa. Studies from Tanzania, Malawi and Ethiopia link de-motivation to workload; staff shortages; lack of opportunities for development, professional exchange and supportive supervision; low accountability; perceived lack of transparency in employment practices; discriminatory remuneration; poor relationships with colleagues and managers; and a lack of respect from the community. Poor motivation leads to apathy and attrition.

An important educational consequence of de-motivation is the discrepancy – called the ‘know-do gap’ – between what health workers ‘can-do’ and what they ‘will-do’; so that, even if they are trained and competent, health workers do not change their real-life practice or take on new responsibilities.

This phenomenon helps to explain a lack of behaviour change after training: in Ghana, a study of antimalarial prescribing showed that that training did improve knowledge but that prescribing behaviour was more difficult to change. Contributing factors included the motivational issues described above; and also patient demand for inappropriate treatment, presentation with multiple complaints, diagnostic uncertainty and fear that patients will not attend for follow-up if treatment failed.

Motivation and education therefore interact in at least two ways:

- through the know-do gap, de-motivation may limit the impact of educational interventions in terms of behaviour change.
- educational interventions may improve motivation through professional development.
**Preventing attrition**

Attrition is the temporary or permanent loss of health workers through factors such as death, ill-health, migration, retirement or movement to a job outside of the health sector. Health worker migration is a significant factor underpinning human resources crisis.\(^{67,72,121-123}\)

**Death and ill-health**

Health workers are not immune to the illnesses that affect the populations they serve. Significant numbers are living with conditions such as HIV and tuberculosis\(^{72,86}\) which impact their ability to perform their role. This sobering fact highlights the need for educational interventions to be delivered in a way that is sympathetic to the pressures faced by health workers and the broad need for a supportive and flexible approach.

**Health worker migration**

The most familiar and widely discussed migration issue is the ‘brain drain’ of health workers with internationally recognised qualifications (such as doctors and nurses) to more developed regions.\(^{56,75,78,124}\) The scale of migration and the associated economic cost are significant:

- A crude average ‘best-estimate’ from medical schools (in the absence of more reliable data) suggests that around 26% of doctors in sub-Saharan Africa emigrate.\(^{78}\)
• Economically, the cost of training from primary school to university in Kenya is estimated to be approximately US$43,180 for nurses and US$65,997 for doctors; and the economic loss to the country from migration is estimated to be between US$32,926 for each nurse and US$101,440 for each doctor. Other studies give even higher estimates and also highlight the less tangible cost of the loss of health workers as participants in the host country’s economic, political and community life (for example, as tax payers, leaders, teachers and role models).

A ‘brain drain’ also operates within countries, pulling health workers away from the public sector and remote areas, towards private and non-governmental positions and larger towns and cities.:

• A 2010 study of doctors qualifying in Mozambique between 1980 and 2006, showed that 25.5% worked outside the public sector, of whom 62.4% had remained within Mozambique employed by NGOs or other donor bodies (87.6%) or in the private sector (12.4%). 28.9% of doctors were primarily involved in non-clinical work and 49.4% worked in the capital city.

• A 2010 study of medical schools in sub-Saharan Africa estimated that 53% of doctors work in urban areas with only 13% in rural settings (although systems for tracking graduates are limited), a figure which is consistent with other studies.

Economic reasons are commonly cited as the reason for health worker migration, with ‘push’ and ‘pull’ effects away from areas with poor wages to those with better opportunities. However, there are other contributors, including job related frustrations (shortages of equipment, dangerous working conditions and outdated equipment) and a lack of recognition and opportunities for professional development.
These non-economic factors suggest a possible role for educational interventions, including strengthening training and professional development.\textsuperscript{57,109,128} There have also been calls for innovative approaches to training and development in rural areas (such as distance learning using technology) which can be accessed by health workers in the places where they live and work.\textsuperscript{66,72,129}

\section*{1.3.4 International comparisons}

Selected international comparisons of disease burden and health policy are presented here, to provide a contrast with sub-Saharan Africa and highlight some important themes which are likely to impact increasingly on sub-Saharan Africa in coming years.

\subsection*{1.3.4.1 Demographic shift}

For the UK and most other regions (both developed and developing), demographic shift (increasing life-expectancy and a growing population of frail, older people with long-term health conditions, continuing care needs and functional impairment)\textsuperscript{4} presents an emerging challenge to health services, requiring new approaches to delivering health care with an impact on the training and professional development needs of professionals.\textsuperscript{130-132}

\subsection*{1.3.4.2 Evidence-based medicine}

Evidence-based medicine (clinical practice based on scientific evidence of efficacy) has produced a profound change in the practice of healthcare in recent decades,\textsuperscript{133} with an increasing need for access to evidence and critical appraisal skills to evaluate evidence and incorporate it into practice. This has clear educational implications.
1.3.4.3 Quality, safety and clinical governance

Specific focus on quality and safety is another emerging theme; with ‘clinical governance’ requiring clear lines of accountability for individuals and organisations.\textsuperscript{134} In the UK, the need for better training, continuing professional development and lifelong learning have been heavily emphasised in health policy.\textsuperscript{135-138} Regulatory bodies in the UK now require evidence of continuing professional development as part of appraisal and re-licensing procedures;\textsuperscript{139,140} and these are also prominent themes in undergraduate education.\textsuperscript{141} This has driven demand for better access to information and learning opportunities; and introduced new motivators for individuals to engage in learning and professional development and for organisations to support and monitor this activity in the health workforce.

1.4 Use of technology

\textit{E-learning materials have to be provided on a suitable platform. This section reviews population-based data on access to computers, internet and other technology. Data from studies assessing health workers’ access, skills, confidence and experience is also presented. It should be highlighted that statistical data related to technology is likely to become quickly outdated in the face of innovation and rapid technological growth.}

1.4.1 Diffusion of innovation

The adoption of new innovations (including technology) has been the subject of academic study. Rogers (1962) proposed the Diffusion of Innovation theory in which cumulative uptake follows an S-shaped curve, with ‘innovators’, ‘early adopters’, ‘early majority’, ‘late adopters’ and ‘laggards’ adopting technology successively.\textsuperscript{142,143} Whilst this model has been criticised as an over-simplification of the situation in the ICT sector,\textsuperscript{144} it provides a useful framework for understanding the adoption of new technologies and predicting what the future might hold.
1.4.2 Technology and development

The development benefits of improving access to technology have been described, including:

- improving service delivery (including health services),
- better access to education, information and communication (including for health workers), increasing economic output and productivity,
- providing a means of innovative development projects (such as ‘mobile money’ (sending and receiving money via mobile phone),
- improving transparency and equality; and preventing corruption.\textsuperscript{145-152}

These benefits were recognised by the international community in the Millennium Declaration and Millennium Development Goals.

\begin{quote}
‘Develop a global partnership for development’ (Goal 8)  
included a specific target to  
‘Make available the benefits of new technologies, especially information and communications.’\textsuperscript{22}
\end{quote}

1.4.3 Population data

The ICT Development Index has been developed by International Telecommunications Union (ITU) as a composite indicator of overall levels of countries’ technology access, derived from measures on access and use of fixed and mobile telephones, computers and internet. This shows that Africa has the lowest levels of overall ICT development, with a regional average of 2.31 and country figures ranging from 0.96 (Central African Republic) to 5.22 (Mauritius). This compares with a global average of 4.77 and a European average of 7.14.\textsuperscript{153}
1.4.3.1 Mobile telephones

Growth in mobile telephony in sub-Saharan Africa provides an example of the willingness of individuals and communities to adopt new technology; and of how capacity can rapidly be built. There is interest in the use of mobile telephones (especially internet enabled ‘smart phones’) as tools for learning and information sharing in sub-Saharan Africa. Growth in mobile phone access is also recognised to be associated with subsequent growth in internet access.\textsuperscript{154}

At the end of 2014, the estimated number of mobile phone subscriptions worldwide totalled 6.9 billion (with a total global population of 7.2 billion).\textsuperscript{23} The divide between mobile subscriptions in developed and developing countries has closed markedly in recent years: with a gap of just 6% (89 subscriptions per 100 population in developing countries and 96 per 100 in developed countries) at the end of 2013.\textsuperscript{155}

Regional data for sub-Saharan Africa, compiled by the World Bank in 2013, showed that 80% of the region’s population was covered by a mobile network; with subscription rates of 66 per 100 population.\textsuperscript{156} There has been a corresponding broadening of access. Early users tended to be young, male, educated, urban dwellers (the ‘early adopters’ in Rogers’ model described above). Users are now much more heterogenous (in terms of age, income and levels of education (Rogers’ ‘majority’). This is linked to lower priced mobile phone handsets and airtime.\textsuperscript{142,147}

Whilst this data shows the massive growth and widespread use of mobile phones, it should be cautioned that ‘number of subscriptions’ is not the same as ‘number of mobile phone users: as it is common for individuals to have multiple subscriptions\textsuperscript{23} and for mobile phone subscriptions to be shared.\textsuperscript{147} An estimate from 2014 places the true level of mobile phone penetration at 48% of the global population: with figures of 45% in developing countries and 30% in least developed countries.\textsuperscript{153} There are also inter-country and intra-country differences in mobile phone access within sub-Saharan Africa\textsuperscript{147,156} for reasons which are discussed in section 1.4.4.
Whilst mobile phones have burgeoned, fixed telephone connections in sub-Saharan Africa remain limited to around 1-3% of the population.\textsuperscript{147,156,157} This suggests that mobile phones are used in sub-Saharan Africa as a substitute for fixed lines (rather than alongside the fixed network)\textsuperscript{145,158,159} and technology has allowed sub-Saharan Africa to ‘leapfrog’ the requirement for expensive landline infra-structure.\textsuperscript{147}

\subsection*{1.4.3.2 Computers and internet}

Computers and the internet are much less widely used in sub-Saharan Africa than mobile phones. At the end of 2013, just under 20% of the region’s population were internet users (compared with 39% of the global population and 77% of the population across all developed countries).\textsuperscript{155} This is the lowest rate of any geographical region; although there has been a significant increase from 4% in 2009.\textsuperscript{160}

- **Fixed line broadband** has remained limited to around 0.1 - 0.2% of the population in sub-Saharan Africa and is typically only accessible to wealthy, urban dwellers due to cost and limited infra-structure.\textsuperscript{157}

- **Mobile broadband** is a promising means of improving internet penetration and offering access at a lower cost\textsuperscript{23,153,157} (another example of ‘leapfrogging’ older technologies).\textsuperscript{147} There has been a significant increase in mobile broadband subscriptions in sub-Saharan Africa, with 40% annual growth (the highest of any region worldwide) although actual subscription rates still remain very much lower (6.3 subscriptions/100 population) than the global average (32.0 subscriptions/100 population) and compares with an average for developed countries of 84.7 subscriptions/100 population.\textsuperscript{153}
Speed and reliability

The quality, reliability and speed of internet connections are also important\textsuperscript{151} and there is a reciprocal relationship between perceptions of reliability/speed and uptake of broadband services.\textsuperscript{161} Africa lags behind other regions in terms of bandwidth per user: in 2011, ITU reported international Internet bandwidth in Africa of 937 bits per second per user, compared with 78,678 bits per second per user in Europe.\textsuperscript{151} This resonates with reports of users’ frustrations at slow connection speeds.\textsuperscript{162,163}

There is a drive to improve high speed intercontinental cable connections between sub-Saharan Africa and the rest of the world, with several intercontinental cables being planned and laid.\textsuperscript{164} Whilst this is a welcome development, it is highlighted that significant internet bottlenecks occur within local and national networks so that improved ‘international’ cabling will not necessarily lead to the expected increase in speeds.\textsuperscript{165} This has been referred to as the ‘last mile’ challenge.\textsuperscript{157} Further problems reducing speed and reliability are the prevalence of computer viruses due to absent or outdated anti-virus software (exacerbated by problems obtaining anti-virus updates over slow internet connections),\textsuperscript{151} and the lack of skilled individuals to maintain computers, networks and other infra-structure.\textsuperscript{152,166,167}

Whilst expectations of internet speeds in sub-Saharan Africa are lower than in other regions, it is likely that slow connections will impact on the uptake and acceptability of internet based educational resources, especially those with larger bandwidth requirements (such as audio and video files). Although it is likely that connection speeds will improve with time, e-learning and health information interventions need to be tailored to currently available infra-structure (including bandwidth constraints for web-based resources).\textsuperscript{168-171} Significant infra-structure investment is required to improve mobile internet speed.\textsuperscript{153,157}
Cost of access

Cost of access is another important consideration: fixed broadband connections in Africa require 291.3% of the average monthly income (compared with 1.4% in Europe); and mobile broadband, whilst more affordable, still costs 8-9% of average monthly income in developing countries. Note 1 placing internet access well beyond the reach of the majority of the population.151,153 It is therefore unsurprising that internet users are typically better educated and have more disposable income.172

Shared internet access

Internet users in developing countries often use shared facilities such as internet cafes (sometimes known as cybercafes), rather than private connections.157,173,174 The term ‘telecentre’ has been used to describe the wide range of places offering shared community access to ICT (including privately owned internet cafes, internet kiosks, libraries and post offices) usually on a pay-per-use basis.150,167,168,175 Whilst these facilities make the internet available to a wider population,153 they are still considered expensive by local standards and tend to be used by younger, more educated and affluent individuals.150,166,172,176 The setting of internet use also changes the way in which it is used: with a more leisurely approach on private connections and a more deliberate, focused approach on public connections.151

Access in rural locations

Computer and internet access in rural locations present a particular challenge with recognised differences in access and higher connection costs.151,152,157,166,172,177,178 In Tanzania, it is estimated that there are up to 16 times more people per internet café in certain rural areas than in the capital city.172 Rural areas are less economically attractive as foci for investment in telecommunications infra-structure151 and access is

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1 Average monthly income measured as gross national income per capita.
further limited by the availability of mains electricity, as highlighted in a Ugandan study.\textsuperscript{166}

Obsolescence

Software developments drive an ever-growing need for more powerful hardware so that computers become ‘functionally obsolete’ well within their lifetime. Computers in developing countries are likely to be older and less able to use the latest software (which requires greater processor power). This acts as a barrier to wider access to ICT in developing countries\textsuperscript{179} and highlights that e-learning materials need to be compatible with older hardware and software.

1.4.3.3 Alternative platforms for delivery

Limitations in computer and internet access have led to interest in alternative delivery platforms for e-learning and information. Options include disc based materials (DVD for television, CD-ROM and DVD-ROM for computer), local networks (intranets and local area networks) and low-cost devices (smartphones, laptops and portable media players).\textsuperscript{164,180-183} Whilst there are many attempts at innovative approaches, there is limited evidence to guide interventions and significant problems in translating small-scale pilot projects to a successful large-scale deployment.\textsuperscript{181,184}

Each alternative platform has advantages and disadvantages, removing some barriers but imposing others. Issues of affordability, accessibility and sustainability exist for all platforms, which need to be weighed carefully.\textsuperscript{180,182,185} It has been suggested that adopting a ‘blended’ technology approach, with materials offered simultaneously in different formats, will help users to overcome access limitations.\textsuperscript{164,181,186}
Disc based materials

Disc based materials (delivered on CD-ROM or DVD-ROM) do not require internet connectivity, removing a physical barrier to access.\textsuperscript{164} DVD for television has the additional advantage that computers are not required and materials can be played on television DVD players which may be more widely available (used primarily for domestic entertainment).\textsuperscript{187} Disc based materials are reported to be available in libraries in sub-Saharan Africa\textsuperscript{163,185,188} and a small number of programmes (in the health, education and development sectors) report using these formats for delivery of information specifically to sub-Saharan Africa.\textsuperscript{180,181,184,189,190} Drawbacks include the fragility of discs, the existence of different DVD formats, the lack of automatic updates and the need for duplication of discs.\textsuperscript{164,191,192} Furthermore, disc based materials cannot be used for synchronous, interactive e-learning (see section 1.6).\textsuperscript{193}

Local networks and intranets

Bandwidth limitations have led to interest in developing local networks which transfer information from a local server (rather than a distant location). However, connection speeds within local networks can still be unsatisfactory and there is a need to ensure that appropriate content is available within the local network. Significant technical support is likely to be required.\textsuperscript{186,188} Similar issues related to updating information on local networks exist as for disc-based materials.\textsuperscript{192} Specific examples of innovative schemes using local networks are described in table 1j (below).

Low cost devices

A number of innovative low-cost devices have been developed for use in resource poor countries. Examples include the OLPC (One-laptop-per-child) laptop computer, a custom-designed robust solar-powered laptop for use in resource poor countries,\textsuperscript{185} and the Aakash tablet (costing US$35 and sufficiently powerful to play high-definition
Low-cost smart phones are being exported, particularly from China, and this effectively lowers the cost of internet enabled mobile devices.\textsuperscript{194}

**Open-access software**

Recent years have seen developments in low cost computers, open-access computer operating systems and software which have the potential to reduce the cost of accessing technology, although awareness of these opportunities is limited.\textsuperscript{168,179}

**1.4.4 The Digital Divide and Information Poverty**

The above data highlights significant differences in the global uptake of information technology and there are corresponding discrepancies in levels of investment in technology.\textsuperscript{146} This has become known as the global digital divide, a term used to refer to inequalities in access to ICT, ability to use it effectively, derive benefit from it or more broadly to ‘any and every disparity in the online community’.\textsuperscript{168,195-197} Differences are observed between countries and regions, and within countries.\textsuperscript{147,172,196,198} The associated term ‘information poverty’ is used to describe those who have a lack of access, skills and opportunities to use ICT.\textsuperscript{168}

On a global scale, the digital divide between highest and lowest ranking countries is dramatic (63 times more computer access, 42 times more Internet users and 24,965.8 times more internet bandwidth per capita in the highest and lowest ranked groups of countries), with sub-Saharan Africa represented entirely within the bottom tiers.\textsuperscript{198} The social and economic consequences are significant: with a risk that the region will be left behind as other regions develop technological capacity, exploit new markets and opportunities for development.\textsuperscript{146,187}
There has been much interest in the determinants of this divide, which is recognised to be a complex entity. Various studies highlight the contribution of demand factors (such as per capita income, population density, literacy, educational and employment levels, which influence uptake) and geographical factors (which influence installation and running costs). English-speaking countries tend to have higher internet penetration, and wider political considerations are also important: with greater internet penetration in more peaceful, open, democratic, libertarian countries; where there are competitive, privatised telecommunications sectors; more cosmopolitan, urbanised communities with international professional, academic and personal connections and enthusiasm for technology; and where development of technological capacity is prioritised at a policy level.

As well as improving access to technology in these neglected areas, a further challenge is to maximise the benefits of technology to the widest cross-section of the population in terms of development, empowerment, access to education and commerce, with improved access to ICT a means and not an end in itself.

1.4.4.1 Models of barriers to effective use of ICT

Several models of the digital divide and barriers to ICT access have been proposed. Two such models, which take a holistic view of barriers to ICT access, are summarised in table 1c with overlapping themes between models highlighted.
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<thead>
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<tbody>
<tr>
<td><strong>‘Mental access’</strong>&lt;br&gt;Experience, confidence and self-efficacy in using technology.</td>
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<tr>
<td><strong>‘Material access’</strong>&lt;br&gt;Access to computers and internet.</td>
<td><strong>‘Physical access’</strong>&lt;br&gt;Availability of computers/internet connections.</td>
</tr>
<tr>
<td><strong>‘Skill access’</strong>&lt;br&gt;Computing skills.</td>
<td><strong>‘Financial access’</strong>&lt;br&gt;Affordability of access.</td>
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<tr>
<td><strong>‘Usage access’</strong>&lt;br&gt;Availability of opportunities to use technology</td>
<td><strong>‘Cognitive access’</strong>&lt;br&gt;Computing skills.</td>
</tr>
<tr>
<td><strong>‘Content access’</strong>&lt;br&gt;Availability of relevant content</td>
<td><strong>‘Production access’</strong>&lt;br&gt;Scope to generate content</td>
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<tr>
<td><strong>‘Design access’</strong>&lt;br&gt;The user-friendliness of applications.</td>
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<tr>
<td><strong>‘Institutional access’</strong>&lt;br&gt;Access to institutions to promote access.</td>
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<tr>
<td><strong>‘Political access’</strong>&lt;br&gt;Broader political context</td>
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Table 1c: Barriers to uptake of technology and contributors to the ‘digital divide’.

Overlapping elements are shown on the same row of the table.

A simpler model, proposed by Furuholt (2007) as the basis for research in Tanzania, describes infra-structural, socio-economic and demographic factors; and also highlights the importance of culture (including community beliefs, attitudes and motivation), reflecting that within poorer communities, individuals often favour and trust information obtained from informal networks of family, friends and local leaders over more formal sources. These models illustrate the range of factors which influence the uptake of technology and the need for a holistic understanding of barriers.

Research and engagement with users has been recommended as a means of developing more relevant, better targeted interventions which use resources effectively.
1.4.4.2 Intermediaries

Whilst the digital divide is described in terms of ‘usage’ and ‘access’, it is recognised that community members who lack ‘access’ to particular technologies can still derive benefit. One example is through intermediaries, who access the internet on behalf of individuals and communities with poor internet access. There are reports of locally relevant information downloaded from the internet being shared using community radio or mobile phones; and of mobile phones being used to submit internet search queries which are then conducted by a third party on an individual’s behalf.\textsuperscript{149,210} Health workers and other community leaders could have a role as ‘intermediaries’ by obtaining and sharing health information on behalf of their communities.

1.4.5 Health workers and institutions

At institutional level, the sub-Saharan Africa Medical Schools Survey explored access to technology within a wide-ranging questionnaire. 52% of schools reported using the internet to augment teaching; but frequently reported a lack of student computers and internet connections (90% of schools reported a lack of infrastructure and 69% a lack of internet connections).\textsuperscript{75,78}

A few studies have assessed the levels of access, use, skills, confidence and experience of health workers in using technology directly with health workers. These are summarised in table 1d. Of note, statistics in this field (especially on access to ICT) are likely to become rapidly outdated and it is therefore more useful to focus on the underlying themes raised from the data:-

- Computer and internet use are relatively widespread amongst doctors and medical students.
- Reported rates of computer ownership vary but seem correlated with seniority.
- Shared facilities (such as internet cafes) are important points of access.
• Access to infra-structure (computers and internet) within educational institutions and health facilities is variable but generally limited.

• Differences in access emerge between professional groups (e.g. medical students and nurses) and between government and private providers. Differences between government and non-governmental sectors are also reported.\textsuperscript{211}

• Skills in using ICT are not consistently developed across the workforce, and are less well developed in nurses than doctors.

• The majority of internet use (at least by medical students) is related to personal tasks rather than learning.

• Computers tend to be reserved, within institutions, for administrative staff rather than for health workers’ use.\textsuperscript{211}

• Access may be a source of conflict between users and librarians/information managers who wish to maintain their role act as gatekeepers to information.\textsuperscript{212}
## Access and use

<table>
<thead>
<tr>
<th>Study design</th>
<th>Key findings</th>
</tr>
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</table>
| **Bediang et al (2013)**<sup>213</sup>  
*Survey of medical students, residents and lecturers in Cameroon.* | 78% of students and all residents and lecturers used computers. 49% of students, 85% of residents and 100% of lecturers used the internet with statistically significant differences between groups. Personal computer access was more common than in other studies (76% of students, 81% of residents and 91% of lecturers); although internet cafe use was also common, especially for students. |
| **Gatero et al (2011)**<sup>214</sup>  
*Survey of doctors at a large teaching hospital in Kenya.* | Majority used internet to find materials but access within the hospital was limited. Shared internet facilities (such as internet cafés) or facilities at the nearby university were used. Barriers included a lack of computer and internet access, and locally relevant information online. |
| **Asangansi et al (2008)**<sup>215</sup>  
*Survey of interns and residents at a large teaching hospital in Nigeria.* | Shared facilities were the commonest source of access. 51.7% reported personal computer ownership. All respondents had used the internet, with 66% using it for more than one hour per week. Increasing age was positively correlated with computer ownership. |

### Skills and confidence

<table>
<thead>
<tr>
<th>Study design</th>
<th>Key findings</th>
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| **Bediang et al (2013)**<sup>213</sup>  
*Survey of medical students, residents and lecturers in Cameroon.* | Computer skills were self-assessed as a Likert item (1 (lowest) to 6 (highest)). Statistically significant differences were observed between students (median score 3, IQR 2-4), residents (median score 2, IQR 2-3) and lecturers (median score 2, IQR 1-2)<sup>Note 1</sup> suggesting that students were the most confident computer users. |
| **Gatero et al (2011)**<sup>214</sup>  
*Survey of doctors at a large teaching hospital in Kenya.* | 87% reported that they had adequate ICT skills. 64% reported that they could access electronic information independently. |
| **Asangansi et al (2008)**<sup>215</sup>  
*Survey of interns and residents at a large teaching hospital in Nigeria.* | 95.9% of respondents could use internet, 79.3% Medline and similar online databases, 62.1% word processing software and 40% basic statistics software. A correlation was noted between technological skills and personal computer ownership. Gender differences were noted (males reporting higher self-rated levels of skill than females). ICT skills tend ‘to go together’ so that those reporting better skills in one task tended to also make more use of ICT and report higher levels of skill in other tasks. |

**Table 1d (i) :** Surveys of health workers and students in sub-Saharan Africa summarising key findings related to ICT access, use, skills and confidence.

---

<sup>Note 1</sup> IQR = Inter-quartile range.
<table>
<thead>
<tr>
<th>Study design</th>
<th>Key findings</th>
<th>Skills and confidence</th>
</tr>
</thead>
</table>
| **Smith et al (2007)**<sup>216</sup>  
Survey of post-graduate doctors at teaching hospitals in Cameroon, Nigeria, Tanzania, The Gambia and Uganda. | 66% had used the internet to find health information in the last week, with internet cafes (47%) and communal computers at the institution (38%) the commonest access points, with smaller numbers using home computers (13%) or private office computers (3%). Responses from doctors at private institutions suggested that they had better access and used electronic resources more widely than their public sector colleagues. |                                                                                                                                                                                                                       |
| **Omona et al (2006)**<sup>212</sup>  
Survey of medical library users at three institutions in Kampala, Uganda. | Responses highlighted limited numbers of available computers and slow internet speeds. Cost of access was identified as a barrier. Respondents highlighted that international donor funding had been important in developing computer facilities elsewhere in institutions. | 19% felt they lacked ICT skills, with a lack of previous experience and lack of awareness of relevant internet links for finding information.                                                                                                                                 |
| **Samuel et al (2004)**<sup>216</sup>  
Survey of Tanzanian medical students. | 2/3 used computers at least once per week for a median 3.8 h/week. 24% had a computer at home. Personal and leisure use comprised the majority of computer use, with 27% reporting using computers for learning and 22% to prepare reports. | 52% felt they understood basic computing concepts; 78% e-mail, 69% internet; 37% word processing with lower numbers reporting skills in powerpoint, spreadsheet and database use.                                                                 |
| **Ajuwon (2003)**<sup>217</sup>  
Survey of medical and nursing students in Nigeria. | Significant differences in access between these groups: 69.8% of nursing and 47.6% of medical students lacked access to a computer; and 38.6% of nursing and 79% of medical students had ever used internet. E-mail was the most commonly used internet service, followed by browsing the web. Internet café facilities were the commonest point of internet access (used by 87.4% of respondents). | Significant differences in self-rated skills and confidence were observed between medical and nursing students: 58% of medical and 24.1% of nursing students considered themselves computer literate; 89.5% of medical and 15.2% of nursing students were “very confident” in accessing CD-ROMs; 86.2% of medical and 13.8% of nursing students were “very confident” to download information from internet; nurses were more likely to need assistance to use internet. Males reported significantly higher skills than females. |

**Table 1d (ii):** Surveys of health workers and students in sub-Saharan Africa summarising key findings related to ICT access, use, skills and confidence.
1.4.6 International comparisons

Data on access to technology in the UK and other developed regions is presented to provide a contrast with sub-Saharan Africa. Some perspectives from studies of health workers in resource-rich countries and other developing regions highlight issues which may emerge in sub-Saharan Africa as technology develops.

1.4.6.1 Access

UK

Across the UK population, access to technology has burgeoned in recent years with 89% of households having a telephone, 92% a mobile phone, 85% a DVD player, 83% a computer and 82% an internet connection. Interestingly, DVD ownership has fallen from a peak of 90% in 2009 (probably reflecting increasing use of ‘on-demand’ television and film downloads).

In 2014, 76% of individuals used the internet every day and 68% used mobile internet. Increasing age, disability and lower income are all correlated with decreased likelihood of using the internet. Although cost of equipment (12%) and connection (11%) are cited by non-internet users, 53% of those without internet access report that they ‘do not need it’, suggesting a positive decision not to use the internet amongst a minority of the population. The UK government has committed to improving the reach and speed of internet connections.
Europe

Across the 28 countries of the European Union, 75% of citizens had used the internet within the last three months, and 72% used it at least once a week. Significant differences exist between countries in both internet use and broadband penetration: 42% of the population in Romania has never used internet, compared with 4% in Denmark and Sweden, and 8% in the UK (amongst the best performing, ranked 6th in Europe). 222

1.4.6.2 Skills and confidence

UK

Skills are a significant issue affecting use of technology: 32% of non-internet users in the UK attribute this to a lack of skills. Generally, younger adults are more confident and experienced in using computers223 reflecting the fact that computers became commonplace at home and school in the 1980s.224 The term ‘digital native’ has been used to describe the younger generation born from 1980 onwards who have grown up immersed in digital technology.225 However, there has also been significant recent growth in the use of computers and internet by older sections of the population.219

1.4.6.3 Studies of health workers

Several useful insights emerge from studies of health workers’ use of technology in other regions, summarised in table 1e. These have been highlighted as they represent issues which may emerge in sub-Saharan Africa due to resource constraints. Again, the speed at which data becomes outdated is an important caveat in interpreting these studies.
### Developed countries

<table>
<thead>
<tr>
<th>Study</th>
<th>Insights</th>
<th>Implications</th>
</tr>
</thead>
</table>
| **Janes et al (2005)**<sup>226</sup>  
*Survey of New Zealand General Practitioners.* | Despite reasonably widespread access to computers and internet, 26.9% of respondents reported never having used the internet with regard to patient care. | ICT access and skills do not necessarily translate into resources being used to support professional development and patient care. |
| **Link and Marz (2006)**<sup>227</sup>  
*Survey of Austrian first year medical students.* | Despite high levels of access, confidence and skill, medical students did not see technology as a replacement for traditional methods of teaching.  
12% of respondents considered themselves ‘inexperienced’ in accessing web-based learning. | Students may not accept the use of technology to replace existing learning opportunities.  
A minority of students may struggle if assumptions are made about their ICT skills. |
| **Ward and Moule (2006)**<sup>228</sup>  
*Focus groups of UK nursing students.* | Access to computers on work-based placements was a significant problem. The culture of placements did not seem to support use of ICT. Time, ICT skills and attitudes to computers also affected engagement. | Health workers and students may struggle to access computers in the workplace. Organisational culture has an impact on uptake of e-learning opportunities. Skills and individual attitudes are also important determinants. |
| **Healy (2005)**<sup>229</sup>  
*Trial of online surgical training in undergraduate medical education.* | The e-learning package was used more frequently by less able students.  
The majority used campus-based computers to access the materials. | E-learning may have a particular role for weaker students.  
Students access materials in a variety of ways both on- and off-campus. This has implications for infra-structure development at educational institutions. |
| **Bennett and Glover (2008)**<sup>230</sup>  
*Survey following an internet based video-streaming intervention for student nurses in Australia.* | 91% of respondents felt that video streaming had assisted their learning, although 46% reported some difficulty with accessing the materials. | Even in places with well-developed infra-structure, there can be technical difficulties accessing e-learning materials. |

**Table 1e (i):** Insights from studies of health workers in developed countries.
### Other developing regions

<table>
<thead>
<tr>
<th>Study</th>
<th>Insights</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Callen et al (2007)</td>
<td>59% rated their computer skills as only poor or fair, with younger and male doctors likely to report better skills.</td>
<td>ICT skills are an important consideration in implementing e-learning.</td>
</tr>
<tr>
<td>Kommalage and Gunawardena (2008)</td>
<td>Significant gender differences in previous ICT experience were noted amongst medical students, with females having significantly less ICT experience.</td>
<td>Corroborates data from Nigeria (described in table 1d) suggesting that gender has an impact on self-reported ICT skills.</td>
</tr>
<tr>
<td>Unnikrihnan et al (2008)</td>
<td>Higher rates of personal computer ownership amongst students at private medical schools.</td>
<td>Differences in personal computer access exist between private and government institutions.</td>
</tr>
<tr>
<td>Martinez et al (2005)</td>
<td>Lack of infrastructure and low income levels were highlighted as significant limiting factors on initiatives to improve information access in rural areas.</td>
<td>At primary health care level, infrastructure constraints and income levels are key issues.</td>
</tr>
</tbody>
</table>

Table 1e (ii): Insights from studies of health workers in other developing regions.

### 1.5 Insights from the educational literature

The development of e-learning materials draws upon a range of psychological and educational research; and learning theory. This section presents insights from this body of literature that are relevant to e-learning approaches for health workers.
1.5.1 Learning

Several theories of learning have been developed which vary in their emphasis and the extent to which they characterise learning as an ‘outcome’ or ‘process’. These theories inform current educational practice and can be used to guide innovation and adoption of new approaches.

1.5.1.1 Definitions

Illich (1971) proposed a definition of learning:-

‘the acquisition of a new skill or other insight’.

Bloom (1956) proposed that learning develops skills in three distinct domains:

- psychomotor – ‘learning to do’
- cognitive – ‘learning to know’
- affective – ‘learning to feel’

Within each domain, Bloom proposed that learning takes place in incremental stages, which have since been defined as shown in table 1f. He suggested that the broad goal of education is the holistic development of each domain.

<table>
<thead>
<tr>
<th>Progression of learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychomotor</td>
</tr>
<tr>
<td>Imitation</td>
</tr>
<tr>
<td>Manipulation</td>
</tr>
<tr>
<td>Precision</td>
</tr>
<tr>
<td>Articulation</td>
</tr>
<tr>
<td>Naturalisation</td>
</tr>
<tr>
<td>Affective</td>
</tr>
<tr>
<td>Receiving</td>
</tr>
<tr>
<td>Responding</td>
</tr>
<tr>
<td>Valuing</td>
</tr>
<tr>
<td>Organising and conceptualising</td>
</tr>
<tr>
<td>Characterising by value or value concept</td>
</tr>
<tr>
<td>Cognitive</td>
</tr>
<tr>
<td>Remembering</td>
</tr>
<tr>
<td>Understanding</td>
</tr>
<tr>
<td>Applying</td>
</tr>
<tr>
<td>Analysing</td>
</tr>
<tr>
<td>Evaluating</td>
</tr>
<tr>
<td>Creating</td>
</tr>
</tbody>
</table>

Dave (1967)\(^{240}\)  
Kratwohl, Bloom and Masia (1964)\(^{241}\)  
Anderson et al (2001) based on Bloom (1956)\(^{242,243}\)

Table 1f: Incremental levels of learning based on Bloom’s taxonomy.
1.5.1.2 Cognitive and behavioural learning theories

**Behaviourism**

Behaviourists understand learning as a change in behaviour (an outcome) which occurs primarily due to influences in the learner’s environment.\(^{237,244}\) Behaviourist approaches underpin the development of learning objectives, outcomes and competencies (especially those which are expressed in terms of behaviours that will be developed through a learning activity).\(^{245}\) In health worker education, where efforts are ultimately directed at achieving better patient outcomes through improved health worker performance,\(^{246}\) a behaviourist approach (focusing on outcomes) is, to some extent, implicit.

**Cognitivism**

Cognitivists focus on the internal process of learning, involving prior knowledge, perception, short and long-term memory and information processing.\(^{237,244}\) Learning produces a change in the brain’s internal processes and associations (without necessarily a demonstrable change in behaviour). Cognitivism highlights the value of a structured approach to educational materials, recognising and building on prior knowledge and encouraging learners to draw out links between new learning and their previous knowledge.\(^{246,247}\)

**Social cognitive theory**

Social cognitive theory (Bandura (1986))\(^{248}\) developed from social learning theory, bringing together cognitive and behavioural theories, asserting that learning occurs as an interaction of personal, environmental and behavioural factors which mutually influence each other.\(^{237,248}\)
In this model, learning is influenced by features of the:-

- **learner** (goals, previous knowledge, skills and beliefs),
- **learning environment** (the setting in which learning takes place),
- **learning activities** (work and interactions with colleagues, teachers and others).

Learning is underpinned by five human capabilities: vicarious capability (the ability to learn from observation of others’ behaviour and its consequences); forethought capability (the ability to predict outcomes, set goals and plan actions); symbolising capability (the ability to use experience as an internal guide to future actions); self-regulatory capability (the ability to evaluate behaviour against internal standards); and self-reflective capability (the ability to think about thought processes). Self-efficacy (the learner’s judgement of their capabilities) is a key influence on learning. Behaviour change is considered a ‘proof of learning’.236,237,248

Social cognitive theory provides a theoretical basis for using demonstrations, guided practice, role-modelling, setting learning objectives (to encourage forethought capacity) and providing positive feedback (to build self-efficacy).236

1.5.1.3 **Humanistic theory**

Humanists view learning as a process of personal growth, focusing on the role of learning in human development and realisation of potential. Humanist approaches emphasise the autonomy, values and intentions of the individual, viewing learning as a lifelong process of growth.245,249,250
1.5.1.4 Constructionism

Constructionists view learning as the construction of knowledge by exploring and integrating new experiences with what learners already know.\textsuperscript{236,251} From Piaget (1967), learning can occur by assimilation (fitting a new experience within the individual’s existing knowledge framework) or accommodation (changing their knowledge framework in the light of experience). This means that learners control what and how they learn from each experience.\textsuperscript{252}

Constructionists favour active approaches (such as problem-based learning) and highlight the importance of learning through ‘failure’, reflection on experience and exposure to experiences which challenge existing knowledge frameworks. The teacher takes the role of facilitator (encouraging students to find the answer) rather than instructor (providing the answer) and provides learning experiences based on their knowledge of students’ existing knowledge frameworks influenced by their culture, background and previous experience. The learner, in turn, takes responsibility for their own learning.\textsuperscript{236,246,253-255} This approach is often contrasted with more traditional models of education (known as instructivist, conservative or didactic models) which emphasise the role of the teacher as ‘instructor’, imparting knowledge.\textsuperscript{253,256}

1.5.1.5 Multimedia learning

Multimedia is defined as

\begin{quote}
‘the combination of audio and visual elements in learning materials.’\textsuperscript{257}
\end{quote}
Several theories refer to the internal (cognitive) processing of multimedia information:

- **Dual coding theory** asserts that auditory and visual information are processed by distinct pathways leading to separate internal auditory and visual representations. The ability to store information as both auditory and visual representations increases the probability of successful recall.258-260

- **Working memory theory** defines working memory as the processes which receive, temporarily store, buffer and manipulate information. Working memory has auditory and visual sub-components.261,262

- **Cognitive load theory** asserts that the working memory has a finite capacity during learning and problem-solving. Cognitive load is the effort required for a task in the working memory and has three determinants:263,264
  - Intrinsic load – related to the difficulty of the task itself,
  - Extrinsic load – related to understanding the presentation of the task,
  - Germane load – related to schema construction (integrating new information gained from the task with previous knowledge and experience).

  Learning becomes more efficient if extrinsic load can be reduced and germane load increased. Furthermore, whilst it is not possible to change the intrinsic difficulty of a task, this can be manipulated, for example, by breaking tasks into smaller components.264

Mayer (2001, 2009) drew upon these theories and explored how they can be applied to multimedia instructional design (‘the creation of learning experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing’).265 His work highlighted that, as working memory contains separate auditory and visual channels, the available capacity of both channels can be harnessed if information is
provided simultaneously in auditory and visual forms. The practical implications of this are discussed in section 1.6.3.2.

1.5.1.6 Experiential learning

Kolb’s experiential learning theory explains how learning results from concrete experience gained through performing a task. Learning takes place through:

- concrete experience (providing new, real-life experience)
- reflective observation (stepping back to think about the experience),
- abstract conceptualisation (assimilating the experience with existing knowledge, experience and other information)
- active experimentation (planning how to perform the task differently)

Thus, each loop of the learning cycle shapes the next attempt at the task (as illustrated in Fig 1a)

Fig 1a: Kolb’s learning cycle.
Concrete experience and abstract conceptualisation are defined as ways of ‘grasping’ experience (gathering information from ‘concrete’ real-life or ‘abstract’ theory and symbols); whilst reflective observation and active experimentation are ways of ‘transforming’ experience (developing new insights from information). Kolb argued that combinations of strengths in these areas form the basis of a person’s ‘learning style’ (see section 1.5.2.5).

The learning environment can provide ‘concrete’ experience in four ways:-

- affective (feeling)
- symbolic (thinking)
- perceptual (watching or listening)
- behavioural (doing)

This concrete experience is not necessarily the ‘starting point’ of the cycle: learners may begin with abstract conceptualisation of information (for example, using books or lectures). However, Kolb’s theory highlights the importance of linking abstract information to a concrete experience or task.270

1.5.2 Adult learning

Whilst the above theories above are widely used in relation to children and adults, there are also some distinct theories of adult and professional learning. Although no theory of adult learning is considered comprehensive, they provide useful insights which can be used to shape learning opportunities including e-learning.236,237,257

Adult learning is heavily influenced by life situation. Typically, adults learn alongside other roles (professional and personal) which influence their goals, previous knowledge, preferred approach to learning and time availability.237,245 Six adult learning concepts, which are widely used in health worker education, are described below.
1.5.2.1 Andragogy

Knowles (1966) defined andragogy as ‘the art and science of helping adults learn’. His work developed five assumptions about adult learners and seven recommendations for effective adult learning, summarised in Table 1g.271,272 Learners go through a gradual process of transition to acquire the characteristics of adult learners.245

<table>
<thead>
<tr>
<th>Assumptions about adult learners</th>
<th>Principles of adult learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent, can determine their own learning needs and find strategies to meet them.</td>
<td>Establish a safe and comfortable environment (where learners feel safe, comfortable and free to express themselves).</td>
</tr>
<tr>
<td>Accumulated experience which can be used to inform and enhance learning.</td>
<td>Develop learning methods in collaboration with learners.</td>
</tr>
<tr>
<td>Prefer learning which relates to their social role and integrates with the demands of everyday life.</td>
<td>Encourage learners to recognise their learning needs.</td>
</tr>
<tr>
<td>Prefer learning which helps them to solve problems immediately.</td>
<td>Encourage learners to set their own learning objectives.</td>
</tr>
<tr>
<td>Motivated by internal factors (such as success, satisfaction and achievement of personal goals)</td>
<td>Encourage learners to develop their own learning plan to achieve their learning objectives.</td>
</tr>
</tbody>
</table>

Table 1g: Summary of Knowles (1966) principles of adult learning

Adult learning theory provides theoretical backing for problem-based approaches to learning and highlights the collaborative nature of adult education, requiring educators to recognise and respond to learners’ previous experience, needs and preferences. Adult learning needs to be carefully paced, recognising competing time demands; and be meaningful in the context of the adult learner’s social and professional roles.111,237,245,257
1.5.2.2 Self-directed learning

Self-directed learning was defined by Knowles (1975) as the process by which individuals take responsibility for diagnosing their learning needs, formulating learning goals, identifying learning resources, implementing learning strategies and evaluating learning outcomes.\(^{273}\) It can also be considered as an attitude or approach to learning which individuals seek to attain.\(^{237}\) It is linked to learning theories which emphasise the importance of the active engagement of the learner in the learning process (constructionism and cognitivism) and growth of the learner (humanism).\(^{237}\)

1.5.2.3 Continuous professional development

Continuous professional development (CPD) refers to the ongoing development of professional expertise, recognising the need to remain up-to-date in the context of rapid advances in practice.\(^{246,274}\) The UK General Medical Council (GMC) defines CPD as any learning outside of undergraduate education or postgraduate training that helps maintain and improve performance. It covers the development of knowledge, skills, attitudes and behaviours across all areas of professional practice, and formal and informal learning activities.\(^{275}\)

1.5.2.4 Reflective learning and reflective practice

Reflective practice was developed with a particular focus on professional development and seeks to facilitate learning from day-to-day professional experience. By reflecting on a problem or a surprising, unexpected or difficult experience, learners seek to link theory with practice and find new insights and approaches to solving problems.\(^{237}\) This learning occurs through ‘reflection in-action’ (whilst solving the problem) and ‘reflection on-action’ (at a later stage to consider how the problem could be handled differently).\(^{276}\) Reflective learning requires learners to bridge theory (for example, from earlier study) and practice; and recognise the limits of their professional competence\(^{236,237}\) and links with constructionist and experiential learning models.\(^{255}\)
### 1.5.2.5 Learning style

Various attempts have been made to categorise learners according to their preferred approach to learning. Some examples in are provided in table 1h. The evidence on learning styles is not clear-cut: classifications have been criticised for their lack of empirical basis and validity. However, research on learning styles does demonstrate that learners have heterogenous preferences (even if these are not necessarily innate characteristics) and it seems reasonable to develop learning materials in ways which engage these preferences.

| Kolb (1984)\(^{267,277}\) | Defines learning styles using experiential learning theory. Each group’s preferred ways of ‘grasping’ and ‘transforming’ experience are shown in brackets below:-
|---|---|
| - Accommodator (concrete experience + active experiment)
| - Converger (abstract conceptualisation + active experiment)
| - Diverger (concrete experience + reflective observation)
| - Assimilator (abstract conceptualisation + reflective observation)

| Honey and Mumford (1992)\(^{281}\) | Defines four learning styles based on how individuals prefer to learn within Kolb’s experiential learning model.
|---|---|
| - Activist (prefers concrete experience)
| - Reflector (prefers reflective observation)
| - Theorist (prefers abstract conceptualisation)
| - Pragmatist (prefers active experimentation)

| Fleming (1992)\(^{282}\) | Defines learning styles in terms of preferred methods of assimilating information:-
|---|---|
| - Visual (through symbols and diagrams)
| - Auditory (through spoken word)
| - Reading and writing
| - Kinaesthetic (through doing)

| Entwistle (1987)\(^{283}\) | Defines learning styles based on students’ approaches to learning.
|---|---|
| - Superficial (motivated by external factors such as passing assessments)
| - Deep (motivated by internal factors such as curiosity/commitment to subject)
| - Strategic (uses different approaches depending on circumstances)

**Table 1h:** Commonly cited definitions of learning styles.
1.5.2.6 Situated learning and communities of practice

Situated learning emphasises the value of learning by participation in the activities of a community through collaboration and social interaction with other members of that community.237,284 ‘Communities of practice’ arise when the community develops a shared set of experiences, beliefs, values and practices related to a common activity, enterprise or profession.285

Communities of practice facilitate:

- **Knowledge translation** – new knowledge is shared with the community, discussed, synthesised and applied. Through this, knowledge is acquired more quickly and a shared understanding of how it should be applied is reached through discussion within the community.119,237

- **New members join the community in a more peripheral role** – gradually acquiring experience and skills, and moving to a more central role, taking on responsibilities of the more senior members of the community.237,284

There is interest in the development of ‘virtual’ communities of practice which are linked using technology (such as e-mail, internet or social networking).237

1.5.3 Learning objectives, outcomes and competencies

Learning objectives define the desired result of participation in a learning activity in terms of the knowledge, skills and attitudes that the learner should be able to demonstrate.286,287 Whilst there may not be much practical difference,288 these ‘desired results’ can alternatively be expressed as ‘learning outcomes’ (emphasising what will be achieved by the learner) or ‘competencies’ (describing the personal qualities or levels of performance to be attained).287,289,290
Opinions vary about how strictly learning objectives should be defined. Strict definitions of ‘behavioural objectives’ (specifying in detail what students should be able to do after the learning)\(^\text{291}\) were once favoured, although it is now well-recognised that this can be impractical and difficult for learning activities which focus on more complex, higher order and affective skills.

In practical terms, the most important features of objectives, outcomes or competencies are clarity and fitness for purpose: they should give sufficient clarity to learners, educators, assessors and other interested parties.\(^\text{286-288,292}\) Guidelines for writing learning objectives are provided by the SMART formula,\(^\text{293}\) table 1i, which is widely used for objective-setting, both in education and other areas (such as management).

<table>
<thead>
<tr>
<th>S</th>
<th>Specific</th>
<th>An exact statement which is clear and unambiguous.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Measureable</td>
<td>Amenable to assessment</td>
</tr>
<tr>
<td>A</td>
<td>Achievable</td>
<td>Possible to accomplish successfully.</td>
</tr>
<tr>
<td>R</td>
<td>Relevant</td>
<td>Matters in the context of the learner’s wider activities and goals.</td>
</tr>
<tr>
<td>T</td>
<td>Time-bound</td>
<td>Provides a target for when the objective will be achieved.</td>
</tr>
</tbody>
</table>

**Table 1i**: the characteristics of ‘SMART’ learning objectives.

Learning objectives are informed by the behaviourist and social-cognitive learning models, as they explicitly link learning to behaviour change and help learners to set goals, plan and self-evaluate as part of the learning process. Adult learning principles highlight the importance of goals being relevant to wider roles and the importance of learner participation in setting objectives.

### 1.5.4 Learning within curricula

Within formal programmes of study, learning resources are used within a curriculum which specifies the aims and objectives, content, learning experiences, outcomes and processes of the programme as a whole,\(^\text{287,294}\) known as the ‘planned’ or ‘intended’ curriculum. Within institutions, the ‘planned curriculum’ is interpreted by teachers and administrators who deliver formal educational activities, to form the ‘delivered
curriculum’. The actual experience of learners is sometimes termed the ‘experienced curriculum’ and this includes a ‘hidden curriculum’ of values, behaviours and social norms that is not formally codified but learnt through experience and interaction with teachers and colleagues.286,295

When developing learning materials to be used across different institutions, it is important to consider how curricula might vary and ensure that materials are likely to complement different curricular approaches. Resources might be specifically recommended (in the ‘planned curriculum’), used by individual educators (as part of the ‘delivered curriculum’) or picked up by students (as part of the ‘experienced curriculum’). The concept of a ‘hidden curriculum’ also highlights the need to consider the values and norms that are being transmitted through e-learning materials.

Four common approaches to curriculum design and delivery are particularly relevant to e-learning:

- **Modular curricula** are designed around self-contained units of study (each with its own learning objectives and activities).287,296

- **Spiral curricula** are designed so that learners re-visit topics during their course of study, at gradually increasing levels of complexity, so that learners can build on what they already know and integrate new learning with previous study.287,296

- **Distance learning** is a widely used curricular approach, whereby the teacher and learner are separated by space and/or time.297 Approaches include ‘true’ distance learning (where learners study entirely remotely and rarely or never meet their teachers) and ‘distributed learning’ (where local centres deliver aspects of the learning).246,277 Modern programmes often rely heavily on technology to bridge the gap between teachers and learners297,298 although in sub-Saharan Africa, institutions continue to use more traditional distance learning approaches (using offline and paper-based materials in a distributed learning model).182 Recent innovations include the MOOC movement (‘massive open online courses’), where
very large numbers (often thousands) of learners participate with limited individual input from the course provider.  

- **Blended learning** combines face-to-face and distance learning and is a common ‘hybrid’ model in health worker education. Research is needed to understand how such programmes should best use and combine the distance and face-to-face components (e.g. which topics should be delivered using each method and how the elements should be sequenced).  

### 1.6 E-learning and educational technology

E-learning and educational technology have potential roles in developing the health workforce, strengthening health systems and improving healthcare delivery in sub-Saharan Africa. This section presents further insights from the educational literature related specifically to e-learning, describes some existing e-learning programmes in sub-Saharan Africa and highlights some of the opportunities and constraints.

#### 1.6.1 Definitions

The widely-used term ‘e-learning’ lacks a clear definition and is used with different meanings in the health and education literature. Most authors take a technological perspective, defining e-learning as ‘learning using the internet’ (online learning or web-based learning) or (more broadly) ‘all computer-assisted approaches to learning’. The allied term ‘m-learning’ is used to describe approaches which use mobile devices (including smart-phones, personal digital assistants and tablet computers).
Some authors have moved towards a definition of e-learning which emphasises the centrality of the learner, rather than technology, highlighting that e-learning represents a distinct educational approach:

‘E-learning is the capability required of a learner to manage their own learning using technology as appropriate to context, sector and task.’

These definitions together highlight the need for access to technology (hardware and software); and skills, confidence and motivation to use the technology for learning. From a research perspective, the learner, the learning environment and the technology need to be understood.

In this thesis the term ‘e-learning’ and ‘technology-based learning’ have been used to refer to all technology based approaches to learning (including computers, internet and other delivery platforms as described in section 1.4.3.3).

1.6.2 Historical perspective

The use of technology in health worker education is not, in itself, a new phenomenon: before the widespread use of digital media, slides, overhead projectors, video and audio tape were commonly used to augment teaching. However, recent years have seen significant developments in the range of available technology. There is much innovation and ongoing debate about how these technologies are best applied in educational practice; and, more radically, the extent to which they can be developed into fundamentally new educational approaches.
1.6.3 Capabilities

Generally, e-learning aspires use technology to deliver flexible, engaging, learner-centred, interactive and collaborative learning.\textsuperscript{246} E-learning has distinctive features which differentiate it from traditional learning approaches.

1.6.3.1 Navigation

Navigation systems are used by learners to interact with content. Alongside high-quality content and a visually attractive appearance, successful e-learning materials need a clear navigation system which is intuitive, consistent and easy to learn.\textsuperscript{280} Usually, a balance of several navigational approaches is used:\textsuperscript{277,280,304}

- **Navigation menus** allow users to select sections of content. In larger resources, information is often organised hierarchically. Menus provide an intuitive way for learners to move through headings and sub-headings to specific content.

- **Hyperlinks** allow users to move quickly to linked content (within the same or different texts) allowing users to explore connected information and follow an area of interest.

- **Breadcrumb trails** allow users to track the information that they have reviewed so that they can re-trace their steps.

- **Search boxes** allow users to search for specific words within the content.

1.6.3.2 Multimedia

A major advantage of e-learning is the scope to combine audio and visual elements within learning materials. The theory underpinning this was discussed in section 1.5.1.5 and this leads to several principles underpinning multimedia instructional design:\textsuperscript{266,305,306}
- **Multimedia** – using words and graphics together,
- **Contiguity** – aligning words and graphics,
- **Modality** – presenting words as audio rather than on-screen text,
- **Redundancy** – explaining visuals with audio or text (not both),
- **Coherence** – avoiding distracting learners with non-essential information,
- **Personalisation** – using a polite but informal, conversational style,
- **Segmenting** – breaking larger topics into smaller components,
- **Pre-training** – ensuring key concepts are explained first,
- **Signalling** – providing visual and verbal cues (arrows, highlights, vocal emphasis).

Exceptions to these broad principles apply. For example, it can be valuable to add key words as on-screen text to an audio description when there is no competing visual information or if learners are not fluent in the language of instruction.

### 1.6.3.3 Podcasts and vodcasts

Podcasts (audio) and vodcasts/videocasts (audiovisual) are methods of transmitting content (such as lectures, revision notes, audio textbooks and selections of clinical material) which students can use flexibly at a time/place to suit them, controlling the pace of learning by stopping and re-playing the content if necessary.\(^{246,251,307,308}\)

### 1.6.3.4 Interactive content

E-learning allows the learner to engage in interactive exercises or self-assessment questions as part of the learning experience, with instant feedback on their performance. Simulation is a specific form of interactive content which accurately replicates a real-life situation allowing students to practice applying their learning to a real-life problem.\(^{246,277}\)
1.6.3.5 Synchronous and asynchronous discussion

E-learning also allows discussion amongst learners and with tutors. This can either be synchronous (with individuals contributing to a real-time online discussion) or asynchronous (individuals can contribute at any time). Each approach has advantages: asynchronous discussion is more flexible (not requiring a fixed time-commitment) and tends to produce more considered, reflective contributions related to complex issues; whereas synchronous discussion is useful for planning and discussing less complex issues.\textsuperscript{246,257,277,297,309-311}

1.6.3.6 Collaborative content

Technology provides the opportunity for collaborative authoring and development of learning materials. Two approaches are widely used:\textsuperscript{277,307}

- ‘Wiki’ sites (most famously wikipedia.org) - websites which can be modified by anyone who has access to the site
- ‘Blogs’ - online journals which can be authored by individuals or groups to share information, experiences, observations and reflections.

Theoretically, the collaborative process allows content to be developed and refined by ‘evolution’ (editing by a wide community of users) although concerns remain about a lack of formal quality control measures and the possibility of misleading information being added (maliciously or accidentally).\textsuperscript{307} Despite these concerns, collaborative materials are widely used in health worker education: in a recent questionnaire study of Italian medical students, Wikipedia was more widely used than any peer-reviewed medical database\textsuperscript{312} and it is recognised that these collaborative authoring approaches can foster the development and activities of ‘virtual’ communities of practice.\textsuperscript{237} The widespread use of such collaboratively authored sites also highlights the need for health workers to have the skills to appraise the quality of information from the internet.
1.6.4 Virtual learning environments

Virtual learning environments provide a framework in which e-learning can take place. Functions include:—\(^{246}\)

- **repository of information** (such as lecture notes),
- **platform for formative and summative assessment**, 
- **storage and organisation of students’ learning portfolios**, 
- **forum for synchronous or asynchronous communication and discussion**.

1.6.5 Re-usable learning objects

Re-usable ‘learning objects’ are proposed as a more-efficient method of authoring e-learning materials for use in multiple curricula. Materials are built around a specific learning objective in such a way that they can be grouped together within larger programmes of study, re-used in different curricula shared with other institutions.\(^{246,251,279,313}\)

1.6.6 E-learning in health worker education

1.6.6.1 Sub-Saharan Africa

In sub-Saharan Africa, there is significant interest in developing e-learning programmes for the health sector; and in their potential as a response to global health challenges and development goals\(^{148,180,314-317}\) and to improve learning opportunities for health workers in rural locations.\(^{66,317,318}\) Potential applications include:—\(^{148,319-325}\)

- improving access to training and professional development (through distance learning, web-conferencing and other innovative approaches),
- developing locally relevant community-generated learning content,
• translation and adaptation of other materials for the local context,
• building learner communities,
• providing remote access to expert consultation (telemedicine),
• gathering accurate data for health planning purposes.

Despite this enthusiasm, there has been relatively little study of the barriers to effective e-learning amongst health workers in sub-Saharan Africa although some successful (mostly pilot) projects have been reported,\textsuperscript{184,189,326-331} summarised in table 1j. Common themes in these reports include the importance of international collaborations and non-governmental partners in supporting innovation and providing technical expertise; the limitations imposed by local infra-structure and skills; and concerns over sustainable implementation and up-scaling. Interestingly, several projects have been reported which combine telemedicine (remote consultation) and e-learning.

Other factors affecting the uptake of e-learning by health workers in sub-Saharan Africa are mentioned in the literature:-

• Start-up and maintenance costs,\textsuperscript{315,332}
• Electricity supply,\textsuperscript{315}
• Difficulties obtaining access to password protected medical sites,\textsuperscript{212,214}
• Lack of support personnel to maintain infra-structure,\textsuperscript{75,78,315}
• Lack of locally relevant information,\textsuperscript{214}
• Government policy towards technology in healthcare,\textsuperscript{315}
• Time constraints,\textsuperscript{214,217}
• Skills in appraising the reliability of online information,\textsuperscript{213}
• Awareness of availability of electronic resources,\textsuperscript{214,216}
• Cultural resistance amongst health workers.\textsuperscript{214}
RAFT
Reseau en Afrique Francophone pour la Telemedicine.

Low bandwidth video conferencing
Francophone (Northern and Western Africa)

RAFT began in 2001 in Mali and has extended to national and regional hospitals in 18 countries, mainly in Northern and Western Africa. Low bandwidth internet is used to deliver interactive presentations and discussions (16 hours/month) and to support remote consultations. Simple infrastructure is used with batteries to overcome erratic electrical supplies, and local expertise is required to maintain the network. Most learning material emanates from African countries. A key benefit reported is the opportunity to create educational links within Africa. South-South collaborations and a North-South partnership with Geneva University Hospitals underpin this work.\(^\text{Note 1}\)

Satellite HealthNet

Satellite and telephone communication system relaying health information
Resource limited countries worldwide, including sub-Saharan Africa.

HealthNet was developed in the 1990s by Satellife (a US based non-profit organisation) linking ground stations in health centres, using either a dedicated orbiting satellite or a telephone connection. Basic e-mail software at the ground station receives information when the satellite is overhead, allowing remote centres to send requests for information to other users and to receive regular updates using ‘store and forward’ technology. Whilst not allowing real-time interaction, ‘store and forward’ approaches are held to be economical and less resource intensive.\(^\text{Note 2}\)

Uganda Health Informatics Network and Satellite PDA project

M-health intervention in rural areas using personal digital assistants
Uganda, Kenya and Ghana

An initial project, undertaken by Satellife, allowed rural health workers to send and receive information from a personal digital assistant (PDA) device connected to the mobile phone network via connection points at health centres. This was further developed by the Uganda Health Informatics Network. The primary purpose of this system is to collect data from facilities but it also has the capacity to transmit information to health centres and provides two way communication to staff in rural areas. Whilst the network has faced significant technical problems and there are concerns about its sustainability, it is reported to have been well-received by staff (contributing to increased job satisfaction) and shows promising cost-effectiveness.

HINARI
Health Inter Network Access to Research Initiative.

Open-access full text journals in resource poor countries
Resource limited countries worldwide, including sub-Saharan Africa.

HINARI, supported by the WHO and publishers of scientific journals, provides free online access to 14,000 journals, 46,000 electronic books and other information sources in 100 resource-limited countries. Whilst HINARI is well used and usage has increased steadily since 2002, some authors highlight that there is still limited awareness of its existence amongst health workers.\(^\text{213,214}\) Limiting factors include difficulties in gaining access to computers and a reliable internet connection.\(^\text{192,212,325}\) The relevance to sub-Saharan Africa of much of the information provided in international journals has also been questioned.\(^\text{325}\)

Table 1j (i): Examples of e-learning approaches from sub-Saharan Africa

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\(^1\) North-south collaborations refer to links between developed countries (in the ‘global north’) and developing countries (in the ‘global south’). South-south collaborations refer to links between developing countries/regions.

\(^2\) ‘Store and forward’ technologies are asynchronous methods where data is stored on a local computer or server for onward transmission at a later time.
<table>
<thead>
<tr>
<th>Project Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telemedicine and e-learning in dermatology</td>
<td>This project uses an online platform to combine remote consultation (using uploaded photographs and case information) and e-learning. The e-learning component includes a curriculum, repository of learning materials and discussion forum. It is supported by a North-South collaboration between sub-Saharan Africa and specialist dermatology units in the USA, Australia and Europe. Its website is currently being re-developed for re-launch in October 2015.</td>
</tr>
<tr>
<td>Video-conferenced education shared with other institutions using internet or DVD</td>
<td>This tele-education service has been running since 2001 and currently offers around 1,400 hours of video-conferenced education per year across a range of topics, which are offered to other institutions in South Africa and elsewhere in the region. Material is delivered synchronously via internet or asynchronously using DVD (in places without adequate internet access). Reports highlight that the programme was beset by some initial difficulties and failures; with its providers suggesting that the programme could have been developed in a more systematic, strategic way; and also highlighting ongoing infrastructure constraints.</td>
</tr>
<tr>
<td>Institutional collaboration to develop high-quality open-access learning materials.</td>
<td>This programme focuses on the local creation of contextually-appropriate and relevant materials shared between participating institutions and more widely. In 2008, 20 modules had been completed and incorporated into the curriculum. The approach incorporates team development, an iterative design, production and review process and measures of quality-control sign-off. Educational technologists support clinicians in developing materials. External funding was obtained for this project through a North-South collaboration with the University of Michigan.</td>
</tr>
<tr>
<td>Local intranet providing offline access to web-pages in areas with low bandwidth</td>
<td>E-granary is a digital library provided on a hard drive ‘internet in a box’ system which can be accessed via local networks without using the internet. This provides access at significantly higher speeds than could be achieved over an internet connection. Whilst e-granary is an offline resource, there is interest in systems which can update this local intranet periodically using an internet connection.</td>
</tr>
<tr>
<td>Web-conferenced presentations for HIV clinicians</td>
<td>10 webinars were delivered covering a range of issues in HIV care, which could be viewed online either live (with interactive capability) or recorded. Participation increased during the ten month programme despite difficulties with computer and internet connections, and the project received generally positive feedback from participants.</td>
</tr>
</tbody>
</table>

Table 1j (ii): Examples of e-learning approaches from sub-Saharan Africa
1.6.6.2 Other regions

The evidence-base around e-learning in health worker education is better developed in other regions, reflecting the fact that these approaches are now widely adopted and considered mainstream aspects of curricula.\textsuperscript{246,296,300,302} Published reports describe a wide variety of e-learning approaches (including multimedia, interactive content, feedback, simulation, synchronous and asynchronous communication) using different technological platforms (including internet, CD-ROM, mobile devices and specialist computer software).\textsuperscript{307,344-346}

Learner and institutional perspectives

Health professionals are generally more satisfied by e-learning than traditional materials, valuing flexibility, interactivity, online discussion, auditory learning and the opportunity to take ownership and control the pace of learning.\textsuperscript{310,311,344,347,348} Generally, students see e-learning approaches as complementary, rather than as a replacement for traditional learning opportunities\textsuperscript{227,311} and continue to value opportunities for face-to-face interaction with teachers and peers.\textsuperscript{347} Institutions can benefit from the opportunity afforded by e-learning to improve the consistency of the learning programme, undertake quality-assurance, make efficiency savings\textsuperscript{257} and collaborate with other institutions.\textsuperscript{349}

Resource factors influencing learner engagement relate to:-

- usefulness\textsuperscript{346}
- ease of use\textsuperscript{311,346}
- attractiveness of learner interface\textsuperscript{311}

Other factors are important including: infra-structure (access to hardware, internet speed),\textsuperscript{311,347} skills in using technology\textsuperscript{350} (which are discussed in section 1.4.5), learner motivation and commitment to ongoing learning.\textsuperscript{351}
1.6.6.3 Implementation

Analyses from sub-Saharan Africa suggests that successful e-learning implementation will be shaped by a range of factors:\textsuperscript{148,227,315,322,343}

- Institutional support,
- Faculty engagement,
- Student engagement,
- ICT technical expertise,
- Infra-structure and support systems.

These themes are reflected in studies and reviews from other regions, which broadly highlight the importance of: the quality of the learning materials (design and content); developing the skills of teachers and learners through training and support; providing appropriate infra-structure (hardware and software); and supporting its use at institutional level (through supporting culture change and solving practical problems such as timetabling).\textsuperscript{253,270}

1.7 Health information and other learning opportunities

\textit{E-learning exists alongside the other approaches used by health workers for learning, professional development and accessing information. This section covers some alternative sources of information that are used by health workers in sub-Saharan Africa and discusses the broad need for better access to health information.}
1.7.1 Health information

1.7.1.1 Health Information for All

Internationally, it is recognised that improving access to health information for health workers is an important priority. Shortly after the Millennium Declaration and MDGs\textsuperscript{21} were published, access to reliable health information was highlighted as a pre-requisite to achieving many of these goals.\textsuperscript{352} This launched Health Information for All 2015 (HIFA2015) with the vision that:

\begin{quote}
‘Every person and every health worker will have access to the healthcare information they need to protect their own health and the health of those for whom they are responsible.’ \textsuperscript{353}
\end{quote}

HIFA has acted as a campaigning and advocacy organisation, with currently 14,000 members worldwide.\textsuperscript{353} The HIFA vision highlights that the need for better health information is not limited to health workers: patients, carers and the wider community can also benefit.

1.7.1.2 Sources of health information

Textbooks and journals

Textbooks remain the main source of health information for many health workers.\textsuperscript{185,216,354,355} Although not extensively studied, the main reported barriers relate to the quality and quantity of available textbooks (including their up-to-datedness and relevance to the local context),\textsuperscript{78,214,354,356} and this is especially true for access to books for more junior cadres and those in more remote, lower-level health facilities.\textsuperscript{354} Journals are less widely used to access clinical information than textbooks, but similar barriers seem to apply.\textsuperscript{78,354}
Meetings and seminars

Meetings, seminars, handovers and formal continuing professional development meetings are identified as important sources of information\textsuperscript{214,357} and are often part of support-supervision and health systems strengthening efforts.\textsuperscript{66,115,117} Some criticisms of existing opportunities are made: primary health workers in Malawi and Tanzania have highlighted a preference for more locally delivered training, more feedback from supervisors and more exchange of knowledge between primary care facilities.\textsuperscript{104,116} Better co-ordination of meetings (to limit staff absence) is also needed.\textsuperscript{104}

Informal learning

Health professionals in sub-Saharan Africa also report using informal discussion with peers and senior colleagues as an opportunity for learning. Limited access to other sources of information may increase the educational importance of these informal exchanges.\textsuperscript{214}

1.7.2 Open Educational Resources

Provision of materials as Open Educational Resources has the important advantage, for local organisations, that they can be legally shared and adapted for local use without incurring royalties.\textsuperscript{164,330} There is a growing movement towards Open Educational Resources and there is a handful of reports of such resources developed within sub-Saharan Africa.\textsuperscript{181,182,330} Copyright can be protected by an open copyright licence (such as that provided by Creative Commons), allowing users to licence material for open use and set limitations (such as the need for author acknowledgement and restrictions on for-profit use and modification).\textsuperscript{164}
1.8 Quality improvement

Whilst the personal growth and development for health workers are important aspects of e-learning, it is likely that most initiatives for health workers in sub-Saharan Africa will have a primary focus on delivering improved clinical care. This section therefore provides a review of quality improvement approaches and their use in healthcare.

1.8.1 Definitions

Quality improvement is defined as

‘combined and unceasing efforts of everyone—healthcare professionals, patients and their families, researchers, payers, planners and educators—to make the changes that will lead to better patient outcomes, better system performance and better professional development’. 358

Many of the current approaches were first developed in industry but have since been applied in the health sector. There are reports of successful quality improvement projects in resource-rich and resource-poor contexts. 46,111,112,359

1.8.2 Concepts

A key assumption of quality improvement is that improving the ‘structures’ and ‘processes’ of care will result in better patient ‘outcomes’. 360

- ‘Structure’ - the characteristics of providers of care and their organisation.
- ‘Process’ - the technical and inter-personal elements of the interaction between providers and patients.
- ‘Outcome’ - the improvement in health that stems from the interaction.
An important contrast between ‘research’ and ‘quality improvement’ is the importance of local context: whilst research aims to be ‘generalizable’ (applicable in a variety of contexts), quality improvement aims to produce better patient outcomes in a specific local context.

Quality improvement requires two steps, as shown in fig 1b:

- recognising how to use evidence in the local context,
- identifying and using ‘levers’ to bring about the desired change.

Fig 1b: Quality improvement formula (Betalden et al (2007))

### 1.8.3 Plan-Do-Study-Act (PDSA) approach

A variety of approaches to quality improvement have been proposed. One of the commonest is the ‘plan-do-study act’ (PDSA) cycle initially developed by Deming (1986) and applied to healthcare by Langley (1996). This approach defines a process of quality improvement which begins with three questions:-

- What are we trying to achieve?
- How will we know that a change is an improvement?
- What changes can be made that will result in improvement?
These questions then inform a quality improvement cycle with four stages, represented diagrammatically in fig 1c:-

- **PLAN** – Decide the objective or change to be made; plan how this will happen.
- **DO** – Carry out the plan (usually first as a small-scale trial).
- **STUDY** – Analyse the impact of the intervention
- **ACT** – Decide if the intervention should be adopted and identify issues which need to be addressed in the next quality improvement cycle.

The cycle is repeated until the quality improvement intervention has been optimised.

![Diagram of the quality improvement cycle](image)

**Fig 1c:** Quality improvement process (Langley et al (1996) in Boaden et al (2008))
Health worker education, as a field of research, draws on theoretical positions and methods from the educational, medical and social science traditions. These approaches are discussed in this section with a more detailed discussion of experimental methods, specifically Objective Structured Clinical Examinations (OSCEs) and their potential for measuring educational impact.

1.9.1 Definitions

Research in the field of health worker education falls into two broad groups:\textsuperscript{363-366}

- **Qualitative research** – seeking to explore social, relational and experiential phenomena in their natural setting using techniques such as observation, interview and focus groups; analysed using a transparent and systematic method.

- **Quantitative research** – seeking to gather data from experiments, surveys and other observations which are analysed statistically to test a hypothesis or characterise a population in numerical terms.

Proponents of these approaches have often been in conflict,\textsuperscript{364} but there is an emerging school of thought that, despite philosophical differences (described in more detail in section 1.9.2), both approaches bring useful insights, suit different purposes and can be complementary (for example, by triangulating qualitative and quantitative findings, using qualitative studies to generate hypotheses, develop interventions and explain statistical findings).\textsuperscript{364,367,368} More broadly, there is a wide range of methods within each tradition and these can be combined and triangulated to elucidate a research topic.\textsuperscript{369}
Utilising the strengths of qualitative and quantitative approaches is further developed in mixed methods research which intentionally combines both approaches to harness the strengths of each.\textsuperscript{369,370} Five characteristics of mixed methods have been identified:\textsuperscript{371}

- Focuses on research questions that call for real-life contextual understandings, multi-level perspectives and cultural influences.
- Employs rigorous quantitative research to assess magnitude and frequency, and rigorous qualitative research to explore meaning and understanding of constructs.
- Utilises multiple methods.
- Intentionally integrates or combines methods to draw on the strengths of each.
- Frames the investigation within philosophical and theoretical positions.

Mixed methods can be particularly valuable when there is a need for greater breadth and depth of understanding of phenomena and/or to increase the reliability of findings by triangulating findings from different methodological approaches.\textsuperscript{370} One example is the development, evaluation and implementation of complex interventions (those with several interacting components) which may usefully combine qualitative methods (to develop the intervention, understand stakeholder perspectives, process and barriers to implementation) and quantitative methods (to evaluate the impact of the intervention).\textsuperscript{372} More broadly, mixed methods can draw on the philosophical and theoretical stances of each approach (discussed below).

Whilst early users of ‘mixed methods’ studies often kept qualitative and quantitative methods separate, the term now implies that methods are intentionally integrated at the design stage to maximise the strengths and minimise the weaknesses of each approach: this includes data collection, analysis and presentation of results. Qualitative and quantitative results can be combined, for example, by ‘merging’ data (presenting qualitative quotes and themes to support and explain quantitative results using text, figures or diagrams), ‘connecting data’ (using one approach to shape a
subsequent stage of the study using another approach) or ‘embedding data’ (gathering supplemental data using another approach from within a larger study group).\textsuperscript{369-371}

A further distinction is drawn between \textbf{research} (which is motivated primarily to generate new knowledge and governed, in ethical terms, by the principles of the Declaration of Helsinki),\textsuperscript{373} \textbf{evaluation} (which defines current practice) and \textbf{audit} (which compares current practice with a pre-determined standard). Methodologically, evaluation and audit may include the use of interviews, questionnaires or medical notes, but not more burdensome assessment of participants, randomisation or additional interventions.\textsuperscript{374}

\subsection*{1.9.2 Philosophical positions}

Health research has traditionally been dominated by quantitative methods such as cohort studies, case-control studies and randomised controlled trials (RCTs) which rely on hypothesis testing, statistical analysis and (in the case of RCTs) allocation to groups\textsuperscript{366}. The philosophical position (paradigm) underpinning these methods is known as ‘positivism’ (the assumption that there is a single, objective reality which can be measured accurately by a researcher);\textsuperscript{366,375} and if this (perhaps unconscious) assumption was incorrect, valid conclusions could not be drawn from such studies.

However, health worker education is also informed by research in the fields of social science and education\textsuperscript{364} and it is therefore useful to understand other paradigms concerning the nature of reality (ontology) and knowledge (epistemology)\textsuperscript{364,365,368,376,377} which are often adopted in these disciplines and challenge positivist assumptions. Such theoretical positions are also taken by those using qualitative and mixed methods approaches in health research:-

- In ‘\textbf{post-positivism}’, a single reality is assumed to exist but cannot be objectively measured (as the act of observation changes the observed reality). No hypothesis
can be proved, only disproved; but conclusions can be strengthened if they are supported by more than one research method (‘triangulation’).\textsuperscript{378,379}

- In ‘\textit{constructivism}’, each observer constructs reality from their own experience. The role of the researcher is to compare and contrast these perspectives.\textsuperscript{375,380}

- In ‘\textit{critical theory}’, the reality of the social world has been shaped by historical, cultural, political and economic factors, resulting in power imbalances between powerful and marginalised groups. Research aims to understand and challenge these factors which also influence the values of the researcher and research participants.\textsuperscript{375}

For researchers holding strict theoretical and philosophical positions, mixed methods approaches (described above) can present a problem: combining ‘positivist’ quantitative methods with other approaches from the qualitative domain can create tensions\textsuperscript{371}. This gives rise to a ‘\textit{pragmatist}’ perspective which focuses primarily on the research question and adopts the most useful and relevant approaches for each situation\textsuperscript{369-371}. Indeed, it is argued that the dialectic between those holding different theoretical positions can generate new knowledge in the context of mixed methods approaches\textsuperscript{371}. Alternatively, mixed methods research can be underpinned by a ‘\textit{transformative}’ perspective, which (perhaps similarly to critical theory) orientates research towards creating a more just society.\textsuperscript{371}

Many of the issues raised by these philosophies have a bearing on developing a broader understanding of health worker education in different cultures: the questioning of a single objective ‘reality’; the distortion of reality that occurs through observation; the influence of historical, political and social factors on researchers’ and participants’ values and interactions; and the need to respect and understand participants’ ‘constructed’ realities are all particularly relevant.
1.9.3 Methodological distinctions

Distinctions are also drawn between quantitative research using a process of ‘deduction’ (testing hypotheses based on pre-defined theories) and qualitative research using a process of ‘induction’ (allowing ideas to develop from real-life observation). These differences underpin the different approaches to selection of study population, data collection and analysis in qualitative and quantitative methods:

1.9.3.1 Quantitative methods

Quantitative studies generally aim to describe observations in numerical terms, using measures of central tendency (e.g. mean or median), distribution (e.g. standard deviation or range), correlation or mathematical modelling; and may be observational (aiming to characterise a population and/or to find associations amongst characteristics) or experimental (aiming to measure the impact of an intervention on a population). Quantitative studies which compare groups generally start with a defined hypothesis and test whether the ‘null’ hypothesis (the hypothesis that there is no difference between experimental groups) can be safely rejected. Key to this method is that data should be collected in a standardised way from each participant using a methodology which is highly consistent and reproducible.

Sampling

A key issue in quantitative study design is to ensure that the sample studied is truly representative of the relevant population, and is large enough to make sufficiently accurate measurements and/or to accurately detect differences between groups.

In quantitative studies which compare groups, two risks arise from random sampling:
• ‘Type I error’ - incorrectly rejecting the null hypothesis: the study may find a difference which does not exist in the population but has been observed in the sample due to random effects.

• ‘Type II error’ – incorrectly accepting the null hypothesis: the study may not find a difference which does exist in the population but has not been observed in the sample due to random effects.

In all studies, there is a probability of type I and type II error. Two statistical terms are used to describe this:

• ‘Confidence’ is the probability that the study will correctly reject the null hypothesis (i.e. the probability that an observed difference in the sample is true for the population). Results are expressed as a p-value (the probability of type I error) and/or as a confidence interval (the range of values within which the true value lies with a given level of confidence). Commonly, a 95% confidence level (or a 5% probability of type I error) is used. Statistical tests are used when the data is analysed to determine p-values and confidence intervals.

• ‘Power’ is the probability that the study will correctly detect a difference between groups in the sample if it exists in the population. If a likely effect size (difference between the two groups) can be estimated at the design stage, it is possible to perform a power calculation to estimate the required sample size to reduce the probability of type II error to a given level. Commonly, 80% power (or a 20% probability of type II error) is accepted.

Statistical power is related to sample size (larger samples are more likely to detect true differences) and effect size (larger differences can be confidently detected with smaller samples). Put another way, larger samples tend to have narrower confidence intervals and can therefore detect smaller effect sizes.
Analysis

The choice of statistical test depends on several factors: different statistical measures and tests are needed depending on whether the data is categorical (nominal) (e.g. hair colour), ordinal (rank) (e.g. 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd}), dichotomous (binary) (e.g. yes, no), interval (e.g. number of children) or continuous (e.g. height). For data which is interval or continuous, a further issue is the distribution of the data: many common statistical tests, known as parametric tests (such as the Student t-test) are based on the assumption that data follows a normal distribution. If this condition is not satisfied, data may need to be ‘transformed’ statistically into a normal distribution, or analysed using non-parametric tests.

1.9.3.2 Qualitative methods

Qualitative methods are typically naturalistic, focusing on studying people in their environment and exploring social, relational and experiential phenomena and the meanings which they attach to those phenomena. Data can come from a wide range of sources including interviews (with individuals or groups), direct observation (by non-participants or by participants functioning within the group) or a review of textual documents (such as diaries or contemporary records). Unlike quantitative research, there is no pre-defined hypothesis; but instead, the research leads to the development of explanations (or putative hypotheses). This highlights a methodological advantage of ‘mixed methods’: qualitative (inductive) approaches can be used to generate hypotheses which are then formally tested using quantitative (deductive) methods; or to provide a deeper understanding of why a particular hypothesis was found to be true or false.
Sampling

For this reason, sampling methods for qualitative research are quite different from quantitative: the goal is not necessarily to study a statistically ‘representative’ sample but instead to capture the range of experiences and beliefs within the population.\(^{365,367,369,384}\)

Commonly, **purposeful sampling** (a deliberate, non-random method of sampling which seeks to sample individuals or settings with particular characteristics) is used. Examples of such methods include: \(^{385}\)

- **Typical case sampling** – the sample is designed to capture ‘typical’ individuals who are likely to have similar perspectives to the majority of the population.

- **Maximum variation sampling** – designed to capture individuals likely to represent the widest range of positions and perspectives related to the phenomenon of interest.

- **Extreme case sampling** – designed to deliberately focus on subjects likely to represent the most divergent views or perspectives within the population.

Other approaches to sampling include ‘snowballing’ (asking respondents to identify further participants from amongst their network), ‘theoretical sampling’ (generating sampling criteria from theories that emerge from the data as the study progresses) and ‘convenience sampling’ (sampling from a group that is easy to recruit).\(^{366,367,385}\)

A further difference is that qualitative methods do not start with a defined ‘target’ sample size. Instead, sampling should ideally continue using the defined sampling method until ‘data saturation’ is reached: this is the point at which no new issues, insights and perspectives emerge from new data.\(^{366,369,371,375,384}\) Decisions about whether data saturation has been achieved are complex: the researcher must carefully consider whether new data adds new themes and insights; and, if not, whether the
individuals studied up to that point are sufficiently diverse that saturation has been reached across the required sample (rather than just within a subset of the sample likely to hold similar views).

**Analysis**

The aim of qualitative analysis is generally to develop analytical categories, theories and explanations, to understand and explain the data. Typically, data such as interview transcripts or field notes, are collected and collated by the researcher. Familiarisation is an important first step in qualitative analysis: the researcher becomes ‘immersed’ in the data as a result of the research process.\(^{366,375,384}\)

In qualitative methods, it is common and often desirable for analysis to occur alongside data collection. This allows the researcher to develop and test emerging theories during data collection and change their focus during data collection based on the emerging data. Typically, textual data is analysed through a process of ‘indexing’ into categories or themes which are interpreted into concepts, theories, phenomena or associations.\(^{366,375,384}\)

Two examples of broad approaches to analysis include:\(^{379,384}\)

- ‘Grounded theory’ – the researcher starts with no pre-defined ideas or categories and these emerge solely through analysis of the data itself.

- ‘Framework analysis’ – the researcher develops categories shaped the data itself, underlying theory and the aims of the study.

Framework approaches are more likely to be applicable in applied research, where the practical advantage is that results can be obtained relatively quickly, focused on a specific question of interest and drawing explicitly on existing theory. However, the corresponding disadvantage is that the process is not purely ‘inductive’ so that
conclusions may be weighted by pre-existing ideas and theories, leading to the possibility that unexpected phenomena will be missed.\textsuperscript{384}

1.9.4 Educational endpoints

A hierarchy of educational endpoints was proposed by Kirkpatrick (1967) and subsequently applied to medical education, as illustrated in fig 1d.\textsuperscript{386-388} It can be argued that evidence from the higher tiers (such as patient outcomes) provides stronger arguments in favour of an intervention, although such studies are likely to be more methodologically challenging and prone to confounding.\textsuperscript{363,387}

![Diagram](image)

**Fig 1d:** Kirkpatrick’s original hierarchy (italics) and its application to health worker education (bold).\textsuperscript{386-388}
The distinction between ‘evaluation of behaviour’ and ‘evaluation of learning’ is important, reflecting the ‘know-do’ gap (see 1.3.3.1), and underpins the distinction between two different types of assessment.  

- **Practice-based assessment**
  Seeks to assess what health workers do in real-life professional practice.

- **Competency-based assessment**
  Seeks to assess what health workers can do in controlled representations of professional practice.

Using these definitions and Kirkpatrick’s hierarchy, practice-based assessment represents an ‘evaluation of behaviour’ in real-life settings, whereas competency-based assessment in an artificial setting represents an ‘evaluation of learning’.

Competencies can be defined as the personal attributes or levels of practical performance that learners are expected to attain and, in health worker education, this incorporates professional attitudes and practical skills, as well as knowledge. Miller (1990) developed a pyramid of competency which divides the development of competency into four steps (‘knows’, ‘knows how’, ‘shows how’ and ‘does’), as shown in fig 1e. These overlap with Kirkpatrick’s hierarchy at the ‘evaluation of learning’ and ‘evaluation of behaviour’ levels, although Miller does not include the top level of Kirkpatrick’s hierarchy: evaluation of results (improved patient outcomes).

Miller’s pyramid highlights the importance of distinguishing ‘tests of knowledge’ (such as multiple choice papers which assess at the ‘knows’ level) and ‘tests of competency’ (such as Objective Structured Clinical Examinations (described below) which assess at the ‘shows how’ level).
1.9.5 Assessment

Assessment can be defined as ‘formal action to obtain information about the competence and performance of the candidate’. Assessment is not a neutral act: it can act as a powerful motivator, with students modifying their approach to learning based on how they will be assessed and can even lead to a ‘testing effect’ of improved memory and learning occurring as a result of the test.

Assessment can be divided into:

- **Summative assessment**
  Information is obtained to make ‘pass/fail’ decisions about students’ eligibility for admission, qualification or progression to the next stage of the curriculum.

- **Formative assessment**
  Information is obtained to provide the student with feedback about their performance to help shape their future learning.
Assessment should be acceptable to students and, as it requires significant resources, needs to be efficient and cost-effective (avoiding unnecessary use of resource intensive assessment methods).\textsuperscript{392,393,398}

For assessment to be appropriate, two methodological issues are of paramount importance:\textsuperscript{366,392-394}

- **Reliability**

  This is the extent to which an assessment gives consistent results when applied to similar candidates. All assessment measurements are subject to error influenced by factors related to the candidate (such as tiredness or nervousness on the day of the assessment) and the assessment itself (such as the range of tasks assessed and examiner consistency).

  To understand reliability in clinical assessments, Collins (1998) proposed a model (illustrated in Fig 1f) in which assessments are influenced by the patient, examiner and student performance, highlighting that conclusions about the student are more reliable if methods can be developed which control these other factors.\textsuperscript{399}

\textbf{Fig 1f}: Collins’s model of the three variables in clinical examination.\textsuperscript{399}
Another approach to reliability is to ‘average’ the effect of these factors by using a large number of test items and examiners. Student nervousness and tiredness can be ‘averaged’ by testing on multiple occasions. Ensuring that a cross-section of relevant topics and skills is tested also increases reliability as it is less likely that the student will ‘lucky’ or ‘unlucky’ in terms of test content.

- **Validity**

Validity is the extent to which a test accurately measures the attribute that it aims to test. Two issues are relevant:

  - **Content validity**
    the extent to which the test covers the appropriate range of content.

  - **Construct validity**
    the extent to which the test accurately measures the attribute that it aims to measure.

Content validity can be improved by techniques such as ‘blueprinting’ (described below and illustrated in table 1k); and construct validity can be assessed by comparing students’ performance with other assessments of the characteristic being tested to ensure that results are consistent.

1.9.6 **Objective structured clinical examinations (OSCEs)**

OSCEs were developed due to concerns about the reliability and validity of traditional clinical assessments (such as ‘long’ and ‘short’ cases) which were often criticised for a narrow case-mix, a small number of examiners, non-standardised marking and inconsistent questioning; and have emerged as a popular method of clinical skills assessment in medical education (and increasingly for other health worker groups). 389,400,401
The OSCE format involves a series of ‘stations’ at which different tasks are assessed. The advantages are:.

(a) **Standardisation** - all students are tested on the same clinical scenarios, given the same instructions, asked the same questions and assessed using the same mark scheme.

(b) **Multiple data points** – each candidate is assessed several times (allowing testing across a range of skills and scenarios) and by several different examiners (to average the effect of examiner variability).

If the OSCE is well-designed, these features serve to increase reliability (by allowing a large number of independent measurements from different assessors) and content validity (by allowing measurements to be taken in stations testing a range of clinical skills and scenarios from across the relevant curriculum).

### 1.9.6.1 OSCE design

OSCE design begins by defining the skills (e.g. history taking, clinical examination) and range of curriculum topics (e.g. cardiology, gastroenterology) to be tested. An OSCE blueprint plotting these dimensions as axes on a grid (see table 1k) then ensures that the assessment covers an appropriate breadth of skills and curriculum content. Within this blueprint, suitable clinical tasks are chosen for each skill and content area.

Each station is then carefully planned with mark sheets and instructions for the candidate, examiner and patient or simulated patient. Piloting of stations is highly desirable to ensure that station is realistic (in terms of timing and level of difficulty); that instructions to candidates, examiners and patients/simulated patients are clear; and that the test is an appropriate measure of the underlying skill.
Table 1k: OSCE blueprint example (based on Boursicot et al (2007)).

<table>
<thead>
<tr>
<th>Content to be tested</th>
<th>Skill to be tested</th>
<th>History taking</th>
<th>Clinical examination</th>
<th>Explanation</th>
<th>Practical skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular</td>
<td>Chest pain</td>
<td>Peripheral pulses</td>
<td>Driving restrictions</td>
<td>BP check</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Altered bowel habit</td>
<td>Abdominal examination</td>
<td>Safe alcohol limits</td>
<td>Rectal examination</td>
<td></td>
</tr>
<tr>
<td>Reproductive/Urinary</td>
<td>Post-menopausal bleeding</td>
<td>Obstetric examination</td>
<td>Contraceptive pill advice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nervous</td>
<td>Loss of consciousness</td>
<td>Cranial nerves</td>
<td>Carpal tunnel surgery</td>
<td>Fundoscopy</td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>Haemoptysis</td>
<td>Respiratory examination</td>
<td>Inhaled therapy</td>
<td>Peak flow measurement</td>
<td></td>
</tr>
</tbody>
</table>

Mark sheets

Mark sheets can be developed either as a ‘checklist’ of specific, narrowly defined performance measures; or as a ‘global rating scale’ with more broadly defined skills. For example, in a ‘rating scale’, ‘physical examination technique’ might be marked on a five point scale (excellent, clear pass, borderline pass, borderline fail, clear fail); whereas in a ‘checklist’, physical examination technique might be divided into several processes (e.g. obtaining consent, positioning patient correctly, looking at hands etc) and marked on a simple (or even binary) scale (e.g. not done/inadequate, adequate, good). Comparisons of these approaches in undergraduate and postgraduate medical education have concluded that, when global rating scales are used by appropriately trained and experienced examiners, both methods demonstrate similar reliability (despite the fact that checklists are more objective and allow less scope for examiner judgement). It is also argued that the construct validity of global rating scales is likely to be higher (as they are less likely to de-construct clinical skills; and more likely to allow examiners to make a holistic assessment of performance and reflect more subtle, professional behaviours. In practice, a balanced approach is often advocated with checklists for assessing technical skills and global ratings for more complex skills. Where global ratings are used, examiner training is considered especially important so that these more subjective ratings are applied consistently.
Real, simulated and standardised patients

The use of patients in OSCE stations has intuitive validity: real-life symptoms and signs can be detected and the test is obviously closer to the reality of clinical practice.\(^{389,405}\) However, reliability is a potential concern: patients may tell their story differently or forget to mention a specific detail to some candidates, they may tire or struggle with the demands of repeated clinical examination, and their clinical signs may change during the assessment.\(^{399,401,402,410,411}\) Therefore, whilst real-life patients have particular value in stations which assess the candidate’s ability to detect abnormal clinical signs,\(^{412}\) simulated patients (actors who have been trained to play a particular role) are held to provide a more consistent performance and are widely used in OSCEs, especially for communication skills stations.\(^{389,399,403,405,410}\) The broader term - ‘standardised patients’ - recognises that both ‘real’ and ‘simulated’ patients can be trained to perform a consistent role, overcoming some of the criticisms above.\(^{408,410}\) Simulated and standardised patients need to be well trained and prepared (in both the verbal and non-verbal aspects of their role) and scenarios need to be carefully developed to be realistic and not artificially simplified.\(^{389,398,402,410,413}\)

Training and preparation

Training of examiners and simulated patients is an important aspect of OSCE preparation. Examiners need to understand the purpose and format of the examination, their role and how to apply the mark scheme.\(^{389,405,407}\) In addition, some OSCE formats (such as MRCP PACES) require examiners to ‘calibrate’ the station beforehand by examining the patient (to confirm the clinical signs) and making a detailed, structured record of aspects of performance to be expected.\(^{414}\) The OSCE circuit needs to be carefully organised in terms of space; recruitment of examiners, patients, simulated patients and marshals; ensuring that stations are laid out with the required equipment and mark sheets; and making provision for the care of patients during the examination.\(^{389,404,405,412}\)
Standard setting

There are two distinct approaches to determining the ‘pass’ level performance for an OSCE:389,402,403,415

- **‘Relative methods’** use the student’s position in the class to determine their performance (so that a fixed proportion of candidates at the lowest scoring end of the class will fail). For tests of competence, ‘relative methods’ are problematic as they make no attempt to define an acceptable standard of performance.

- **‘Criterion referenced’ methods** make judgements based on the expected standard of performance (so that theoretically the entire class could pass or fail the assessment depending on whether they meet the required standard).

Over 30 different criterion-based standard setting methods have been described416 of which the borderline group method has become widely-accepted on grounds of rigour and practical applicability.389,417,418 This method uses OSCE examiners themselves to determine the pass mark during the examination by making an overall judgement of how the candidate performs relative to a minimum acceptable standard.416

In this method, as well as scoring specific aspects of the candidate’s performance (using checklists or global rating scales), the examiner gives each candidate an ‘overall rating’ (e.g. ‘pass’, ‘fail’ or ‘borderline’). Marks from the checklist or global rating scales are used to calculate the individual candidate’s score for the station. The ‘overall rating’ does not contribute to the candidate’s personal score but, instead, the average score of candidates who are assessed to have an overall ‘borderline’ performance becomes the pass mark for the station. The effect is that the pass mark is derived from a large number of independent judgements from multiple assessors.389,416,419
1.9.7 Using assessment results in research and evaluation

Assessment results can be used within quantitative research methods to evaluate the effectiveness of educational interventions, although it should be recognised that these are complex interventions and several methodological issues need to be addressed.  

1.9.7.1 Allocation to groups

‘Randomisation’ (random allocation to an intervention or control group) is considered the gold-standard experimental design as it overcomes differences in baseline characteristics and hence allows conclusions to be drawn about cause and effect. However, especially with smaller sample sizes, it is possible that randomisation may randomly generate groups which are not evenly matched with respect to important baseline characteristics. This is likely to be relevant if, for example, characteristics such as previous exam performance are not matched between the groups. A ‘matched pairs’ approach overcomes this by allocating students with similar baseline characteristics to matched pairs and then randomly allocating one member of each pair to the intervention and control groups. A further advantage is that paired statistical tests may be used (which are often more powerful than unpaired tests).

Other approaches to equalising baseline characteristics include ‘minimisation’ where the probability of allocation to each group is adjusted for each new participant to reduce the overall imbalance in baseline characteristics. ‘Cluster randomisation’ can be used when individual participants cannot be randomised (as may often be the case in educational research), so that pre-existing groups of participants are randomly allocated to intervention or control groups. Importantly, the unit of randomisation is then the ‘cluster’ rather than the individual participant: analysis needs to take account of cluster-effects (baseline differences between clusters which are not attributable to
the intervention) and the power of the study can be considerably reduced compared with a study which randomises a similar number of individual participants.\textsuperscript{366,423}

1.9.7.2 Blinding/Masking

The term blinding (or more appropriately, especially in the context of ophthalmological research, masking), is the process of concealing the ‘treatment received’ from the patient and the person assessing them.\textsuperscript{381} In educational research, it is not practicable to blind learners or teachers to their allocations. However, it remains possible to ‘blind’ examiners to the candidate’s allocation. Therefore, ‘single blinding’ is feasible; but ‘double-blinding’ is not.\textsuperscript{363}

1.9.7.3 Pre-testing

Whilst studies which obtain ‘before’ (pre-test) and ‘after’ (post-test) measurements are considered superior in some areas of health research,\textsuperscript{366} this can be problematic in educational research. Candidates are likely to perform better on their second attempt regardless of any intervention. Learning is also likely to be influenced by the experience of the pre-test, especially if candidates know that they will receive a similar post-test.\textsuperscript{363,424,425} In randomised trials, pre-testing will influence the subsequent behaviour of both groups so that the study conclusions may not then be applicable to situations where the intervention is not accompanied by the pre-test, potentially limiting validity.

1.9.7.4 The control group

Whilst randomisation addresses the risk of confounding, other weaknesses are not necessarily overcome. A key consideration is how to treat the control group in a way which allows useful and valid comparisons to be made.\textsuperscript{426} For example, if students in
the intervention group receive additional teaching, there is a risk that overall instruction time becomes a confounding variable (and the hypothesis risks becoming ‘more teaching is better than less’). It is therefore more appropriate to substitute teaching elements so that overall instruction time does not become a confounding factor.\textsuperscript{363} An alternative, advocated by some influential medical educationalists in the field of e-learning, is to compare two experimental interventions\textsuperscript{301} although this is only likely to be useful if both approaches can be applied in real-life practice.

\textbf{1.9.7.5 Timing of evaluation}

It is recognised from a range of studies (across health worker groups and geographical regions) that knowledge and skills fade with time, especially if not re-enforced.\textsuperscript{85,120,427-430} Therefore, students’ performance is likely to be better if measured soon after receiving the intervention. However, the corollary is that only learning which is retained over a longer period can translate into the desired changes in real-life practice.\textsuperscript{431} Timing of evaluation needs careful consideration; and the dilemma is further complicated by the fact that post-test scores may not predict long term retention of information.\textsuperscript{430}

\textbf{1.9.7.6 Sources of bias}

Several types of bias are recognised in research studies. The Cochrane Collaboration defines five broad types of bias, reproduced in table 1\textsuperscript{381}. It is important that studies are designed to reduce this risk.
<table>
<thead>
<tr>
<th>Type of bias</th>
<th>Description</th>
<th>Relevant domains in the Collaboration’s ‘Risk of bias’ tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection bias.</td>
<td>Systematic differences between baseline characteristics of the groups that are compared.</td>
<td>• Sequence generation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Allocation concealment.</td>
</tr>
<tr>
<td>Performance bias.</td>
<td>Systematic differences between groups in the care that is provided, or in exposure to factors other than the interventions of interest.</td>
<td>• Blinding of participants and personnel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Other potential threats to validity.</td>
</tr>
<tr>
<td>Detection bias.</td>
<td>Systematic differences between groups in how outcomes are determined.</td>
<td>• Blinding of outcome assessment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Other potential threats to validity.</td>
</tr>
<tr>
<td>Attrition bias.</td>
<td>Systematic differences between groups in withdrawals from a study.</td>
<td>• Incomplete outcome data</td>
</tr>
<tr>
<td>Reporting bias.</td>
<td>Systematic differences between reported and unreported findings.</td>
<td>• Selective outcome reporting.</td>
</tr>
</tbody>
</table>

Table 1: Sources of bias (from the Cochrane Handbook).³⁸¹

Some of the methods of reducing risk of bias (such as randomisation and blinding of assessors) and the problems of doing so in educational research (such as blinding of learners and teachers) are described earlier in this section. Further risks relate to the risk of bias if those with a vested interest (especially those who developed the intervention) are responsible for the assessment methods:

- Assessors who are familiar with the content of the intervention may detect the student’s group allocation from aspects of their performance in the assessment.

- If assessment materials (such as OSCE blueprints, scenarios and mark sheets) are developed by those who developed the intervention, this may (consciously or unconsciously) focus the assessment to favour the intervention group.

- If those who developed the intervention are responsible for setting the pass mark, there is a danger that disproportionate marks might be allocated to topics covered in the intervention.

These issues need careful consideration in study design.

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1.9.8 The effectiveness of e-learning

1.9.8.1 Current evidence

Cook (2008) performed a meta-analysis of 200 studies of internet based learning interventions in health worker education and found that internet-based approaches performed broadly similarly to traditional methods; and were unsurprisingly superior to no intervention\(^{432}\). These findings reflected the conclusions of an earlier review.\(^{311}\) A further meta-analysis by Cook et al (2010) focused on studies which directly compared different computer based approaches and found that interactivity, practice exercises, repetition, and feedback contribute to improved learning outcomes.\(^{344}\) Of note, no studies were identified (in Cook’s meta-analyses or in the literature search described in this chapter) which tested the effect of e-learning on learners’ clinical skills in sub-Saharan Africa.

1.9.8.2 Proposed research directions

Cook has been an influential critic of the evidence on e-learning in health worker education, arguing that trials which compare technology-based and traditional approaches are prone to confounding and do little to change practice; and advocating that, instead, research should focus on when and how technology can most usefully be deployed and used.\(^{433}\) Other authors take a similar view that research should focus on how e-learning should be used within curricula: defining features of e-learning interventions which increase effectiveness, determining how it can form part of a blended learning approach, the extent to which general e-learning principles are applicable in health worker education and how quality standards for e-learning should be developed.\(^{270,302,346,433}\)
Methodologically, there is fundamental debate about the value of RCTs in health worker education but, whilst raising methodological criticisms, Cook advocates their continued use due to the strength of evidence they provide, especially in the context of ‘mixed methods’ studies.\textsuperscript{434}

Whilst these arguments are compelling, they may need to be tempered in the context of sub-Saharan Africa:-

- From this literature review, it appears that there are no trials of e-learning in sub-Saharan Africa despite wide-ranging evidence (described above) of differences in culture, health systems and access to infra-structure.
- Training capacity issues (described in section 1.3.1) in sub-Saharan Africa mean that the ‘traditional approaches’ to teaching are unlikely to be comparable to the studies used in Cook’s meta-analyses.\textsuperscript{432}
- The argument that comparisons of traditional and technology-based approaches do nothing to change practice is predicated on the assumption that capacity (infra-structure and skills) already exist to allow engagement with technology-based approaches. This is less likely to be the case in sub-Saharan Africa where donor investment is needed to build capacity. In this context, evidence of effectiveness over traditional approaches is more likely to influence policy and practice, including prompting investment by governmental and non-governmental donor bodies.

\textbf{1.10 Summary}

\textit{This section summarises the main findings of this literature review for each theme, and highlights directions for research which will be developed later in this thesis.}
1.10.1 Main findings

1.10.1.1 Context and challenges

Sub-Saharan Africa faces a distinct disease burden: with communicable disease and malnutrition (due to poverty and poor living standards); and emerging non-communicable diseases such as diabetes and cardiovascular disease (linked to the adoption of western lifestyles). HIV places a very significant strain on individuals, communities and health services. Health care is delivered in an evolving policy environment which is heavily shaped by non-governmental and donor bodies. There is ongoing debate about how the agenda will develop after the MDGs mature in 2015.

Two inter-related issues, health systems and human resources for health, have received significant attention: weak health systems limit the impact of interventions; human resource capacity is in crisis. These challenges require a multi-faceted response including broadening training capacity, ‘task-shifting’ to less highly trained staff, developing new cadres of health worker, improving productivity and preventing attrition (including health worker migration). There is growing interest in the role of support-supervision as a tool to improve productivity and prevent attrition. Beyond these crises, it is likely that sub-Saharan Africa will face similar demands to other regions in coming years, with demographic shift towards an older, frailer and more sedentary population; and will face the same challenges of implementing evidence-based medicine and improving the quality and safety of healthcare delivery.

E-learning approaches have some potential as part of initiatives to increase training capacity, support a more robust educational component to support-supervision and provide a means of access to health information. However, interventions need to be carefully designed, considering the broader context; and it is likely that they will work best if deployed as part of a more multi-faceted intervention to strengthen health systems and develop human resources for health. Implementation across a range of healthcare providers and educational establishments (government, private, private
not-for-profit and informal) presents a further challenge. More broadly, access to reliable, up-to-date health information is a key requirement for effective, evidence-based healthcare although it may not automatically lead to changes in behaviour (especially in the context of ‘de-motivation’ and the ‘know-do’ gap).

1.10.1.2 Current situation

The most widely understood barriers to effective use of e-learning in sub-Saharan Africa are technological: access to computers and the internet is limited, especially in rural areas, with cost of computers and internet access, speed and reliability of internet connections (and a lack of electricity in some areas) all problematic. Institutional ICT capacity is limited (although possibly better in the private/non-governmental sector); and health workers, similarly to the wider population, often rely on shared internet access (at internet cafes). Despite these limitations, health workers seem to be using computers and the internet and there is enthusiasm for its potential contribution. Access to technology is a rapidly developing area and statistical data will rapidly become outdated.

Technological barriers have led to interest in innovative approaches to delivering health information using discs on computer (DVD-ROM, CD-ROM) and television (DVD for television), local intranet, low-cost computers and mobile devices. DVD for television seems a promising platform and it is possible that DVD players will be more accessible to health workers than computers. One suggestion is to use a ‘blend of technology’, developing materials simultaneously on different platforms. These possibilities require further evaluation.

A more holistic view of barriers to e-learning for health workers in sub-Saharan Africa is lacking, even more so outside of large, urban hospitals where factors including ICT skills, culture; a lack of time, locally-relevant content and suitably qualified technical support personnel are highlighted as factors which may impact the success of e-learning interventions. Population based work on the digital-divide and models of
barriers to the use of ICT can contribute to a framework for further research in the health worker group.

1.10.1.3 Underlying theory

There is a large body of theory to support and guide the use of e-learning. Particular insights (with links to specific learning theories) include:-

- the value of well-written learning objectives and how they can be constructed (behavioural, social cognitive, adult learning theories).

- how audio and visual materials can be most effectively combined (dual code, cognitive load and multimedia learning theories).

- the need to understand the goals, values and workplace challenges of learners; and the setting in which materials will be used (adult learning, humanistic and situated learning theories).

E-learning has specific capabilities related to navigation, interactivity and synchronous/asynchronous discussion. These can be used imaginatively to improve the efficiency of learning but can also potentially confuse and distract learners, highlighting the need for thoughtful design.

To maximise usefulness, it is important to consider how e-learning materials fit within curricula, and to develop materials so that they are applicable within different curricular structures. Considering how e-learning interventions will be implemented early in the development stage is likely to result in more flexible materials. Self-contained ‘learning objects’ based on specific learning objectives are one example of how this can be done.
1.10.2 Directions for research

This review highlights several gaps in our understanding of how e-learning materials should be developed and implemented in sub-Saharan Africa which will be developed in this thesis.

(a) A few studies have explored health workers’ access, skills, confidence and current use of ICT. However, these have primarily focused on medically trained personnel and large, urban centres. There is a need for wider data from other health worker groups (nurses, midwives and mid-level health workers) and from more rural areas.

(b) A significant driver for e-learning approaches in sub-Saharan Africa comes from international non-governmental organisations and donor bodies. As such, it is important to contrast the situation in sub-Saharan Africa with that in more developed regions (to avoid inappropriate assumptions being made about infrastructure, skills and capacity).

(c) There is a need for a broader, more holistic understanding of how health workers learn, access information and use technology. Their experiences of e-learning are likely to provide insights to guide the authors of new materials and inform practical decisions about resource development (such as the most appropriate technical platform, language of instruction and setting for filming) and implementation (such as distribution, publicity and sustainability).

(d) Quality improvement approaches are broadly applicable, and the adaptation of these approaches to e-learning has potential advantages as a means of focusing and structuring development. A proof-of-concept is needed.

(e) A key goal of health worker education is to improve patient care. Understanding the current processes of care as experienced by patients is likely to provide insights which will inform the content of e-learning materials.
The effectiveness of e-learning interventions has not been tested in sub-Saharan Africa. In resource-constrained settings, there is particular value in assessing effectiveness so that limited resources are directed towards more effective interventions. Methodologies need to be carefully designed to provide insights into how the e-learning approach has aided learning and produce generalizable conclusions to guide future resource development and integration into curricula.
2.1 Introduction

The literature presented in chapter 1 highlights a lack of research to underpin e-learning interventions for health workers in sub-Saharan Africa and identifies several potential research questions. This thesis will first seek to develop an understanding of health workers’ perspectives on e-learning in sub-Saharan Africa; then apply these insights to an e-learning resource in eye health as a proof-of-concept; and, finally, use a randomised trial to assess the impact of exposure to the e-learning resource on clinical skills.

2.2 Objectives

The work will be based around three objectives, described briefly below.

**Objective 1:**
Understand and synthesise the issues affecting the development and implementation of e-learning for health workers, with a particular emphasis on sub-Saharan Africa.

**Chapters 3-6:** A variety of methods will be used to understand the range of issues affecting access to health information and the use of e-learning by health workers in sub-Saharan Africa. The aim will be to generate a holistic understanding of the current situation and future possibilities, including learners who are less well represented and described in existing literature (such as non-medically qualified personnel and those in rural locations). Comparative work will compare the situation in sub-Saharan Africa with that in the UK.
Objective 2:
Develop and pilot a new e-learning resource in eye health for health workers in sub-Saharan Africa using a quality improvement approach.

Chapters 7-10: The lessons learnt above will be applied to the development of a multimedia resource in eye health as a proof-of-concept. The aim will be develop a robust design and development process, based on a quality improvement approach, which can be applied to future e-learning projects in sub-Saharan Africa. To broaden the range of insights which shape the materials, patient perspectives will be sought through a study of patients’ journeys of care following eye injury. These will be used to identify learning needs derived from the patient experience. Piloting of the materials in sub-Saharan Africa will be undertaken as part of the process.

Objective 3:
Assess the impact of this resource on health workers’ clinical skills using a robust experimental design.

Chapter 11: The impact of the materials on medical students’ clinical skills will be assessed using a randomised trial. Such a study has not previously been reported in the literature from sub-Saharan Africa.

2.3 Organisation of the work

Within these objectives, a mixture of qualitative and quantitative methods will be used to analyse a wide range of data: questionnaires, individual interviews, focus groups, non-participant observation notes, patients’ case notes and assessment results. Due to the wide range of methods used, these will be described in each relevant chapter. Syntheses will be presented in chapter 6 (describing insights that will be applied to the development and evaluation of the e-learning resource) and in chapter 12 (bringing together the entire work). It should be noted that work on objectives 1 and 2 took place concurrently; followed by work on objective 3.
Objective 1:
Understand and synthesise the issues affecting the development and implementation of e-learning for health workers, with a particular emphasis on sub-Saharan Africa.
3.1 Abstract

**Purpose:** To explore the use of ICT in undergraduate medical education in Africa.

**Setting:** Medical schools in English-speaking countries across Africa.

**Participants:** Educators (Deans and Heads of Medical Education).

**Methods:** A questionnaire was developed to gather cross-sectional data about availability of computers, specifications, internet connection speeds, use of ICT by students and teaching of ICT and using computers for research and literature searching. Participants were contacted by postal and electronic (where possible) mailings, followed by two further monthly mailings and telephone contact with non-respondents.

**Results:** Responses were received from 53/78 institutions (68%). Median computer/student ratio 0.08 (range 0.01-0.74). Internet speeds were rated ‘slow’/‘very slow’ on a five point Likert scale by 25% of respondents overall, but by 58% in Eastern Africa and 33% in Western/Middle Africa. Mean estimates showed that campus computers more commonly supported CD-ROM (91%) and sound (87%) than DVD-ROM (48%) and internet (73%). Teaching of ICT and computerised research skills, and use of computers by medical students for research/assignments and personal projects were common.

**Discussion:** It is clear that ICT infrastructure in Africa lags behind other regions. Poor download speeds limit the potential of internet resources (especially videos, sound and other large downloads) to benefit students, particularly in Eastern, Western and Middle Africa. CD-ROM capability is more widely available. Despite infrastructure limitations, ICT is already being used and there is enthusiasm for developing this further.

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1 Published as: Williams CD, Pitchforth E, O’Callaghan C. Computers, the internet and medical education in Africa. *Medical Education*. 2010;44:485-488
3.2 Aims

- To gain an overview of medical students’ access to ICT, formal teaching in ICT skills and use of ICT at medical schools.
- To compare and contrast the situation in different geographical regions.

3.3 Methods

3.3.1 Questionnaire design

A questionnaire was developed to collect information about the size and structure of the medical school, students’ access to ICT, formal teaching of ICT and computerised literature searching, use of computers by students, and access to ICT away from medical school. At the time of preparing the questionnaire, no previous study had explored these issues and a new instrument was therefore developed drawing upon the aims of the study, a review of relevant literature (as presented in chapter 1), discussion within the research team and advice from external experts. Questions were developed and refined by discussion and consensus within the research team and then through informal pre-piloting with colleagues in the UK.

3.3.2 Piloting

More formal piloting then involved a sample of 10 institutions from different geographical regions within English-speaking Africa. Respondents were asked to complete the questionnaire and to highlight any questions which were unclear or ambiguous. Their responses highlighted three questions which required slight modification before the main study.
3.3.3 Recruitment

A list of medical schools was obtained from the list maintained by the Institute for International Medical Education\(^4^3^6\) and cross-checked with information from each medical school’s website whenever possible. After piloting, questionnaires were sent by post to the Dean and Head of Medical Education at each institution in countries where English was either the official language or widely spoken. A letter of explanation was sent with each questionnaire explaining the aims of the study, how data would be used and providing contact details for the research team.\(^1\) Careful attention was paid to confidentiality. Data was collected between January and July 2007. Two further mailings were sent at three monthly intervals, with a single electronic mailing if an e-mail address was identified from an online search. After the third mailing, non-respondents were contacted by telephone and, if contact was successful, a further questionnaire sent by post, fax or e-mail as agreed by telephone. If institutions returned more than one questionnaire, the response from the more senior faculty member was used.

3.3.4 Analysis

Data was analysed using Microsoft Excel 2007 and stratified by region and country using the United Nations Statistics Division classification.\(^4^3^5\) Cameroon, the only country included from Middle Africa, is grouped with Western Africa in the analysis. Number of responses are presented as frequencies and percentage of institutions contacted. Computer/student ratios were calculated for each institution separately and presented as country, regional and continental median and range. For other data, mean and standard deviation are presented.

\(^1\) Copies of the covering letter and questionnaire are provided electronically in addendum disc 3.
3.4 Results

53 out of 78 medical schools (68%) responded. Responses stratified by region and country are shown in table 3a. Four institutions responded to the pilot study but not the main study and their responses are included in the analysis for questions which were unchanged after piloting.

3.4.1 Institutional details

Overall, the median number of students per institution was 844 (range 83 - 9662) with Southern Africa having the largest and Eastern Africa the smallest institutions. Mean course duration was 5.7 years (SD 0.5). 96% of institutions reported receiving state/government funding.

3.4.2 Computer access

All institutions reported having computing facilities available to students. The median computer/student ratio was 0.08 (range 0.01 – 0.74) but with regional variations. Means of respondents’ estimates of the proportion of their computers with particular hardware capabilities were:- CD-ROM 91% (SD 18); DVD-ROM 48% (SD 36); ability to play sound 87% (SD 23); internet 73% (SD 30).

3.4.3 Internet connectivity

Satisfaction with internet speed was mixed. Overall, speed was rated ‘fast’ or ‘very fast’ by 19%; ‘average’ by 56%; ‘slow’/‘very slow’ by 25%. Regional variations were seen: no respondents in Northern and Southern Africa reported speeds worse than ‘average’, whereas speeds were rated ‘slow’/‘very slow’ by 58% in East Africa and by 33% in Western/Middle Africa.
3.4.4 ICT in the curriculum

Overall, 72% of institutions reported formal teaching of computing skills and 65% taught computerised literature searching, with higher rates in Southern and Eastern Africa. Mean estimates of the proportion of students using computers for producing assignments and research were 60% and 58% respectively; although, again, there were regional differences with Southern Africa reporting wider use than other regions.

3.4.5 Students’ use of ICT

The mean estimate of proportion of students using computers for personal use was 75% with the highest estimates from Southern Africa. The estimated rate of personal computer ownership by students was 27% but was higher in Southern Africa at 46%. Correspondingly, the estimated proportion of students using public computers was 58% overall, and this was lower in Southern Africa at 28%.

3.4.6 Aspirations

Respondents were generally enthusiastic about the role of computers in the medical curriculum. All respondents agreed/strongly agreed with the statement ‘I would like to improve my students’ access to IT’. 98% agreed/strongly agreed with the statements ‘I feel that computers allow my students better access to information’ and ‘I see funding computing as a priority area’.
<table>
<thead>
<tr>
<th>Region/Country</th>
<th>Number of responses (% of institutions contacted)</th>
<th>Median (range) Number of Students per institution</th>
<th>Median (range) Computer per student ratio</th>
<th>In undergraduate medical curriculum, % of institutions teaching literature searching</th>
<th>Mean (SD) Estimated % of institutions teaching computing skills</th>
<th>Mean (SD) Estimated % of institutions owning computers</th>
<th>Mean (SD) Estimated % of institutions using computers for assignments</th>
<th>Mean (SD) Estimated % of institutions using computers for research</th>
<th>Mean (SD) Estimated % of institutions using computers for personal use</th>
</tr>
</thead>
<tbody>
<tr>
<td>E Africa</td>
<td>12/18 (67)</td>
<td>550 (234-930)</td>
<td>.16 (.03-.34)</td>
<td>82</td>
<td>83</td>
<td>15 (10)</td>
<td>49 (33)</td>
<td>63 (34)</td>
<td>61 (32)</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>2/3 (67)</td>
<td>556 (500-612)</td>
<td>.12 (.05 – .18)</td>
<td>100</td>
<td>100</td>
<td>25 (-c)</td>
<td>15 (14)</td>
<td>13 (11)</td>
<td>28 (32)</td>
</tr>
<tr>
<td>Kenya</td>
<td>1/2 (50)</td>
<td>700 (-c)</td>
<td>.d</td>
<td>.d</td>
<td>100</td>
<td>.d</td>
<td>.d</td>
<td>100 (-c)</td>
<td>60 (-c)</td>
</tr>
<tr>
<td>Malawi</td>
<td>1/1 (100)</td>
<td>234 (-c)</td>
<td>.34 (-c)</td>
<td>100</td>
<td>100</td>
<td>10 (-c)</td>
<td>10 (0)</td>
<td>100 (-c)</td>
<td>90 (-c)</td>
</tr>
<tr>
<td>Moz’ambique</td>
<td>1/1 (100)</td>
<td>930 (-c)</td>
<td>.03 (-c)</td>
<td>0</td>
<td>0</td>
<td>.d</td>
<td>.d</td>
<td>50 (-c)</td>
<td>50 (-c)</td>
</tr>
<tr>
<td>Somalia</td>
<td>0/2 (0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tanzania</td>
<td>3/4 (75)</td>
<td>444 (259-920)</td>
<td>.16 (.07-.33)</td>
<td>100</td>
<td>100</td>
<td>25 (7)</td>
<td>85 (21)</td>
<td>97 (6)</td>
<td>90 (10)</td>
</tr>
<tr>
<td>Uganda</td>
<td>2/3 (67)</td>
<td>450 (300-600)</td>
<td>.18 (.17-.20)</td>
<td>100</td>
<td>100</td>
<td>5 (0)</td>
<td>73 (11)</td>
<td>48 (4)</td>
<td>53 (25)</td>
</tr>
<tr>
<td>Zambia</td>
<td>1/1 (100)</td>
<td>350 (-c)</td>
<td>.d</td>
<td>0</td>
<td>0</td>
<td>.d</td>
<td>60 (-c)</td>
<td>60 (-c)</td>
<td>10 (-c)</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>1/1 (100)</td>
<td>840 (-c)</td>
<td>.05 (-c)</td>
<td>100</td>
<td>100</td>
<td>10 (-c)</td>
<td>30 (-c)</td>
<td>40 (-c)</td>
<td>90 (-c)</td>
</tr>
</tbody>
</table>

SD = Standard Deviation;

a Including one pilot response; b Including two pilot responses;

c Single answer to questionnaire item from this group of respondents therefore range and SD not calculated;

d No answer to questionnaire item from this group of respondents, mean not calculated.

**Table 3a (i):** Questionnaire responses stratified by country and region – Eastern Africa
<table>
<thead>
<tr>
<th>Region/Country</th>
<th>Number of responses (% of institutions contacted)</th>
<th>Median (range) Number of Students per institution</th>
<th>Median (range) Computer per student ratio</th>
<th>In undergraduate medical curriculum, %age of institutions teaching literature searching</th>
<th>Mean (SD) Estimated %age owning computers</th>
<th>Mean (SD) Estimated %age using public computers</th>
<th>Mean (SD) Estimated %age using computers for assignments</th>
<th>Mean (SD) Estimated %age using computers for research</th>
<th>Mean (SD) Estimated %age using computers for personal use</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Africa</td>
<td>15/30 (50)</td>
<td>991 (539-9662)</td>
<td>.03 (.01-.13)</td>
<td>47 80</td>
<td>35 (21)</td>
<td>49 (30)</td>
<td>61 (31)</td>
<td>47 (31)</td>
<td>69 (26)</td>
</tr>
<tr>
<td>Egypt</td>
<td>5/11 (46)</td>
<td>3900 (2000-9662)</td>
<td>.01 (.01-.02)</td>
<td>80 100</td>
<td>32 (19)</td>
<td>31 (31)</td>
<td>56 (39)</td>
<td>43 (35)</td>
<td>80 (14)</td>
</tr>
<tr>
<td>Libya</td>
<td>1/4 (25)</td>
<td>539 (-)</td>
<td>.06 (-)</td>
<td>100 100</td>
<td>50 (-)</td>
<td>60 (-)</td>
<td>70 (-)</td>
<td>100 (-)</td>
<td>80 (-)</td>
</tr>
<tr>
<td>Sudan</td>
<td>8/14 (57)</td>
<td>725 (600-1250)</td>
<td>.05 (.02-.13)</td>
<td>25 63</td>
<td>36 (26)</td>
<td>61 (29)</td>
<td>68 (28)</td>
<td>39 (27)</td>
<td>66 (34)</td>
</tr>
<tr>
<td>Tunisia</td>
<td>1/1 (100)</td>
<td>.d</td>
<td>.d</td>
<td>0 100</td>
<td>30 (-)</td>
<td>30 (-)</td>
<td>25 (-)</td>
<td>40 (-)</td>
<td>50 (-)</td>
</tr>
<tr>
<td>S Africa</td>
<td>7/8 (88)</td>
<td>1110 (500-1200)</td>
<td>.16 (.12-.40)</td>
<td>100 100</td>
<td>46 (30)</td>
<td>28 (20)</td>
<td>98 (4)</td>
<td>79 (36)</td>
<td>90 (13)</td>
</tr>
<tr>
<td>South Africa</td>
<td>7/8 (88)</td>
<td>1110 (500-1200)</td>
<td>.16 (.12-.40)</td>
<td>100 100</td>
<td>46 (30)</td>
<td>28 (20)</td>
<td>98 (4)</td>
<td>79 (36)</td>
<td>90 (13)</td>
</tr>
</tbody>
</table>

SD = Standard Deviation;  
\(^a\) Including one pilot response; \(^b\) Including two pilot responses;  
\(^c\) Single answer to questionnaire item from this group of respondents therefore range and SD not calculated;  
\(^d\) No answer to questionnaire item from this group of respondents, mean not calculated.

Table 3a (ii): Questionnaire responses stratified by country and region – Northern and Southern Africa
<table>
<thead>
<tr>
<th>Region/Country</th>
<th>Number of responses (% of institutions contacted)</th>
<th>Median (range) Number of Students per institution</th>
<th>Median (range) Computer per student ratio</th>
<th>In undergraduate medical curriculum, %age of institutions teaching literature searching</th>
<th>Median (range) Computer per student ratio</th>
<th>Mean (SD) Estimated %age owning computers</th>
<th>Mean (SD) Estimated %age using public computers</th>
<th>Mean (SD) Estimated %age using computers for assignments</th>
<th>Mean (SD) Estimated %age using computers for research</th>
<th>Mean (SD) Estimated %age using computers for personal use</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+M Africa</td>
<td>19/22 (86)</td>
<td>949 (83-1380)</td>
<td>.05 (.01-.74)</td>
<td>58</td>
<td>47</td>
<td>18 (10)</td>
<td>79 (16)</td>
<td>41 (31)</td>
<td>53 (32)</td>
<td>74 (21)</td>
</tr>
<tr>
<td>Cameroon</td>
<td>1/1 (100)</td>
<td>640 (-)</td>
<td>.03 (-)</td>
<td>0</td>
<td>0</td>
<td>10 (-)</td>
<td>80 (-)</td>
<td>10 (-)</td>
<td>30 (-)</td>
<td>70 (-)</td>
</tr>
<tr>
<td>Gambia</td>
<td>0/1 (0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ghana</td>
<td>2/2 (100)</td>
<td>845 (771-918)</td>
<td>.40 (.05-.74)</td>
<td>50</td>
<td>50</td>
<td>25 (-)</td>
<td>90 (-)</td>
<td>25 (-)</td>
<td>35 (-)</td>
<td>65 (-)</td>
</tr>
<tr>
<td>Liberia</td>
<td>1/1 (100)</td>
<td>83 (-)</td>
<td>.12 (-)</td>
<td>100</td>
<td>0</td>
<td>10 (-)</td>
<td>60 (-)</td>
<td>25 (-)</td>
<td>10 (-)</td>
<td>60 (-)</td>
</tr>
<tr>
<td>Nigeria</td>
<td>15/16 (94) b</td>
<td>1080 (600-1380)</td>
<td>.04 (.01-.17)</td>
<td>60</td>
<td>53</td>
<td>19 (10)</td>
<td>79 (17)</td>
<td>47 (33)</td>
<td>61 (32)</td>
<td>76 (21)</td>
</tr>
<tr>
<td>Sier Leone</td>
<td>0/1 (0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>53/78 (68)</td>
<td>844 (833-9662)</td>
<td>.08 (.01-.74)</td>
<td>65</td>
<td>72</td>
<td>27 (21)</td>
<td>58 (30)</td>
<td>60 (34)</td>
<td>58 (33)</td>
<td>75 (23)</td>
</tr>
</tbody>
</table>

SD = Standard Deviation;

a Including one pilot response; b Including two pilot responses;

c Single answer to questionnaire item from this group of respondents therefore range and SD not calculated;
d No answer to questionnaire item from this group of respondents, mean not calculated.

**Table 3a (iii): Questionnaire responses stratified by country and region – Western and Middle Africa, and continental totals**
3.5 Discussion

This data provides a cross-sectional description of access to ICT at African medical schools from the perspective of educators/institutions and is the first study to attempt collection of such data from across the continent.

ICT capacity at medical schools in Africa clearly lags behind more developed regions. Computer ownership by a minority of students is reported and is unsurprisingly more common in more prosperous regions. There is quite widespread use of shared public facilities (such as internet cafes) away from medical school in areas with lower levels of reported personal access to computers. Particularly in Eastern, Western and Middle Africa, internet connection speeds are a likely barrier to downloading medical information, especially bulky files containing video, audio, large documents and pictures. CD-ROM appears to be more widely available and may provide a means of reaching students with poor internet access. Local intranet is another potential solution for institutions with better ‘internal’ facilities but poor ‘external’ internet links. Across the continent, the majority of institutions provide literature searching and computing skills training; and this data shows that students are already using ICT for literature searching, preparing assignments and personal tasks such as e-mail, suggesting both a degree of applied ICT skill and willingness to use technology. Educators are positive about the opportunities provided by ICT and funding such developments.

Many of the findings triangulate with other studies (summarised in chapter 1) which used other methods of data collection. The more recent Sub-Saharan Africa Medical Schools Study (SSAMS) presented wide-ranging data on medical education in the region using a combination of questionnaires and site visits, highlighting a lack of infrastructure and internet connections. Questionnaire studies of students and doctors at individual institutions broadly corroborate that ICT skills are reasonably well developed amongst medical students and doctors and that computer and internet use are quite widespread despite infra-structure limitations. The findings also corroborate studies of health workers and the wider population related to widespread
use of shared internet facilities\textsuperscript{157,173,174,214-217} with lower (but variable) rates of personal computer ownership\textsuperscript{213,215,217} and frustrations about levels of access, cost and speed of computer/internet access.\textsuperscript{151,153,161-163,212,214}

This study is subject to several limitations. The SSAMS study identified 168 medical schools in sub-Saharan Africa, suggesting that a significant proportion was not included in this study (due partly to a large number of recently established institutions).\textsuperscript{75}

Institutions were contacted by postal and electronic mailing and, given that communications infra-structure is unevenly developed across the continent (as discussed in chapter 1), it is likely that countries with less well-developed postal and ICT infra-structure might be under-represented. This study relies on reports from senior faculty members (Deans and Heads of Medical Education): whilst these were targeted for their broad overview of the topic (including students’ use of computers and the role of ICT in the curriculum) and visibility within institutions (so that postal/electronic mailings would be likely to reach them), it is likely that more accurate estimates of computer numbers would be obtained from those with direct responsibility for ICT infrastructure. Estimates of computer and student numbers are prone to error and it is possible that respondents calculated these in different ways. Therefore, ‘computer per student’ ratios should be interpreted with particular caution.

Data is aggregated at country, regional and continental level and there is a risk that inter-regional and inter-continental differences are lost in these figures. Further limitations relate to the speed with which data is likely to become outdated and the lack of data from training institutions for other health worker groups such as nurses, midwives and mid-level personnel (although the lack of a register of training institutions for these cadres is a significant barrier). Also, findings may not be reflected in non-English speaking countries which have, in population-based studies (see chapter 1), lower internet penetration.

Regular longitudinal data collection from institutions is likely to provide useful insights into how ICT capacity is developing and being applied in evolving medical student curricula. Including more objective measures within the questionnaire (such as asking
respondents to download standardised file sizes/types and record the time taken) could provide a more accurate assessment of internet speed.

3.6 Conclusions

This study provides an overview of the current situation related to access and use of ICT at medical schools in Africa from the perspective of educators. Whilst data is subject to several potential sources of error, the results highlight the extent to which technology is already being used and the levels of enthusiasm about ICT and e-learning. The main barriers which emerge from this study are speed of internet access and limited access to technology, especially in less developed regions of Africa.
4.1 Abstract

**Purpose:** To compare and contrast the issues affecting use of ICT for continuing professional development (CPD) by non-medically qualified health professionals in ‘resource rich’ and ‘resource poor’ countries.

**Setting:** Leicester Children’s Hospital, Leicester Royal Infirmary, UK; Mnazi Moja Hospital, Stone Town, Zanzibar, Tanzania; and Makunduchi Hospital, Zanzibar, Tanzania.

**Participants:** Children’s nurses \((n = 112)\) in the UK; Nurses/midwives \((n = 65)\) and mid-level health workers (Clinical Officers and Assistant Medical Officers) \((n = 36)\) in Zanzibar.

**Methods:** Questionnaires were developed for each location covering access to ICT, skills and confidence, barriers and opinions about ICT and professional development habits. The Zanzibar questionnaire was translated into KiSwahili. After piloting, volunteers in each setting were invited to complete the questionnaire. Statistical analysis was performed for structured items and thematic analysis for open responses. The findings from each setting were compared and contrasted.

**Results:** In the UK, access to technology was widespread (92% had a home computer, 87% had internet) and most nurses used technology regularly for day-to-day tasks including CPD. Internet was a common source of professional development materials. A significant minority (more likely to be older and part-time staff) reported lack of ICT access, skills and confidence. Analysis of qualitative data highlighted a more complex picture related to use of ICT for CPD with uptake related to environmental, individual and resource factors. In Zanzibar, access to technology was more limited (32% of nurses and 8% of mid-level workers had never used a computer; and only 5% of nursing and 21% of mid-level staff owned their own computer). The commonest places for accessing ICT were computers at work and internet cafes. Mid-level staff generally reported higher levels of access, skills and use of ICT than nurses. Qualitative
responses from this group focused on issues of infra-structure and ICT skills. *Across both settings*, access to DVD for television was widespread (100% of respondents in the UK, 74% nursing and 88% mid-level staff in Zanzibar).

**Discussion:** *In the UK*, most nurses are actively engaged with technology but a significant minority has limited ICT access, skills and confidence; and is therefore likely to have particular problems accessing CPD provided using computers. *In Zanzibar*, access is less widespread and respondents rely more heavily on ‘shared’ ICT facilities (such as internet cafes and work computers). *Across both settings*, DVD for television is widely available and is therefore a potential alternative platform for delivering CPD materials. However, to maximise accessibility and acceptability, it may be preferable to develop materials for more than one technological platform when possible (e.g. DVD for television and internet). In the UK cohort, nurses frequently raised issues such as work-life balance, family commitments and workplace morale as influences on their uptake of technology based CPD, alongside other individual, environmental and resource factors. Addressing these issues may increase the uptake and acceptability of technology based CPD and should be considered when implementing such programmes. These issues were not raised by the Zanzibar cohort but it seems likely that they will become more relevant as infrastructure and ICT skills develop.

### 4.2 Aims

- To understand issues related to use of ICT and current CPD activities from ‘front line’ health workers in two contrasting settings (UK and Zanzibar, Tanzania).
- To develop a model of factors affecting the use of ICT for CPD in each setting.
4.3 Methods

3.2.1 Setting

Data was collected in two contrasting settings. In the UK, data was collected from all in-patient paediatric wards at the Leicester Royal Infirmary Children’s Hospital, a large teaching hospital paediatric unit comprising an acute admissions unit and six children’s wards (covering medical, surgical and medical/surgical specialties and haematology/oncology). In Zanzibar, data was collected from two provincial hospitals: Mnazi Moja Hospital, Stone Town (the regional hospital) and Makunduchi Hospital (a smaller satellite hospital). UK data was collected in April – July 2007 and Zanzibar data from July – September 2010. Institutions were chosen pragmatically to ensure contrasting settings: in the UK, a large teaching hospital unit in a ‘resource-rich’ country where ICT has been available in home and work settings for many years; and in Zanzibar, two smaller institutions in ‘resource-poor’ countries, away from large cities and where ICT infrastructure is less well developed.

4.3.1 Participants

In the UK study, all trained children’s nurses working on in-patient wards across the Children’s Hospital were invited to participate. In Zanzibar, all nurses and mid-level workers across the two hospitals were invited to participate. The Tanzanian health system recognises two cadres of mid-level health workers who undertake some of the responsibilities traditionally undertaken by medically qualified doctors (including clinical assessment of patients and prescribing):\(^437\)

- **Clinical officers** are the more junior cadre, entering training either direct from secondary school or following qualification as a nurse/midwife. They receive three years of initial training leading to a Diploma in Clinical Medicine. Their scope of practice includes the assessment and management of common medical, paediatric, simple surgical and reproductive health problems, typically serving more rural
populations). Specific exclusions to their scope of practice include performing Caesarean sections.

- **Assistant medical officers** are more senior. To enter training, they need to have completed the Diploma qualification (required for Clinical Officers) and to have three years’ experience in a health facility. They receive a further two years’ training including obstetrics, surgery and more advanced training in medicine, paediatrics and reproductive health leading to an Advanced Diploma in Clinical Medicine. Their scope of practice specifically includes surgical and obstetric care and they typically take greater responsibility for planning, co-ordination and supervision of health services.

### 4.3.2 Development and piloting of questionnaires

#### 4.3.2.1 UK Questionnaire

The UK questionnaire aimed to cover: (i) access to information and communications technology (ICT) at home and work, (ii) current activities undertaken using ICT, (iii) resources used for continuing professional development (CPD), (iv) previous training in the use of ICT and (v) opinions about ICT and potential barriers. As no questionnaire studies were identified which had previously addressed these issues, a new instrument was developed based on the aims of the study, a review of the relevant literature (as presented in chapter 1), discussion within the research team and with external experts.

Questions were developed and refined by discussion and consensus within the research team and then informally pre-piloted with a group of practising nurses. The questionnaire contained a combination of closed questions (seeking factual responses about their use of different type of technology, CPD resources and demographic data (age, gender, date of first qualification, weekly hours of work and pay-band)), Likert items (seeking their level of agreement/disagreement about barriers), rankings (of
preferred technology platforms) and open-ended questions (to invite more detailed responses and highlight new issues). For Likert items, a five point rating was used to allow participants to give a ‘neutral’ response.

The questionnaire was piloted with five practising nurses who were invited to complete the questionnaire with the author. Note 1 They were asked to highlight any questions which were inaccurate or ambiguous and discuss their answers in more detail. Through these discussions, the author identified ambiguous or unclear questions and proposed some minor changes to the questionnaire. Note 2

4.3.2.2 Zanzibar Questionnaire

The Zanzibar questionnaire was adapted and shortened from the questionnaire developed and used in the UK, aiming to cover: (i) access to technology, (ii) training and confidence in using technology, (iii) resources used for CPD, (iv) opinions about ICT and potential barriers. Adaptations were made based on the aims of the study, literature review and discussion within the research team and with external experts (from the UK, Zanzibar and elsewhere in sub-Saharan Africa). Similar to the UK questionnaire (described above), the questionnaire contained a combination of closed questions, Likert items and rankings. Space for additional free-text comments was provided. Data was also collected on job title (nurse, midwife, clinical officer, assistant medical officer). The questionnaire was translated into KiSwahili by a native speaker and the translation independently checked by a second native speaker to confirm the accuracy of the translation. Piloting was undertaken with five nursing staff who completed the questionnaire with a KiSwahili speaking researcher. No problems with this version of the questionnaire were reported.

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1 Throughout, ‘the author’ refers to the author of this thesis.
2 Copies of the questionnaires and publicity materials for each setting are provided electronically in addendum disc 3.
4.3.3 Data collection

A similar approach to data collection was used in each setting: written information was provided in advance with assurances that participation was voluntary and responses would be reported anonymously. A series of visits was then made to each ward and clinical area; at least one visit was made when each member of staff was scheduled to be at work. At each visit, the study was explained to the personnel on duty. Potential respondents were offered the opportunity to complete the questionnaire independently or for a researcher to fill in the questionnaire with them. Whenever possible, if respondents were willing to take part but not free at the time of the visit, a further visit was made at a convenient time. In Zanzibar, to reduce the risk of bias as a result of respondents’ perceptions of the researcher’s status or role, visits were made by Tanzanian personnel who had undergone training and familiarisation with the purpose of the study, ethical issues related to questionnaire collection (including the need for informed consent and confidentiality), the need for accurate recording of participants’ answers and good record keeping.

4.3.4 Analysis

Questionnaire responses (qualitative and quantitative) were computerised using Microsoft Excel 2007 and analysis performed using IBM SPSS version 16. The questionnaire gathered a combination of dichotomous and ordinal data related to use of technology and CPD activity; and associations were sought between these data and the following predictor variables: age, hours of work, gender, seniority and (in Zanzibar) professional group. Association with predictor variables was sought using logistic regression, Kendall tau-C (Tc) or Mann-Whitney test (U) as summarised in table 4a. For logistic regression, unadjusted (crude) odds ratios were calculated using a univariate model; and adjusted odds ratios were calculated using a multivariate model which contained the predictor variables listed above.
Table 4a: Statistical tests used to explore associations with predictor variables

Free text responses were analysed using a framework approach, as described by Pope et al (2000). An initial thematic framework was developed from the aims of the study based on a literature review (see chapter 1) and discussion within the research team. Responses were read and re-read for familiarisation by the author, and then indexed and categorised within the thematic framework using QSR N6. This was an iterative process so that new themes were added to the framework based on emerging themes in the data. After this stage, the categorised data was comprehensively discussed within the research team and any disagreements about categorisation resolved by consensus. Next, categories were classified into clusters of

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1 Likert items were also analysed as ordinal data.
2 $e^B$ (logistic regression) for interval predictors is the change in odds ratio for each unit increase in the predictor. This is analogous to the odds ratio (OR) for dichotomous predictors.
3 $T_c$ is the rank association of the independent and dependent variable; 1 indicates perfect positive association; -1 indicates perfect negative association; 0 indicates no association.
4 Data on seniority was dichotomised in the analysis: in the UK, nurses in band 5 formed the ‘less senior’ group and nurses in band 6/7 formed the ‘more senior’ group; in Zanzibar, clinical officers and assistant medical officers were grouped as ‘mid-level’ workers.
5 Mann Whitney U statistic is count of pairwise wins (each counted as 1) or ties (each counted as 0.5)
6 Throughout, ‘the author’ refers to the author of this thesis.
related themes; with further discussion within the research team to agree these classifications.

Statistical and qualitative results are presented for the UK and Zanzibar.

4.4 Results

4.4.1 UK setting

124 nurses were available on the wards at the time of the study (excluding staff on maternity, long term absence or secondment elsewhere). 112 responses were collected (88%). Median age: 30 years (range 22-59), median time since qualification 7 years (range 0 -39). 94% female and 6% male. 75 (67%) worked full-time (37.5 hours per week) and 37 (33%) part time (range 11.5 - 37.5 hours per week). Pay bands were 79% band 5, 15% band 6, 6% band 7 (most senior).

4.4.1.1 Quantitative data

Access to technology

At home, 92% had computer access and 87% had internet access. 91% could play CD-ROM and 82% could play DVD-ROM. All respondents had a television DVD player at home although three (3%) respondents (all aged 46 and over) could not use it without help from family. At work, all respondents had computers in their clinical area, although 17% did not have current passwords. Younger nurses were less likely to have a current password although this did not reach significance in the multivariate model (unadjusted $e^b=1.093$, $p=0.028$; adjusted $e^b=1.085$, $p=0.087$). Only 5% of staff found it easy to use a computer for 30 minutes at work without disruption, and 61% of staff reported that this was impossible.
Use of ICT

Fig 4a shows the frequency with which nurses in the UK cohort performed different tasks with ICT at home and work. (Apart from CPD, the questionnaire did not ask respondents to differentiate professional and personal computer use). Staff who worked fewer hours tended to use internet ($Tc=0.167$, $p=0.007$) and email ($Tc=0.143$, $p=0.023$) at home less frequently; and also tended to use their home computer for CPD activities less frequently ($Tc=0.156$, $p=0.014$). Older staff tended to use internet ($Tc=-0.194$, $p=0.010$) and e-mail ($Tc=-0.143$, $p=0.041$) less frequently at home, and use the internet less frequently at work ($Tc=-0.204$, $p=0.023$). Senior nurses tended to check e-mail ($Tc=0.212$, $p<0.001$) and use computers for CPD at work ($Tc=0.164$, $p=0.010$) more frequently.

Current use of learning resources

Table 4b shows the proportion of respondents who had used different formats of learning resources for CPD in the last six months. Nurses working fewer hours were less likely to have used journals (unadjusted $e^{B}=1.06$, $p=0.038$; adjusted $e^{B}=1.12$, $p=0.005$). More senior nurses were more likely to have been on day release courses (unadjusted OR=3.528, $p=0.008$; adjusted OR=3.976, $p=0.009$). Older nurses were more likely to have used DVD for television (unadjusted $e^{B}=1.081$, $p=0.010$; adjusted $e^{B}=1.114$, $p=0.002$ in multivariate model). Younger nurses were more likely to have used the internet for CPD although this did not reach significance in the multivariate model (unadjusted $e^{B}=0.943$, $p=0.031$; adjusted $e^{B}=0.958$, $p=0.161$).
Fig 4a: Frequency of performing ICT tasks (UK cohort, bar labels show % of responses)
<table>
<thead>
<tr>
<th>Learning Resource Used</th>
<th>Percentage of respondents using resource format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books</td>
<td>80</td>
</tr>
<tr>
<td>Residential courses</td>
<td>7</td>
</tr>
<tr>
<td>Journals</td>
<td>84</td>
</tr>
<tr>
<td>Ward based courses</td>
<td>98</td>
</tr>
<tr>
<td>Day release courses</td>
<td>35</td>
</tr>
<tr>
<td>Distance learning courses</td>
<td>10</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>15</td>
</tr>
<tr>
<td>DVD for TV</td>
<td>13</td>
</tr>
<tr>
<td>Internet</td>
<td>84</td>
</tr>
</tbody>
</table>

Table 4b: Learning resources used for CPD by UK cohort in last six months

Home was the preferred venue for CPD in 65%, work for 29% and university/college for 6%. 40% of respondents reported having received ICT training although only 8% had received such training since qualification. Similarly, 21% reported training in using the internet but only 5% since qualification.

**Barriers and opinions on use of ICT**

Fig 4b shows respondents’ views of potential barriers to the use of ICT for professional development (as five point Likert items). ICT skills were more likely to be considered a barrier by older (Tc =-0.341, p<0.001) and part time staff (Tc=0.185, p=0.006). Free time at home was also more likely to be a barrier for older (Tc=-0.216, p=0.008) and part-time staff (Tc=0.165, p=0.011). Younger nurses were more likely to see the cost of buying resources as a barrier (Tc=0.161, p=0.041).
Fig 4b: Barriers to use of ICT for professional development showing extent of agreement/disagreement with each factor as a barrier. (UK cohort, bar labels show % of responses). SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree.
Preferences of format

Respondents were asked to rank different formats in order of preference (1<sup>st</sup> – 4<sup>th</sup> choice) for an example educational resource. Results are shown in figure 4c.

![Preferred resource formats](chart)

**Fig 4c:** Preferred resource formats (UK cohort, bar labels show % of responses), (1<sup>st</sup> (favourite) – 4<sup>th</sup> (least favourite))
4.4.1.2 Qualitative Data

All UK respondents provided one or more free-text comments. Ten themes arose from this data, which were grouped into infra-structure, individual and resource factors.

Infra-structure factors

These related to the availability of infra-structure in the respondents’ environment; and issues affecting their ability to make use of available infra-structure for CPD purposes.

Computer access at home

Nurses without computer/internet access at home voiced concerns that they might be disadvantaged. For others, access was limited by sharing computers with other family members, particularly children. Respondents mentioned a range of distractions at home: family, housework and leisure, which reduced their likelihood of doing CPD at home.

“I could sit in front [of a TV] and do it in my own time. Otherwise, have to fight for computer.”

Respondent A20 (36-40y, female, band 5, part time)

“Children are a big issue”

Respondent B10 (26-30y, female, band 5, part time)

Computer access at work

Use of computers at work for CPD was not generally considered viable because of time pressures and limited numbers of computers, reflecting the quantitative data. Some
were concerned about how using computers at work might appear to patients and colleagues.

“Never enough time to do it at work. Can barely staff the wards but it would be nice in an ideal world”

Respondent C5 (31-35y, female, band 5, full time)

“Sometimes not seen as being ‘as important’ as clinical care. Using computers seen as messing around”

Respondent A9 (40-45y, female, band 6/7, full time)

Individual factors

These related to individuals’ preferences, attitudes and beliefs which influenced their engagement with technology-based learning and wider CPD activity.

Time and work life balance

Time and work-life balance were key concerns. Time for study, at work and home, was considered short. Several respondents were not willing to do technology based CPD in their own time, either because it upset their work-life balance or they would not be paid. A larger number of respondents felt that there was a distinction between self-directed and compulsory study; this group was happy to study subjects that interested them in their own time. A third group was happy to use their own time both for compulsory and self-directed study.

“I would not be happy to do compulsory training at home. I spent a lot of time doing work at home for qualifications. You need to separate work and home as best you can”

Respondent C6 (36-40y, female, band 5, full-time)
Learning style

Respondents who preferred to study at their own pace or liked spoken, video and pictorial material tended to be positive about technology-based learning whereas those with a preference for questioning colleagues, practical demonstrations and group learning had reservations about this approach. Some considered DVD-TV useful for group study. Internet and CD/DVD-ROM were favoured by those who liked to control their learning. DVD-TV was favoured by those who preferred watching prescribed content. Respondents who liked to read around a subject preferred books, with e-learning as an additional resource.

“CD-ROM/DVD comes across that there would be something to watch rather than lots of text. I hate reading at best of times.”

Respondent C4 (21-25y, female, band 5, full time)

“Would like control over what I was learning. If it was just played then mind would wander”

Respondent G16 (26-30y, female, band 5, full time)

Perceived learning needs

Respondents’ perceived learning needs were also important, reflecting the distinction between compulsory and self-directed study. Relevance to clinical setting and level of interest in the topic were important.

“Resource would have to be relevant to my clinical area”

Respondent A9 (46-50y, female, band 6/7, full time)

“It would have to be something relevant and interesting”

Respondent E2 (46-50y, male, band 5, full time)
ICT skills

Another key issue was ICT skills, reflecting the quantitative data. Respondents reported lacking skills, feeling under-confident or fearful of appearing stupid or becoming flustered. Some voiced a need to be shown how to use technology-based learning resources or for broader ICT training.

“It is often presumed that you can use computers but I find them difficult”

*Respondent D3 (31-35y, female, band 6/7, full time)*

“Fear of appearing stupid if other people explain things”

*Respondent E15 (51-55, female, band 5, part time)*

Morale and relationship with organisation

Several nurses reported low morale as a barrier to using technology-based learning for CPD, mentioning low staffing levels or feeling undervalued.

“I am not motivated to use what I do have access to – low morale about job...

*Low staffing levels caused morale to fall.*”

*Respondent B6 (46-50y, female, band 5, full time)*

Resource factors

These related to the development, design and implementation of specific technology-based learning resources.
Quality of resource

Unsurprisingly, the quality of the resource was important, particularly that resources were up to date, locally relevant, succinct, quick to load and easy to navigate.

“[Other barriers:] if programs were slow, difficult to use etc”
Respondent F12 (36-40y, female, band 5, part time)

“On internet, it would be great as information can be regularly updated”
Respondent D3 (31-35y, female, band 6/7, full time)

Perceptions of format

Respondents mentioned a range of beliefs about the features of different technology platforms. Often, this was based on previous (good or bad) experience, but sometimes on information from others or instinctive reaction. Specific issues affecting preference of platform included portability, download speeds, size of screen, setting up materials (time and expertise), ease of finding relevant material and comfort whilst learning.

“Most would prefer website. More control over which parts you look at. On DVD may have to sit through things you already know.”
Respondent A2 (26-30y, female, band 5, full time)

“Internet is easy access, open to all, don’t have 2 discs between 200”
Respondent B9 (31-35y, female, band 5, part time)

Awareness of availability

Finally, respondents mentioned limited awareness of available resources and how to obtain them. There were concerns about quality assurance and difficulties in accessing password protected educational sites.
“Do not have passwords for peer-reviewed sites”

Respondent F9 (21-25y, female, band 5, full time)

“[Other barriers:] Knowing where to look”

Respondent D2 (26-30y, female, band 5, full time)

“Would like some teaching on using the internet to obtain some quality information”

Respondent F15 (51-55y, female, band 5, part time)

4.4.2 Zanzibar data

A total of 101 eligible staff (65 nursing (nurses/midwives) and 36 mid-level (assistant medical officers and clinical officers) were employed across the two hospitals. Of these, 44 nursing and 24 mid-level staff completed questionnaires (response rate 67% (68% nursing and 67% mid-level). Median age 30y (range 23-50), 61% female and 39% male (nursing staff: median age 32y (25-50), 81% female, 19% male; mid-level staff: median age 30y (23-48), 23% female, 77% male). Results are presented for all staff (combining nursing and mid-level staff) and separately for each group. As there is regular movement of staff between the two hospitals and several split their time between the two institutions, data for both institutions is combined in this analysis.

4.4.2.1 Quantitative data

Access to technology

23% of respondents (32% nursing and 8% mid-level) had never used a computer; with nurses significantly more likely to have never used a computer (unadjusted OR=5.135, p=0.043; adjusted OR=7.456, p=0.042).
5% of nursing and 21% of mid-level staff owned their own computer; 5% of nursing and 4% of mid-level staff accessed a friend’s computer; 27% of nursing and 38% of mid-level staff accessed a computer at work; and 23% of nursing and 33% of mid-level staff accessed computers at an internet cafe. 94% of respondents (92% nursing and 96% mid-level) had a television at home, and 79% (74% nursing and 88% mid-level) had a DVD player.

Use of ICT

59% of respondents (55% nursing and 67% mid-level) had their own e-mail address; 67% (58% nursing and 83% mid-level) had previously used the internet; and mid-level staff were more likely to have used the internet, although this did not reach significance in the multivariate model (unadjusted OR=3.600, p=0.042; adjusted OR=3.959, p=0.088). 37% of respondents had received formal training in computers (37% nursing, 38% mid-level). Fig 4d shows respondents’ reports of when they last used a computer. Mid-level staff tended to have used a computer more recently (U=334.000, p=0.037).

Fig 4d: Last use of computer (Zanzibar cohort, bar labels show % of responses).
Confidence

Fig 4e shows respondents' ratings of their confidence in performing different tasks using technology. Mid-level staff tended to be more confident than nurses with using e-mail (U=315.000, p=0.023), CD-ROM (U=298.500, p=0.006) and word processor (U=242.000, p<0.001).

**Fig 4e:** Confidence in performing ICT related task (Zanzibar cohort, bar labels show % of responses) showing extent of agreement/disagreement that they are confident to perform each task.
Current use of learning resources

Respondents were asked to rate which ICT resources they had used to access information related to their work the preceding six months. Results are shown in table 4c.

<table>
<thead>
<tr>
<th>Learning Resource Used</th>
<th>All</th>
<th>Nursing</th>
<th>Mid-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books</td>
<td>68</td>
<td>64</td>
<td>75</td>
</tr>
<tr>
<td>Courses</td>
<td>50</td>
<td>46</td>
<td>58</td>
</tr>
<tr>
<td>Journals</td>
<td>52</td>
<td>50</td>
<td>54</td>
</tr>
<tr>
<td>Training meetings at the hospital</td>
<td>37</td>
<td>39</td>
<td>33</td>
</tr>
<tr>
<td>Training meetings away from the hospital</td>
<td>24</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>CD-ROM or DVD</td>
<td>37</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Internet</td>
<td>29</td>
<td>16</td>
<td>54</td>
</tr>
</tbody>
</table>

Table 4c: Learning resources used for CPD by Zanzibar nursing and mid-level staff

Mid-level workers were more likely than nurses to have used the internet for CPD in the last six months (unadjusted OR=6.246, p=0.002; adjusted OR=9.660, p=0.011). Older staff were more likely to attend training meetings away from the hospital (unadjusted \( e^B = 1.143, p=0.012 \); adjusted \( e^B = 1.207, p=0.007 \)). This trend was also significant for the nursing group (unadjusted \( e^B = 1.177, p=0.030 \); adjusted \( e^B = 1.165, p=0.046 \)). In multivariate modelling, mid-level workers were more likely than nursing staff to attend training meetings away from the hospital (adjusted OR=44.9, p=0.007), although this was not significant in univariate analysis (probably due to the impact of adjusting for age in the multivariate model). Older nursing staff were more likely to attend training meetings at the hospital, although this did not reach significance in the multivariate model (unadjusted \( e^B = 1.135, p=0.048 \); adjusted \( e^B = 1.019, p=0.062 \)).
Barriers and opinions

Respondents were asked to rate how easily they could access educational materials provided on three common formats: CD-ROM, DVD and internet, and also how they rated different barriers to use of ICT as five point Likert items. Results are shown in fig 4f and 4g. Mid-level staff were more likely to be able to use educational materials provided on internet (U=343.000, p=0.002).

![Barriers and opinions](image)

**Fig 4f:** Ease of use of different technology-based learning resource formats for Zanzibar cohort, showing agreement that they can use each format (percentage of respondents).
Fig 4g: Barriers to use of ICT (Zanzibar cohort, bar labels show % of responses) showing extent of agreement/disagreement with each factor as a barrier.
4.4.2.2 Qualitative data

Four themes arose from the data, which are grouped into infra-structure and individual factors. Of note, only 11 respondents made any free text comments on the questionnaire, mostly about infra-structure. Their comments reflected the quantitative data.

Infra-structure factors

Respondents highlighted access to computers, electricity supply and ICT training. Several respondents voiced a wish to see computers in their work area.

“It is good to progress with science and technology. We need one computer for every ward to simplify our job. It will keep us up to date and help our patients.”

Respondent 5 (21-25y, female, nurse)

First we need enough computers and training. Electricity can be a problem

Respondent 15 (26-30y, female, nurse-midwife)

Individual factors

The ICT skills of staff were also highlighted as an issue.

We need more skills for computer use and email.

Respondent 35 (26-30y, male, clinical officer)
4.5 Discussion

This data provides insights into the issues affecting the use of technology based learning for CPD amongst nurses in the UK and nurses and mid-level staff in Zanzibar, Tanzania. The UK data describes how nurses perform CPD; highlights the perceived barriers, needs and preferences and shows how these issues correlate with age, seniority and hours of work; with qualitative data which develops a more holistic view of the influences on uptake of technology-based learning and CPD opportunities. The Zanzibar data provides insights into access to ICT by health workers in sub-Saharan Africa, outside of large central referral/teaching hospitals. This population (nurses and mid-level health professionals) has not previously been well studied.

The study is subject to several limitations. Both questionnaires were developed specifically for this study and there are limitations in the design and piloting stages. More detailed qualitative work to refine research questions may have resulted in a more reliable questionnaire, and, for assessing opinions, a better instrument would comprise multiple Likert items which are tested for validity and reliability at the piloting stage, with the most consistent items being combined into a Likert scale. Due to this limitation, data about opinions obtained from this questionnaire should be interpreted with some caution. A further limitation is the potential for bias due to participants not wishing to admit to negative opinions or a lack of skills/access, especially when the questionnaire was completed with a researcher present. In the Zanzibar study, better validation of the translation would have been achieved if a formal, independent ‘back translation’ of the questionnaire had been undertaken prior to piloting (although it should be noted that no ambiguities were subsequently detected in Zanzibar at the piloting stage). Responses from the UK study were also higher (88%) than in Zanzibar (67%) and, moreso at this lower response rate, the results may be influenced by sampling bias: for example, males represented a higher proportion of mid-level respondents and females a higher proportion of nurse respondents. Unfortunately, data on gender distribution of nurses and mid-level health workers in Zanzibar is not available for the study period across the population.
as a whole, so it is not possible to compare these proportions with the overall population.

4.5.1 UK dataset

The data shows that the vast majority of UK nurses are already actively engaged in CPD, have access to ICT and use it confidently for personal and work related tasks such as CPD. However, a significant minority faces problems with ICT access, skills and confidence: 8% do not have a home computer, 14% do not have access to internet at home and 15% use the internet less than once every six months. Furthermore, even when nurses have computers at home and work, their opportunities to use these computers may be limited: for the vast majority, use of a computer at work for CPD purposes was not feasible; only 5% of nurses reported that they would easily be able to use a computer for 30 minutes at work without disruption and the qualitative analysis highlighted a fear that using a computer whilst at work might be perceived (by colleagues or patients) as ‘messing around’. Several nurses also highlighted that, whilst they have access to computer/internet at home, it is heavily used by other family members, particularly children, who often take priority, thus limiting their opportunities to use it.

Social learning theory emphasises the importance of self-efficacy. Previous studies have recognised the importance of ICT skills and confidence to the successful uptake of e-learning by nurses\textsuperscript{348,350} and this data suggests that this is a significant issue: with 23% of nurses agreeing/strongly agreeing that their ICT skills are a barrier. Indeed, the qualitative data illustrates the intensity of some nurses’ fear of technology. Of note, these differences in ICT access and skills are correlated with age, seniority, years since qualification and part time working. Older staff and part time workers are less likely to use ICT, more likely to perceive their lack of ICT skills as a barrier and more likely to have difficulties finding time at home for CPD. This group is at particular risk of being left behind by technology-based learning programmes.
The qualitative data suggests that nurses’ decisions about engaging with technology-based learning are likely to be shaped by a combination of individual, environmental and resource factors. Consistent with adult learning theory, it is notable that nurses view CPD and technology-based learning in the context of their professional interests, work-life balance and morale. Their uptake is also influenced by their learning style, perceptions of quality and relevance of materials. From an organisational perspective, an advantage of technology-based learning is that it can be done independently, away from work, thereby reducing the impact of training on patient care through staff absence. However, respondents were wary of the impact of this on their work-life balance and viewed the replacement of ‘paid’ study days with ‘unpaid’ technology-based learning with suspicion. Many were not happy to do unpaid compulsory training and some are not happy to do any unpaid study. These diverse opinions may reflect the range of professional self-images which nurses hold and how these self-images then shape a sense of professional responsibility for CPD.

It was not possible to identify a single preferred platform for technology-based CPD resources. DVD-TV was a popular option and does not require ICT access and skills. However, this is more restrictive than internet and computer based packages and may not be satisfactory to younger, computer-literate nurses who take a more active and selective approach to learning. Increased engagement may result from developing materials which can be used on more than one platform (e.g. internet and DVD-TV).

Importantly, the UK data comes from children’s nurses on general paediatric wards. It is possible that staff in other clinical areas – outpatients, community nursing, critical care and emergency departments – might give different responses. It is also likely that, in coming years, access to ICT and ICT related skills will improve. This study did not explore mobile devices, such as ‘smart phones’ and ‘tablet’ computers, although these have been explored with other health worker groups and are now widely available.
4.5.2 Zanzibar Dataset

There were clear differences between nurses and mid-level staff, with the latter reporting better ICT access, skills and engagement in ICT based activities including CPD. Across all respondents, 23% had never used a computer (32% of nurses). The commonest venues for computer use were work and internet cafes, with only a minority of respondents owning their own computer. The most significant barriers reported by respondents related to ICT access, skills, and the cost and speed of internet access. This was consistent with the qualitative data provided in the free text responses (although only a small number completed these fields).

One potentially important finding is statistical confirmation that DVD players are much more widely available than computers, with 74% of nurses and 88% of mid-level staff having access to suitable players. Respondents were also more confident in using DVDs than computers (70% agreed or strongly agreed that they were confident) and 91% felt that they could use them easily for educational purposes. This provides a potential solution, at least in the short term, to the lack of ICT infrastructure and provides some evidence to guide choice of platform for e-learning materials in sub-Saharan Africa.

4.5.3 Comparisons between UK and Zanzibar data

Unsurprisingly, this data confirms that health workers’ ICT access and skills are better developed in the UK than in sub-Saharan Africa and that the geographical differences in access reported in population-based studies (see chapter 1) are also apparent in the health workforce. The data also highlights differences in how computers and internet are accessed: the Zanzibar cohort relied far more heavily on shared computers at the hospital or internet café. This ‘communal’ approach to computer access using internet cafes has been reported elsewhere. However, unlike most other studies (see chapter 1), the Zanzibar respondents were more likely to use computers at work than internet cafes, perhaps on grounds of cost and/or convenience.
Across both contexts, DVD for television emerged as a potentially useful format for CPD materials. In the UK, DVD appealed to nurses with low levels of IT skills/confidence and in Zanzibar as a means of overcoming the limitations of ICT access and skills.

An interesting difference between cohorts relates to their perceptions of time as a barrier to using ICT for CPD which was more prominent in the UK than Zanzibar. The complex issues around time and work-life balance which emerged strongly from the qualitative analysis of the UK responses was not detected in the (albeit limited) free text responses from Zanzibar, which focused entirely on ICT infra-structure and skills. The tendency of individuals’ responses in developing countries to focus on technological challenges, with other factors predominating in settings with better ICT access, has been reported elsewhere.\(^\text{303}\) Whilst this may be related to cultural factors, it seems more likely that the two settings are at different ‘stages of evolution’ in their use of technology-based learning: for respondents in Zanzibar, the most obvious barrier is infra-structure and access to learning materials, whilst for the UK cohort, there is a more complex picture of barriers and motivating factors related to factors such as time, work-life balance, morale, learning style and perceived learning needs. It is therefore conceivable that, as infra-structure develops in resource poor countries and learners become more experienced in using technology-based learning, a more complex picture of motivating factors (similar to that seen in the UK) will emerge in coming years. Indeed, one study from sub-Saharan Africa (outside of the health sector) has already highlighted that technology issues may not be the major obstacle to adoption of e-learning approaches, but that barriers such as lack of awareness, negative individual attitudes, institutional and national policy issues are more pervasive barriers.\(^\text{181}\) It cannot therefore be assumed that simply providing infra-structure and access to materials will increase uptake of technology-based learning opportunities in developing countries unless these wider issues are addressed.
4.6 Conclusions

This study looks in detail at learner attitudes to technology-based learning in the UK and at peripheral hospitals in Zanzibar, Tanzania and highlights current issues related to infra-structure and skills in both settings, which are clearly at very different stages of development. A complex picture emerges (particularly in the UK) of how uptake of technology-based learning relates to infra-structure, individual and resource factors. The data highlights that a significant minority of nurses is likely to struggle to engage with technology-based learning initiatives due to a lack of ICT skills and confidence. It is conceivable that this more complex and nuanced picture will be replicated in developing countries as infra-structure improves; and it therefore cannot be assumed that simply investing in infra-structure will improve uptake. Indeed, the factors referred to in this study may provide some useful pointers to those implementing technology-based learning programmes in the UK and developing countries.

From a resource development perspective, DVD for television is a promising platform: it was universally available in the UK and the most widely available platform in Zanzibar. Two potential problems arise: the lack of DVD players in work settings; and the possibility that DVD might be considered too restrictive by younger, computer literate personnel. Reflecting the ‘blended’ technology approach described in chapter 1 (with materials offered on more than one device), it may therefore be more appropriate to develop simultaneously on two platforms, allowing learners to use whatever platform is most accessible and attractive based on their level of access, skills and preferences. In this study, DVD and internet emerged as the two most popular platforms (across both settings) and each offers distinctive benefits in terms of navigation, interactivity and accessibility at work/home.

Again, data is likely to become out-dated quickly. Repeated data collection would highlight trends and ensure an up-to date analysis to inform institutions, policymakers and e-learning developers. It would also be useful to track the impact of innovations, such mobile devices and social networking, as these are both now quite widespread in the UK and are likely to emerge in sub-Saharan Africa.
Chapter 5:  
Health worker perspective -  
an interview study of doctors, mid-level and primary health care workers in  
Uganda and Tanzania

5.1 Abstract

**Purpose:** To gain an in-depth understanding, from medical staff, mid-level and primary health care workers, of their use of technology and health information; current professional development opportunities; experience and attitudes to technology-based learning and opinions about its development and implementation.

**Setting:** 9 hospital units in Uganda and Tanzania: purposefully sampled across small and large units, government and private not-for-profit sectors, rural and urban locations; and government dispensary facilities in Tanzania.

**Participants:** 43 health workers (24 in Uganda, 19 in Tanzania; 18 in government, 25 in private-not-for-profit units; 19 in urban, 24 in small town/rural locations; 9 dispensary workers, 14 mid-level hospital staff, 9 junior, 4 middle grade and 8 senior medical officers).

**Methods:** Semi-structured interviews were conducted at each facility, using a flexible question guide (in English at hospital units and with a KiSwahili interpreter at dispensary units) and tape recorded. Transcription and translation were done by experienced transcriptionists and native KiSwahili speakers, and all transcripts independently checked by the interviewer. Analysis was performed using a framework approach and thematic data presented.

**Results:** Wide ranging data were obtained covering access to technology and health information, current professional development practice and underlying issues related to health systems and organisational/professional culture. Respondents highlighted a wide range of issues relevant to the development and implementation of technology based learning programmes for health workers in sub-Saharan Africa.
Discussion: There is enthusiasm for improving access to health information and using technology based learning. Resource limitations are a key issue and differences in access emerge between junior and senior workers, government and private-not-for-profit institutions and rural and urban centres; with uptake influenced by health systems issues and professional culture. In developing technology based learning materials, priority should be given to materials which reflect local health priorities and describe investigation and treatment that is realistic in the local setting. Clinical material (video and photographs) from the local context is likely to be valued for clinical and cultural reasons, and to increase engagement; although more senior health workers also appreciate a wider perspective. Choice of language is important but preferences vary depending on seniority, with hospital workers generally preferring English due to its wider technical vocabulary and increased reach. Given resource constraints, it may be appropriate to provide materials on formats such as DVD for television, which is more widely accessible to junior personnel, and better still, to develop materials which can be adapted for multiple platforms to use whatever infrastructure is available. Implementation issues include publicity, distribution (especially to remote areas) and updating. Electronic materials are widely copied and it may be appropriate to consider a partial copyright waiver for health workers copying materials related to their work in resource-poor countries. The study highlighted areas where existing resources could be used more effectively to improve access to health information such as making computers at institutions available to health professionals at evenings and weekends, adding an educational component to existing supervision/outreach/monitoring visits and better publicity of available materials within institutions. The value of international links was highlighted, although these are much more widespread in the private-not-for-profit sector and at larger urban units.
5.2 Aims

- To reach a detailed understanding of the issues affecting the use and adoption of multimedia education in resource poor settings.
- To explore issues affecting health workers across a range of cadres and settings, including government and private-not-for profit; rural and urban.

5.3 Methods

5.3.1 Setting

Hospitals in Uganda and Tanzania were purposefully sampled, so that interviews were conducted with staff working in smaller and larger units; rural, small town and urban locations; and within government and private-not-for-profit providers. In addition to hospital facilities, Tanzania has a system of dispensaries which deliver health care to the local population, usually staffed by a clinical officer and/or nurse/midwife. To sample health workers in this setting, interviews were conducted at dispensaries in Moshi Rural District (the rural area around the town of Moshi, Northern Tanzania). This sample strategy was chosen to reflect data presented in chapter 1 regarding known influences on access and use of technology amongst health workers, aiming to capture a range of experiences, opinions and perspectives. Descriptions of the hospitals involved in the study (location, organisational structure, description of services and distances from the nearest town/city) are given in table 5a.

5.3.2 Participants

At hospitals, volunteers were recruited from junior (intern), middle grade (resident) and senior (consultant or medical superintendent/deputy medical superintendent) medical officers; and from mid-level health workers (see section 1.3.3.1). Tanzania recognises two mid-level cadres: clinical officers (the more junior) and assistant
medical officer (the more senior); whereas Uganda recognises one cadre: clinical officers. Participants were sampled purposefully across this cross-section of background and seniority, and across the settings described in 5.3.1.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Structure/location</th>
<th>Description of services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uganda</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mbarara Regional Referral Hospital,</td>
<td>Government referral hospital, city location.</td>
<td>Specialist referral hospital.</td>
</tr>
<tr>
<td>South-west Uganda. 266 km from Kampala.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ruharo Mission Hospital,</td>
<td>Private not-for-profit hospital and health centre, city location.</td>
<td>Small hospital with primary care and in-patient facilities.</td>
</tr>
<tr>
<td>South-west Uganda. 4 km from Mbarara.</td>
<td></td>
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<tr>
<td>269 km from Kampala.</td>
<td></td>
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</tr>
<tr>
<td>Kuluva Hospital, West Nile, North-west Uganda.</td>
<td>Private not-for-profit hospital and health centre, rural location</td>
<td>Small hospital with primary care and in-patient facilities.</td>
</tr>
<tr>
<td>13 km from Arua. 443 km from Kampala.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matany Hospital, Karamoja, Northern Uganda.</td>
<td>Private not-for-profit hospital, rural location</td>
<td>Small hospital with primary care and in-patient facilities.</td>
</tr>
<tr>
<td>139 km from Soroti 429 km from Kampala.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjumani Hospital, North Western Uganda.</td>
<td>Government hospital, small town location</td>
<td>Small hospital with primary care and in-patient facilities.</td>
</tr>
<tr>
<td>460 km from Kampala</td>
<td></td>
<td></td>
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<tr>
<td>Kagando Hospital, Western Uganda.</td>
<td>Private not-for-profit hospital, rural location.</td>
<td>Small hospital with primary care and in-patient facilities.</td>
</tr>
<tr>
<td>43 km from Kasese. 410 km from Kampala.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tanzania</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kilimanjaro Christian Medical Centre,</td>
<td>Private not-for-profit referral hospital, city location.</td>
<td>Specialist referral hospital.</td>
</tr>
<tr>
<td>Moshi, Northern Tanzania. 568km from Dar es Salaam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Songea Regional Hospital, South Eastern Tanzania.</td>
<td>Private not-for-profit hospital, urban location.</td>
<td>Small hospital with primary care and in-patient facilities.</td>
</tr>
<tr>
<td>1059 km from Dar es Salaam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kibosho District Hospital, Northern Tanzania.</td>
<td>Private not-for-profit hospital, rural location.</td>
<td>Small hospital with primary care and in-patient facilities.</td>
</tr>
<tr>
<td>89 km from Arusha 580 km from Dar es Salaam</td>
<td></td>
<td></td>
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</tbody>
</table>

**Table 5a:** Participating institutions, distances shown by road from the nearest large town and capital city.
5.3.3 Recruitment

Written and verbal information was provided to health workers in advance, highlighting that participation was voluntary and transcripts kept confidential, with only anonymised information being made available outside the research team. The interviewer travelled to the smaller hospitals selected for the study with an outreach ophthalmic team; and at dispensary units, with a research team carrying out a separate project in eye health. Interviews were conducted between January and June 2008.

5.3.4 Interviews

Semi-structured individual interviews were conducted, at the interviewee’s institution, in a private room away from colleagues. Informed consent was obtained before each interview. None of those approached to take part in the study refused. All interviews were conducted by the author, Note 1 using a question guide based on the aims of the project, a review of existing literature (see chapter 1) and discussion within the research team. The question guide covered five areas: (i) background and clinical experience; (ii) access to medical information (such as text books and journals) and educational opportunities (continuing professional development and other courses) including any barriers to access; (iii) use of technology (access, skills, experience and barriers); (iv) demonstration and feedback about a sample of multimedia educational resources (shown during the interview); and (v) recommendations for developing multimedia education and improving educational opportunities. The question guide was used flexibly, allowing the interviewer to ask further questions based on interviewees’ responses. At hospital facilities, interviews were conducted in English; whereas at dispensary units (due to limited English skills), interviews were conducted with the help of an experienced research nurse (a native KiSwahili speaker) who

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1 Throughout, ‘the author’ refers to the author of this thesis.
translated questions and responses. All interviews were tape recorded and the interviewer also made detailed notes following each encounter. During data collection, the question guide was reviewed regularly so that new questions were added if interviewees identified new issues and modified if interviewees struggled to understand questions or found them ambiguous. Whilst not valid in quantitative methods, the scope to modify questioning during the study for valid reasons (such as the need to explore new insights, theories and explanations) is widely accepted in qualitative research and, when done appropriately, strengthens the findings.\textsuperscript{366} Importantly, interviewees were not shown any sample multimedia materials until they had discussed the earlier topics in the interview guide. Interviews were conducted between January and June 2008 and continued until the researcher judged that data saturation had been reached (that no new themes were being detected in interviews) and that this had occurred across the purposeful sample described above.

5.3.5 Translation and transcription

Interviews in English were transcribed by an experienced transcriptionist and then checked independently by the author to confirm accuracy. KiSwahili interviews were transcribed and translated by a native KiSwahili speaker who checked the accuracy of the research nurse’s interpretation of questions and answers. The transcripts were then checked again by the author. These were then considered a verbatim transcript of the discussion. Any disagreements were resolved by consensus between the transcriptionists and author.

5.3.6 Analysis

Analysis was undertaken based on the framework approach described by Pope et al (2000).\textsuperscript{384} An initial thematic framework was developed from the aims of the study based on a literature review (see chapter 1) and discussion within the research team. Transcripts were read and re-read for familiarisation by the author; and then the
transcripts were indexed and categorised using QSR N-Vivo 7. Categorisation was an iterative process so that new categories were added to the framework based on emerging themes from the data. The categorised data was then discussed within the research team and any disagreements resolved by consensus. Next, the categories were classified into clusters of related themes in a process which primarily aimed to find links between categories. Classifications were then discussed again within the research team and agreed by consensus. The thematic data is presented below with illustrative comments from respondents.

5.4 Results

The interviews covered a wide range of issues, yielding rich qualitative data and revealing a complex interplay of factors affecting use of technology, access to health information and professional development activities. A total of 43 interviews were conducted: 24 in Uganda, 19 in Tanzania; 18 in government institutions, 25 in private-not-for profit institutions; 19 urban; 24 in small towns or rural locations (away from main centres); 9 with dispensary workers, 14 with mid-level hospital staff (Clinical Officers and Assistant Medical Officers), 9 with junior medical officers, 4 with middle grade and 8 with senior medical officers. This information is represented diagrammatically in fig 5a.

5.4.1 Resources

The availability of resources was a key issue, and similar issues affected access to all sources of health information including computers, internet, textbooks, journals and disc based materials.
Fig 5a: Breakdown of interviewee characteristics. (PNFP = Private not-for-profit)
5.4.1.1 Obtaining resources

Cost was the major factor underpinning lack of resources and limited the ability of individuals and institutions to obtain computers, internet access, textbooks and other educational materials. Other barriers compounded this: there were few places at which to buy reliable computers and medical textbooks outside of major cities and the transport to do so was costly; participants were wary about buying computers, especially in the second hand market, as these were often considered unreliable and prone to viruses; there was a lack of technical support at institutions and elsewhere to help with purchasing, repair and maintenance. For textbooks, specialist bookshops were limited to major cities (Kampala, Dar Es Salaam, Nairobi) and books often needed to be specially ordered at further cost.

Yeah, for myself, I like to buy books but I, most of the books, they are very expensive so it becomes difficult for me to buy those books. Because when you compare to my income and those books of medicine, they are very expensive, it is difficult to afford.

Interview T10 (Tanzania), Assistant Medical Officer, Urban, PNFP, Referral.

Sometimes you have to use little computers, the laptops. You, you, you don’t get them, normally, sometimes you get broken ones in Kampala. And if you buy a computer there but you bring them back here, it won’t work. So that’s the other problem that, I think, people are wary to buy it.

Interview U5 (Uganda), Clinical Officer, Rural, PNFP.

5.4.1.2 Shared access

Individuals relied heavily on sharing resources through formal and informal mechanisms. Several institutions had libraries and resource rooms with some institutions having specifically invested in providing computers, internet facilities, textbooks and journals for staff (free or at reduced cost). At one private not-for-profit
unit in Northern Uganda, this was highlighted as a factor which generated a ‘pull’ effect to the institution, attracting staff to work in this under-served area.

We are lucky because you can even see, our library here, it is full of books, so it is very easy for us to access text books and every new editions they bring, at least we have most of the editions are here... The new ones that keep on changing... at least we, they get them, and our library is always equipped.

Interview U14 (Uganda), Clinical Officer, Rural, PNFP.

Informal sharing took the form of borrowing resources from colleagues or occasionally purchasing resources jointly. There was a remarkable lack of reports of difficulties arising from these informal arrangements (such as disputes about ownership or non-return of materials). It appeared that most health workers aspired to better personal access to resources and, whilst shared resources were generally valued, there were common frustrations at the related inconveniences such as queuing for library copies of popular textbooks and for shared computers (at the institution or internet cafe), the cost of internet cafe access (and their availability outside of towns and cities) and the limited number and range of shared textbooks. Theft of books from libraries (or ripping out pages of books) was another frustration. The environment at public internet cafes was considered less conducive to study.

I think that the main problem would be accessibility of books. Because, you can, er, this is a teaching university, yeah, there are more than 500 students, okay. You have a library with a limited capacity... I am not convinced there’s enough, you know and they cannot, even the hospital cannot buy reading resources for them.

Interview T3 (Tanzania), Medical Officer, Junior, Urban, PNFP, Referral.
Inequities in access to resources emerged. There was variation between institutions although generally respondents from the private-not-for-profit sector reported better access to resources than those in the government sector. Access was also better at larger, urban hospitals than in smaller, rural units. Notably, all respondents from private not-for-profit institutions reported computers and internet access at their institution, whereas there was a relative lack of computers at smaller government hospitals in Uganda and a complete absence of such facilities at dispensary facilities in Tanzania. These differences seemed to be mediated by better access to international links and foreign donations, and also possibly by greater institutional autonomy allowing private not-for-profit units to spend funds and innovate more freely.

Actually we are lucky that we are in a real place but the management here, as you can see, have internet facilities and have computers... So I can surf anytime I want. So, me accessing a computer, I have no problem with it... We have a wireless network here so people, this is active or whatever, but people who stay about 20 metres from here, you can access it from your home.. We don't have any problem with the internet, actually.

Interview U11 (Uganda), Medical Officer, Junior, Rural, PNFP.

Getting access to a computer here is not easy, because of the location of the place. We are very far from the city, as you know. Usually if we want to send messages like through e-mail, we go in town and per minute they charge you 50 shillings... so it becomes a bit difficult, when you don’t have the money, it means you can’t have access.

Interview U3 (Uganda), Clinical Officer, Rural, Government.

Seniority was an important factor underpinning personal access for individuals, with more senior medically qualified workers reporting better access to computers, internet (at home using mobile networks or fixed lines) and textbooks than their junior and non-medically qualified colleagues. Disposable income was a key influence but this
group also seemed to have better access to resources obtained through joint research projects and international collaborations, more opportunities to obtain resources whilst travelling overseas and from overseas visitors. Several more junior respondents described receiving personal gifts of books from international visitors (see section 5.4.4).

We are travelling a lot, either one of us will be out of Tanzania. So if you need a book or whatever you need to buy a, I’ve brought books from South Africa, once bought in US. But in Tanzania, no, I don’t even know where, really.

Interview T9 (Tanzania), Medical Officer, Senior, Urban, PNFP, Referral.

5.4.1.4 Under-utilisation of resources

Examples were also found of under-utilisation of available resources. Computers were often used by administrative staff during the day but the offices were locked at evenings and weekends despite the fact that clinical personnel would be keen to use these computers outside of office hours. Similarly, textbooks and disc-based materials were often locked away in offices or their availability poorly publicised.

OK. Of course, maybe in general where they are connected, internet is there in administration. Not in any other computers. And if you are the only one, you can access it in the secretary’s and after 4.30 when she has left. So sometimes she can leave. When you are late maybe and you are on duty and there are some patients, you cannot leave the patients, by the time you leave there, she has already closed the door.

Interview U6 (Uganda), Clinical Officer, Rural, PNFP.

[People] will tell you, yes we like this and we like that. But when you do a follow-up, one person took it, kept it in their house and nobody else is using it.

Interview U8 (Uganda), Medical Officer, Senior, Uganda, Rural, PNFP.
5.4.2 Health information as a valued commodity

Health workers described the range of formats in which health information was available to them, the strengths and weaknesses of each format and some of the practical problems in gaining access. Across all formats and cadres, health information was a highly valued commodity. Practical manifestations of this included the common practice of photocopying textbooks page by page.

5.4.2.1 Textbooks and journals

Despite limited availability, textbooks were an important source of health information at hospitals and health centres and were associated by health workers with authoritative, reliable and comprehensive information. Advantages were that they could be accessed without technical equipment and electricity; but they were also felt to be difficult to read, sometimes long winded, bulky and often not easily available in clinical areas. The commonest frustrations were the age and limited range of available textbooks.

The textbook I think gives profound and detailed information... And most of the time the textbooks may talk about what is less common.

Interview U10 (Uganda), Medical Officer, Senior, Rural, PNFP.

Still with textbooks it is not easy because we don’t have a library... the hospital has a few books here but because it lacks a library, I think sometimes we cannot access the books easily and there are few... some are very old.

Interview U7 (Uganda), Clinical Officer, Rural, PNFP.

Some highlighted that textbooks were often based on ‘developed world’ problems and paid less attention to the medical problems seen in their setting. For clinical officers, the difficulty in accessing textbooks appropriate to mid-level health workers (who have no ‘developed’ world equivalent cadre) was also highlighted. Journals were valued by senior cadres and those undertaking research, and there was some awareness and use
of electronic journals, although this was limited by problems obtaining passwords for online journals.

Textbooks which are oriented to local settings are actually not very many, which would be necessary, that talk about health situations in East Africa, for example, health situations in Africa. You know textbooks are available, because they come, the origin is right from somewhere, I mean in developed countries.

Interview U24 (Uganda), Medical Officer, Senior, Urban, Government, Referral.

5.4.2.2 Materials from Ministries of Health

Training materials and guidelines provided by Ministries of Health were important information sources. At lower level units, and particularly at dispensary level in Tanzania, these seemed to be the sole source of current health information (with minimal access reported to textbooks and other sources). Materials were often provided in partnership with World Health Organisation and/or non-governmental organisations and often linked to workshops or seminars. Specific positive mention was made of the Uganda Clinical Guidelines and the materials developed for Integrated Management of Childhood Illness in Tanzania. Health workers were generally satisfied that these materials were relevant, appropriate and up to date. Distribution mechanisms seemed reasonably reliable (materials were often distributed at workshops, seminars and supervision visits). The main frustration was that these materials were limited in number, and respondents typically could identify several topics where they would value more information.

Here the sources of information, of course, as far as the Ministry of Health is concerned, they always develop some, er, update information... I have one of the copies here. So this is the Uganda clinical guidance, so that’s how we access all the medical information.

Interview U18 (Uganda), Clinical Officer, Urban, PNFP.
Q: Where do the manual books and the guidelines come from?

It comes from the district and the DMO and others we get it when we go to the seminar.

*Interview T19 (Tanzania), Dispensary worker, Rural, Government.*

5.4.2.3 Electronic resources

More senior and medically qualified cadres tended to be more familiar with electronic resources such as internet, disc based materials (CD-ROM, DVD-ROM, DVD for TV) and materials on USB stick, often reporting previous experience of using them in their initial training, continuing professional development or for research. Electronic resources tended to be considered easier to use, more concise, engaging and practically based, and easier to navigate and search than textbooks. It was felt that they could be particularly used to demonstrate real-life clinical practice, including demonstrating practical skills, procedures and operations more effectively than a traditional textbook. The capacity to combine graphics, audio, photographs and video into the resource was considered a significant strength; and participants valued the opportunity to re-play the materials. Availability of computers and internet were the commonest barriers to uptake.

*I believe learning should be, should be a comfortable experience... because, believe me, if you are, if you are, if you are holding a 5,000, 2,000 page book, yeah, on your table and you are having a CD ROM, they are two different things... I will give you an example, if you are, like, if you are reading something like, about say heart murmurs, you go, you read a book, it will tell you ‘First heart sound, lup-dup, second heart sound’ that’s the end of the story but if you are having a multimedia book, you have the sounds, you can play the sounds, you can have a systolic murmur sounds like, and how a diastolic murmur sounds like, like, how a pleural rub sounds like.*

*Interview T3 (Tanzania), Medical Officer, Junior, Urban, PNFP, Referral.*
So, for me, I have to say because one thing I know is we are so fascinated, me personally, by pictures, by videos, by sound, just advice, so that if you can integrate all this, text bit of it, exactly the way you show it, and then with videos. Yeah, and maybe the CDs should be, should use programmes which really are readable by every computer. Otherwise you may want to go for something which is very advanced and someone may have an old computer.

Interview U11 (Uganda), Medical Officer, Junior, Rural, PNFP.

Internet based materials

Internet was a common source of information for more senior cadres, although notably no dispensary workers had any experience of using the internet (for personal or professional tasks). Most respondents were positive about the internet as a means of obtaining information that is up to date. However, complaints about the speed and reliability of internet connections (leading to slow download times for text and photographs, and inability to stream or download videos) were almost universal. A note of caution was also sounded about the range of distractions on the internet and the potential for workplace internet connections to be used for other purposes.

Yeah, because, er, to print a book it takes a, er, it, it takes a year, some years, but for the, someone to put the material in the computers, you know internet, it’s current. So when you go there I find other changes, which are new.

Interview T10 (Tanzania), Assistant Medical Officer, Urban, PNFP, Referral.

The internet has become slow... so if I’m looking at like here, the pictures on the internet and it is video, this kind of video is not downloadable on internet. You can’t download the files or whatever.

Interview U9 (Uganda), Medical Officer, Senior, Rural, PNFP.
The commonest method of obtaining information from the internet was through a generic search engine, usually ‘Google’. More senior health workers were often aware of professional websites such as ‘E-Medicine’, ‘UpToDate’ and ‘PubMed’ and were impressed by the quality and depth of information available. However, they also highlighted that they were often excluded from accessing information on these sites due to subscription and password requirements. The cost of subscription to these sites was often considered prohibitive and, even for those willing to subscribe, the need for credit card subscription prevented this. However, several respondents reported that they had been able to access these restricted sites using passwords obtained through international links.

Well I may go to the Google website… the common one is Google. Other websites like Pubmed, Up To Date require subscription. They are not easily accessible.

Interview U22 (Uganda), Medical Officer, Middle grade, Urban, Government, Referral.

Nowadays, there are a lot of what I can say, complications maybe, yeah, that you have to have a username or password, may be they tell “click here to get a password”, when you click you are being told you have to pay, I don’t know, 200,000 dollars and those stuff, so I find them, I mean, I don’t like it.

Interview T5 (Tanzania), Medical Officer, Middle grade, Urban, PNFP, Referral.

Disc based materials (CD-ROM, DVD-ROM and DVD for television)

Several respondents had used disc-based resources previously. Advantages included the potential to overcome problems with internet speed, whilst disadvantages were the relative fragility of discs, lack of availability in shops and difficulties updating materials. DVD players were more widely owned than computers by individual health workers, and DVD ownership seemed to penetrate to less senior cadres (although not to dispensary level). Several respondents described having ‘burned’ (copied) disc
based materials using their own computer or in DVD shops (which were widely accessible). This was seen as a potential method of spreading health information more widely, although it was acknowledged that this might infringe copyright. Some users highlighted problems with getting DVD discs to play, possibly due to regional settings, physical damage to discs or copy protection.

*If I can now like me I can use my laptop to make the CD. I think I cannot make the videos but the CD I have a programme so I can make a copy easily. But even close to the compound there are many computer points that people are making video, VCDs and DVDs so I think even this learning material can be easily accessed... I hope they are not copyright!*  

*Interview U12 (Uganda), Medical Officer, Junior, Rural, PNFP.*

*You need a computer... Here many of us don’t have, medical professionals here don’t have, you need to know CDs, keeping them is a bit delicate.*  

*Interview U11 (Uganda), Medical Officer, Junior, Rural, PNFP.*

**Materials on USB sticks**

Many respondents reported using memory sticks as a method of transferring lecture notes, electronic copies of textbooks and other health information quickly amongst themselves and this practice appeared to be widespread. One respondent suggested that this might be a viable method of distributing materials and avoid some of the problems of disc based materials. Participants reported frequent difficulties with computer viruses infecting USB sticks.

*So then we formed some kind of a network of colleagues where you exchange interesting things that if I get access to something about e-learning... I will feel very much privileged to share it with another friend somewhere. I will send it to him. You know, that kind of thing. So it is one way we are trying to build up, our, can I say, our e-learning er libraries.*  

*Interview U13 (Uganda), Medical Officer, Senior, Rural, PNFP.*
Other approaches

Whilst not widespread, respondents from one private not-for-profit institution described the availability of networked resources at their institution and highlighted the advantage that materials are available to local users without requiring an internet connection. Mobile devices, including internet enabled ‘smart phones’, were not widely used.

5.4.3 Professional development and support/supervision

Professional development and support/supervision programmes were widespread, although there were significant differences in how these were delivered and resourced at different institutions; and several barriers to engagement were identified.

5.4.3.1 Professional development opportunities

Educational meetings

Most hospitals and larger health centres held weekly, fortnightly or monthly continuing medical education (CME) meetings, usually comprising presentations and peer discussion. These were generally valued although, at some institutions, the programme was felt to be fragmented and poorly organised. Some found it difficult to prepare CME presentations due to limited access to information.

Yeah, OK, yeah. Internally we have the CMEs. We assign people to prepare. We think and hope that whoever prepares, who delivers to look around for the latest [information].

Interview U12 (Uganda), Medical Officer, Junior, Rural, PNFP.
Q: How do the people presenting for those things prepare?

Very hard, very hard. Most people try to go and look around in a textbook or look at their old notes which are often years out of date. So it’s very hard.

Interview U8 (Uganda), Medical Officer, Senior, Rural, PNFP.

At some institutions, there were also other meetings, such as handover meetings, with an educational element; and less formal learning took place through bedside teaching and discussions and with senior colleagues, and informal discussions with peers. These opportunities were valued as a way of getting practical knowledge that is not available in textbooks and were more widespread at larger units with more clinical staff and, for senior staff, in departments where there were reported to be good colleague relationships.

The next day usually, even call if you think you have to call, you call. If you think there is no need of calling, usually present in our clinical conference in the morning, because every morning we meet. So when we meet there then you present your case, then you discuss.

Interview T9 (Tanzania), Medical Officer, Senior, Urban, PNFP, Referral.

Of my cadre, I phone... We are, we are supporting. Not every department, there are departments which are difficult. But our department is really well, we are co-operative with each other. We discuss with each other, we assist, no problem at all.

Interview T9 (Tanzania), Medical Officer, Senior, Urban, PNFP, Referral.

Workshops and seminars

Across all cadres, workshops and seminars, lasting between one day and two weeks away from the institution, were a popular source of updates. At dispensary level, these were the main professional development opportunity. The content of these workshops was largely centrally determined (with no descriptions of health workers having input into the agenda), and usually organised around topics where new
guidelines were to be disseminated. Often, written educational materials were provided at these workshops.

Whenever there are changes, we are called to the seminar. When we finish the seminar, we then get the guidelines.

Interview T14 (Tanzania), Dispensary Worker, Rural, Government.

Q: How often [do you get] the opportunities to go for seminars?
It does not take a long time maybe three months; or we’d go this month and the following one. It all depends how they [the District Medical Office] plan themselves... There are some which can stay for three days, others a week, others two weeks... It’s good... First of all it educates, maybe I was doing something in a wrong way and in other cases I don’t know things so the seminars add them to me. And also exchange of ideas.

Interview T15 (Tanzania), Dispensary Worker, Rural, Government.

Aside from some concerns about travelling from less safe areas, workshops and seminars were very popular; and this seemed related to the content of the course itself, the opportunity to meet with peers and the payment of a per-diem allowance (a supplement paid to health workers for attending training).

Q: Would you like to go to the seminars or should they come here for you?
Going to the seminar is better because there are many people that one can discuss with than staying with someone all alone... I want to go to the seminar because I also get an allowance.

Interview T19 (Tanzania), Dispensary Worker, Rural, Government.

Few problems were identified and interviewees generally wanted more opportunities to attend. The majority felt that other staff could cover their absence when they went for training, although in practice this often involved a less qualified colleague ‘deputising upwards’ and some did recognise the potential for an adverse impact on clinical care as a result.
Actually the problem occurs in the management of patients... maybe if somebody gets some wound which needs to be sutured, maybe the wound is not sutured properly, or management of patients other cases which need to be seen very urgently.

*Interview T15 (Tanzania), Dispensary Worker, Rural, Government.*

Dissemination of learning within the unit following workshops and seminars was inconsistent; so that whilst some units held in-house meetings after seminars to share information, this was not consistently done.

**Supervision visits**

Dispensaries in Tanzania described supervision visits from the District Medical Officer, and whilst some respondents occasionally reported an educational element to these visits, they seemed to focus more on delivering supplies and auditing records. This was, however, a means of providing new guidelines and information.

*No body from the DMO’s office would provide any training...*  
*Q: Do they visit for other reasons?  
Bringing medicine. Also checking books if we have written reports and attendance register.*  

*Interview T15 (Tanzania), Dispensary Worker, Rural, Government.*

**5.4.3.2 Professional development barriers**

**Workload**

Intensity of clinical workload as a common constraint, with many participants being too busy with clinical work to attend educational meetings during the day, and feeling too tired in the evening to engage in learning or professional development. Health workers with managerial responsibilities (such as medical superintendents at rural hospitals) highlighted this additional demand on their time.
So the only problem is that the working hours are long. At times you get home and you are exhausted and you then you won’t open maybe a book, or you won’t go to the computer. But once in a while you try to go through that.

Interview U7 (Uganda), Clinical Officer, Rural, PNFP.

We have such a very big deficit in terms of doctor population ratio in Uganda... There are hospitals where you will find only one doctor, just one, who is the medical superintendent, he’s the surgeon, he’s the what, you know, he’s everything.

Interview U13 (Uganda), Medical Officer, Senior, Rural, PNFP.

Professional isolation

The impact of professional isolation was highlighted by several respondents from rural areas. This impacted the viability of professional development programmes at smaller units; and limited the opportunities for informal interaction and learning from colleagues. Indeed, one of the benefits of seminars and workshops was the opportunity to meet with peers and learn from each other’s experiences.

It is not being isolated in such but it is actually the same as being isolated because you don’t know what others do. We don’t know for instance how to treat pneumonia at the moment, or diarrhoea but if we had sources like computers we would know what it is like at the moment.

Interview T15 (Tanzania), Dispensary Worker, Rural Government.

I have had 2 or 3 cases when I am on table in theatre where I open up a patient and I find I am having difficulties, and I have been calling surgeons in Mulago... Then there are situations when I can’t connect, I can’t connect and get the information I want.

Interview U4 (Uganda), Medical Officer, Senior, Rural, Government.
Learning and Professional Development Culture

There appeared to be an expectation that a person was fully equipped to do their job on completing their training; and whilst it was generally accepted that keeping up to date was desirable, this did not translate into a widespread sense of keeping up-to-date as a professional obligation. Systems for monitoring professional development activity also appeared lacking. On a practical level, there were usually a range of competing financial and time demands which limited opportunities for professional development; and most participants linked their engagement in professional development to external factors such as workload, availability of learning materials, and their feeling of being valued by their boss and health unit. Some respondents also highlighted that, despite professional development opportunities, professional practice was slow to change.

As soon as they have finished [training]… they are considered complete… and there is no hierarchy for learning. We don’t have it in the mindset that actually you’ve only begun your career… and I think because people get to independence so early, they get in their minds the fact that they begin to think they know it all.

Interview U8 (Uganda), Medical Officer, Senior, Rural, PNFP.

I still think it depends on... how interested you are in acquiring new knowledge or acquiring new skills because there are so many workshops are trying to help us learn but still you will find that the practice has the same old system, eh. So I think it still depends on how much we are willing to change, eh. How much the medical officers and clinical officers are willing to take up the new changes according to the information.

Interview U16 (Uganda), Medical Officer, Junior, Urban, Government, Referral.
The culture within and between health units was hierarchical and this was reflected in the approach to resolving clinical questions or uncertainties about patient management. Referral to a more senior colleague within the health unit or at a referral hospital was more common as a response to uncertainty than searching for information. However, this appeared to be changing and it seems likely that a historical lack of health information has shaped this learning culture.

As a clinical officer, we normally consult a doctor. And maybe, if you find that you can’t manage then you refer. But we refer through a particular doctor where you, but you may know the condition, but, the, the, the machinery to work on it. You find, you know, you cannot, you’re unable so you just refer.

Interview T20 (Tanzania), Clinical Officer, Urban, PNFP.

People are given opportunity because people now are searching. People are making researches with new advents and new changes in medicine. They are following it, especially those who are accessible to internet.

Interview U10 (Uganda), Medical Officer, Senior, Rural, PNFP.

5.4.4 International links

International links seemed an important driver of improved access to health information and were well developed in the two large hospitals visited and in the private not-for-profit sector, whereas smaller government run institutions and dispensaries had no discernible access to such links. The value of links included access to resources through donations of money and educational materials, managerial and clinical support, research collaborations and facilitation of visits from international experts. Opportunities for international engagement were much valued although some concerns were raised about well-meaning but inappropriate donations (such as less relevant or outdated textbooks and journals). It was highlighted that such donations often went unused and that better consultation might help to ensure more appropriate donations.
There is an increasing tendency to collaborate with external universities and researchers especially and so sometimes these collaborations come along with some other benefits. One is sharing knowledge and sharing knowledge in different forms... but also there are other facilities that are set up like internet facilities... and sometimes these universities go ahead and extend even their library subscriptions to the collaborating institution... We have to acknowledge that the huge, huge number of people, human resources are down in the communities and... even though the opportunities are happening, they are happening to so like centres of excellence but not necessarily in the rural communities where the problem is most.

Interview U24 (Uganda), Medical Officer, Senior, Urban, Government, Referral.

Though the rationale behind donation is highly welcome and very good, but at least there should be an attempt to consult what the local setting wants... Because sometimes they donate books... and then actually the needed books are not being donated.

Interview U24 (Uganda), Medical Officer, Senior, Urban, PNFP, Referral.

At junior level, short term placements of visiting doctors and elective medical students were a further source of links. These visits were often accompanied by donations of equipment and textbooks, which were valued by recipients both for their utility and as an expression of friendship.

So about half of my books are from friends, visiting doctors from abroad and there’s some good friends who also send the books through the post.

Interview T2 (Tanzania), Medical Officer, Junior, Urban, PNFP, Referral.

Some units had tried to set up telemedicine and remote consultation initiatives through international links and there were examples of successful and unsuccessful attempts at this.
There are some Americans who came but they were in a rush. They wanted to start [tele]medicine... The problem they were in a hurry and the password they want to activate this software was in America, so the activation of the software is in America and they went. So they went before we got the password so we couldn’t activate the system.

Interview U9 (Uganda), Medical Officer, Senior, Rural, PNFP.

5.4.5 Technology based learning

Respondents were generally positive about the potential for technology based learning to improve their knowledge, skills, confidence and support better patient care; and they made wide ranging observations and recommendations about the development and implementation of technology based learning materials in their context.

If I have up-to-date learning, I will be able to determine what my patients need. Likewise, I will know what the problem is which means I will be able to provide the necessary and good services to them. It will reduce the mortalities in women and children which is the main target.

Interview T1 (Tanzania), Dispensary Worker, Rural, Government.

A minority expressed a concern that over-reliance on technology would impact on the clinical skills and experience of health workers as they would spend less time seeing real patients. This was based partly on an observation that overseas doctors and students were less clinically skilled than their local counterparts.

If you have just watched the video, you may fail to integrate that information directly. From there you can’t put it to the patient. You need to have some introduction to clinical thinking, before you start.

Interview U15 (Uganda), Clinical Officer, Rural, PNFP.
5.4.5.1 Development of technology based learning materials

Ensuring relevance

A key issue raised by many respondents was the need to ensure that the content of materials was relevant to common problems experienced in their practice and reflected the local burden of disease. When asked to identify priority topics, respondents particularly highlighted communicable disease, tropical disease, malaria, HIV, TB and malnutrition, although many also mentioned the increasing burden of non-communicable diseases (such as diabetes, heart disease, alcohol related disease), mental health and road traffic accidents.

Another priority was to ensure that information about investigation and treatment was realistic and took account of resource constraints: both what patients can afford and the available facilities, drugs and specialist expertise. It was highlighted that many diagnoses are made clinically (in the absence of facilities for investigations) and that encouraging good clinical skills is a priority.

But some other diagnostic tools are not available. So, it should be made in such a way, you, that, you can balance more clinically, less than the investigations, there’s not too much based on investigations.

Interview T6 (Tanzania), Medical Officer, Junior, PNFP, Referral, Urban.

Respondents recognised a tension between ensuring that materials include more sophisticated management (even where this is not available locally) and maintaining the relevance of the materials. More senior health workers seemed more interested in new developments. For some, this was related to professional interest, whilst others felt it was important to know about these options so that they can better advise their patients, and others noted that being aware of new developments was useful in advocating and planning the development of health services.
I think that a comprehensive learning guide needs to have what is available as well as what should be available... So you want to mention what is available in our set up as well as suggest that if it were possible, you’d want to do A, B, C, D... You can’t edit them out. It limits their ability to think. You need to think beyond the immediate environment.

Interview U8 (Uganda), Medical Officer, Senior, Rural, PNFP.

It was considered important to define the target audience and interviewees highlighted that learning resources tend to be ‘compartmentalised’ so that other cadres are less likely to use materials associated with a specific professional group.

If you make it for doctors, then the nurses won’t even go into it because it’s too much for them. If you want some material for nursing students, you can put it as nursing students and the doctors generally don’t go into it... I think there a bit of an attitude thing... Our learning is all clustered. We don’t mix very much.

Interview U8 (Uganda), Medical Officer, Senior, Rural, PNFP.

Considering how materials will be used

Respondents’ previous experience and ideas highlighted that materials can be used in a variety of ways: for reference, self-directed learning and group learning. This has implications for resource development and how materials are used within technology based learning programmes. Some respondents also suggested that technology based learning had potential application in lay health education for the wider community. Amongst many respondents, there was enthusiasm for bringing new approaches to learning, such as distance learning, allowing people to be trained at remote, rural locations.
It could be like... you are posted to a particular hospital that trains you and you
don’t have to come to the university umbrella to be trained... So I believe that
really would enhance a lot of sharing of information.

Interview U19 (Uganda), Medical Officer, Middle grade, Uganda, Urban,
Government, Referral.

Choice of platform

When asked about available infra-structure, there was no single preferred platform
and choices were largely determined by what was available, rather than by issues such
as ease of use. For many, particularly more junior, non-medically qualified
interviewees and those employed in government institutions and in rural areas,
computers were not available, so that formats such as internet, CD-ROM and DVD-
ROM were inaccessible. However, many had DVD players at home and were
comfortable with using these devices to watch materials, although some were
uncertain how other family members would feel about them doing this. The main
drawback of this platform was the lack of DVD players at institutions. Compatibility
with older computers was also a key issue, with older platforms (such as CD-ROMs)
being preferred and concerns that some of the available computers would not play
DVD-ROM. One proposed solution was to develop materials on more than one
platform so that materials could be accessed using whatever infra-structure was
available locally. Several respondents highlighted that technology based resources are
often developed using the latest hardware, operating systems and web browsers,
which were often inaccessible on their older machines.

Almost every house they have televisions. But computers we have not got. So
what can be read in a television is a DVD. So if they can put it on DVDs, people
will appreciate it. For me I will appreciate it because I can watch it from my
place.

Interview U2 (Uganda), Clinical Officer, Uganda, Rural, Government.
I would go for two. I’ve never seen the other option [DVD-ROM and internet] working... I would go for a DVD for TV and a CD-ROM, those two.

Interview U9 (Uganda), Medical Officer, Senior, Uganda, Rural, PNFP.

**Language and accent**

There were inter-country differences in language preferences which seemed related to the spoken language in each country: Tanzania uses KiSwahili as a national language (alongside English and different tribal languages) whereas Uganda uses English alone as a national language, with many other tribal languages across the country. These differences were reflected in respondents’ views about language and accent.

A clear majority at larger units voiced a preference for English. The two main reasons were the lack of technical medical vocabulary in local languages, and secondly (especially in Uganda) the limited reach of resources developed in local languages. At dispensary level, some respondents voiced a preference for KiSwahili due to their own language abilities; whilst others voiced a preference for English to help them practice their language skills or to overcome the more limited technical medical vocabulary in KiSwahili.

Yeah, that’s OK to have the information in English because our people here do not study medicine so some of those medical terms will be hard to put in the local language. So when they remain in English, it will be easy to understand, because our doctors also train in English.

Interview U3 (Uganda), Clinical Officer, Rural, Government.

I think if the, this thing would be best in English because if it is put in a local language, other people would also like it in their own language. Put in Bukonzo, and you know in our language, because in our country we have many languages.

Interview U5 (Uganda), Clinical Officer, Rural, PNFP.
Respondents were divided on whether they would prefer an English or African narrator. Many respondents at hospital level preferred a UK English accent because they felt that it would be difficult to get an African accent which was widely understood outside of the immediate country/tribal area. However, others felt that an African accent would be clearer and some highlighted the importance of an African accent to making the resource rooted in context.

_I think the British English is very easily understood, very easily understood, as long as it’s presented in a fluent manner, and with illustrations... In fact when you come in locally, there are often problems with some narrators. There are some tribal influences in people’s narration._

_Interview U8 (Uganda), Medical Officer, Senior, Rural, PNFP._

_African speaking English is more understandable by most of the Ugandans. You know, the accent in the UK, they tend to accent of somebody, depends on the experience. Not too many Ugandans are experienced in listening to accent of the British people._

_Interview U10 (Uganda), Medical Officer, Senior, Rural, PNFP._

The need for clear, slow articulation was highlighted, and subtitles were suggested as a means of helping learners who are not fully fluent in English.

_When I am watching movies, I like movies with subtitles, yeah, because of the way they talk... sometimes subtitles can be very helpful, very much helpful, yeah. Otherwise, also I think, believe, to make things easy, just the way to articulate the words._

_Interview T2 (Tanzania), Medical Officer, Middle grade, Urban, PNFP, Referral._
Clinical material

Respondents were generally in favour of clinical material (videos and photographs of patients) being obtained in sub-Saharan Africa for both clinical and cultural reasons. Clinically, differences were highlighted in the appearance of clinical signs (such as jaundice, anaemia, cyanosis) on dark coloured skin. In addition, many important diseases (particularly communicable and tropical diseases) would be difficult to find elsewhere in the world. It was also highlighted that there are cultural and practical differences in the way that doctors and patients communicate with each other which would be reflected in clinical material sourced locally. Several respondents also felt that clinical material from the African context may increase the likelihood of people believing that the learning materials were relevant and realistic for their context. There was a suggestion that this might be a particularly true for materials targeted at junior health workers with a less international outlook, and for materials targeted at the wider community.

I would really wish is the same approach is done to cases which are more common in Uganda...I think it would be a very beneficial... I would prefer things, the patients are African, or Ugandan for that matter because what may appear as a bruise on white skin, may not necessarily appear as a bruise on black skin.

Interview U22 (Uganda), Medical Officer, Middle grade, Urban, Government, Referral.

Our understanding of our patients is different... they may even not pick, advance an issue because of stigma and issues of culture so these settings depend a lot, of what, how exactly we handle situations.

Interview U24 (Uganda), Medical Officer, Senior, Urban, Government, Referral.

So seeing this, er, European patients maybe it would be a distracting and picturing the real Africa picture, so if the patients are real African children, then that makes more, more good thing that these are realistic.”

Interview T4 (Tanzania), Medical Officer, Middle grade, Urban, PNFP, Referral.
Whilst there was general enthusiasm for filming in the local context, there was also readiness to accept and learn from materials from other settings. On a practical level, respondents highlighted that, for many conditions, clinical features were unchanged by skin colour; and for some respondents, there was also a philosophical belief that scientific knowledge is universal and that it is desirable to have a wider view of medicine. Some respondents felt that learners might be more willing to learn from materials from resource rich countries because of a perception of a higher international standard.

On the contrary, with this, I may sit back, and say “Ah” I will get taken up by the one that is one in Europe and I will take keen interest and I say, “oh yeah, that is how they do it, how decent is it.

Interview U4 (Uganda), Medical Officer, Senior, Rural, Government.

5.4.5.2 Implementation of technology based learning programmes

Infra-structure

Respondents were able to point out a range of infra-structure limitations which could limit the adoption of technology based learning initiatives. In addition to the issues affecting access to computers, the internet and other technology (described above), electricity was another concern, especially at rural hospitals and dispensaries (with limited or no electricity supply).

I don’t know if it’s the government or it’s the hospital management, should see into increasing the number of computers, the accessibility, and the computers connected to the internet especially, yeah. Because... my friends tell me that the internet is of very great use, especially in this medicine.

Interview T2 (Tanzania), Medical Officer, Junior, Tanzania, Urban, PNFP, Referral.
It depends on electricity, so the use is limited to, like these days now, 3 hours only, from 7 to 10, then after that, no more. Again, we wait because the power is really 3 hours, after that there is no power.

Interview U3 (Uganda), Clinical Officer, Rural, Government.

Respondents highlighted the need for advocacy at policy level for better access to technology although it was also highlighted that learners would seek to find solutions to allow them to access materials which are useful and relevant and, to some extent, find their own solutions to infra-structure limitations.

If you really see that there is some advantage or some help or some aid to my learning and to increase the efficiency of the work, then the interest starts.

Interview U7 (Uganda), Clinical Officer, Uganda, Rural, PNFP.

ICT skills and experience

Whilst several respondents were already regular users of ICT and reported feeling confident with internet, CD-ROM, e-mail and word processing, it was clear that a large proportion of interviewees had little or no training in ICT and limited confidence. There was greater confidence amongst younger people, more senior personnel (such as doctors) and those from urban areas and private-not-for-profit institutions, perhaps as a result of having better opportunities to use ICT. Amongst this group, most were ‘self-taught’ although some younger doctors reported having some formal ICT training during their undergraduate studies and others reported having computing lessons at school. Many of those who were themselves confident in using ICT described friends and colleagues who lacked ICT experience and skills. Some respondents suggested better ICT exposure and training during initial training courses. The lack of ICT skills amongst sections of the health workforce (likely to be more junior and older personnel, those in rural areas and government institutions) could present a significant barrier to adoption of technology based learning.

What I feel is that all the staff would want to be computer literate but if I gauge, like at the moment... I would say about 1/8 of my staff are computer
literate, because they don’t have access to that... And that is the starting point, that they must have that computer knowledge... Here, my colleague is not literate but I have been encouraging him... and there are a few clinical officers who are taking on that and because of various assignments that I have given them and then a few nurses because of their ambition.

Interview U4 (Uganda), Medical Officer, Senior, Rural, Government.

Distribution and publicity

It was highlighted that technology based learning opportunities are often clustered in large centres and several respondents felt that it was important to avoid this so that materials reach staff in rural areas. This requires materials to be produced in sufficient numbers to allow wide dissemination. It was also considered important to ensure that materials are made available within health facilities, rather than locked away or taken by an individual member of staff for their own individual use. Publicity was also important, with a need to raise awareness amongst front line health workers, both of the potential of technology based learning, and the availability of specific resources.

Because sometimes, most of us we are, we are living at the periphery, so when other things have been achieved they are started from the big centres, so, until it will reach in the periphery, it comes but quite long of time... but the problem is how to get these things - special computers and other things.

Interview T10 (Tanzania), Assistant Medical Officer, Urban, PNFP, Referral.

The advice I would give them is that first they have to produce the CD-ROMs a bit in bigger numbers so that they can reach to many people, especially staff in Uganda, those who work in the rural areas.

Interview U3 (Uganda), Medical Officer, Senior, Uganda, Rural, Government.
Updates and sustainability

Sustainability of technology based learning programmes was also considered important. This included ensuring that programmes were not just ‘short-lived’ but part of a longer term partnership with updates and opportunities to obtain feedback from learners. The potential for materials (especially those delivered on CD-ROM, DVD or DVD-ROM) to become outdated was a concern, reflecting frustrations about outdated textbooks and a general lack of access to up-to-date health information. A mechanism to ensure that updated materials are continuously developed and delivered was considered important.

_The challenges here, we have somebody starts something and then stops somewhere, cannot sustain it for some time. They never let you, you won’t be able to thank them or comment whether it was useful or not useful._

_Interview U7 (Uganda), Medical Officer, Senior, Uganda, Rural, PNFP._

5.5 Discussion

This study provides wide-ranging insights into the range of issues affecting learning, professional development and the use of ICT by health workers in Uganda and Tanzania. It provides novel data, both in terms of the population sampled (especially the inclusion of non-medically qualified cadres, and those working away from urban settings) and in the breadth and depth of the thematic analysis. A picture emerges of inter-related issues of resource and infra-structure factors, skills, professional culture and systems issues and the data illustrates the range of issues which must be considered if technology based learning is to be successfully adopted in this setting.

This study included a large number of interviews, sampled purposefully to understand issues affecting health workers in different contexts, including those in remote and difficult to reach locations. There were some practical limitations to sampling so that, for example, rural government units in Uganda and rural private not-for-profit units in
Tanzania are possibly under-represented. However, across the two countries, the sampling frame seems reasonably balanced and, importantly, interviews were obtained from health workers based away from large units where other studies suggest that barriers are most likely to be experienced. Potentially, the use of a KiSwahili interpreter may have reduced the depth of discussion possible at dispensary level units. Furthermore, interview data is always subject to bias and, in this study, where the interviewer was obviously from overseas, responses may have been influenced by perceptions of status. However, the data shows that health workers spoke freely and widely about problems and concerns; and seemed willing to discuss cross-cultural issues and talk about both negative and positive experiences.

Unsurprisingly, resource limitations are a key issue, affecting access to computers, internet, textbooks, journals and disc based materials for institutions and individuals. Institutional access is better at private-not-for-profit institutions and larger urban hospitals; and individual access is better for senior workers. Personal internet access is not widespread with most health workers relying connections at their institution or at public internet cafés; with speed, reliability and cost of internet access highlighted as significant barriers to the use of internet for professional development. For developers of technology based learning materials, this is particularly relevant and limits the capacity of users to download audio and video material.

A further issue relates to the age of infra-structure, and it is necessary to develop materials that are compatible with older computers and software (such as web browsers). This study also highlights the power of international links as a means of building capacity, leveraging funding and securing other donations of time, expertise and equipment. These links are much valued but seem far more active in the private-not-for-profit sector and at larger institutions.

For those developing and implementing technology based learning programmes, these resource issues are a key concern. This data highlights potential strategies for improving reach, such as developing materials on DVD for television which is more widely accessible; or developing simultaneously on several different platforms so that
whatever infra-structure is available locally can be used. Materials need to be relevant and care is needed in planning and developing materials so they focus on health priorities and are applicable to clinical practice in a resource limited context with limited access to drugs, equipment and diagnostic tests. There is a tension here, as health workers also appreciate insights into new approaches which might not be immediately available in their context and this may prompt advocacy for better facilities and resources. The delivery of information is also important. In terms of language, hospital staff in Uganda and Tanzania, find English (narrated in a neutral, international accent) acceptable; although it is likely that staff at lower level units, especially in countries such as Tanzania, where English is less commonly used for day to day communication, might struggle with this. There is enthusiasm for materials being filmed locally for clinical and cultural reasons, and to increase engagement.

It is widely recognised that health systems in sub-Saharan Africa are fragile, and implementation of technology based learning needs to take account of barriers identified here such as workload and professional isolation. On a practical level, systems need to allow materials to be publicised, distributed in sufficient quantities, provided to more remote locations, and regularly updated. Learners need ICT skills and engagement is further influenced by organisational and professional culture. It should be noted that informal copying of materials onto ‘burned’ DVDs or USB memory sticks is widespread and, whilst this infringes copyright, has the advantage of allowing materials to spread and reach a wider audience.

Whilst many of the issues identified in this study require investment in infra-structure and resource development, there is also evidence that existing resources could be used more effectively through changes at institutional level. Units could make available computers and educational materials more accessible to clinicians, for example by opening a resource room or letting staff use administrative computers out-of-hours; by publicising the availability of educational resources amongst the workforce; or by using existing monitoring and outreach visits to provide education and peer-support.
5.6 Conclusions

This study provides an in-depth review of the issues affecting access to health information, use of technology and development and implementation of technology based learning materials at hospitals and dispensaries in Uganda and Tanzania. Differences emerge between private-not-for-profit and government sectors, rural and urban locations and junior and senior health workers. The need for investment in infra-structure and educational materials is highlighted, but also ways in which existing resources could be used more effectively. The data provides insights related to development and implementation of technology based learning interventions and highlights the range of issues which need to be considered, holistically, for the successful adoption of these approaches in sub-Saharan Africa.
6.1 Introduction

This chapter synthesises six recurring themes from the research presented in chapters 3-5 and existing literature (chapter 1):

- Infra-structure
- ICT skills and confidence
- Health systems
- E-learning Design and development
- Sustainable implementation at scale
- Feedback and evaluation

These findings will then be applied the development of a multimedia resource, using a quality improvement approach (section 1.8).

6.2 Synthesis

6.2.1 Infra-structure

Access to ICT in sub-Saharan Africa lags significantly behind other regions and the data presented provides a deeper understanding of the constraints. It is clear that technology is already used by a significant proportion of health workers in the region, despite significant limitations in computer and internet access. Differences in access exist across cadres with medical staff reporting better access than nurses; and from chapter 4, mid-level health workers also having better access than nurses. Chapter 5 confirms that many of the issues found in population-based studies are relevant to health workers: access from rural locations is especially constrained, and also from
smaller government units (when compared with larger and private-not-for-profit institutions) possibly due to the impact of international links and donor funding.

Despite published reports of successful ‘low-bandwidth’ web-based videoconferencing, internet speed, cost and reliability are significant limitations and it does not currently appear feasible to rely on internet to deliver ‘high-bandwidth’ resources (such as streamed video and audio) to sub-Saharan Africa. Pragmatically, when internet is used, resources should use the minimum possible bandwidth and offer low graphic/text-only versions for slow internet connections. Materials should also be compatible with older computers and web browsers; and avoid unnecessary plug-ins and cookies (downloadable programs required to access materials). Other infrastructure barriers include the prevalence of computer viruses, lack of reliable sources from which to buy computers, lack of ongoing technical support and under-use of existing computers within institutions.

Disc-based materials provide an alternative to the internet, albeit with some drawbacks (fragility of discs, problems updating, cost of duplication and distribution). Also, DVD players for television are more available than computers, even in rural locations, and seem to emerge from this research as the most promising technical platform in the short-term. However, there are strong arguments for developing materials on an appropriate ‘blend’ of platforms so that materials can be used on whatever device is locally accessible.

Infra-structure is developing rapidly and some health workers raise the possibility that, rather than waiting for infra-structure, relevant, high-quality content will instead act as a ‘driver’ for better access to technology. This resonates with Diffusion of Innovation theories (section 1.4.1) where most users are attracted to new technology by its practical application (rather than by technology for its own sake). The advent of new devices (such as smart phones) highlights the pace at which technology advances and hence the need for content to be developed in such a way that it can be re-developed and re-packaged for such emerging technical platforms.
6.2.2 Skills and confidence

ICT skills are not consistently developed across the health workforce and are influenced by factors including professional group, age, gender and seniority. Most health workers in sub-Saharan Africa appear to learn computing skills informally with encouragement, coaching and support from colleagues and friends. Data from the UK (presented in chapter 4) where this informal, experiential approach is recognised to be widespread, suggests that most health workers pick up the required skills informally but that a proportion will struggle due to a lack self-efficacy and support. From the data presented, this may disproportionately affect female workers, nurses and midwives (who seem to report lower levels of confidence) and those in smaller, more remote units (who have smaller support networks). Strategies for developing ICT skills, especially in these groups, should be considered as part of implementation.

6.2.3 Health systems

Extensive data highlights the fragility of health systems in sub-Saharan Africa and the impact of weak health systems on quality of care and slow progress towards quality improvement. Data (presented in chapter 5) highlights constraints from health workers’ perspectives, adding to the argument that educational interventions should be viewed in a health systems context. This means:-

- developing e-learning based on the needs of the health system as a whole,
- making efficient use of financial and human resources,
- planning implementation carefully to avoid additional burden on health systems,
- developing and implementing materials in a way which strengthens health systems,
- whenever possible, developing materials as part of a broader health systems and human resources strategy.
6.2.4 E-learning design and development

6.2.4.1 Choice of content

Consistent with the characteristics of adult learners, health workers prefer learning materials which are relevant to their context. This includes ensuring that investigation and treatment recommendations are locally appropriate and highlighting approaches that can be used when facilities, drugs or specialist human resources are unavailable. However, this is balanced with some (typically more senior) health workers wanting a broader perspective including newer investigations and treatments which might not be immediately available.

6.2.4.2 Language and narration

Preferences vary by country and seniority. Local languages are not generally used for study amongst clinically qualified cadres (with many highlighting the lack of technical vocabulary and limited reach of some vernaculars). However, more junior, unqualified and community-based workers may struggle with materials in English. Similarly, respondents vary in their opinion as to whether an ‘international’ or ‘local’ narrator is more comprehensible and engaging. Decisions are therefore probably best made individually for each resource in consultation with the proposed audience, and ideally user-tested. Multimedia learning theory highlights approaches (such as subtitling key words) which can be used to aid understanding by non-native speakers.

6.2.4.3 Clinical context

Again, consistent with adult learning theory, most health workers are keen for materials to use videos and photographs which reflect their context. There are clinical and cultural advantages to this: with differences in the appearance of certain clinical
signs in different skin colours; and (drawing upon social cognitive theory) the possibility that seeing ‘good practice’ in a familiar context might build self-efficacy. However, most health workers are pragmatic and willing to learn from other contexts; with some even suggesting that materials from more developed regions might be considered more authoritative.

6.2.5 Sustainable implementation at scale

Effective, sustainable implementation represents a key challenge and requires a clear plan for publicity and dissemination of materials. Steps include:-

- ensuring that financial resources are available for materials to be duplicated and delivered to the intended audience,
- developing a publicity strategy to engage learners and opinion leaders who act as advocates for the materials,
- understanding and leveraging existing systems which can be used to distribute and publicise materials (such as support-supervision programmes and existing logistics networks),
- considering how materials will be updated, and updates shared with learners.

E-learning materials seem more likely to be used at scale if there is engagement from policymakers, if materials can be developed and used within a wider programme of health systems strengthening and if a grass-roots movement to advocate for access can be developed.


6.2.6 Feedback and evaluation

6.2.6.1 Learner engagement

The value of learner engagement in shaping the design of e-learning materials is highlighted both in chapters 4-5 and in adult learning theory. It is likely that consulting with learners before and during the development process will increase relevance of content, ease of navigation and overall acceptability of materials. Careful piloting and evaluation can help to shape future resources, inform revisions to materials and contribute to the broader evidence-base.

Usability testing (systematic testing with users during the development process) provides a useful method of identifying and rectifying problems. It is important that this is done with local staff, locally available computers and internet connections so that any issues related to skills (e.g. unacceptable technical complexity) or infrastructure (e.g. unrealistic bandwidth or software requirements) are identified early and resolved.

6.2.6.2 Piloting and evaluation

There is a need for evidence to shape the development of e-learning for health in sub-Saharan Africa. Incorporating piloting and evaluation steps into resource development programmes may help to identify unmet learning needs, improve the quality of materials and generate evidence to inform future resource development and implementation.
6.3 Application

The research presented so far can help to define a quality improvement process for developing multimedia learning resources for sub-Saharan Africa, presented in fig 5a.

**Fig 5a: Applying a plan-do-study-act (PDSA) cycle to multimedia resource development using the framework developed by Deming (1986) and Langley (1996)\(^{361,362}\)**

This application of this approach to a multimedia resource in ophthalmology for health workers in sub-Saharan Africa, as a ‘proof of concept’ from which further insights and conclusions can be drawn, is the focus of the remainder of this thesis.
Objective 2:
Develop and pilot a new e-learning resource in eye health for health workers in sub-Saharan Africa using a quality improvement approach.
7.1 Introduction

The remainder of this thesis describes the development and evaluation of a multimedia learning resource in eye health. The rationale for choosing this as a ‘proof of concept’ topic was partly pragmatic (the research group to which the author is attached had been in discussion with subject experts in ophthalmology who were keen to support such a project) and partly based on the significant burden of avoidable blindness worldwide, much of which is amenable to prevention or treatment by an appropriately skilled health worker based on clinical assessment without the need for expensive diagnostic tests.

This chapter therefore provides an overview of the current state of eye health in sub-Saharan Africa. Three topics are covered:

- Epidemiology of eye disease and visual disability,
- Delivery of eye health services in sub-Saharan Africa,
- Policy issues in global eye health, including the Vision 2020 initiative.

7.2 Epidemiology of eye disease and visual disability

7.2.1 Definitions of visual impairment and blindness

The WHO International Classification of Diseases (ICD-10)\(^{460}\) defines visual impairment in five categories (see table 7a). Measurements are taken binocularly (with both eyes open) using the person’s ‘presenting correction’ (ie: the glasses they normally use, if any). Monocular blindness and monocular visual impairment are defined respectively as acuity <3/60 and <6/18 in the affected eye.
### Table 7a: Definitions of visual impairment and blindness (CF = Counts fingers)

<table>
<thead>
<tr>
<th>Category</th>
<th>Presenting distance visual acuity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Worse than:</td>
</tr>
<tr>
<td>0 Mild or no visual impairment</td>
<td>6/18</td>
</tr>
<tr>
<td>1 Moderate visual impairment</td>
<td>6/18</td>
</tr>
<tr>
<td>2 Severe visual impairment</td>
<td>6/60</td>
</tr>
<tr>
<td>3 Blindness</td>
<td>3/60</td>
</tr>
<tr>
<td>4 Blindness</td>
<td>1/60</td>
</tr>
<tr>
<td>5 Blindness</td>
<td></td>
</tr>
</tbody>
</table>

The term ‘low vision’ is used to describe those with category 1-2 visual impairment (ie: acuity <6/18 but >= 3/60) despite the best possible glasses correction. Functionally, this group is likely to be able to navigate independently but will need support with many other activities; whereas blindness means that a person is likely to need assistance with navigation.

#### 7.2.2 Prevalence of visual impairment

Two large systematic reviews have recently measured the prevalence of blindness and visual impairment for the global population and the African region. A summary of their estimates are presented in table 7b and 7c.
Table 7b: Estimates of burden of visual impairment globally and in Africa for 2010.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Proportion of cases (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blindness (WHO category 3-5)</td>
</tr>
<tr>
<td></td>
<td>Global¹</td>
</tr>
<tr>
<td>Cataract</td>
<td>51</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>8</td>
</tr>
<tr>
<td>ARMD</td>
<td>5</td>
</tr>
<tr>
<td>Childhood blindness</td>
<td>4</td>
</tr>
<tr>
<td>Corneal opacities</td>
<td>4</td>
</tr>
<tr>
<td>Uncorrected refractive error</td>
<td>3</td>
</tr>
<tr>
<td>Trachoma</td>
<td>3</td>
</tr>
<tr>
<td>Diabetic retinopathy</td>
<td>1</td>
</tr>
<tr>
<td>Other/undetermined</td>
<td>21</td>
</tr>
</tbody>
</table>

¹ Left hand column shows estimates from Pascolini and Mariotti (2012);² Pascolini and Mariotti (2012);³ Bourne et al (2013)

Table 7c: Leading global causes of blindness and visual impairment.
Important observations include the significant global burden of eye disease and the striking proportion attributable to treatable and preventable conditions (cataract and refractive error; glaucoma, trachoma and diabetic retinopathy). Such treatable and preventable causes are estimated to account for 65% of global blindness and 76 - 80% of visual impairment.\textsuperscript{441,443,444}

A significant burden of blindness is seen in less developed countries, with Africans accounting for 15% of the world’s blind.\textsuperscript{441} Socio-economic factors including income, level of education, gender and ethnicity all influence the likelihood of visual impairment\textsuperscript{445} and age-standardised prevalence figures (which adjust for inter-regional demographic differences) further highlight the disproportionate burden of blindness and visual impairment in developing countries.\textsuperscript{446} Table 7c also shows inter-regional differences in aetiology (most strikingly for trachoma).\textsuperscript{444}

Population growth and demographic shift towards an older population have offset improvements in age-standardised prevalence rates for blindness and visual impairment over the last 20 years to produce little overall change in the number of blind people worldwide (31.8 million in 1990, 32.4 million in 2010) and an increase in the number of vision impaired (110 million in 1990, 191 million in 2010).\textsuperscript{446,447} It is therefore highly likely that population growth and ageing will continue to increase demand on eye health services.

7.2.3 Social and economic impact of eye disease

The impact of visual disability on individuals and communities (in terms of economic productivity, social functioning and broader quality of life) is well-recognised both globally\textsuperscript{446,448-450} and in sub-Saharan Africa\textsuperscript{451} and an association with increased mortality is also observed.\textsuperscript{452} Economic modelling suggests that lost economic output due to blindness worldwide in 2000 was US$19 billion; and for visual impairment was US$42 billion.\textsuperscript{448}
The impact of an untreated or untreatable disabling condition, in economic terms, depends on its prevalence and age of onset relative to life expectancy. The concept of ‘blind-person years’ has been used to express this: highlighting that, for example, a child who is blind from birth can expect to experience an average of 40-50 years of disability; whereas an untreated age-related cataract, glaucoma or diabetic retinopathy will result in typically 5-8 years of disability for each case.\(^{450,453}\)

### 7.2.4 Eye disease in sub-Saharan Africa

#### 7.2.4.1 Eye diseases in hot climates

The distinct social, economic, geographical and climatic features of sub-Saharan Africa underpin many of its eye health challenges, some of these are summarised below:\(^{442,454}\)

- **Trachoma** occurs due to recurrent conjunctival infection by *Chlamydia trachomatis* and cumulative scarring. It is spread through an insect vector and is common in areas with poor water and sanitation and high densities of flies. The World Health Organisation SAFE strategy\(^{\text{Note 1}}\) has been developed to counter this condition through a combination of medical, environmental and behavioural strategies.\(^{450,455}\) The number of cases of active trachoma worldwide has declined from 500 million to 40 million since 1980 but it remains a significant cause of blindness, loss of productivity and reduction in quality of life.\(^{456,457}\)

- **Xerophthalmia** is a significant cause of childhood blindness (see below) related to vitamin A deficiency (linked to malnutrition) and childhood infections (particularly measles), possibly complicated by the use of traditional eye medicine.\(^{453}\)

\(^{1}\text{SAFE: Surgery for trachoma (inturned lids and lashes); Antibiotics (for active infection); Facial and Environmental hygiene}\)
- **Onchocerciasis** (*river blindness*) is a parasitic infection spread by an insect vector which affects a localised geographical belt with the majority of the resulting blindness focused in West Africa. Community treatment with ivermectin is effective.

- **Cataract, solar keratophy** and **pterygia** are commoner in dry, hot conditions. **Fungal keratitis/corneal ulcers** are commoner in warm, moist conditions.

Socio-economic factors also have an impact on the availability of eye care services (such as cataract surgery, access to appropriate care for eye problems and availability of essential medicines).445,454

### 7.2.4.2 HIV and the eye

HIV has various ocular manifestations including conjunctival squamous cell carcinoma and herpes zoster ophthalmicus. HIV related retinal diseases due to toxoplasma, cytomegalovirus and other opportunistic infections may occur.

### 7.2.4.3 Demographic shift and emerging diseases

Demographic shift and emerging diseases are likely to impact eye health, with an increasing burden of diabetic retinopathy, age-related macular degeneration441,443,458 and other diseases (such as cataract and glaucoma) which increase in incidence with age.459
7.2.4.4 Childhood blindness

Childhood blindness is estimated to contribute around 4% of the world’s burden of blindness but (as discussed above) a significantly higher proportion of ‘blind person years’ due to its early onset. The associated social and economic burden provides a strong economic argument for focusing on childhood blindness.

In Africa, most childhood blindness (estimated at 38%) develops after the perinatal period. Corneal blindness due to xerophthalmia remains an important contributor, although there is evidence that this has decreased due to improved vaccination, nutrition and vitamin A supplementation. As corneal blindness falls, other diseases (congenital/developmental cataract, trauma, retinal pathology (including retinopathy of prematurity), retinoblastoma and congenital anomalies) become relatively more significant and present the next stage of challenges in childhood blindness.

7.3 Delivery of eye health services in sub-Saharan Africa

7.3.1 Human Resources for Eye Health

Human resource constraints on eye care services in sub-Saharan Africa are well recognised and several mid-level cadres, including cataract surgeons (in 18 countries), ophthalmic clinical officers (in 7 countries) and mid-level refractionists (in 16 countries) complement the more traditional professional groups. Ophthalmologists, optometrists and other refractionists are disproportionately distributed in urban areas and capital cities (probably for economic and health systems reasons, including private practice); with a more even rural-urban distribution of other cadres. Using mid-level surgeons to improve access to cataract and lid rotation surgery (for trachomatous trichiasis) has been an important strategy in some countries. Estimated ratios of eye health workers to patients with targets and projections for 2020 are given in table 7d. It seems unlikely, based on current trends,
that these targets for practitioner coverage will be met, most strikingly for refractionists.\(^{468}\)

<table>
<thead>
<tr>
<th>Cadre</th>
<th>Coverage (practitioners/million population)</th>
<th>Current</th>
<th>Projected 2020 (target coverage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ophthalmologist</td>
<td></td>
<td>2.3 - 2.7</td>
<td>2.7 (4.0)</td>
</tr>
<tr>
<td>Cataract surgeon non-specialist doctors/mid-level workers trained in cataract surgery.</td>
<td></td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Ophthalmic clinical officer/medical assistant Mid-level workers with an advanced qualification in ophthalmology.</td>
<td></td>
<td>0.7</td>
<td>7.5 (10.0)</td>
</tr>
<tr>
<td>Ophthalmic nurse</td>
<td></td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Optometrist</td>
<td></td>
<td>1.7</td>
<td>3.6 (20.0)</td>
</tr>
<tr>
<td>Mid-level refractionist Mid-level worker trained in refraction techniques.</td>
<td></td>
<td>2.1</td>
<td></td>
</tr>
</tbody>
</table>

Table 7d: Specialist eye health workforce estimates and comparisons with proposed Vision 2020 targets in brackets (see section 7.4)\(^{463,468,469}\)

Some of the health systems issues highlighted in chapters 1-5 are likely to apply: concerns about quality of care, productivity, governance; and availability of equipment, professional development and support-supervision opportunities have all been raised in the eye health workforce.\(^{462,464-467,470}\)

7.3.2 Primary eye care

There is significant interest in integrating eye health with primary and community health care in an approach known as ‘primary eye care’,\(^{471,472}\) defined as:-

‘an integrated, participatory and inclusive approach to the eye health component of primary health care consisting of promotive, preventative, curative and rehabilitative services, delivered by the health workforce (formal and informal) in conjunction with community members, up to and including services at the front line health facilities’.\(^{473}\)
Whilst different countries adopt different service configurations,\textsuperscript{474} it is recognised that both community and hospital based activity is needed.\textsuperscript{450} Examples of activities currently undertaken in different parts of the health system and typical staffing arrangements are given in table 7e.

<table>
<thead>
<tr>
<th>Level and typical staffing</th>
<th>Examples of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specialist</strong></td>
<td></td>
</tr>
<tr>
<td>Tertiary (ophthalmologist)</td>
<td>Complex surgical treatment (e.g. paediatric cataract surgery, strabismus, retinoblastoma). Laser treatment of diabetic retinopathy.</td>
</tr>
<tr>
<td><strong>Primary</strong> (usually non-specialist)</td>
<td></td>
</tr>
<tr>
<td>Patient based</td>
<td>Initial triage of patients with ocular symptoms and referral for specialist assessment. Hosting specialist outreach.</td>
</tr>
<tr>
<td>Population based</td>
<td>Community treatment (e.g. onchocerciasis, trachoma). Health education (e.g. trachoma prevention). Measles vaccination and vitamin A supplementation.</td>
</tr>
</tbody>
</table>

*Table 7e: Examples of eye health activities and typical staffing at different levels of the health system in sub-Saharan Africa.*\textsuperscript{464,465,473,474}

The practical role of non-specialist primary care workers in eye health is controversial. Specialist eye services in sub-Saharan Africa are generally found only at the secondary and tertiary level\textsuperscript{473,475} and the potential for primary care to take an educational, advocacy and prevention role and provide a ‘bridge’ to specialist services has been highlighted.\textsuperscript{462,474-477} However, the capacity to meet the needs and expectations of patients at primary care level is uncertain.\textsuperscript{475} Knowledge and skills are lacking\textsuperscript{478} and clinical complexities make the production of adequate symptom-based triage guidelines problematic.\textsuperscript{476} Training and support-supervision are likely to be key practical issues in the adoption of primary eye care approaches.\textsuperscript{473}
7.3.3 Training capacity

Human resource shortages, discussed above, highlight the need to build capacity at eye health training institutions. The number of training institutions for different eye health worker groups in sub-Saharan Africa is shown in table 7f.

<table>
<thead>
<tr>
<th>Population (millions)</th>
<th>Anglophone</th>
<th>Francophone</th>
<th>Lusophone</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>522</td>
<td>259</td>
<td>47</td>
<td>828</td>
</tr>
<tr>
<td>Number of training institutions</td>
<td>90</td>
<td>25</td>
<td>7</td>
<td>122</td>
</tr>
<tr>
<td>Ophthalmologists</td>
<td>39</td>
<td>9</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Cataract Surgeons</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Optometrists</td>
<td>20</td>
<td>3</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Allied Eye Health Professionals</td>
<td>22</td>
<td>11</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90</strong></td>
<td><strong>25</strong></td>
<td><strong>7</strong></td>
<td><strong>122</strong></td>
</tr>
</tbody>
</table>

*Table 7f: Training institutions for eye health personnel in sub-Saharan Africa*[^1]

The International Agency for the Prevention of Blindness has highlighted the need to strengthen training capacity, calling for a strategy which utilises existing training capacity fully: developing faculty and infra-structure at institutions and ensuring appropriate continuing professional development. The development and quality assurance of e-learning and other learning materials is specifically highlighted in this strategy.[^1]

7.4 Global eye health policy and Vision 2020

‘Vision 2020 – the right to sight’ is a joint project between the World Health Organisation (WHO) and International Agency for the Prevention of Blindness (IAPB), aiming to eliminate avoidable blindness worldwide by 2020. It represents a coalition of governmental, non-governmental, professional and training bodies and eye care institutions, aiming to develop three key elements:[^2]

1. Control of major causes of blindness, including a specific goal to eliminate blindness due to cataract, trachoma, vitamin A deficiency, onchocerciasis and refractive error worldwide by 2020.

[^1]: 479
[^2]: 448,454,480
2. Development of the eye health workforce.
3. Development of infra-structure and appropriate technology.

The choice of priority conditions was informed by the availability of proven, cost-effective treatments (cataract surgery, provision of glasses, SAFE treatment of trachoma, ivermectin for onchocerciasis, and measles vaccination and vitamin A supplementation for xerophthalmia prevention. Surgically avoidable childhood blindness was also highlighted as a priority.

Vision 2020 envisions human resource development both at the community level (through primary eye care) and specialist level, with targets for minimum numbers of different specialist cadres (listed in table 7d) as well as managers and equipment technicians; and infra-structure development based on a model of specialist services at the district level (serving populations of 0.5 – 2 million) integrated with primary health care and a supporting regional, national and global eye health structure. The development of computers as tools for better information exchange is also highlighted.

Whilst it remains to be seen whether Vision 2020 will achieve its ambitious aims, it has clearly become a powerful focus for global prevention of blindness activities and sets the policy framework in which e-learning materials in eye health will be used.

### 7.5 Conclusions

The data presented in this chapter highlights scale of eye disease and visual disability in sub-Saharan Africa, the qualitative and quantitative differences from other regions, and the impact of climatic, geographical and socio-economic factors on disease burden. These factors, specific to eye disease, combine with the other arguments presented earlier in this thesis (from theory and research with learners) in favour of a specific, appropriate, e-learning resource for eye health workers for this setting.
The Vision 2020 initiative and recent strategic developments related to strengthening training capacity in eye health provide a supportive policy environment for e-learning; but also highlight the need for careful impact evaluation to justify the allocation of resources to subsequent implementation. Further challenges relate to development of materials for Francophone and Lusophone communities; and materials which can be used at the primary health care level.
8.1 Abstract

**Purpose:** To use patients’ descriptions to understand processes of care following a significant eye injury and the extent and reasons for delay in accessing specialist care.  
**Setting:** Eye department at Kilimanjaro Christian Medical Centre (KCMC), a large private-not-for-profit teaching hospital in Moshi, Northern Tanzania. 
**Participants:** 93 consecutive admissions to the eye department following eye injury, their parents and accompanying relatives (as appropriate).  
**Methods:** Semi-structured interviews were used to obtain information about the injury, subsequent symptoms and the patient’s journey from time of injury to being assessed by a specialist at KCMC; supplemented by a review of medical notes to obtain clinical information. Statistical analysis was undertaken to measure delay in reaching KCMC and predictor variables. Framework analysis was undertaken for interviews.  
**Results:** 90 of 93 patients took part. There was significant visual loss in 95.5% of affected eyes on arrival. Mean delay between injury and assessment at KCMC was 6.8 days. Most participants were seen at a health facility soon after injury: 61.1% within 24hr, and 82.2% within 48hr. Injury at a weekend, using topical drops and visiting other health facilities before KCMC were independently associated with delay >24 and >48hr, and female gender associated with delay >24hr (but not >48hr). Patient journeys involved milestones and processes. Journeys were frequently ‘circular’, involving delays caused by repeated visits to health units unable to treat the injury, often on a health worker’s advice. Systems problems reported by patients included unclear referral systems and opening times, frequent staff absence and unqualified staff deputising. Individual health workers had an important influence on delay but

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1 Published as: Al-Attas AH, Williams CD, Pitchforth EL, O'Callaghan CO, Lewallan S. Understanding delay in accessing specialist emergency eye care in a developing country: eye trauma in Tanzania. *Ophthalmic Epidemiology.* 2010;17:103-112
their performance appeared variable. They influenced patient journeys positively when they made an accurate diagnosis, referred directly to KCMC, discussed practicalities and communicated the seriousness of the injury, the need for urgent treatment and the adverse consequences of delay.

**Discussion:** There is significant delay in accessing appropriate specialist care following eye injury in Tanzania, much of which occurs after first visiting a health facility. Journeys are influenced by a complex interplay of poverty, health systems and the performance of individual health workers; and do not occur in isolation, resulting in a cumulative effect of delay. Several potential foci for training and development are identified but the impact of this may be limited by wider health systems limitations. A model that may help guide wider health systems interventions to reduce delay is proposed.

### 8.2 Aims

- To understand the experiences of patients in seeking and receiving care following an eye injury.
- To map the real-life pathway of care for patients following an eye injury and identify issues influencing the timeliness and quality of care.
- To use these insights to inform a multimedia educational package in eye health.

### 8.3 Introduction

Ocular trauma is a significant\textsuperscript{482,483} and under-recognised\textsuperscript{484} cause of visual disability worldwide, with a lifetime prevalence in developing countries greater than diabetic retinopathy, glaucoma and age related macular degeneration.\textsuperscript{483} Injuries occur most frequently in childhood or early adulthood, resulting in several decades of visual disability, with social and economic sequelae.\textsuperscript{482,483,485-487} Early specialist assessment
of significant injuries is good practice, as prompt treatment improves visual outcome, prevents infection and reduces corneal scarring.\textsuperscript{488-491}

Previous studies have explored the epidemiology of ocular trauma in developing countries, highlighting a delay between injury and definitive treatment and suggesting that significant delay occurs after the patient first consults a health worker.\textsuperscript{485-487,492} Models of delay in accessing appropriate care for other medical conditions have been proposed, subdividing delay into stages and highlighting the interplay of disease perception, personal, environmental, socioeconomic and organizational factors.\textsuperscript{493} In developing countries, much of this research has focused on maternal health. The best known model – The Three Phase Model – distinguishes delay in deciding to seek care, delay in arrival at a health facility and delay in the provision of appropriate care.\textsuperscript{494} The extent to which such models can be applied to other conditions, including ocular trauma, is unclear.

This study focuses on how patients and families make decisions about seeking help, overcome practical barriers and interact with the health system and individual health workers. The lessons learnt can be used to add a more ‘patient-centred’ dimension to training and professional development for eye health professionals (by recognising how their behaviour may impact journeys of care) and to identify targets for wider health systems strengthening.

\textbf{8.4 Methods}

\textbf{8.4.1 Setting}

This study was based in Kilimanjaro region, Tanzania. Tanzania has an established system of government dispensaries, district and regional hospitals. Nationwide, 54.1\% of patients who consult a healthcare provider report using the government sector. The remainder of private services are run by churches, charities and private individuals. The mean distance to a dispensary is 3.9km, with over 90\% of households
within 10km of a dispensary. The mean distance to a hospital is 21.3km although 17.7% of the population live at a distance > 40km. Dispensaries are staffed by Clinical Officers, with a three year training programme including basic eye care. Each district (population 150,000-250,000) has a district hospital, feeding into a larger regional hospital. District and regional eye co-ordinators, with a variety of training backgrounds, oversee eye services. There are 3 tertiary referral hospitals. Kilimanjaro Christian Medical Centre (KCMC) is one such unit, serving five regions. KCMC is one of only two hospitals in Tanzania with the capacity to provide comprehensive ocular trauma services (including vitreoretinal surgery). KCMC is open 24 hours every day, with a Resident Ophthalmologist on-call for emergencies. A standard charge of 10,000 Tanzanian Shillings (US$7-8) is levied for ophthalmic surgery, including a three day postoperative stay. No referral letter is required and no payment is required before treatment for emergencies. Doctors and the hospital social worker have access to a discretionary ‘poor fund’ to cover treatment costs incurred at KCMC.

8.4.2 Participants

Patients with an eye injury sufficient to require in-patient admission to KCMC were recruited consecutively from 2006 –2008 with a one-month break in January 2007 when the interviewer was not available. Patients were identified from the ward admission book, which was checked daily. A previous study from Tanzania suggests that a 7 day delay in reaching the specialist centre was experienced by 30% of patients. A sample size of 81 is necessary to detect delay among this proportion of the population plus or minus 10% with 95% confidence.

8.4.3 Recruitment

Patients (and parents of those aged under 16 years) were approached. The study was explained and verbal consent was sought. Participation was entirely voluntary and participants were free to withdraw at any stage. Recognising that relatives may have
an important role in the journey of care, accompanying relatives were also invited to participate in interviews and verbal consent obtained from them.

8.4.4 Interviews and data collection

Semi-structured interviews were conducted with patients and (where appropriate) parents or accompanying relatives, using a question guide which explored their patient journey from the time of the injury to being assessed by a specialist at KCMC. A semi-structured interview guide was developed based on a literature review and discussion within the research team. Each patient was asked the same questions although the guide was used flexibly and the interviewer was free to ask further questions based on responses. Information about the timing of events, demographic and socioeconomic data was collected and used in the quantitative analysis. The rest of the interview focused on gaining a holistic understanding the patient journey, the decisions taken and the underlying reasons, and descriptions of advice given by health workers and others. Further questions covered the patient’s perception of the seriousness of the injury, pain, visual symptoms and financial resources. Interviews were conducted in KiSwahili by a Tanzanian Doctor, who was a native KiSwahili speaker, in a private room on the ward. With consent, interviews were audio recorded. Hospital records were reviewed to extract data related to age, sex, visual acuity on presentation, location of injury, date and time of injury, admission and discharge date.

8.4.5 Piloting

Prior to this study, three patients participated in piloting, testing the recruitment process and question guide. Minor modifications were made to the question guide and interview style based on the results of piloting. Pilot interviews were not included in the analysis.

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1 The final visual acuity (after treatment) was not collected. This limitation is discussed further in section 8.6.
8.4.6 Translation and transcription

Audio recordings were translated and transcribed verbatim by the interviewer. A random sample of 10% of interviews was independently checked by another native KiSwahili speaker for completeness and accuracy. No problems with the translations were identified.

8.4.7 Analysis

Analysis combined quantitative analysis of the structured items from interviews and data from hospital records with qualitative analysis of interview transcripts.

8.4.7.1 Quantitative results

From the hospital records and interviews, factors related to the injury were categorized and coded: number of facilities visited before KCMC (when patients treated themselves by purchasing medicine from a pharmacy or using medicine provided by a friend or relative, this counted as one step), whether topical medicine was used before admission (yes/no), highest education level in the household (none, primary, secondary, higher), and number of days between injury and presentation at KCMC (delay). Based on interview responses, the interviewer made a subjective assessment of the amount of pain the patient experienced after trauma (mild, moderate, severe). To assess the impact of distance and quality of the road network, patients were grouped according to the transit time for a direct journey from the place of injury to KCMC using known public transport routes: zone 1 (up to 30 minutes), zone 2 (30-60 minutes), zone 3 (1-4 hours), zone 4 (4-6 hours), zone 5 (6-12 hours) and zone 6 (>12 hours). Times did not include waiting for buses or at intermediate stops which vary considerably due to the nature of public transport in Tanzania. The variables listed above were entered into SPSS version 15. Frequencies were tabulated and associations sought between predictor variables and delay using chi-square or t-test.
Multivariate logistic regression models were then constructed for delay of >24 and >48 hours (as dependent variables) using independent (predictor) variables found to be significantly associated with delay in the analysis above.

8.4.7.2 Qualitative analysis

A framework approach was used, based on the technique described by Pope et al.\textsuperscript{384} Two reviewers each read and re-read every transcript independently to identify recurring themes. A framework of categories was developed from this process, driven partly by the research questions but more specifically from the data. Each transcript was indexed and categorised against this framework using QSR N6. Data analysis was an iterative process and minor modifications to the framework were necessary as analysis progressed. The categorised data was discussed within the research team and disagreements resolved by consensus. In the next step, links between categories were identified so that data was classified into clusters of related categories. Again, these were discussed amongst the research team and any disagreement resolved by consensus. The interplay of themes was then considered, leading to a model showing how individual causes of delay were linked within patient journeys. In an additional stage, the qualitative data was interrogated to propose explanations for the significant quantitative findings. Anonymised quotations are used to illustrate themes, showing gender, age and nature of injury for the participant.

8.5 Results

93 patients were admitted during the study period. Three left hospital before consent could be obtained. Informed consent was obtained from the remaining 90 patients (or their parent/guardian if aged <16). No patient refused to take part. Children and adolescents <18 years accounted for 36 (40%). 95.3% had visual impairment or blindness in the affected eye on presentation at KCMC by WHO definitions.\textsuperscript{496} Other details of the sample (sex, age, education, visual acuity, perception of pain, day of
injury, use of medicine, number of facilities visited before KCMC, and type of injury) are illustrated in table 8a.

8.5.1 Measurement of delay

The mean delay from injury to presentation at KCMC was 6.8 days (range 0-40) and the median was 3 days. However, 61.1% of patients visited a health worker within 24 hours and 82.2% did so within 48 hours of the injury. Injury at a weekend (Friday – Sunday), use of topical eye medicine and number of health facilities visited before arrival at KCMC were all significantly associated with delay >24 hours and delay >48 hours, as shown in table 8a. Female gender was associated with delay >24 hours, but not >48 hours. Using multivariate logistic regression, two models were constructed using (i) delay > 24 hours and (ii) delay > 48 hours as dependent variables. Variables which had been found to be significantly associated with delay in the analysis above (injury on weekend, use of topical medicine, number of facilities and gender) were used in the model as independent (predictor) variables. With the exception of gender, all predictor variables remained significantly associated with delay in the multivariate model, as shown in table 8b.
<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Number (%)</th>
<th>Delay &lt; 24 hours No. (%)</th>
<th>Delay &gt;24 hours No. (%)</th>
<th>p = p-value</th>
<th>OR = Odds ratio (95% confidence interval)</th>
<th>Delay &lt; 48 hours No. (%)</th>
<th>Delay &gt; 48 hours No. (%)</th>
<th>p = p-value</th>
<th>OR = Odds ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
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</tr>
<tr>
<td>Male</td>
<td>62 (69%)</td>
<td>24 (39%)</td>
<td>38 (61%)</td>
<td>p = 0.03</td>
<td>OR = 3.8 (1.2-12.3)</td>
<td>29 (47%)</td>
<td>33 (53%)</td>
<td>p = 0.19</td>
<td>OR = 1.8 (0.7-4.7)</td>
</tr>
<tr>
<td>Female</td>
<td>28 (31%)</td>
<td>4 (14%)</td>
<td>24 (86%)</td>
<td></td>
<td></td>
<td>9 (32%)</td>
<td>19 (68%)</td>
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</tr>
<tr>
<td>Age</td>
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<tr>
<td>&lt;18</td>
<td>41 (46%)</td>
<td>11 (27%)</td>
<td>30 (73%)</td>
<td>p = 0.81</td>
<td></td>
<td>16 (39%)</td>
<td>25 (61%)</td>
<td>p = 0.89</td>
<td></td>
</tr>
<tr>
<td>19-50</td>
<td>33 (37%)</td>
<td>13 (39%)</td>
<td>20 (61%)</td>
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<td></td>
<td>17 (52%)</td>
<td>16 (49%)</td>
<td></td>
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</tr>
<tr>
<td>&gt;50</td>
<td>16 (18%)</td>
<td>4 (25%)</td>
<td>12 (75%)</td>
<td></td>
<td></td>
<td>5 (31%)</td>
<td>11 (69%)</td>
<td></td>
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<tr>
<td>Travelling time to KCMC</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>&lt; 1 hour</td>
<td>58 (64%)</td>
<td>20 (34%)</td>
<td>38 (66%)</td>
<td>p = 0.35</td>
<td></td>
<td>26 (45%)</td>
<td>32 (55%)</td>
<td>p = 0.39</td>
<td></td>
</tr>
<tr>
<td>1-6 hours</td>
<td>19 (21%)</td>
<td>5 (26%)</td>
<td>14 (74%)</td>
<td></td>
<td></td>
<td>8 (42%)</td>
<td>11 (58%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;6 hours</td>
<td>13 (14%)</td>
<td>3 (23%)</td>
<td>10 (77%)</td>
<td></td>
<td></td>
<td>4 (31%)</td>
<td>9 (69%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>14 (16%)</td>
<td>5 (36%)</td>
<td>9 (64%)</td>
<td>p = 0.88</td>
<td></td>
<td>5 (36%)</td>
<td>9 (64%)</td>
<td>p = 0.06</td>
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</tr>
<tr>
<td>Primary</td>
<td>49 (54%)</td>
<td>14 (29%)</td>
<td>35 (71%)</td>
<td></td>
<td></td>
<td>16 (33%)</td>
<td>33 (67%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>19 (21%)</td>
<td>7 (37%)</td>
<td>12 (63%)</td>
<td></td>
<td></td>
<td>13 (68%)</td>
<td>6 (32%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>8 (9%)</td>
<td>2 (25%)</td>
<td>6 (75%)</td>
<td></td>
<td></td>
<td>4 (50%)</td>
<td>4 (50%)</td>
<td></td>
<td></td>
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<tr>
<td>Health facilities visited before KCMC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1</td>
<td>30 (33%)</td>
<td>17 (57%)</td>
<td>13 (43%)</td>
<td>p&lt;0.001</td>
<td></td>
<td>22 (73%)</td>
<td>8 (27%)</td>
<td>p&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>42 (47%)</td>
<td>10 (24%)</td>
<td>32 (76%)</td>
<td></td>
<td></td>
<td>14 (33%)</td>
<td>28 (67%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-5</td>
<td>18 (20%)</td>
<td>1 (6%)</td>
<td>17 (94%)</td>
<td></td>
<td></td>
<td>2 (11%)</td>
<td>16 (89%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Table 8a(i): Descriptive statistics and associations with predictor variables and delay of 24 and 48 hours from time of injury to arrival at KCMC (n = 90 unless otherwise stated). |
### Table 8a(ii): Descriptive statistics and associations with predictor variables and delay of 24 and 48 hours from time of injury to arrival at KCMC

*(n = 90 unless otherwise stated).*
Table 8b: Logistic Regression Model for predictor variables found to be significantly associated with a delay of 24 and 48 hours.

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Odds ratio for delay &gt; 24 hours (95% confidence interval)</th>
<th>Odds ratio for delay &gt; 48 hours (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury at weekend (Friday-Sunday)</td>
<td>9.30 (4.58 - 18.86)</td>
<td>5.32 (2.89 - 9.78)</td>
</tr>
<tr>
<td>Using topical medicine before arrival at specialist eye centre (KCMC)</td>
<td>4.61 (2.51 - 8.56)</td>
<td>5.19 (2.81 - 9.54)</td>
</tr>
<tr>
<td>Number of health facilities visited prior to arriving at specialist eye centre (KCMC)</td>
<td>4.48 (2.83 - 7.09)</td>
<td>5.22 (3.35 - 8.13)</td>
</tr>
</tbody>
</table>

\* odds ratio is the increase for each additional facility visited

8.5.2 Reasons for delay

Interviews provided rich qualitative data. It was possible to trace detailed journeys of care from the point of injury to treatment. These were synthesised and presented diagrammatically in fig 8a, showing milestones in patients’ journeys, the processes they go through and the mediating factors which shorten or lengthen delay at each step. The issues identified in the thematic analysis are described in detail below.

8.5.2.1 Recognising the seriousness of the injury and the need for help

The perceived seriousness of an injury was an important factor in decisions to seek care. Adult patients appeared to respond more quickly to severe, immediate pain or marked visual loss, and tended to delay or use self-treatments if their symptoms were mild enough that they could continue comfortably with daily activities.

Children were particularly dependent on others to recognise the seriousness of an injury. If a parent was not present due to other responsibilities, other adults sometimes delayed decisions until they returned. Parents tended to rely more heavily on the visual appearance of the eye and the child’s demeanour than the child’s
complaints about pain or loss of vision. Parents were hindered by children trying to hide injuries, particularly if another child was responsible for it and told them to hide it from adults.

Injuries that were perceived as serious did not necessarily result in a prompt visit to a health facility. Instead, patients balanced the perceived seriousness of the injury with barriers to obtaining help. The most important barriers were money, transport and competing commitments to family, livestock and their job. Delays occurred when patients considered these barriers to be too high.

“He was complaining of pain, so I brought him some paracetamol… [Three days later,] I saw that the eye was all white. I got very startled. And I called his elder brother and said, “Look at this poor boy, he has been hurt so much and we did not note that.” So we immediately took him to a nearby dispensary.”

Interview 49 – Father of Male, 14yr, Sealed corneal perforation with traumatic cataract.

“I asked, “What had hit your eye.” She said, “It is just dust.” But I asked her more and more every day, later on she told me it was a bottle. I asked her, “Who had that bottle.” She mentioned her fellow child. I thought it might be that they were fighting for the bottle or something else. I didn’t have a clue.”

Interview 05 – Father of Female, 2yr, Corneal foreign body.

8.5.2.2 The role of social and financial resources

Throughout the journey of care, the patient’s financial and social resources (social networks, relationships and perceived and actual social support) were important mediating factors. Patients were reliant on their family and community for financial support, information, opinion and support in decision making. The patient’s
perception of their social resources influenced the decision to seek care and which unit to attend. For example, patients without money who perceived that they lacked the social resources to obtain finance from others would tend to delay. The practical costs of seeking care and the difficult choices faced by patients were clear. Some described pawning or selling livestock, seed and bedding, resulting in likely future impoverishment for them and their family.

“I sold a goat and I also had some money left over from selling my harvest.”

Interview 49 – Father of Male, 14yr, Sealed corneal perforation and traumatic cataract.

“I was told that surgery for the child would cost me 15,000 shillings. Fortunately I met someone I know and I asked them to go to my place, get my mattress and pawn it. So I got 20,000 for it and I have it with me.”

Interview 74 – Mother of Male, 3yr, Corneal laceration.

When patients were uncertain, other people were often involved in giving an opinion about the severity of injury and the need for treatment. If financial resources were readily available, the patient was then able to decide for themselves whether to seek help, based on their own opinion and the advice given. However, where financial resources were more limited, a shared decision was often made about whether shared resources should be mobilised to seek help. If support was not forthcoming, this contributed to delay. Women were sometimes reliant on support and agreement from male family members.

“[Interviewer:] Was there anyone you consulted about coming to KCMC?
Yes, my neighbours and relatives. I had to borrow money from them because I did not have any at the time and my husband was not
around. They all said that it was important to come quickly otherwise the eye would have to be removed.”

*Interview 69 – Mother of Female, 11yr, Panendophthalmitis due to penetrating corneal injury.*

The process of mobilising social resources and the speed of doing so also contributed to delay. Several patients described a time consuming process of visiting others to gather donations and loans, sometimes involving a long journey back to the patient’s home village. Common sources of support were family members, neighbours and friends. Less commonly, employers (for work related injuries) and church leaders were called upon to provide support. Some patients were aware that payment could be made at the hospital in stages, and went to hospital directly whilst sending someone to gather funds on their behalf. Importantly, mobilising social resources was not a ‘once-only’ process. It became necessary when a health worker referred a patent to another unit, or when patients sought help again because previous treatment had not worked.

“It was money I was looking for so I could get proper medical help...

When I went to [the hospital], they gave me the referral and asked me to come to KCMC. So I went back home, and collected money to come here, it took less than a week to do so then I was on my way. I think I got the money on Tuesday and on Thursday I left...

[Interviewer:] And where did the money to get here come from?

I borrowed it from relatives. I will pay back when I go home.”

*Interview 73 – Male, 44yr, Lens rupture.*

8.5.2.3 Self-treatment and lay referral

Patients’ accounts suggested that self-treatment (treatment undertaken without consulting a health worker) was common before seeking formal help or if formal treatments seemed to have failed. Reported forms of self-treatment included re-using eye drops from previous illnesses or medication donated by family members,
neighbours and friends. Medications were passed on if others had found them beneficial (often for a different condition) or the drug had been given by a health worker for a seemingly similar problem. Most participants perceived that it was worth trying treatments if they were an ‘eye medicine’. Only a few explained their decision in terms of infection or the medicinal properties of the chosen treatment. Only one patient reported being specifically advised against self-medication by a neighbour, suggesting that the potential problems of re-using medication were not widely known.

“[Interviewer:] Did you give him any medicine?
Yes
[Interviewer:] Where did you get it from?
I borrowed some from our neighbour.
[Interviewer:] And what did you tell your neighbour?
I just told him that my child was hurt and did he have any eye medicine, so he gave me some and I put it...
[Interviewer:] Do you remember the name?
No.”

Interview 38 – Mother of Male, 12yr, Sealed corneal perforation, traumatic uveitis and traumatic cataract.

Pharmacies were another common first source of medication because they were nearby, low-cost, relatively well-stocked and had convenient opening hours. Again, eye drops were the main treatment provided. Patients appeared to receive the medicine they requested rather than expert advice. Sometimes, a family member was sent to the pharmacy on the patient’s behalf. Only one patient described being referred to a health worker by a pharmacy and, in several cases, patients appeared to describe a significant eye injury to pharmacy staff before being sold eye drops.

“I just said to [the pharmacy worker] that my eye had been hurt the previous day and that it could not see and was pain and that if he could sell me some medicine to put in it then that would be sensible of him...
So he sold me those eye drops for five hundred shillings and I used
them on Friday, Saturday and Sunday and on Tuesday I went to [hospital].”

Interview 34 - Male, 32, Blunt trauma with hyphaema.

The use of traditional medication was uncommon, and reported by only three patients from the Masai Tribe. Practices were based on pre-existing beliefs of the patient or the community and no interviewee reported consulting a traditional healer.

“I went home. There, the women put milk in my eye, the milk that is breast fed to a baby girl... The next morning... you know, the Masai believe that sheep fat is good for treating eye problems - so I slaughtered a big fat sheep and drank a huge bowl of its fat... I finished the whole bowl. I had diarrhoea night and day after that! Loh! It did not help at all... We Masai have two or three things that we consider important. One is that we consider that PPF [injectable antibiotic powder used topically] is the best medicine ever. So we use it for everything. Secondly, we believe that sheep fat, not cow fat, not goat fat, is very good for eye problems. When you drink it and your stomach goes like this (churns) it clears out every impurity. So I decided to go through all these processes before coming here. You get me?”

Interview 75 - Male, 60, Pupil block.

When patients did begin to seek care from the formal health sector, their help-seeking behaviour was shaped by their own previous knowledge and experience of the system, and by the advice of their family and wider community. Patients often did not know about opening hours at health facilities and how to get emergency treatment.

“We'd heard that there were no services over the weekend. We were later to learn that we had made a big mistake and that services were available every day.”

Interview 41 - Female, 9yr, Lens dislocation with vitreous in anterior chamber.
Many patients thought that KCMC was only for problems that could not be treated elsewhere and that there was a rigid referral system requiring a letter from a lower-level unit before treatment was sought at a higher-level unit. Importantly, this belief was often shared by health workers. As a result, several patients entered the referral system at the lowest level and moved stepwise up the chain.

“I thought that it wasn’t so serious and that it could be taken care of at the dispensary... I have never gotten any "KCMC disease". [Interviewer:] What kind of disease is that? Well for example, if your eye was ruptured and they weren’t able to treat it at [the regional hospital], you come to KCMC.”

Interview 14 - Male, 22yr, Corneal laceration, iris prolapse, severe anterior uveitis and traumatic cataract.

8.5.2.4 Infrastructure and health system delays

In seeking help, patients had to negotiate health and transport systems. Delays arose within both systems. Most patients relied on public transport, which was often unavailable in the evenings, at weekends and from remote rural locations. Bus journeys were often long and uncomfortable with several intermediate stops and changes. Transport was expensive, particularly for long journeys, and bus fares had to be paid up-front.

“It was late when I got hurt. Where I live, the only transport we have is by bicycle. It is only when we get to Mwanga that buses are available.”

Interview 12 - Female, 75yr, Imminent endophthalmitis secondary to penetrating trauma
Several patients arrived at health units to find them closed, sometimes visiting several units before finding one open. Health worker absence was also common. Reasons given to participants included sickness, training, meetings and attending to other business. Sometimes, patients were admitted or told to return later. Frequently, unqualified workers deputised or patients were unsure of the professional status of the person they consulted. In other cases, patients were turned away by clerical staff and told to return during normal working hours or told by passers-by that the unit was closed.

“There were some people nearby and they took me to hospital. At first they took me to a nearby dispensary but it was closed, then the next, but that one was also closed. So they took me to [the] hospital.”

Interview 67 - Male, 30yr, Corneoscleral rupture

“[Interview:] When you arrived, who was there to help you? It was just an attendant.
[Interview:] A nurse or?
I don’t know if she was a nurse or what!”

Interview 9 – Mother of Female, 1yr, Corneal laceration with iris prolapse, lens rupture and vitreous prolapse

8.5.2.5 Health worker interactions

The interaction between patients and health workers had an important impact on delay. In some cases, such encounters were a clear catalyst to obtaining effective treatment. In other cases, they appeared to lead to further delay. Comments made by patients reflected that health workers had significant social authority and that the community was generally prepared to follow their advice, even if this caused practical difficulties. Patients also spoke positively about health workers who acknowledged their limitations and referred promptly.
“[Interviewer:] What did your brother make of the matter?
He did not have anything to add because we were following the
doctor’s orders.”

Interview 85 - Male, 26yr, Corneal laceration, iris prolapse and
traumatic cataract.

“[Interviewer:] Who did you meet at there?
The doctor, he is such a good doctor. I told him my problem, he looked
in the eye and said, ‘We should not touch or do anything to this eye at
all, it would be better if you run quickly to [hospital].’”

Interview 3 - Female, 62yr, Corneal perforation, iris prolapse, lens
rupture, vitreous in the anterior chamber, retinal detachment.

Most patients sought help initially through dispensaries and local hospitals. The
features of these encounters were varied but patients reported certain features that
seemed to consistently influence delay. A key factor was the health worker’s advice
about referral destination. Whilst some patients were referred directly to KCMC
resulting in a reduced delay, others were directed to a unit without the necessary
facilities. Time and money were spent on each intermediate stage until KCMC was
reached. This often reflected the health worker’s belief in the stepwise referral
process. Several patients were told that they needed treatment at KCMC but first to
call at another hospital for a referral letter. In one case, the patient was required to
have the referral letter typed at his own expense before it was signed and rubber-
stamped.

“I started going to the dispensary... and then I was referred to [the
district hospital]. Then I was told to go to [the regional hospital]. I
slept there one night, the next morning I was referred to come here.”

Interview 3 - Female, 62yr, Corneal perforation, iris prolapse, lens
rupture, vitreous in the anterior chamber, retinal detachment.
“She wrote the letter then I took it for typing and sent it back to her for signing. After that I took it to the hospital to be stamped. After that we were on our way.”

Interview 27 – Father of Male, 6yr, Corneal perforation.

Sometimes, patients’ reports suggested that the health worker was reluctant to cause the expense and inconvenience of a referral to KCMC. In one case, the patient was offered a choice of KCMC or a nearby unit without the necessary expertise. In another case, the patient was advised to wait for an outreach clinic as an alternative to going to KCMC, which caused further delay.

“[He said that] it was a big work, which required me to be transferred directly to KCMC Hospital or [the regional hospital]. I told them that it would have been better if I don't go far that will cost me much for something that could have been done nearby.”

Interview 7 - Male, 34yr, Foreign body between globe and inner canthus with lid laceration.

Clear communication from the health worker also appeared important: patients repeatedly reported responding decisively to being told that the problem was urgent, receiving a clear explanation from the health worker of the seriousness of the problem, the benefits of urgent action and the adverse consequences of delay. They also responded positively to accurate information about how to access services at KCMC and specific discussion of financial and transport issues. Negative experiences of communication also occurred. One patient reported an encounter with a drunken doctor and several patients reported having concerns about their eye dismissed by health workers. Patients rarely recalled receiving specific advice about follow-up.
“There we were seen by one doctor who after attending us said that she would write us a referral to KCMC in order to avoid any delay. She also told us that there was pus forming in the eye already and that we had to hurry. So we quickly got onto the bus and came over.”

Interview 18 – Mother of Female, 4yr, Severe corneal ulcer with hypopyon and possible endophthalmitis.

“That’s when the doctors examined her... and said that I should go to KCMC and that it was very important... I said that my home was far and they said that it would be best to go down directly since I was already here and there was transport.”

Interview 23 – Father of Female, 10yr, Corneal ulcer.

“She asked me where I lived and I told her that I lived far. So she said that she would write me a letter and that I would be received at KCMC even if I got here at midnight.

[Interviewer:] Does this mean that you went back home?

No, I came directly to KCMC.

Interview 68 – Mother of Male, 7yr, Corneal laceration with cataract and vitreal opacities.

When health workers did not refer, they typically prescribed medication and referred only if the eye did not improve. This approach was described by patients with a range of injuries including those, such as corneal lacerations, requiring prompt surgical treatment. This decision contributed to delay because patients would wait to see if the treatment worked and then spent time mobilising social resources before seeking further help. In one case, it was clear that medication was prescribed despite the correct diagnosis having been made. This suggested the possibility of a failure to integrate diagnosis and management or a lack of knowledge about appropriate treatment.
[Interviewer:] And did you ask what was wrong with your grandson?

Grandmother: Yes, he said that something had pierced the eye.

[Interviewer:] And did he give him any medicine?

He just instilled some in the eye and gave us some paracetamol.

Interview 59 – Grandmother of Male, 2yr, Partial thickness corneal laceration.

In some cases, patients’ reports suggest that health workers did not appear to recognise their professional limits. Some patients returned to a health worker several times and received multiple ineffective medical treatments before being referred. Others with gross injuries received incorrect treatment after being examined with loupes (specialist magnifiers), suggesting that the examiner did not have the necessary skills to use the equipment. In such cases, the perception of an expert examination may have added credence to the incorrect advice.

“When I got there the doctor put on those big goggle-like things and examined me. Then he instilled three different kinds of eye drops and padded me. He also wrote out a prescription for me to buy, a medicine... it is a kind of eye drop.”

Interview 24 - Male, 24yr, Blunt injury.

8.5.3 Triangulating qualitative and quantitative findings

The quantitative data highlights several variables which were significantly linked with delay in presentation at KCMC, and the qualitative data provides a number of potential explanations. Links between statistically significant quantitative findings and explanations from the qualitative data is given in table 8c. Furthermore, the qualitative data highlights that delays do not occur in isolation, and that each patient’s journey could be subject to multiple delays. A diagrammatic representation of the patient journey with positive and negative influences on delay at each stage, is given in fig 8a.
Fig 8a: Diagrammatic representation of participants’ journey of care
<table>
<thead>
<tr>
<th>Significant factor in delay</th>
<th>Proposed Explanation with illustrative quotes where appropriate (y = years, M = male, F = female, Int = Interview)</th>
</tr>
</thead>
</table>
| Injury at a weekend          | Availability of transport.  
“It was late when I got hurt. Where I live, the only transport we have is by bicycle. It is only when we get to Mwanga that buses are available.”  
Int 12 – F, 75y, Imminent endophthalmitis secondary to penetrating trauma |
|                             | Opening times at smaller units and absence of staff.  
“At first they took me to a nearby dispensary but it was closed, then the next, but that one was also closed. So they took me to [the] hospital.”  
Int 67 – M, 30y, Corneoscleral rupture |
|                             | Patients’ and health workers’ beliefs about availability of services.  
“We’d heard that there were no services over the weekend. We were later to learn that... services were available every day.”  
Int 41 – F, 9y, Lens dislocation with vitreous in anterior chamber |
| Use of topical eye medicine | Obtaining medication from family, neighbours, friends or pharmacies as a first response to injury.  
“I just said to [the pharmacy worker] that my eye had been hurt the previous day and that it could not see and was pain and that if he could sell me some medicine to put in it then that would be sensible of him... So he sold me those eye drops for five hundred shillings and I used them on Friday, Saturday and Sunday and on Tuesday I went to [hospital].”  
Int 34 - M, 32y, Blunt trauma with hyphaema |
|                             | Inappropriate prescription by health worker  
“And did you ask what was wrong with your grandson? Yes, he said that something had pierced the eye. And did he give him any medicine? He just instilled some in the eye and gave us some paracetamol.”  
Int 59 – M, 2y, Partial thickness corneal laceration |
|                             | Time taken to realise that treatment is ineffective and then mobilise resources to seek further help |
| Number of facilities visited before KCMC | Health workers making stepwise referrals or not advising referral  
“Ttarted going to the dispensary... and then I was referred to [the district hospital]. Then I was told to go to [the regional hospital]. I slept there one night, the next morning I was referred to come here.”  
Int 3 - F, 62y, Corneal perforation, iris prolapse, lens rupture, vitreous in anterior chamber, retinal detachment |
|                             | Travelling time for each visit |
|                             | Gathering funds for transport and treatment before each visit |
| Female gender               | Difference in social roles and perception of social resources  
“Was there anyone you consulted about coming to KCMC?  
Yes, my neighbours and relatives. I had to borrow money from them because I did not have any at the time and my husband was not around.  
They all said that it was important to come quickly otherwise the eye would have to be removed.”  
Int 69 - F, 11yr, Panendophthalmitis due to penetrating corneal injury |

**Table 8c**: Factors in delay with explanations and examples from the qualitative data
8.6 Discussion

There is evidence that prompt specialist treatment of serious eye injuries improves visual outcome and prevents complications.\textsuperscript{488-491} This data shows that there are significant delays between sustaining an injury and reaching a specialist centre, much of which occurs after first visiting a health worker, and adds new insights about the underlying reasons. Injury at the weekend, use of topical eye medicine and visiting other health facilities before the specialist centre are significant predictors of delay. The model represented in fig 8a summarises positive and negative influences on patient journeys and can be used to guide training and professional development for eye health workers and wider health systems interventions.

This study did not set out to assess delays occurring after arrival at KCMC, although studies from other large hospitals in developing countries have highlighted that such delays frequently occur.\textsuperscript{497} This study only included patients who reached KCMC and it is possible that some patients with eye injuries did not reach this unit and that their characteristics and experiences of seeking care may have been substantively different, resulting in sampling bias. Interview accounts are inevitably subject to recall bias, and some details may be inaccurate or incomplete. Some patients may have been hesitant to share some views or criticise KCMC because of the interview setting and their perception of the interviewer’s role and status. Patients may have withheld information if they felt ashamed or regretted a decision or action: possible examples include decisions not to seek medical advice, use sources of advice such as drug stores or traditional healers (of which the interviewer might be perceived to disapprove), delay treatment for financial reasons or because they doubted the value of treatment at KCMC. Other studies in sub-Saharan Africa suggest that these sources of advice are commonly used (as discussed in chapter 1) and this study may therefore underestimate of the contribution of these factors to delay. The study aimed to estimate travelling time using known public transport routes but did not consider the impact of waiting times or intermediate stops (which were frequently mentioned in patients’ descriptions of their journey). Whilst this provided an objective measure of travelling time and reduced recall bias from participants’ recollections, it affects the validity of
estimates of the burden of travelling to KCMC by public transport. A further limitation is the lack of data on visual acuity after treatment and, whilst correlating visual outcome with delay was not a specific aim of this study, this additional data may have helped to put the patient’s journey, with its associated cost and inconvenience, in the context of any long term benefit. Indeed, it is possible that, especially for late presentations, there may be little improvement in visual outcome from treatment and some clinicians may have decided not to refer such patients for treatment at KCMC.

In common with other models of delay this study identifies key stages and processes in patients’ journeys. The speed at which each stage is reached depends on a range of complex and inter-related mediating factors: poverty, the patient’s social resources, transport infrastructure, health systems organisation and the practice of individual health workers are important. Delays do not occur in isolation with most patients experiencing more than one cause of delay during their journey. An important insight from this study is the frustrating ‘circular’ nature of many journeys, whereby patients make repeated contacts with health workers, receiving inappropriate treatment and advice, before finally being referred to a unit which can provide proper care. Each contact with a health worker only occurs after a process of finding and mobilising financial and social resources, obtaining transport and negotiating health-systems barriers. This process must be repeated before each subsequent contact. This time-consuming process can also be financially costly.

8.6.1 Training and development

Individual health workers have an important influence on patients’ journeys of care: journeys appeared to be hastened if health workers told patients to go to KCMC urgently, discussed practical barriers (such as money and transport), explained the benefits of prompt treatment and warned about the adverse consequences of delay. However, diagnostic and treatment errors appeared to be common and fell into four categories: inappropriate referral destination, inappropriate advice about urgency, incorrect prescription of eye drops and failure to arrange appropriate follow-up.
From patients’ reports, journeys appeared to be hastened when health workers combined specific knowledge of eye disease with more broad-based skills (communication, problem-solving and recognising limits of competence). These broad-based skills also seemed to provide a safety-net against other errors. The importance of effective communication skills is increasingly recognised in developed countries,\textsuperscript{498} has been shown to shape patient satisfaction in a Tanzanian study\textsuperscript{499} and influence future help seeking behaviour.\textsuperscript{494} It is recognised from other geographical regions that specialists and non-specialists approach clinical problem solving in different ways\textsuperscript{500} and training may be more effective if these differences are understood. These observations support training in eye care which combines eye specific training with broad-based communication and consultation skills; and also improved awareness of local referral pathways and up to date information about opening times, emergency treatment and how to get help with treatment costs.

Delivery of training is another important consideration. Participants in this study frequently reported problems due to staff absence and a lack of contingency planning. To avoid this, it may be appropriate to look at innovative training methods such as self-directed distance learning or locally delivered training and, given the potential risks to patients of staff absence, it is important that training and professional development interventions are evaluated carefully to ensure long term effectiveness.

8.6.2 Health systems issues

This study highlights a wide range of health systems problems, including confusion amongst health workers and patients about the referral system and its administrative requirements, limited information about services and opening hours, frequent staff absence and a lack of contingency planning for such absences. There is growing evidence of poor health systems in developing countries and the need to address this to improve outcomes. This data supports a simpler, more transparent referral process and empowering health workers to refer directly to the most appropriate unit. Given
the influence of community beliefs on delay, public health education about the potential seriousness of eye trauma and the availability of health services may be worthwhile, including how to obtain urgent help.

Distance to health units is also important, reflecting other studies. This is a complex issue, with evidence that patients may be prepared to travel further for services that they know to be of high quality. There is a need to balance accessibility and quality: several patients in this study lost time and money visiting nearby units which could not help them.

This study revealed widespread mis-selling of eye drops by drug stores. Tanzanian regulations stipulate that drug store workers should have four years of health related training. However, this rule is not obeyed, and staff are typically nurse assistants, with a mean of 1.4 years’ training. The capacity of governments to enforce regulations is often limited and strict enforcement could reduce the supply of essential drugs to rural communities. Drug stores are considered to be accessible and well stocked and, given the problems experienced at dispensaries and other health units, they are likely to remain popular.

No participants reported consulting a traditional healer following injury and only three (all from the Masai tribe) tried traditional remedies, either on the advice of their community or based on their own knowledge of traditional remedies. This suggests that traditional healers are not commonly consulted following eye injury, in contrast with other eye conditions, although participants may have withheld this information from the interviewer (as discussed above).

8.6.3 Poverty

Unsurprisingly, poverty is a major contributor to delay. Many patients are unable to fund treatment without support from others. Even if treatment costs at a tertiary unit can be met from a poor fund, costs incurred at lower level health facilities and
transport costs are still a significant barrier. The need to obtain finance and other support quickly following an unexpected event is a particular issue in the case of eye trauma. Reducing treatment costs, improving awareness of the facility to pay after treatment and strengthening the ‘poor fund’ may reduce delay. However, such interventions need to be balanced with the financial sustainability of services. It may be appropriate to encourage individuals and communities to plan how they might respond to unexpected health problems.

8.7 Conclusions

This data provides new insights into multi-faceted difficulties faced by patients in obtaining proper treatment following an eye injury, and elucidates the pathway of care for patients with eye problems in Tanzania. As well as the important contribution of poverty and limited infra-structure, it is clear that decisions made by patients and communities, the organisation and structure of health services and the skills and practices of individual health workers contribute to delay; and it is common for there to be a cumulative effect of multiple individual delays. This study suggests a role for well-designed training initiatives which combine eye-specific knowledge and skills with broader, generic consultation skills and practical information about local services; and for innovative methods of training (such as locally delivered training or self-directed distance learning) to reduce staff absence. However, the impact of training and development interventions may be limited by wider health systems problems, which also need to be addressed to improve care.
Chapter 9:
Integrating the lessons learnt –
developing a multimedia learning resource in eye health

9.1 Abstract

Aims: to develop an educational resource in eye health based on earlier research and other published literature, applying a quality improvement approach.

Overview of process: An author team was convened, combining members with expertise in eye health and in multimedia resource development. An eight stage process was followed based on a quality improvement (plan-do-study act) model: **Plan** – (1) initial specifications, (2) detailed plans; **Do** – (3) gathering assets, (4) production, (5) informal review; **Study** – (6) formal review and piloting (chapter 9), (7) evaluation (chapter 10); **Act** – (8) publicity, distribution and dissemination.

Methods and outputs: The resource was targeted primarily at mid-level eye health workers and trainees, non-specialist doctors, medical students and ophthalmology trainees (at the beginning of their training) to be developed on DVD for television and used for initial training, revision, professional development and reference. Detailed content specifications were agreed amongst the author team based on their previous experience of teaching the primary audience and a review of relevant curriculum documents. The resource was structured with **seven video modules** in three broad areas: **Skills** – (1) Checking Visual Acuity, (2) Assessing the Eye, (3) Practical Procedures; **Common eye problems** – (4) Red Eye, (5) Loss of Vision, (6) Eye Injury; **Optics and refraction** – (7) Prescribing glasses; and **two reference sections** – (1) Atlas of eye diseases, (2) Prescribing information. Learning objectives and content maps were developed, which were then used as the basis of scripts and storyboards (for the modular content), bullet point summaries (for the reference content), filming lists and technical specifications. Clinical videos were obtained primarily in Uganda and

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1 Published as: Williams CD, Sandford-Smith J, Waddell K, O’Callaghan C. Ophthalmology: Multimedia Learning for Health Workers Worldwide - Africa. OCBMedia: Leicester, 2015. (2 DVDs). Copies of the sleeve art and discs are provided as addenda discs 1 and 2.
Tanzania with informed consent from patients and/or parents/carers. Production was undertaken using Adobe Premiere Pro and Photoshop CS4 and CS5. Content was reviewed, first by the author team, two independent pharmacists (for drug accuracy) and an informal group of mid-level eye health workers; then by an external expert and in a formal pilot study (chapter 10). After modifications based on these review stages, the materials were tested in a randomised trial in Uganda (chapter 10) to test the impact on medical students’ clinical skills. Finally, practical issues related to distribution, publicity and dissemination of the materials were addressed.

**Lessons learnt:** The quality improvement approach brought structure to the development of the resource, and it was useful to combine ‘subject specific’ and broader ‘multimedia’ expertise within the author team. The process was complex involving authors, technical teams and reviewers; and the process could have been more efficient if project management approaches had been applied to time and human resources. Whilst practical (budget and timeframe) constraints may mean that pragmatic compromises are needed in designing future multimedia materials, the experience described in this chapter highlights some methodological steps that should be considered in developing educational resources.

**Conclusions:** With some modifications, the broad approach described in this chapter can apply ‘quality improvement’ methods to educational resource development, and is likely to be applicable to projects for other learner groups and topics.

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**9.2 Aims**

- To develop an educational resource in eye health, applying the lessons learnt from the research in earlier chapters of this thesis and other published literature.
- To apply a quality improvement approach to multimedia resource development and better understand how development processes can be optimised.
9.3 Overview of development process

9.3.1 Development process

A quality improvement process was used, based on the model described by Deming (1986) and Langley (1996), summarised in table 9a.

<table>
<thead>
<tr>
<th>PLAN</th>
<th>Stage 1: Initial specifications</th>
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<tbody>
<tr>
<td></td>
<td>Define target audience, purpose and technical format.</td>
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<td></td>
<td>Review relevant curriculum documents and recommendations from training institutions, learned and professional bodies.</td>
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<td></td>
<td>Develop structure and educational objectives.</td>
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<th>Stage 2: Detailed plans</th>
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<tr>
<td>Developing lists of required assets (including clinical videos, animations and illustrations, retinal and other photographs).</td>
</tr>
<tr>
<td>Producing scripts and storyboards for each video section.</td>
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<tr>
<td>Preparing content for reference sections.</td>
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<tr>
<th>Stage 3: Gathering assets</th>
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<tbody>
<tr>
<td>Filming of clinical videos (primarily in Uganda and Tanzania) and collection of additional video/photographic materials (such as retinal photographs).</td>
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<tr>
<td>Preparing animations and illustrations.</td>
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<td>Professional voicing (prepared from scripts above).</td>
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<tr>
<th>Stage 4: Production</th>
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<tr>
<td>Producing ‘first draft’ video sequences (combining assets above) based on scripts and storyboards developed by the author team.</td>
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<tr>
<td>Producing reference sections (atlas of eye disease and prescribing information for eye medicines).</td>
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<td>Designing and producing DVD navigation system.</td>
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<th>Stage 5: Informal review and revision</th>
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<tbody>
<tr>
<td>Review of ‘first draft’ video sequences and reference information by the author team.</td>
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<tr>
<td>Review of prescribing information by two pharmacists (to check accuracy).</td>
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<tr>
<td>Pre-piloting review by an informal group of mid-level eye health workers in Uganda.</td>
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<tr>
<td>Revisions based on recommendations from this informal review stage, as agreed by author team.</td>
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<tr>
<th>Stage 6: Piloting and formal review</th>
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<tr>
<td>Independent review of video and reference content by independent ophthalmologist.</td>
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<tr>
<td>Piloting of materials with two cadres of mid-level eye health worker in Uganda (see chapter 10).</td>
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<tr>
<td>Further revisions based on their recommendations and agreed by author team.</td>
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<tr>
<th>Stage 7: Evaluation of impact on clinical skills</th>
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<tr>
<td>Randomised trial of the resource in undergraduate medical student attachments in Ophthalmology, testing the impact on students’ clinical skills (see chapter 11).</td>
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<tr>
<th>ACT</th>
<th>Stage 8: Final publication, dissemination and publicity</th>
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<tr>
<td></td>
<td>Organise distribution network.</td>
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<td></td>
<td>Publicise resource through appropriate channels.</td>
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<td></td>
<td>Seek further feedback from learners.</td>
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Table 9a: Summary of resource development process, represented as a quality improvement ‘Plan-Do-Study-Act’ (PDSA) cycle.
9.3.2 Authorship and technical teams

To develop the resource, an authorship team was convened, combining knowledge and experience of Ophthalmology and skills in multimedia resource development. This team reviewed the learning objectives, scripts, storyboards and technical specifications and gave advice, comment and other expert input throughout the development process. At the end of each stage, the author team was responsible for ‘signing off’ the work as an internal quality check. A technical team, including a multimedia illustrator, DVD producer, web developer and professional voice artist, was also convened to give advice and support on the technical aspects of the development of the resource. Training in video editing was provided by appropriate members of the technical team.

With support and advice from the authorship and technical teams, the role of the author of this thesis was to:-

- organise and co-ordinate the authorship, asset collection and production processes,
- develop and refine educational objectives, scripts and technical specifications in consultation with the authors,
- liaise with experts outside of the author team, who could provide additional insights,
- ensure that the decisions taken by the author team were informed by the evidence presented earlier in this thesis,
- liaise with technical experts (voice-over artist, animator/illustrator, DVD publisher, web developer),
- gather clinical filming (primarily in Uganda and Tanzania),
- edit video sequences,
- prepare reference sections,
- design the review, pre-piloting, piloting and evaluation stages, gathering and analysing the resulting data.
9.4 Methods and outputs

A description of the methods and outputs of each stage of the process is given below.

9.4.1 Initial specifications

9.4.1.1 Target audience

Discussion within the author team and with external experts highlighted a general lack of multimedia learning materials in eye health for sub-Saharan Africa. This was particularly the case for materials for mid-level eye health workers, medical students, non-specialist doctors and those in the early stages of training in ophthalmology. It was agreed that the primary audience would be mid-level eye health personnel and trainees, medical students and non-specialist doctors and ophthalmologists at the beginning of their specialist training, with a geographical focus in sub-Saharan Africa.

9.4.1.2 Purpose of resource

Data presented in chapters 4-5 highlighted three stages at which health workers and trainees need to access learning materials, with different requirements at each stage:

- **Initial training**
  
  Early in the student’s or trainee’s exposure to the subject, there may be limited pre-existing knowledge and skills. It follows that information should be provided in an accessible way without assuming prior knowledge. Learners are likely to progress through materials in a relatively linear fashion and care is needed to introduce new concepts in a stepwise way.
• **Review, revision and professional development**

Learners have already developed some degree of knowledge, skills and practical experience. It is likely that they will want to be more selective in the information they access, perhaps under greater time pressure.

• **Reference**

Learners will approach materials to address a specific gap in their knowledge or skills. It is likely that ease of finding the relevant information would be the key consideration.

It was agreed to develop the resource so that, as far as possible, it would be useful in all three situations.

**9.4.1.3 Technical platform**

From data presented in chapters 4-5, DVD for television emerged as the most appropriate initial technical platform for the resource, and also highlighted that producing materials on more than one platform would be likely to increase the potential audience. It was therefore important to ensure that content could easily be adapted for other formats (such as internet) so that it would remain useful if and when new technologies supersede DVDs.\(^1\)

\(^1\) The resource has since also been released online (for internet and smart phone) at learning.worldmedicaleducation.org
9.4.2  Review of curriculum documents and existing materials

9.4.2.1  Review strategy

An online search of learned and professional bodies was conducted to identify curriculum recommendations for medical students, mid-level health workers, non-specialist doctors and trainees in ophthalmology (for formal training and continuing professional development). The following internet sites were searched: Ophthalmic Society of East Africa (OSEA) and East African College of Ophthalmologists (EACO), International Council for Ophthalmology (ICO), Joint Commission on Allied Health Personnel in Ophthalmology (JCAHPO), World Council of Optometry, International Centre for Eye Health, WHO, International Agency for Prevention of Blindness and UK Royal College of Ophthalmologists (RCOphth). A narrative review of these documents was conducted, focusing on the scope and organisation of curricula. A summary of the main findings is presented below and a more detailed analysis of curricula is given in appendix A1.

9.4.2.2  Main findings

7 relevant documents were found (5 from ICO and 1 jointly from ICO/JCAHPO, 1 from RCOphth). No curriculum recommendations were identified which were specific to sub-Saharan Africa. Curricula focused on eye-specific knowledge and clinical skills, but all also sought to develop broader communication, inter-personal, professional, ethical and scientific skills. This resonates with findings presented in chapter 8, where patient journeys seemed to be influenced by health workers’ broader consulting and professional skills (such as concern for the patient and recognition of their professional limits), as well as by their eye-specific knowledge and skills. It also resonates, more broadly, with concepts such as the ‘know-do’ gap between what health workers are able to do and what is applied in routine clinical practice.

Note 1 OSEA and EACO have since merged, in 2012, to form the College of Ophthalmologists of Eastern, Central and Southern Africa (COECSA).
Unsurprisingly, in curricula which were not specifically focused on sub-Saharan Africa, conditions of particular regional relevance (such as trachoma and onchocerciasis) were not specifically mentioned; others (such as age-related macular degeneration) were arguably given greater precedence than might be necessary in the region; and local issues in treatment/management (for conditions such as fungal keratitis and chronic glaucoma) were not addressed.

There were several differences in curriculum organisation in the documents reviewed, highlighting the practical difficulties of designing the resource to be relevant within different curricular structures. This difficulty is likely to be compounded at institutional level, where even more variability in curricula is likely. There were particular differences for ‘knowledge-based’ objectives, with two broad approaches:

- **Symptom-based**
  Conditions are listed according to their presenting symptoms.
  
  *(e.g. Conjunctivitis would be classified under “red eye”)*

- **Anatomically-based**
  Conditions are listed according to the structure affected by pathology.
  
  *(e.g. Conjunctivitis would be classified under “diseases of the conjunctiva”)*

### 9.4.3 Defining structure, content and learning objectives

In reaching a consensus about the structure and learning objectives for the resource, the authors considered the lessons learnt from the review of curricula (presented above), the research and literature reviews (presented earlier in this thesis) and their professional experience of clinical practice and teaching the primary audience. Some curricular recommendations for mid-level eye health workers (such as lensometry, keratometry and contact lenses) were felt to be less applicable to the target audience in sub-Saharan Africa, highlighting the need for the authors to exercise judgement.
It was agreed that:-

- The language would be English with the option for translation into other languages at a later stage.
- Based on the data in chapter 5, the resource would be voiced professionally with an English accent.
- The resource would aim to develop knowledge and skills, but also highlight the importance of professional behaviour (a general professional approach to the patient, good communication skills, holistic approach to management, awareness of professional limitations and the need for supervised practice of practical skills).
- Learners would be encouraged to think about the local knowledge they require (such as details of eye care services at referral destinations, travel arrangements and locally available medicines) which could not be specifically included in the DVD.
- The resource would not attempt to define a curriculum but would contain modules which could be mapped to local curricula by educators and used as ‘learning objects’ within formal programmes of study (section 1.6.5).
- Decisions about content would take account of the curriculum recommendations reviewed above, but would be made by consensus within the author team, considering the relevance of content in the African context.

From these considerations, a consensus emerged that the resource would contain a series of ‘video modules’ and additional ‘reference material’.

**9.4.3.1 Video modules**

It was envisioned that these would be accessed first during initial training courses. These were therefore designed in a linear fashion with new concepts introduced step-wise (as in spiral curricula), avoiding assumptions of prior knowledge/skills. Modules followed a similar structure, starting with a statement of learning objectives which were then addressed in series, followed by some concluding key messages.
The use of learning objectives is considered good educational practice and, from the authors’ perspective, provided a focus for scripting and developing the DVD navigation system. It also has practical advantages for learners and educators accessing the resource:-

- **learners** can navigate to specific sections of the video modules for review/revision and reference; and can monitor their progress in meeting objectives.
- **educators** can map the resource to their own local curriculum and quickly find relevant sections of the materials to show in group teaching sessions.

The authors agreed that seven modules would be prepared, divided into three sections, with a ‘symptom-based’ approach to organising information on common eye problems (as this was felt to be a more accessible format for learners early in their education in eye health):-

<table>
<thead>
<tr>
<th>Part 1: Basic eye care skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Module 1: Checking the visual acuity</td>
</tr>
<tr>
<td>• Module 2: Assessing the eye</td>
</tr>
<tr>
<td>• Module 3: Practical procedures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 2: Common eye problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Module 4: Red, irritated and painful eye</td>
</tr>
<tr>
<td>• Module 5: Loss of vision</td>
</tr>
<tr>
<td>• Module 6: Eye injury</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 3: Refractive problems and optics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Module 7: Prescribing glasses</td>
</tr>
</tbody>
</table>

From this broad structure, a detailed content list and learning objectives for each module were developed. These are presented in appendix A2.
9.4.3.2 Reference material

It was envisioned that the reference material would be accessed mainly for review, revision and reference after learners had viewed the video modules. It would therefore be designed to be accessed in a more flexible fashion, allowing learners to navigate directly to the relevant information. These sections would be text and still image based, without specific learning objectives.

It was agreed that two reference sections would be included in the resource:-

<table>
<thead>
<tr>
<th>Atlas of eye diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>An anatomically catalogued summary of eye diseases supported by carefully labelled and annotated still photographs, providing a wider range of examples for each condition than would be possible in the video modules.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>List of common eye medications with prescribing information</th>
</tr>
</thead>
<tbody>
<tr>
<td>A catalogued list of eye medicines with prescribing information, appropriate to sub-Saharan Africa.</td>
</tr>
<tr>
<td>Information (where appropriate) about how to prepare drugs (such as fortified gentamicin drops).</td>
</tr>
</tbody>
</table>

From this outline, a content list for these reference materials was developed as shown in appendix A3.

9.4.4 Detailed plan

Alongside the resource specification, a list of required clinical material was prepared and approved by the authors. This was then used to prioritise filming in Uganda and Tanzania and identify potential sources of material such as retinal photographs which could not easily be gathered at these sites.
Scripts were then developed for each video module followed by storyboards to plan how this scripted content would fit with clinical videos, photographs, illustrations and animations; and how subtitles and summary text boxes would be added to reinforce and summarise concepts. Each script/storyboard was prepared in consultation with one or more of the authorship team and then signed off by the rest of the team. Within these parameters, processes were allowed to evolve as the resource developed, and tended to vary according to the content of the module, the complexity of the information and the preferences of the individual authors: some sections were reviewed in face to face meetings; others were drafted and then revised via e-mail.

A similar approach was taken to preparing the reference sections. For the atlas, first drafts of bullet-point summaries for each condition were prepared and passed to the author team for review and amendment. For prescribing information, information was prepared based on a range of references, including the British National Formulary (BNF), BNF for Children, Summaries of Product Characteristics, WHO Model Formularies and WHO Essential Drugs Lists for Adults and Children. Where these sources were not sufficient, other sources of information were used.

9.4.5 Gathering assets

9.4.5.1 Video assets

It was considered important to focus the resource heavily on clinical video obtained in Uganda and Tanzania, for clinical and cultural reasons and to increase learner engagement (as discussed in chapter 5). The resource required two distinct types of video content:

- Clinical videos showing real-life patients with eye problems, demonstrating abnormal clinical signs.
- **Staged videos** showing how to perform clinical skills (such as measuring visual acuity, clinical examination and practical procedures).

The majority of videos were obtained during a seven month field placement divided roughly equally between Uganda and Tanzania. Some of this time was spent in teaching hospital units (at Kilimanjaro Christian Medical Centre, Moshi, Tanzania and Ruharo Eye Centre, Mbarara, Uganda), with the remainder spent in more remote, rural settings as part of an eye surgical outreach programme in Northern Uganda (West Nile and Karamoja). This outreach work provided the opportunity to capture a wider range of diseases such as trachomatous trichiasis and solar keratopathy (which were not routinely seen in the larger centres) and to show clinical practice in a more remote, rural setting (closer to that in which some of the target audience would practice).

**Recruitment of cases**

Clinical cases were identified by discussion with clinical staff at each centre, who were provided with verbal and written information about the filming project and the range of clinical conditions required. Staged filming was conducted with volunteers from staff (and occasionally patients) at each centre.

The majority of cases were recruited in Uganda and Tanzania but for some conditions (such as onchocerciasis and active trachoma) it was not possible to find suitable patients; and in others, the authors decided that extra examples were needed after the period of field work. These missing videos were obtained in the UK or substituted with photographs or videos obtained from other sources (with acknowledgement and regard to copyright and consent).
Consent

Obtaining informed consent from patients and parents/guardians in the case of children was a key concern. Details of the project and consent process were provided to each institution and institutional agreement obtained prior to filming. It was important to ensure that the aims of filming and the potential dangers were clearly understood. A consent form and information sheet had already been developed and approved for use in the UK, highlighting the need for participants to be aware of:-

- purpose of the materials,
- target audience,
- formats in which materials might be used (internet, DVD etc),
- potential for others (besides the target audience) to see the video if they gained access to learning materials intended for health workers,
- potential for participants to be identifiable so that others may learn something about their medical history,
- participation being optional and medical treatment unaffected by refusal or withdrawal of consent,
- practical impossibility of withdrawing consent once the educational materials are in the public domain.

Further issues, in Uganda and Tanzania, were the need for consent to be sought from patients who did not speak English and/or were unable to read or sign their name. Translation of consent forms in Uganda was a particular issue due to the wide variety of tribal languages.

In all cases, the project was explained verbally in an appropriate language (using a local interpreter when necessary) and opportunity was given for patients to ask questions. In all cases, if there was any concern that the patient was uncertain or unhappy to participate, filming did not proceed. Participants were offered information sheets (prepared in English or KiSwahili).
To confirm consent, two different processes were used (depending on whether the patient could read English or KiSwahili):

- **For literate patients**: after verbal and written explanations and opportunity for questions, participants would be asked to complete and sign a consent form. The doctor taking consent and (if necessary) the interpreter would also sign.

- **For non-literate patients**: after verbal written information and questions, the person taking consent (and the interpreter) would sign to record that they had explained everything to the patient and were confident that the person understood. Then, a short video would be taken in which the patient was asked to confirm that the above information had been explained and that they were happy to proceed.

After filming, patients and relatives were asked (whenever appropriate) if they would like to see the video. If the person expressed any doubts during or after filming, the video was erased and not used in the resource.

**Filming process**

Filming was undertaken in high-definition format using a Sony HVR-A1E camera, recording onto mini-DV cassettes, and a Manfrotto 728B DIGI tripod. In the early stages of clinical filming, a number of poor quality videos were obtained and considerable work was needed to find solutions to these technical challenges. Problems included maintaining tight control of focus, working within the resolving power of the camera for close-up images, balancing the need for adequate light exposure with avoiding obtrusive light reflexes and other reflections in the cornea and overcoming the cold ‘blue-white’ colour of fluorescent strip lighting which sometimes gave a false impression of cataract.
Optimisation of this process was an important early methodological issue. After filming, tapes were transferred to computer using Adobe Premiere Pro CS4. As video data was patient identifiable, these images were stored on password-protected encrypted external hard discs which were backed up each day. A paper-based filming log and a more detailed clinical proforma were also prepared and stored under lock and key. Completed consent forms were stored separately.

**Obtaining other assets**

At Kilimanjaro Christian Medical Centre, there was access to a slit lamp, indirect ophthalmoscope and operating microscope with video capability (recording in standard definition). This equipment was not entirely reliable, although with practice and optimisation of settings, this did produce some useful additional images. These images were recorded using a Sony GV-D1000 portable video recorder. None of the centres had access to a digital retinal camera, and it was therefore necessary to obtain retinal photographs in the UK and from other international sources. Patient identifiable assets were stored using password protected, encrypted hard drives.

**9.4.5.2 Animations and illustrations**

To explain concepts (such as anatomy, physiology/pathophysiology and optics), illustrations and animations were required. The content of illustrations and animations were agreed at the storyboarding stage. Technical specifications and draft sketches were then prepared, approved by the author team and passed to a specialist medical illustrator. Any queries were addressed. Outputs were reviewed, sent for amendment if necessary and finally signed-off by the authorship team.

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1 Copies of a Standard Operating Procedure for Clinical Filming, developed from this period of field work, is provided electronically in addendum disc 3 and shows how these technical issues were resolved.
9.4.5.3 Professional voicing

Research (see chapter 5) suggested that English was the preferred language of instruction for our target audience and that a ‘British’ accent was acceptable. Several potential professional voice artists were suggested and the most appropriate voice was chosen by the author team based on clarity of speech. Any queries over pronunciation of technical vocabulary were addressed. The audio files were reviewed, sent for amendment if necessary and finally signed-off on behalf of the authors.

9.4.6 Production

9.4.6.1 Video modules

With training and support from members of the technical team, video sequences were prepared for each objective, based on the storyboards, using Adobe Premiere Pro CS4 and CS5. Clinical videos, professional voicing, illustrations and animations (as described above) were combined with subtitles, summary boxes and labels (produced using Adobe Photoshop CS5 from templates prepared by the technical team). The final resource contained approximately 7.5 hours of video modules.

9.4.6.2 Reference materials

The development of text content for the reference sections has already been described. For the atlas, annotated still photographs were prepared from the clinical video cases, retinal photographs and materials shared from other sources. Annotations and explanatory subtitles were added to each photograph using Adobe Photoshop CS5 and reviewed by the author team. These were then presented as a ‘slide-show’ accessed from the text summary for each condition. The atlas covered 86
conditions, with 590 annotated photographs; and the prescribing information contained 64 pages of information.

9.4.6.3 DVD navigation

For practical reasons related to distribution and cost, it was necessary that the materials fitted onto the smallest possible number of discs. Two DVD discs were therefore used.

Ease of navigation is an important issue in multimedia instructional design (see 1.6.3.1) and it was important to ensure that the DVD menu system organised the modules and reference materials in an engaging, intuitive way. This was especially important as the DVD format does not allow free text searches, so learners need to use a menu system to reach information.

The specification for the DVD navigation was developed with advice from a specialist DVD producer as a detailed map showing how the components should interlink. The key components are summarised below:-

- **Main menu**
  On loading the disc, the main menu presents links to each video module and the two reference sections. Users can then navigate to modules or reference information using their DVD remote control.

- **Module menus**
  On selecting a module from the main menu, the module menu lists its learning objectives. Learners can select each objective using their DVD remote control. For the practical procedures module, an additional layer in the navigation (above objectives) is required to allow users to select each procedure.
• **During video modules**
  Whilst watching video modules, learners can pause, fast forward/back or jump forward or backwards to chapter points. Chapter points are arranged at key points (for example, in the red eye, loss of vision and eye injury modules, each new condition is marked by a chapter point). Users can also use their DVD remote control to return to the module menu. After playing the video for each objective, users return to the module menu (with the next objective highlighted so that they can quickly link to the next objective or select another section). Each menu has a link to the top level navigation.

• **Atlas menus and slide shows**
  The first atlas menu lists anatomical structures (e.g. lens) with conditions affecting that structure (e.g. cataract) in the second level. On selecting a condition, the text summary appears. Learners can then view a ‘slide show’ for this condition (with annotated photographs) or return to the condition menu. During slide shows, learners can navigate backwards and forwards, returning to the text summary at the end of the slide show.

• **Prescribing information**
  After statements and disclaimers about safe prescribing, a two layer menu structure is used – the first with broad categories (e.g. drugs used to treat infection in the eye) and the second with links to specific information (e.g. specific drugs or information about treating specific infections). Again, users can return to the menu at any stage.

Based on this specification, the DVD menu system was built by the specialist DVD producer and then carefully tested for bugs and usability. Any bugs were then fixed by the DVD producer.
9.4.7 Informal review and revisions

Each completed section of content was circulated to the authors for review/revision. Once the authors had signed-off each section, the materials were reviewed by an informal group of Ophthalmic Clinical Officers in Uganda. This provided a further check on accuracy and local relevance; and further assurance that the presentation of materials (for example, the voice-over) was comprehensible to the intended audience. As an additional check, the accuracy and completeness of the prescribing information was independently checked by two pharmacists. Comments from this informal review stage were then considered by the authors and appropriate modifications made to the resource.

9.4.8 Piloting and formal review

Once comments and revisions arising from the informal review had been addressed, a review version of the DVD was prepared which was used for piloting and formal expert review.

9.4.8.1 Piloting

The pilot study is described in detail in chapter 10, providing further recommendations for amendments to the final version of the resource which were then incorporated.
9.4.8.2 Expert review

Methods

An independent ophthalmologist was commissioned to review the entire DVD, making structured comments and suggestions for modifications using a pre-prepared template. The reviewer prioritised these as follows:-

- ‘Category A’ – issues which must be addressed before publication.
- ‘Category B’ – less-urgent issues/recommendations which could be addressed before publication (if resources permit) or in subsequent editions.

The authorship team undertook to respond to all ‘category A’ recommendations prior to publication to the reviewer’s satisfaction; and to make case-by-case decisions about ‘category B’ recommendations.

Outputs

The reviewer identified 16 ‘category A’ and 49 ‘category B’ recommendations. The authors then responded with proposed amendments (or justifications for the current version) for each ‘category A’ comment; and also for several ‘category B’ comments which were considered sufficiently significant or practically feasible to amend prior to publication. Once the reviewer confirmed that they were happy with the authors’ responses, the agreed changes were made to the video and reference content.

9.4.9 Evaluation of impact on clinical skills

Following these amendments, the final version of the resource was compiled. The impact of the resource on medical students’ clinical skills was tested using a randomised trial, described in chapter 11.
9.4.10 Publication, dissemination and publicity

Ensuring awareness and access to the resource amongst learners and educators was the final stage of the development process. To facilitate this, a focus group was convened involving members of the author team, representatives of the International Agency for Prevention of Blindness (IAPB), International Centre for Eye Health (ICEH) and representatives of relevant non-governmental organisations. This focus group provided useful insights and suggestions and a plan for publication, dissemination and publicity was then prepared by the author team and representatives of the charitable bodies who funded the resource.

9.5 Discussion/lessons learnt

The quality improvement process described in this chapter, bringing together authors with subject-specific and multimedia expertise, led to the successful development of a multimedia resource in eye health for mid-level eye health workers, medical students, non-specialist doctors and ophthalmology trainees at the beginning of their specialty training in sub-Saharan Africa. The insights gained can inform the development of future multimedia resources (both in sub-Saharan Africa and elsewhere). The process highlights the value of defining clearly the scope, purpose, intended audience and detailed learning objectives for the resource, reviewing the available evidence, guidelines and curriculum recommendations; and shows how research with patients and health workers can inform resource development and be integrated into resource development projects. Practical compromises (budget and delivery timeframe) may limit opportunities to undertake such a comprehensive process.

This chapter highlights that multimedia resource development can be a complex process involving individuals and teams in different locations with different backgrounds and skills. With hindsight, the project could have been organised with
clearer schedules, roles and responsibilities. Using project management techniques to manage time and human resources could result in greater efficiency.

9.6 Conclusions

This chapter describes a quality improvement approach to developing a multimedia educational resource in sub-Saharan Africa. Using project management techniques may help to overcome some of the inefficiencies experienced in developing this resource and modifications to this approach may be needed so that future projects can be undertaken within time and resource constraints. However, with these pragmatic modifications, the process described above could be applied to future resource development projects. This will be discussed and synthesised in chapter 12.
10.1 Abstract

**Purpose:** To pilot a multimedia learning resource (Ophthalmology: Multimedia Learning for Health Workers Worldwide - Africa) in the training of mid-level eye health workers in Uganda and explore learners’ views, recommendations for improvements to the resource and implementation.

**Setting:** Two training units in Uganda: Jinja School of Ophthalmic Clinical Officers (OCOs) and Ruharo Eye Centre (providing training for Ophthalmic Assistants (OAs) and Ophthalmic Theatre Nurses (OTNs))

**Participants:** 23 OCO trainees, 12 OA/OTN trainees, two experienced OCO facilitators.

**Methods:** Participants were exposed to the multimedia materials in a series of group sessions facilitated by two experienced OCOs. Feedback questionnaires were completed after each session and one session was observed by a non-participant. To gather more detailed feedback at the end of the course, semi-structured interviews and focus groups were conducted in English using a question guide developed from the aims of the study and existing literature. This question guide was used flexibly so that emerging themes could be explored. Four focus groups were held with the OCO trainees; and three semi-structured interviews with OA/OTN trainees. A further focus group discussion was held with the OCO facilitators. All interviews and focus groups were tape recorded. Transcription was done by an experienced transcriptionist and independently checked. Statistical analysis was performed for questionnaire data and a framework analysis approach used for qualitative data.

**Results:** Feedback questionnaires demonstrated high levels of learner satisfaction: 87% rated the level of detail as ‘about right’; 82% felt that the materials were neither ‘too complicated’ nor ‘too simple’; 97% enjoyed watching the multimedia modules and 94% would recommend them to a friend. Qualitative data highlighted some recommendations for minor modifications to the resource and provided learner and tutor perspectives on how materials can be implemented, integrated with training
curricula and used for group and individual study, training and professional development.

Discussion: The resource was received enthusiastically by learners and valued as an additional curriculum element with enthusiasm for its wider use. This is a novel approach and a careful implementation strategy is needed; with support for trainers to maximise the benefit of the resource.

10.2 Aims

- To introduce the multimedia resource into training programmes for two mid-level eye health worker cadres in Uganda.
- To identify improvements and issues related to implementation through questionnaires, focus groups, individual interviews and non-participant observation.

10.3 Methods

10.3.1 Setting

The multimedia resource (Ophthalmology: Multimedia Learning for Health Workers Worldwide - Africa) was introduced into initial training programmes at two institutions in Uganda: Jinja School of Ophthalmic Clinical Officers (OCOs), a government institution which trains the more senior cadre of mid-level eye health professionals (a 12 month course based at Jinja Regional Referral Hospital); and Ruharo Eye Centre, a private not-for-profit institution which trains the more junior Ophthalmic Assistant (OA) and Ophthalmic Theatre Nurse (OTN) cadres (a three month course). The multimedia content was delivered in a series of teaching seminars, facilitated in English by two experienced Ugandan OCOs. The timing and schedule of the seminars was decided in consultation with faculty at each institution so that it did not interfere with other teaching elements.
10.3.2 Participants

At Jinja School of Ophthalmic Clinical Officers, two groups of OCOs received training using the multimedia package: one group (11 students) received the programme three months after the start of their course; the second group (12 students) received the programme three months before the end of their course. At Ruharo Eye Centre, 12 students (six OAs and six OTNs) received the training. All students who received the training were asked to take part in the study.

10.3.3 Recruitment

Prior to recruitment, participants were given verbal and written information about the purpose of the study, highlighting that participation in each element (questionnaires, focus group/individual interview and non-participant observation) was voluntary, that responses and observations would be treated anonymously and not shared, in identifiable form, outside the research team and specifically, not with their tutors.

All students were invited to complete a feedback questionnaire after each seminar; and students in the observed multimedia seminar were asked (before the seminar) if they were happy for this to be observed. For interviews and focus groups, participants were recruited after the last seminar. At Jinja School of Ophthalmic Clinical Officers, focus groups were conducted shortly after the last training seminar so that all students were still available. At Ruharo Eye Centre, due to the availability of the interviewer (the author of this thesis), interviews were conducted after the training course finished so that some students had already returned home and could not be reached for interview. In addition, a separate focus group discussion was held with the two facilitators. Piloting was undertaken between April – November 2012.
10.3.4 Data gathering

Methods of data gathering were chosen so that a variety of issues related to the materials could be explored:

- Questionnaires were used to gain feedback from participants on each module in the multimedia resource.\(^1\)
- Focus group discussions were conducted with the OCO trainees, and with the facilitators (tutors), primarily to generate and refine ideas about improvements to the resource and to guide implementation.
- Individual interviews were conducted with the OA and OTN cadres to explore more sensitive issues related to individual perceptions of the resource (particularly issues around educational level, understanding and to explore group interactions in the tutorial).
- Non-participant observation was used to identify issues that learners and facilitators may not be aware of (or may not wish to admit) and as a comparison with participants’ and facilitators’ views.

10.3.4.1 Questionnaire

A questionnaire was developed using a series of 5 point Likert items to obtain learner feedback on the length of the tutorials, the amount of detail, the complexity of the material, and specific multimedia elements (narration and voicing, videos and pictures of clinical cases, animations and illustrations). Overall impressions were sought related to their enjoyment of the tutorial, the impact on confidence in their clinical skills and willingness to recommend the tutorial to others. Further free text responses were invited about the things they liked, things that could be improved and other comments/suggestions. Participants were invited to complete the feedback questionnaire anonymously after each tutorial.

\(^1\) Copies of the questionnaire are provided electronically in addendum disc 3.
10.3.4.2 **Non-participant Observation**

Non-participant observation of one seminar was undertaken with the OCO cadre. After obtaining consent from participants and facilitators, the observer sat at the back of the class, out of direct view of the participants, and observed the tutorial, making contemporaneous free-text notes on the students’ response to the multimedia materials, the facilitators’ role and any technical issues.

10.3.4.3 **Individual interviews and focus groups**

Semi-structured individual interviews were conducted, using a question guide based on relevant literature and the aims of the study, covering five broad areas: (i) background, (ii) previous experience of using technology in training, (iii) feedback about the training materials (general comments and specific feedback on videos, language/narration, clinical videos, retinal photographs, illustrations and animations), (iii) feedback on facilitation (how the multimedia materials were used in the group seminars), (v) ideas about implementation (recommendations for future use). Interviews and focus groups were conducted in English in a private room at each institution, and tape recorded. The interviewer also made detailed notes after each interview and focus group.

10.3.5 **Analysis**

Questionnaire data was analysed using Microsoft Excel 2010 and IBM SPSS version 22 and presented, graphically, as response frequencies for each Likert item, combined for all modules, and then for each module separately. Qualitative data (free text questionnaire responses, transcripts of interviews and focus groups and non-participant observer notes) were transcribed by an experienced transcriptionist and then independently checked by the author. Any disagreements were resolved by consensus.
A framework approach for analysis was used, based on Pope et al (2000). The data was read and re-read for familiarisation; and a framework developed from the aims of the study and from the data. Data was then indexed and categorised within the framework using QSR N-vivo 7. During this process, additional categories emerging from the data were added to the framework as necessary, in an iterative process. This was then discussed within the research team and any disagreements resolved by consensus. Next, links between categories were identified and the data classified into clusters of related categories with further discussion within the research team. Data gathered by the different qualitative methods (free text questionnaires, interviews, focus groups and non-participant observation) were included in the framework to compare, contrast and triangulate insights and perspectives from different methods of observation.

10.4 Results

10.4.1 Quantitative results

Questionnaire responses (for all modules combined) are shown fig 10a with a breakdown for each individual module in appendix B. Due to its length, module 5 (loss of vision) was shown across two group sessions with questionnaires completed at the end of both sessions (hence the larger number of questionnaire data items for this module).

Responses were overall positive: 87% responded that the amount of detail in the tutorial was ‘about right’ and 82% felt that the information was neither too complicated nor too simple. 97% enjoyed watching the tutorials, 94% would recommend the materials to a colleague studying in eye health. A lower proportion, 81% felt that the length of the tutorials was ‘about right’, (although the qualitative data suggests that this was related to the need for more breaks in group sessions rather than a need to modify the modules). For the specific multimedia elements, 99% agreed or strongly agreed that they understood the narrator, 100% agreed or strongly
agreed that the videos of clinical cases were clear, 98% agreed or strongly agreed that they understood the illustrations and animations. In terms of impact on learning, 94% felt that they were more confident in their skills after using the materials. There were differences between modules, reflecting the length and complexity of the content so that, for example, modules 4 and 5 were more likely to be considered too detailed.

Overall | OCO | OA/OTN
---|---|---
(Q1) The length of the tutorial was: (n = 225 (163 OCO, 62 OA/OTN))

FTL = Far too long, TL = Too long, AR = About right, TS = Too short, FTS = Far too short

(Q2) The amount of detail was: (n = 224 (163 OCO, 61 OA/OTN))

FTL = Far too much, TL = Too much, AR = About right, TS = Too little, FTS = Far too little

(Q3) The information in the tutorial was: (n = 216 (158 OCO, 58 OA/OTN))

FTL = Far too complicated, TC = Too complicated, AR = About right, TS = Too simple, FTS = Far too simple

Fig 10a (i): End of module questionnaires: (i) overall impressions.
(Number of responses is plotted with percentages shown as bar labels. Data is presented for overall responses and separately for OCOs and OA/OTNs.)
(Q4) I understood the voice of the narrator. \((n = 223 \ (163 \text{ OCO}, \ 60 \text{ OA/OTN}))\)

(Q5) The videos and pictures of clinical cases were clear. \((n = 225 \ (164 \text{ OCO}, \ 61 \text{ OA/OTN}))\)

(Q6) I understood the animations and illustrations. \((n = 222 \ (162 \text{ OCO}, \ 60 \text{ OA/OTN}))\)

**Fig 10a (ii):** End-of-module questionnaires: (ii) specific multimedia elements.

(Number of responses is plotted with percentages shown as bar labels. Data is presented for overall responses and separately for OCOs and OA/OTNs.)
(Q7) I enjoyed watching the tutorial. \((n = 226 \text{ (164 OCO, 62 OA/OTN)})\)

(Q8) I would recommend this tutorial to another person training in eye health. \((n = 224 \text{ (162 OCO, 62 OA/OTN)})\)

(Q9) I feel more confident in my skills after watching this tutorial. \((n = 222 \text{ (160 OCO, 62 OA/OTN)})\)

Fig 10a (iii): End-of-module questionnaires: (iii) enjoyment, recommendations and confidence. (Number of responses is plotted with percentages shown as bar labels. Data is presented for overall responses and separately for OCOs and OA/OTNs.)

10.4.2 Qualitative results

The interviews, focus groups, questionnaires and non-participant observation yielded rich qualitative data which highlighted issues related to the resource itself and to its implementation in eye health training and professional development programmes.
10.4.2.1 General comments

The resource was received positively by all cadres. For several participants, this was the first time they had used multimedia materials, although some reported watching training videos or Powerpoint presentations in previous training or seminars. The materials were perceived as practical, quicker and more enjoyable to use than traditional textbooks. Participants felt that access to the tutorials during their training had given them an advantage over their predecessors. The opportunity to watch video (rather than read from a book) was felt to aid recall and understanding, and learners reported a positive impact on their confidence.

“It was such a nice experience and you know, when you look at something, it’s difficult, very difficult for you to forget, than reading. Because at least you can remember, oh, one time, I saw this.”

Interview 2 – OTN trainee.

“It gives us a platform, for building confidence as you present yourself to a patient in your profession, it makes you build confidence that what you are doing is the right thing.”

Focus group 1 - OCO trainee 6.

“I personally have got knowledge, but some of the things which I did not know. And it is a faster way of learning. So to me it is good.”

Focus group 3 - OCO trainee 5.

10.4.2.2 Impact on skills and practice

Students at OCO level described a primarily ‘apprenticeship’ based training programme, learning on-the-job in wards, clinics and theatres, describing regular episodes where they tried to use skills that had not been formally taught. In this context, the materials were seen as a useful way of learning these skills. The materials
also corrected information that had been misunderstood in lectures and helped to resolve situations where students had been given contradictory information by more senior students or clinicians.

“So you may find out even sometimes maybe the, the tutor was dictating, and I made a mistake somewhere, this video is able to correct it.”

Interview 1 - OA trainee.

“We have been having the challenge previously, because we have different teachers on the ward... so you find someone is telling you this is how this is done, and another person contradicts... but, at least if students are to watch as a group... at least they will all have one mind about something, than everyone having a different view... It’s still a challenge, but, at least for students, they can clarify with the clips, they will have the same view of everything.”

Focus Group 4 - OCO trainee 4.

Aspects of practice where students reported an impact included treatment of penetrating injuries, checking visual acuity, ensuring a systematic approach to clinical examination, practical procedures (eye shielding, eye pad, irrigation), refraction and screening for glaucoma. Students also reported that the materials helped them to understand concepts such as visual field and think more clearly about differential diagnoses during history and examination.

“To know, really, the steps to follow when examining a patient. Before, some of the steps we go in and jump them. But really, they taught us some, I mean we watch some of the steps to follow... really it has helped us to improve on the steps to follow, when examining a patient.”

Focus group 1 – OCO trainee 3.
**10.4.2.3 Scope and level of detail**

OCO trainees were generally happy with the scope of material and level of detail. They were keen to have more information about extra-ocular surgical techniques (which are part of their curriculum but not included in the multimedia modules). Students who used the materials towards the end of their course also mentioned some quite specific areas where they wanted more information (retrobulbar neuritis, convergence insufficiency, aetiologies of uveitis) although it appeared, in the non-participant observed session, that this was linked more to anxieties about possible end-of-course examination topics than ‘real life’ clinical practice.

“Our main concern is at the minor surgery which we are required to be able to perform at the end of the course which has not been included. So there’s a need for some surgical videoing as well.”

*Focus group 4 – OCO trainee 3.*

For the OA and OTN trainees, the tutors felt that some of the terminology and content on posterior segment disease (affecting the vitreous, retina and optic disc) was difficult. However, the trainees themselves, whilst acknowledging this, did not want the material to be omitted from their programme.

“Since we are mixed both the, the OAs and the OTNs, certain words... they were finding certain things strange... Maybe when it came to retinopathies, it’s a bit confusing... but the rest was okay... I think they should be included, because at least now you will see something and then at least you will try to interpret.”

*Interview 2 – OTN trainee.*

Further suggestions included adding a focused module on anatomy and physiology as the first module (from tutors) and adding more details about overcoming lack of equipment and supplies (from trainees). It was suggested that similar materials could be usefully developed for primary eye care and patient education, but would need to be very much simplified.
“We do not have a tutorial on the anatomy and physiology. All the institutions whenever the students are brought in... the first thing they go in is the anatomy and physiology.

Tutor focus group participant.

The topics were straight, direct. Not this issue of having a lot of things and which are not useful ... there are some other things that was missed out like... suppose [equipment is] not there... you may find that it, for example that it, you are lacking certain material and you don’t have this, what material would you use?

Interview 1 – OA trainee.

_10.4.2.4 Specific multimedia elements_

Clinical videos and photographs

No concerns were raised about the clinical videos and photographs, which were felt to be of good quality. One participant would have preferred a wider range of ages to be presented in the module on measuring visual acuity, as most of the patients filmed were of a relatively young age.

Voicing and narration

A professional female voice-over with an English accent was used for all modules (based on feedback during the development process). Participants were happy with English as the language of instruction and highlighted the difficulties of translating into multiple vernacular languages, although they recognised that this would be necessary at ‘grass roots’ level.
The narrator’s English accent was broadly acceptable and most found her articulation clear, although some participants mentioned that Ugandans often have difficulties with English accents. The OA class included some French-speaking students from Rwanda who required other members of the class to translate. The main criticism was the speed of narration: participants felt that they needed more time both to comprehend and make lecture notes.

“In Uganda we have so many tribes... something like 56 tribes, so... we have very many, too many languages, meaning that we take English as the first priority.”

Interview 1 – OA trainee.

“The narrator, it’s very clear... but fast, the speed is. What you want is the speed, it was so speedy, very clear the voice was smooth, yeah and then it was speedy, we cannot pick it well.”

Focus group 3 – OCO trainee 2.

Illustrations and animations

No concerns relating to the Illustrations and animations were raised, and these were considered to be appropriate and of good quality. Facilitators noted that subtitles and text boxes were a useful adjunct to the voice-over for highlighting and clarifying technical terms.

Other suggestions

Other suggestions for additional multimedia elements were self-assessment questions (with specimen answers); some ‘grey’ cases to reflect clinical uncertainty; and to add better ‘sign-posts’ to orientate learners to clinical features, investigation and treatment for each condition.
10.4.2.5 *Incorporating the resource into training programmes*

There was a consensus from all cadres that the materials had a useful role in their training and they would strongly recommend them to future trainees. The materials were not generally seen as a replacement for other learning opportunities (such as lectures and clinical placements) but as an additional resource.

> To me, I think the normal teaching should not be stopped. That one should be as an attached to. [It] will help students to know some areas... but the normal teaching will be there because in a normal lecture a student is able to ask questions.”

*Focus group 1 – OCO trainee 5.*

**Timing within formal training curricula**

There was some debate in focus groups about the optimum timing of formal exposure to the multimedia modules. There was consensus that modules 1 and 2 (visual acuity and clinical assessment) should be delivered early in the course. Some students then wanted to watch the other modules early (so that they could apply learning in early clinical placements); others felt that modules should be mapped to the curriculum and timetabled to be shown parallel to the corresponding lectures; and others advocated watching the materials twice: early in the course for familiarisation and then again later on. There was a preference for the multimedia tutorials (apart from modules 1 and 2) to be more spread out than the intensive approach used in this pilot project.

> “Kindly, I disagree... I would say, it’s better they give me maybe a start because... we shouldn’t only rely on the information of the data they give us in class, but we even go to the wards or clinics, whereby meet these cases, but you’ve never seen them, but the moment you watch, at least you remember something... These are things we are dealing with daily in our clinics... maybe even the second semester, we go through that again.”

*Focus group 1 – OCO trainee 2.*
It’s like for the modules where they are examination of the eye, visual acuity. I think it would be better in the first of your months, then you go to the wards to carry out with our clinical work.

Focus group 4 – OCO trainee 1.

What you include in the module... you can use the curriculum for the training...
What is in the first semester, you put. Then what is in the last semester, you put all the topics... So when you use the curriculum you will include all the topics, which we are supposed to cover in the module.

Focus group 3 – OCO trainee 1.

Group sessions

Watching the modules for the first time in a group was considered valuable, as it allowed questioning of colleagues and tutors to clarify understanding and stimulated useful discussion. After tutorials, discussion often continued informally amongst trainees in their hostels. Participants generally found the tutorial environment supportive, and the group sizes (10-12 students) were acceptable. Some technical problems during formal group sessions were reported (short power cuts, discs failing to play) and, although these were resolved, the tutors highlighted that they would not be able to deliver the programme in the event of a prolonged power-cut or a fault with projection equipment.

“I think as long as for training purpose we need to be in a group because there are times when we here at least we will know how, what to do.... so that when you’re missing something you can ask the person who has got some knowledge around that area.”

Focus group 3 – OCO trainee 1.
“There was some power cuts, fortunately it could come back in a short while...
But there is a time when maybe it can go off for the rest of that day... And if the
beamer... went wrong... then it would be a major setback because, it is the only
one that is available.”

Tutor focus group participant.

Duration of tutorials

The length of the multimedia modules varied and most students felt that certain
modules (usually modules 4, 5 and 7) were too long for a single tutorial and reported
that they struggled to maintain concentration. Despite this, they did not want content
to be removed but instead proposed splitting the material across more tutorials. Some
students voiced a preference for morning tutorials when they are less tired and could
concentrate for longer.

“The fifth was too long. And the time when we watched that one, it was in a
bad time, whereby people were sleeping at that time. It was too, too long... But
it was very much interesting.”

Focus group 1 – OCO trainee 1.

“I think it would be like, 5a, 5b, split into 2, and then a break, yeah.”

Focus group 2 – OCO trainee 5.

Breaks and discussion

Recommendations from trainees about the optimum duration of tutorials ranged from
30 minutes to two hours, whilst tutors recommended regular short breaks after 40
minutes of video material noting that students return more promptly from shorter
than longer breaks.
“40 minutes would be good enough with maybe a 5 minute break in between... Only maybe delay can come on this major break of 30 minutes... But this break of 2 minutes, 5 minutes I think they will still come promptly. After 5 minutes, they come back and then you go on.”

Tutor focus group participant.

There was some debate about how discussion should be structured within tutorials: most students wanted frequent opportunities for discussion while new material was still fresh in their minds; but a minority preferred waiting until the end of the module. Tutors highlighted the need to balance valuable discussion time with a risk of tutorials over-running.

“[Student 4:] After maybe like one objective or two objectives, then we could first stop in a bit, have some questions... If you just continue... then you can forget what to ask.
[Student 7:] and even... that’s when the dozing can get.
[All:] Um [agreement]”

Focus group 4 – OCO trainees 4 and 7.

“There’s some students who would be interested to have a discussion after every sub-topic... I think it would be another ideal thing to do... but the only trouble with that is it will prolong the time of the tutorial.”

Tutor focus group participant.

Training of trainers

Tutors suggested that it might be useful to develop some advice to trainers about using the resources in group sessions and provide some ‘train the trainer’ opportunities. In the non-participant observed session, students wanted discussion about topics outside of the curriculum and scope of the resource. This could usefully be addressed in advice to trainers.
Self-directed learning

Participants also saw a further role for the multimedia materials in self-directed learning during their training and were keen to have personal access, mentioning that self-directed study would allow them to review materials at their own pace and watch material repeatedly to aid learning. Some students also discussed the possibility of using the materials for informal group study at evenings and weekends.

“Friends will learn slowly the other learns very fast, so we are not the same. But this video, it’s simple, I can even pause it and I repeat it and I see again.”

Interview 1 – OA trainee.

“I believe the brain keeps on picking the same information if it is repeated, several times. So the best way would be, each one getting a copy of the DVD… as you expose yourself on repeated information the brain, pick it very well.”

Focus group 1 – OCO trainee 6.

“Like, during in our free time, we just switch on and we see what, what we are not understand, what we have not understood. Instead of being organised from a certain place and, if it was within us here… so during weekends, we, we can say together we are going to watch this.”

Focus group 1 – OCO trainee 1.

Most students felt that initial group exposure should be combined with personal access to their own copy of the materials. Some also suggested providing a paper-based handbook to avoid the need to take notes whilst watching the materials, which could also be used if the disc-based materials were not accessible or when seeing patients.

“I prefer first of all by group. Just, by group. Then, by individual.”

Interview 3 – OA trainee.
Continuing professional development

Participants saw that the materials could be used after formal training as a source of reference and professional development. They also discussed using the materials to facilitate professional development/continuing medical education sessions at their own institutions.

“We can also use it as a continuous education programme for our colleagues…. when we go back.”

Focus group 3 – OCO trainee 3.

10.4.2.6 Access to infra-structure and educational materials

Participants reported that their access to computers at home and work was limited, with only two participants having their own computer. DVD players for television were more commonly (but not universally) available to students at home. Other problems included access to computers, internet and electricity, especially for those from more rural areas. Students mentioned a lack of reliable electricity, projection equipment, screens and blinds in tutorial rooms at the training institution; and a lack of access to computers (which were reserved for the secretary’s use). Books were also difficult to obtain due to cost and limited availability in bookshops (which were located only in major cities). Some students also complained about library access and a lack of up to date editions of library textbooks.

Interestingly, lack of access to computers and DVD players was not widely perceived to be an insurmountable barrier to using the multimedia materials, and students felt that they could find ways of borrowing or buying devices if they had access to the materials.
“[Student 2:] So I think if you’re giving the CD’s we can take them somewhere and... 
[Student 5:] That one will push, will be a guide to you that, okay now I have this, I must have one [DVD player], at my home.”

Focus group 1 – OCO trainee 2 and 5.

One interviewee suggested that USB memory sticks (‘flashes’) would be a better means for sharing materials, as they were less fragile than discs.

“Maybe what I can request is that you know with us, the handling of the CD’s, so I would request maybe that at least people have it on their flashes and that kind of thing... because the CDs, handling it is not easy.”

Interview 1 – OA trainee.

10.5 Discussion

This evaluation provides evidence to shape minor revisions to ‘Ophthalmology: Multimedia Learning for Health Workers Worldwide – Africa’ and to guide its implementation in training programmes for mid-level eye health personnel in sub-Saharan Africa. Feedback questionnaires, interviews and focus groups confirm that the resource was overall viewed positively by participants and tutors. Participants wanted further access to the materials and, importantly, were keen to find ways of overcoming limited access to ‘hardware’ to use the materials again. Whilst their enthusiasm is probably increased by the lack of alternative information sources (such as textbooks), it also reflects positively on the resource. It is encouraging that participants were able to identify areas of their practice which they felt improved after using the materials; and it is possible that their enthusiasm and confidence could help to build ‘self-efficacy’ and bridge the ‘know-do’ gap (described in chapter 1) so that learning is more effectively translated into practice. However, it cannot be concluded that such ‘real-life’ improvements in practice will necessarily occur and this requires different methodological approaches (to be discussed in chapters 11-12).
This evaluation used several methods to obtain feedback and explore the use of the resource in a tutorial setting. These methods are subject to potential bias: participants may be afraid to raise ‘negative’ opinions or admit to views that may be perceived badly by their peers in focus groups; their perception of the interviewer’s status could also influence responses although the interviewer was mindful of this and took care to reassure participants of anonymity, encourage all views to be expressed fully and receive all comments positively. It appears from their comments that participants did indeed raise criticisms, and conclusions are strengthened by the fact that the views expressed in interviews and focus groups triangulate well with the anonymous questionnaire data and non-participant observation.

10.5.1 Modifications to the resource

The major criticism of the resource was the speed of narration. This was addressed by re-editing the modules with longer pauses between objectives; and adding longer gaps between sentences to ‘slow’ the narration (as it was not practical to re-voice it completely).

Longer term issues, that are specific to the resource, include:-

- translation into other languages,
- adaptation for different technological platforms (such as USB memory sticks),
- developing modules on surgical techniques,
- providing self-assessment questions and additional ‘grey’ cases,
- developing simpler materials for use in ‘primary eye care’.

Future revisions will also be needed to ensure that the resource remains up-to-date and responds to feedback from future learners. Research to determine the optimum speed for narrated voice-overs may be useful.
10.5.2 Implementation

With modifications, the resource appears ready for formal evaluation in a research setting and implementation into training and professional development programmes in sub-Saharan Africa. This requires the support of partners including trainers, training institutions, government and non-governmental organisations. Sensitivity to infrastructure constraints is important; and timetabling is a key issue, with a strong preference from learners for early viewing of modules 1 and 2 (visual acuity and clinical assessment). Careful consideration of how the materials fit within curricula is also needed, with learners preferring initial facilitated group exposure followed by personal access to the materials. This evaluation highlights the value of obtaining feedback from learners and educators and, following adult learning and quality improvement principles, this engagement should continue in the implementation stage.

For personal access, learners are keen to have their own copies of materials and most are confident that they can overcome their limited access to technology to use them. In distributing materials, a strategy is needed which ensures that materials reach front line workers, that cost is not a barrier to uptake and that the programme remains financially sustainable (both in terms of the distribution and updating/revision of materials).

This is a novel educational approach and, as suggested by the tutors, it may be useful to produce guidelines and recommendations to trainers and institutions to aid implementation; and to provide ‘train the trainer’ opportunities to introduce local tutors to the materials and develop their teaching skills. Such approaches should result in a more locally relevant and sustainable training programme.\textsuperscript{522,523}
Finally, although multimedia materials represent a promising approach to training and professional development in sub-Saharan Africa, this must be evidence-based (especially in a resource-constrained setting). This evaluation has focused on learner perspectives but the next key step is to assess the impact of the materials on clinical skills. Such evidence from this ‘proof of concept’ resource is a key building block for future multimedia learning for health workers in developing countries.

10.6 Conclusions

This study confirms that adding multimedia learning to the training of mid-level eye health workers is feasible and acceptable to learners. The enthusiastic response of learners is encouraging although a clear strategy is needed for implementation. After some minor modifications suggested by this study and in other quality control steps (described in chapter 9), the resource was considered ready for release.
Objective 3:
Assess the impact of this resource on health workers’ clinical skills using a robust experimental design.
11.1 Abstract

**Purpose:** To measure the impact of a multimedia learning resource in ophthalmology on medical students’ clinical skills assessed in an Objective Structured Clinical Examination (OSCE).

**Setting:** Department of Ophthalmology, Mbarara University of Science and Technology and Ruharo Eye Centre, Uganda.

**Participants:** 64 fourth year clinical medical students undertaking their clinical placement in ophthalmology.

**Methods:** Students were allocated to matched pairs with respect to timing of placement, previous grade point average and gender. Within each matched pair, students were randomly allocated to the intervention group (receiving supervised multimedia tutorials replacing 1.5 hours of their clinical placement each day) or the control group (receiving the usual 3 hour clinical placement). Multimedia tutorials comprised 45 minutes watching the materials as a group and 45 minutes of supervised study using the materials on a personal DVD player. No student was allowed to ask questions during the tutorial or take materials away. Students sat a ‘low stakes’ OSCE (which did not contribute to their formal faculty assessment) at the end of the second week, comprising fifteen stations, each based on one of five clinical tasks (history, examination, case discussion, counselling/explanation and practical procedures) covering a cross-section of ophthalmological presenting problems. Standard setting was undertaken by a panel of Ugandan ophthalmologists who had not seen the educational resource or been involved in its development. The pass mark was set using the borderline group method. OSCE assessors were trained and blinded to the group allocation of the student. Data was analysed using chi-squared and t-tests as appropriate. Linear and logistic regression models were built as appropriate to adjust for confounding variables.
Outcome measures: Mean OSCE score, number of stations passed and overall pass rate. (Mean scores for each skill domain were calculated as secondary outcomes).

Results: 61/64 students completed the OSCE assessment. The intervention group performed significantly better in each primary outcome measure: 27/30 (90.0%) students vs 20/31 (64.5%) passed the OSCE examination (p = 0.032), mean number of stations passed were 12.4 and 11.1 (p = 0.043), mean overall percentage scores were 71.6% and 68.4%, (p=0.048). Statistically significant differences were observed in scores for ‘differential diagnosis’ and ‘making a management plan’.

Discussion: Supervised multimedia tutorials in this resource poor setting have a significant impact on students’ clinical skills (as measured by OSCE performance). The most striking impact is on number of students achieving an overall ‘pass’ although all three methods of comparing performance showed statistically significant differences. The multimedia resource appears to have a particular impact on students’ skills in differential diagnosis and management planning.

11.2 Aims

- To undertake a robust randomised trial of the impact of multimedia materials on medical students’ clinical skills (assessed in a ‘low stakes’ OSCE).
- To measure the impact of exposure to the resource on overall score, pass rate and number of stations passed; and secondarily on different skill domains.

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1 ‘Low stakes’ assessments are those which carry no significant consequences for the individual taking the test. By contrast, tests which have important consequences (such as those used to decide on students’ academic progression), may be referred to as ‘high stakes’.
11.3 Methods

11.3.1 Setting

Mbarara University of Science and Technology is a government run university in South-West Uganda. The medical school offers a five year undergraduate degree, leading to the award of MBChB. Students undertake their Ophthalmology attachment in the second semester of the fourth year, as part of their training in surgical specialties (also covering ENT, radiology, anaesthesics and urology). The usual student programme for the semester comprises a daily lecture (for the entire year group across all specialties) and a series of half-day clinical placements, each lasting 3-4 weeks, in each specialty. In Ophthalmology, students receive clinical teaching at two sites: Mbarara University Department of Ophthalmology Referral Centre (which is part of the government run Regional Referral Hospital) and Ruharo Eye Centre, a private-not-for-profit eye hospital located 2km from Mbarara. Students spend alternate weeks at each site. Formal assessment covering each surgical specialty (including ophthalmology) takes place at the end of the semester and includes a formal OSCE (introduced for the first time in 2014) and written examination. The decision to include a formal OSCE in students’ summative assessment was made by the medical school, independently of the research team, and the results of the ‘low stakes’ OSCE used in this study did not contribute to students’ formal assessment.

11.3.2 Sample size calculation

A sample size calculation was undertaken in conjunction with an independent statistician. A sample size of 72 was needed to detect differences of 0.65 standard deviations with 80% power\(^1\) and 95% confidence,\(^2\) and 0.75 standard deviations with 90% power and 95% confidence. Assuming a similar distribution of

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1 Power is the probability of correctly rejecting the null hypothesis if it is false. 80% power means that there is a 20% chance of incorrectly accepting the null hypothesis if it is false (type II error).
2 Confidence is the probability of correctly accepting the null hypothesis if it is true. 95% confidence means that there is a 5% chance of incorrectly rejecting the null hypothesis if it is true (type I error).
marks to those obtained by UK medical students (based a specimen dataset of 400 OSCE results from a UK medical school)\textsuperscript{524} this would detect differences of 3.6\% (80\% power, 95\% confidence) and 4.1\% (90\% power and 95\% confidence) of the total available marks. Pragmatically, a single year group (typically 70-80 students) was therefore considered a reasonable sample for the study.

11.3.3 Participants

All medical students undertaking their ophthalmology placement were invited to take part in the study. The only exclusion criterion was previous experience as an eye health professional (although no student had to be excluded on these grounds).

11.3.4 Allocation to groups

Students were randomly allocated to one of two teaching groups using an allocation protocol determined in advance of the study (on advice from an independent statistician). All fourth year medical students who registered at the start of the semester were grouped into matched pairs with respect to previous examination performance (measured by grade point average in their most recent summative faculty examination), timing of their Ophthalmology placement, and gender. One member of each matched pair was then allocated to each teaching group using a random number generator. One teaching group was then randomly allocated to be the ‘intervention group’ and the other to be the ‘control group’.

11.3.5 Participant recruitment

Students were informed of the study by oral presentation and written information at the start of the semester, and asked to consent to participate in an optional ‘low stakes’ OSCE at the end of the second week of their placement. They were advised
that participation was voluntary and would not affect any other aspect of their training or assessment: students would attend the teaching with the rest of their allocated teaching group (as part of their scheduled placement as agreed by the faculty) regardless of their participation in the study; and feedback on their performance would be shared with them (if they wished) for formative purposes but not with faculty or tutors, and would not be used for formal summative assessment.

11.3.6 Educational intervention

The intervention group received the multimedia teaching component in the first two weeks of their attachment (before the OSCE). To deliver this, 1.5 hours of their clinical placement was replaced by a tutorial, during which they watched sections of the multimedia resource (each lasting approximately 45 minutes) followed by time for personal study with the resource on a portable DVD player. The tutorials were supervised by experienced Ophthalmic Clinical Officers, who were not allowed to answer students’ questions or provide any further teaching during the sessions; and students were not permitted to take the multimedia materials away or use them outside of the tutorial. No other aspect of the standard teaching programme was changed. The control group received the usual teaching programme of a half day clinical placement spent in wards, theatre and outpatients. The teaching schedules for the two groups are shown diagrammatically in table 11a.¹

<table>
<thead>
<tr>
<th>Time</th>
<th>Scheduled activity</th>
<th>Intervention group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00-09:00</td>
<td>Early morning lecture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:30-11:00</td>
<td>Clinical placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00-12:30</td>
<td>Multimedia tutorial</td>
<td></td>
<td>Clinical placement</td>
</tr>
</tbody>
</table>

Table 11a: Teaching programme for students

¹ The control group received the multimedia tutorials in the 3rd and 4th weeks of the ophthalmology placement (after the OSCE). This was considered important for ethical reasons and to ensure that all students had similar educational opportunities across the ophthalmology attachment as a whole.
To reduce the potential for ‘mixing’ of the two groups, the groups alternated together between each teaching site so that, by the end of the second week, both groups had spent one full week at each site. The order of rotation was determined by random number generator.

11.3.7 OSCE assessment

At the end of the second week of their placement, students undertook the OSCE which assessed their clinical skills applied to eye disease. This was timed so that the intervention group had completed their multimedia tutorials.

11.3.7.1 OSCE Blueprint

The OSCE comprised 15 stations based on five clinical tasks, each of which was assessed three times:

(i) history taking,
(ii) clinical examination,
(iii) case presentation/discussion (with a senior colleague),
(iv) counselling and explanation,
(v) practical procedures

To ensure an appropriate cross section of eye disease was covered, a station for each clinical task was developed around each of the following presenting problems:

- red, painful or injured eye.
- loss of vision due to disease of the cornea, anterior segment, lens or extraocular disease.
- loss of vision due to disease of the posterior segment, retina or optic nerve.
This formed the OSCE blueprint as illustrated in table 11b.

<table>
<thead>
<tr>
<th></th>
<th>History</th>
<th>Clinical Examination</th>
<th>Case Presentation / Discussion</th>
<th>Counselling / Explanation</th>
<th>Practical Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red, painful or injured eye</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Checking visual acuity</td>
</tr>
<tr>
<td>Loss of vision due to disease of the cornea, anterior segment or lens; or extra-ocular disease.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Visual acuity (Low vision)</td>
</tr>
<tr>
<td>Loss of vision due to disease of the posterior segment, retina or optic nerve</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Fundoscopy</td>
</tr>
</tbody>
</table>

Table 11b: OSCE blueprint

The 15 OSCE stations were entirely independent so that a student’s performance in one station would have no impact on their potential performance in another station. To ensure content validity, skills and knowledge were only tested if they were mentioned in the medical school curriculum or student log book which was devised independently of the authors of the resource.

11.3.7.2 Development of mark sheets

For the history, examination, case discussion and counselling/explanation stations, the marking schedule was based on the skill domains identified in the Royal College of Physicians’ MRCP PACES examination, a validated and internationally respected test of clinical skills, which tests the following skill domains:-

- Communication skills
- Managing patient concerns

1 Copies of mark sheets are provided electronically in addendum disc 3.
• Maintaining patient wellbeing
• Physical examination technique
• Detecting abnormal findings
• Differential diagnosis
• Making a management plan

MRCP PACES is a postgraduate examination, structured around five stations and testing several clinical tasks (history taking, examination etc) within each station. At undergraduate level, where students’ skills are likely to be less consistently developed, the disadvantage of this approach is that poor performance early in a station (for example, history taking or examination) might impact on the student’s potential performance later in the station (for example, differential diagnosis). Therefore, in this assessment, the OSCE was structured so that each station tested only one clinical task. All stations were weighted equally, so that all contributed equally to the overall mark. Students were marked in each skill domain on a five point scale: ‘Poor’, ‘Unsatisfactory’, ‘Borderline’, ‘Satisfactory’, ‘Good’. The skill domains tested within each station are shown in table 11c.

For the Practical skills stations, specific mark sheets were developed for each station. In these stations, students were assessed on their ability to perform specific steps in the task on a four point scale (usually ‘Not done’, ‘Not adequate’, ‘Adequate’, ‘Good’ although descriptors were modified if necessary so that they were appropriate to the task. (For example, in writing down the correct visual acuity, the four point scale: ‘Not done’, ‘Not correct’, ‘Correct (after prompting), ‘Correct (no prompting)’ was used.) In addition, students were assessed on ‘maintaining patient welfare’ using the five point scale described for the other stations above.

In all stations, the mark sheet included a global rating of the student’s ability to perform the task on a six-point scale (‘Inadequate’, ‘Clear fail’, ‘Borderline fail’, ‘Borderline pass’, ‘Clear pass’, ‘Outstanding’). This global score did not contribute to the individual student’s mark but was used to set the pass mark for the assessment using the borderline group method (see section 11.3.8.3).
11.3.7.3 **Standard setting**

In each station, the standard for a ‘satisfactory’ or ‘adequate’ grade was ‘the standard expected of a newly qualified doctor beginning their first job as a doctor’ and assessors judged the candidate’s performance in each skill domain against this standard. Whilst it was recognised that students may not yet have reached this standard, it was chosen because it would be more easily understood and consistently applied by assessors. From the students’ perspective, the ophthalmology placement is their main opportunity to develop specific skills in eye health, and it was therefore felt reasonable to measure their skills relative to a ‘new doctor’ standard in this OSCE (as it did not contribute to their formal assessment).

Prior to the first sitting of the OSCE, a focus group of three Ugandan Ophthalmologists (who had not seen the multimedia resource or been involved in its development) was convened to decide the mark scheme by considering four questions:-

1. What marks should be allocated to each grade (‘Poor’, ‘Unsatisfactory’, etc) in the marking scale?
2. What proportion of marks within each station should be allocated to each skill domain?
3. Does the weighting decided for each station result in an acceptable weighting across the assessment as a whole?
4. What would count as a ‘pass level’ performance across the assessment as a whole?

For the history, examination, case discussion and counselling/explanation stations, the focus group decided that the marks allocated to each grade would be:-

- ‘Poor’ – 10%
- ‘Unsatisfactory’ – 35%
- ‘Borderline’ – 50%
- ‘Satisfactory’ – 65%
- ‘Good’ – 90%
For the practical skills stations, the focus group decided that the marks allocated to each grade in the four point scale would be:-

- Not done – 0%
- Not adequate – 30%
- Adequate – 60%
- Good – 90%

The focus group then decided the weightings of different skill domains within each station. From these, the cumulative weightings for the different skills were calculated as shown in table 11c. The group reached a consensus that (i) the weightings within each station were appropriate; and (ii) that these weightings translated into an appropriate weighting across the whole assessment.

Finally, it was agreed that an overall ‘pass’ would be awarded to students who passed 10 or more stations across the OSCE as a whole and at least one station for each clinical task (ie: 10 stations overall including at least one history, examination, case discussion, counselling/explanation and practical skill). This was judged to provide a better measure of all-round performance than the overall ‘pass mark’ or ‘number of stations passed’ as students would be required to demonstrate all clinical tasks to a satisfactory standard on at least one occasion.

11.3.7.4 Use of patients and simulated patients

English speaking simulated patients were used for the history, practical skills and counselling/explanation stations. Simulated patients are widely used in OSCE assessments for practical reasons and to provide standardisation. In this study, a specific advantage of simulated patients (over real patients) is language: Uganda uses English as its main official language, although this is not spoken consistently by all sections of the population. There is a large number of tribal languages, so that students may not be able to speak the patient’s language without the assistance of an interpreter.
<table>
<thead>
<tr>
<th>Clinical topic</th>
<th>Station/clinical task</th>
<th>Skill domain tested and weighting within the station</th>
<th>Cumulative weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red, painful or injured eye (5)</td>
<td>Loss of vision due to disease of the cornea, anterior segment or lens (5)</td>
<td>Communication skills 45%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Managing patient concerns 20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Differential diagnosis 25%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintaining patient wellbeing 10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>History taking (3)</td>
<td>Physical examination technique 35%</td>
<td>Communication skills (9) – 25%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identifying physical signs 35%</td>
<td>Making a management plan (6) – 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Differential diagnosis 20%</td>
<td>Managing patient concerns (6) – 10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintaining patient wellbeing 10%</td>
<td>Maintaining patient wellbeing (12) – 7.5%</td>
</tr>
<tr>
<td></td>
<td>Clinical examination (3)</td>
<td>Differential diagnosis 25%</td>
<td>Differential diagnosis (9) – 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Making a management plan 35%</td>
<td>Physical examination technique (9) – 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication skills 40%</td>
<td>Detecting abnormal findings (3) – 8.75%</td>
</tr>
<tr>
<td></td>
<td>Case discussion (3)</td>
<td>Making a management plan 35%</td>
<td>Practical skills (3) – 18%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication skills 40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintaining patient wellbeing 10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Counselling and explanation (3)</td>
<td>Making a management plan 30%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication skills 40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Managing patient’s concerns 20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintaining patient welfare 10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Practical skills (3)</td>
<td>Performing specific skill elements 90%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintaining patient welfare 10%</td>
<td></td>
</tr>
</tbody>
</table>

Table 11c: Overview of OSCE design showing stations with their clinical topics, clinical task, skill domains and their weighting within the station; and cumulative weighting of skills across the examination as a whole. Numbers in brackets refer to the number of times the topic, clinical task or skill is tested in the examination.
English speaking simulated patients were recruited from local ophthalmic nurses and other assistants. All simulated patients took part in training sessions, which included the opportunity for familiarisation and practice in their simulated role. Appropriate ‘real’ patients were used for the clinical examination stations, recruited from the out-patient department or wards in the two days before the OSCE. To ensure that students did not meet these patients before the OSCE, students were kept away from the wards during the two days before the OSCE. The study was explained and consent obtained. If the patient did not speak English, students were able to ask the assessor for the station to act as interpreter. In this situation, they were instructed to speak to the interpreter exactly as they would speak to the patient.

11.3.7.5 Development of scenarios

Scenarios were developed for each station and station specifications prepared, comprising a set-up sheet, assessor briefing, candidate briefing, patient/simulated patient briefing, mark sheet and calibration sheet. Scenarios were chosen so that they represented a reasonable range of challenge. Two sets of scenarios were developed, and used with the 1st & 3rd and 2nd & 4th group of students respectively. Table 11d shows the clinical scenarios in each assessment.

11.3.7.6 Recruitment and training of assessors

Assessors were recruited from local Ophthalmologists, Ophthalmic Clinical Officers and experienced senior Ophthalmic Nurses. All assessors undertook a series of training seminars in the weeks before the first OSCE to introduce them to the principles of OSCE assessment and provide specific information about the different types of station. Training sessions included presentations, opportunities to practice marking stations using video cases and time for discussion and questions. It was a prerequisite that
assessors completed assessor training before being allowed to mark students’ performance in the OSCE.

<table>
<thead>
<tr>
<th>Station</th>
<th>OSCE sittings 1 and 3</th>
<th>OSCE sittings 2 and 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>History (Simulated patient)</td>
<td>A patient with typical symptoms of angle closure glaucoma.</td>
<td>A patient with a persistently watering right eye.</td>
</tr>
<tr>
<td>Examination (Real patient)</td>
<td>A real patient with red, irritated, injured or painful eye.</td>
<td>A real patient with red, irritated, injured or painful eye.</td>
</tr>
<tr>
<td>Case discussion</td>
<td>A patient with trachomatous trichiasis.</td>
<td>A child with neonatal conjunctivitis (paediatric).</td>
</tr>
<tr>
<td>Counselling/explanation (Simulated patient)</td>
<td>A patient with a bacterial corneal ulcer.</td>
<td>A patient with chronic allergic conjunctivitis.</td>
</tr>
<tr>
<td>Practical skill (Simulated patient)</td>
<td>Measuring visual acuity.</td>
<td>Measuring visual acuity.</td>
</tr>
<tr>
<td>History (Simulated patient)</td>
<td>A patient with gradual loss of vision.</td>
<td>A patient with gradual loss of vision.</td>
</tr>
<tr>
<td>Examination (Real patient)</td>
<td>A real patient with anterior segment disease.</td>
<td>A real patient with anterior segment disease.</td>
</tr>
<tr>
<td>Case discussion</td>
<td>A child with a left convergent squint. (paediatric)</td>
<td>An adult with secondary cataract.</td>
</tr>
<tr>
<td>Counselling/explanation (Simulated patient)</td>
<td>A patient with cataract.</td>
<td>A patient with squamous cell carcinoma of conjunctiva.</td>
</tr>
<tr>
<td>Practical skill (Simulated patient)</td>
<td>Measuring visual acuity (low vision).</td>
<td>Measuring visual acuity (low vision).</td>
</tr>
<tr>
<td>History (Simulated patient)</td>
<td>A patient with typical symptoms of retinal detachment.</td>
<td>A diabetic patient with sudden loss of vision.</td>
</tr>
<tr>
<td>Examination (Real patient)</td>
<td>A real patient with posterior segment disease.</td>
<td>A real patient with posterior segment disease.</td>
</tr>
<tr>
<td>Case discussion</td>
<td>A patient with Proliferative Diabetic Retinopathy.</td>
<td>A patient with Chronic Glaucoma.</td>
</tr>
<tr>
<td>Counselling/explanation (Simulated patient)</td>
<td>A patient with chronic glaucoma.</td>
<td>A patient with dry age related macular degeneration.</td>
</tr>
<tr>
<td>Practical skill (Simulated patient)</td>
<td>Fundoscopy.</td>
<td>Fundoscopy.</td>
</tr>
</tbody>
</table>

Table 11d: Clinical scenarios used in stations for each sitting of the OSCE
11.3.7.7 Calibration and familiarisation

For history, examination, case discussion and counselling/explanation stations, generic mark sheets were used (as described above). Based on the approach taken for the MRCP PACES examination, groups of assessors met before each OSCE to familiarise themselves with the scenarios and to ‘calibrate’ the scenario (generate specific ideas about what they would look for in assessing each skill domain for each station). These familiarisation/calibration sessions involved the assessor who would mark the station in the OSCE, at least one other trained assessor (who would act as a ‘reserve’ assessor) and a member of the research team (whose role was solely to ask calibration questions, record the decisions made by the assessors and act on any recommended revisions). During these sessions, the scenario and station specification were carefully reviewed and the assessors discussed and agreed answers to calibration questions (based on the calibration questions used for the MRCP PACES examination). Note 1 If the assessors recommended any changes to the scenario, these were agreed by consensus between the assessors and included in the final station specifications. Calibrations for history, case discussion and counselling/explanation stations were held in the week before the OSCE. Calibrations for examination stations were held on the morning of the OSCE. For the examination station (posterior segment disease), the calibration exercise included the selection of a suitable retinal photograph (from a library which had not been included in the multimedia resource) which was representative of the patient’s illness. This was shown to students who attempted fundoscopy on the patient (so that students who struggled to visualise the fundus would not be unduly penalised in their differential diagnosis for the station).

11.3.7.8 Organisation of the OSCE

Each OSCE station lasted 10 minutes, including a one minute changeover period spent outside the next station to read the candidate briefing. Within each station, timings were decided according to the task and, in some stations, time was allocated at the

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1 Calibration proformas for each station are provided electronically in addendum disc 3.
end of each station for pre-defined structured questions. Timings and structured questions for each station are summarised in table 11e.

<table>
<thead>
<tr>
<th>Station</th>
<th>Timings</th>
<th>Structured question(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Read briefing [1 min]</td>
<td>What is your differential diagnosis for this patient’s symptoms?</td>
</tr>
<tr>
<td></td>
<td>History taking [8 min]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Structured questions [1 min]</td>
<td></td>
</tr>
<tr>
<td>Examination</td>
<td>Read briefing [1 min]</td>
<td>What abnormalities does this patient have?</td>
</tr>
<tr>
<td></td>
<td>Examination [7 min]</td>
<td>What is your diagnosis?</td>
</tr>
<tr>
<td></td>
<td>Structured questions [2 min]</td>
<td>Are there any other differential diagnoses?</td>
</tr>
<tr>
<td>Case discussion</td>
<td>Read briefing [1 min]</td>
<td>*What is the most likely diagnosis?</td>
</tr>
<tr>
<td></td>
<td>Preparation [3 min]</td>
<td>*Are there any other differential diagnoses that you would consider?</td>
</tr>
<tr>
<td></td>
<td>Presentation/discussion [6 min]</td>
<td>*Are there any further tests or investigations that you would like to perform?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*If the most likely diagnosis is confirmed, what is your management plan?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*What is your plan to follow-up this patient?</td>
</tr>
<tr>
<td>Explanation</td>
<td>Read briefing [1 min]</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Preparation [3 min]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Explanation to patient [6 min]</td>
<td></td>
</tr>
<tr>
<td>Practical skill</td>
<td>Read briefing [1 min]</td>
<td>Depending on skill under test</td>
</tr>
<tr>
<td></td>
<td>Perform task and answer questions (if appropriate) [9 min]</td>
<td></td>
</tr>
</tbody>
</table>

**Table 11e:** Timings and prescribed structured questions for each station. Questions used if the candidate did not cover the issue in their presentation are indicated with *.

For the OSCE, students were given badges with anonymised candidate numbers (providing no indication of their identity or whether they had been in the intervention or control group). All candidates received briefings about the OSCE on the day before the assessment and a further reminder of the key points from this briefing immediately before the examination. Assessors and simulated patients also had a morning briefing on the day of the assessment re-iterating the key points.
For practical reasons, the OSCE was divided into two parts (comprising 8 and 7 stations respectively) with a break in between. Assessors marked 1-2 stations across the entire assessment (so that students were assessed by a minimum of 8 different assessors across the examination as a whole). Assessors were matched to appropriate stations based on their background and previous experience. Students surrendered their mobile phones at the start of the OSCE.

There were two sittings of the OSCE, in the morning and afternoon and students were quarantined (with no access to mobile phones) until the afternoon sitting of the OSCE had begun. Allocation of students to the morning and afternoon sitting; and their allocation to starting stations within the OSCE was by random number generator. Throughout the assessment, marshals and members of the research team were available to deal with queries from the assessors and patients and to ensure the smooth running of the assessment.

### 11.3.7.9 Collection and checking of mark sheets

Mark sheets were collected from assessors at regular intervals during the OSCE. At this stage, an initial check was performed to ensure that the forms had been completed correctly. If any box was empty, the assessor for the station was asked if they could recall the student’s performance so that they could allocate their intended mark. If the assessor was unable to recall the student’s performance to do this, this mark was left blank (see analysis below).
11.3.8 Analysis of results

11.3.8.1 Processing of mark sheets

Completed mark sheets were put immediately into sealed envelopes and sorted after the examination by two members of the research team. This data was then computerised using Microsoft Excel 2010 using independent double entry by the author and another member of the research team. Conflicts between entries were reviewed and resolved by consensus.

11.3.8.2 Calculation of marks

Marks were then computed using the mark scheme agreed at the standard setting focus group (see 11.3.7.3). The overall score in the OSCE was then calculated (as a primary outcome measure) and scores in individual skill domains (as secondary outcome measures).

11.3.8.3 Deciding the pass mark

The borderline group method was used to set the pass mark. This is widely considered to be ‘gold standard’ method of setting OSCE pass marks and has the effect that the assessors set the pass mark during the OSCE itself. In this study, where assessors had not previously used the resource or been involved in its development, this method has the additional advantage that the study could not be biased as a result of examiners with experience of the resource deciding the pass mark.

For each station, assessors gave a ‘global rating’ of the student’s performance which did not contribute to the individual student’s mark but instead was used to identify students in the ‘borderline’ group (those who had been rated overall as ‘borderline pass’ or ‘borderline fail’). The median mark for students in this borderline group was
then taken as the ‘pass mark’ for the station; so that students scoring at or above this mark ‘passed’ the station.

The total number of stations passed by each student was then calculated (as a primary outcome measure) and it was then determined if the student had passed the OSCE overall (using the agreed criteria).

11.3.8.4 **Comparing groups**

The baseline characteristics of the students (grade point average, gender, timing of placement, group allocation, age) were calculated at recruitment and at follow-up (excluding students who did not complete the OSCE examination). Comparisons between the intervention and control groups were made using the Independent samples t-test or Pearson Chi-squared test as appropriate.

The proportion of students in each group which passed the assessment was calculated using the borderline group method. The mean number of stations passed by students and the mean overall mark was calculated for each group and the distribution of this data was plotted diagrammatically.

As primary outcome measures, the proportion of students from each group reaching a satisfactory standard in the assessment was compared using a chi-squared test and a logistic regression model to adjust for confounding variables (grade point average, gender, teaching group allocation, age). The mean overall mark for each group and the mean number of stations passed in each group were compared using the Student t-test and linear regression to adjust for confounding variables.\(^1\) As secondary outcome measures, the mean score for each skill domain was compared using the Student t-test and linear regression to adjust for confounding variables. Analysis was performed using Microsoft Excel 2010 and SPSS version 22.

\(^1\) A matched analysis was also performed and presented in appendix C2 using a paired samples t-test.
11.4 Results

11.4.1 Characteristics of participants

64 students registered at the start of the semester (22 female, 42 male; mean age 23.5y, SD 1.3y) and were allocated to teaching groups. No students refused to take part in the study and none failed to meet the inclusion criteria. Three students did not complete the OSCE due to sickness absence (two in the intervention group and one in the control group). There were no significant differences between the groups at baseline or in the group which completed the OSCE assessment, as shown in table 11f.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Recruitment</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>Control</td>
</tr>
<tr>
<td>Gender</td>
<td>22/32 (68.9%)</td>
<td>20/32 (62.5%)</td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>male</td>
</tr>
<tr>
<td>OR</td>
<td>1.32 (CI: 0.469, 3.716)</td>
<td>1.47 (CI: 0.509, 4.271)</td>
</tr>
<tr>
<td><strong>Grade point average</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(mean and SD)</td>
<td>(years)</td>
</tr>
<tr>
<td>Grade point average</td>
<td>3.079 (0.385)</td>
<td>3.098 (0.392)</td>
</tr>
<tr>
<td></td>
<td>Difference in mean = -0.191</td>
<td>Difference in mean = -0.016</td>
</tr>
<tr>
<td></td>
<td>(CI: -0.213, 0.175)</td>
<td>(CI: -0.216, 0.183)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Teaching group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(mean and SD) (years)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B – 9/17*</td>
<td>B – 8/17</td>
</tr>
<tr>
<td></td>
<td>C – 6/13</td>
<td>C – 7/13*</td>
</tr>
<tr>
<td></td>
<td>D – 8/17*</td>
<td>D – 9/17</td>
</tr>
<tr>
<td>Age</td>
<td>23.2 (0.830)</td>
<td>23.8 (1.515)</td>
</tr>
<tr>
<td></td>
<td>Difference in mean = -0.573</td>
<td>Difference in mean = -0.593</td>
</tr>
<tr>
<td></td>
<td>(CI: -1.187, 0.041)</td>
<td>(CI: -1.215, 0.029)</td>
</tr>
</tbody>
</table>

*OR refers to odds of male/female between intervention and control group.
* Allocation protocol matched for these variables.
CI: lower and upper bounds of 95% confidence interval.

Table 11f: Characteristics of intervention and control group at recruitment and amongst students who completed the OSCE assessment. Students lost to follow-up due to illness are indicated by *.
11.4.2 Accuracy of marking

915 mark sheets (15 mark sheets for 61 students) were completed and checked for accuracy. In one mark sheet, there was an incomplete dataset (for practical skills – fundoscopy) due to the assessor not marking two (out of twelve) criteria. Their score for the missing criteria was therefore calculated from the mean of their scores in this skill domain for the station. Sensitivity analysis (using several other methods of estimating this student’s score) gave similar estimates and did not alter the findings of the study (see appendix C).

11.4.3 Processing data and determining pass mark for each station

The median mark for students marked as ‘borderline pass’ or ‘borderline fail’ in their overall performance for the station was calculated. This was then used as the pass-mark for the station. The number of students in the borderline group for each station, the median (pass) mark and the number of students in the intervention and control groups passing each station is shown in table 11g.
<table>
<thead>
<tr>
<th>Station</th>
<th>Number of students in borderline group (n = 61)</th>
<th>Pass mark (median mark of borderline group)</th>
<th>Number of students passing station</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intervention (n = 30) Control (n = 31)</td>
</tr>
<tr>
<td>Red, painful or injured eye.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>18</td>
<td>59.7%</td>
<td>26</td>
</tr>
<tr>
<td>Examination</td>
<td>42</td>
<td>58.5%</td>
<td>21</td>
</tr>
<tr>
<td>Case discussion</td>
<td>24</td>
<td>55.6%</td>
<td>29</td>
</tr>
<tr>
<td>Counselling/explanation</td>
<td>2</td>
<td>57.2%</td>
<td>30</td>
</tr>
<tr>
<td>Practical skill (Visual acuity)</td>
<td>6</td>
<td>75.9%</td>
<td>29</td>
</tr>
<tr>
<td>Loss of vision due to disease of the cornea, anterior segment or lens.</td>
<td>23</td>
<td>59.7%</td>
<td>25</td>
</tr>
<tr>
<td>History</td>
<td>23</td>
<td>59.7%</td>
<td>25</td>
</tr>
<tr>
<td>Examination</td>
<td>34</td>
<td>63.1%</td>
<td>23</td>
</tr>
<tr>
<td>Case discussion</td>
<td>16</td>
<td>59.7%</td>
<td>27</td>
</tr>
<tr>
<td>Counselling/explanation</td>
<td>10</td>
<td>63.9%</td>
<td>27</td>
</tr>
<tr>
<td>Practical skill (Visual acuity – low vision)</td>
<td>27</td>
<td>57.2%</td>
<td>22</td>
</tr>
<tr>
<td>Loss of vision due to disease of the cornea, anterior segment or lens.</td>
<td>21</td>
<td>61.4%</td>
<td>22</td>
</tr>
<tr>
<td>History</td>
<td>21</td>
<td>61.4%</td>
<td>22</td>
</tr>
<tr>
<td>Examination</td>
<td>29</td>
<td>61.8%</td>
<td>18</td>
</tr>
<tr>
<td>Case discussion</td>
<td>19</td>
<td>61.4%</td>
<td>27</td>
</tr>
<tr>
<td>Counselling/explanation</td>
<td>40</td>
<td>57.2%</td>
<td>19</td>
</tr>
<tr>
<td>Practical skill (fundoscopy)</td>
<td>28</td>
<td>50.1%</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 11g: Overview of borderline group calculations for each station and the number of students passing each station.

11.4.4 Primary outcome measures

11.4.4.1 Pass/fail

Using the agreed criteria for passing the examination (passing a total of 10 or more stations and at least one station of each skill type), 27/30 (90.0%) students in the intervention group and 20/31 (64.5%) in the control group passed the OSCE examination (Odds ratio = 4.95 (CI: 1.22, 20.1, p=0.043). Note Using logistic regression to adjust for potential confounders (gender, teaching group allocation, previous grade point average and age), the difference remained statistically significant (Adjusted odds ratio = 6.18 (CI: 1.32, 28.83), p=0.032).

---

Note: CI = Lower and upper bound of 95% confidence interval
11.4.4.2 Number of stations passed

The mean number of stations passed were 12.4/15 (SD 1.63) in the intervention group and 11.1/15 (SD 2.3) in the control group (Difference in means = 1.31 (CI: 0.28, 2.33), p=0.014). Using linear regression to correct for potential confounders (gender, teaching group allocation, previous grade point average and age), the difference between the two groups remained statistically significant (Adjusted difference in means = 1.07 (CI: 0.04, 2.10), p=0.043). The distribution of number of stations passed is shown in fig 11a.

Fig 11a: Distribution of number of stations passed in the control (left) and intervention (right) groups

11.4.4.3 Overall mark

The mean overall percentage scores were 71.6% (SD 5.47%) for the intervention group and 68.4% (SD 6.7%) for the control group (Difference in means = 3.16% (CI: 0.03, 6.28%), p=0.048). Using linear regression to correct for potential confounders (gender, teaching group allocation, previous grade point average and age), the difference
between the two groups remained statistically significant (Adjusted difference in means = 2.96% (CI: 0.03%, 5.89%), p=0.048). The distribution of marks is shown in fig 11b.

Fig 11b: Distribution of overall marks in the control (left) and intervention (right) groups.

The results of a matched analysis, comparing the mean scores of students in the intervention and control groups, is presented in appendix C2.

11.4.5 Secondary outcome measures

The mean score for each of the skill domains (expressed as a percentage of the total marks available for that skill) are shown in table 11h. There were significant differences (favouring the intervention group) in scores for making a management plan and differential diagnosis in the unadjusted and adjusted analyses. A significant difference was observed in the adjusted analysis only for communication skills.
<table>
<thead>
<tr>
<th>Skill domain</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Unadjusted difference in means (with 95% confidence intervals and p-value)</th>
<th>Adjusted difference in means (with 95% confidence intervals and p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>3.92% (CI: -0.04%, 7.88%) p = 0.052</td>
<td>3.74% (CI: 0.07%, 7.42%) p = 0.046</td>
</tr>
<tr>
<td>Communication skills</td>
<td>74.7 (6.8)</td>
<td>70.7 (8.6)</td>
<td>4.72% (CI: 0.20%, 9.25%) p = 0.041</td>
<td>4.94% (CI: 0.49%, 9.39%) p = 0.030</td>
</tr>
<tr>
<td>Making a management plan</td>
<td>70.7 (6.8)</td>
<td>65.9 (10.5)</td>
<td>-0.01% (CI: -4.64%, 4.62%) p = 0.997</td>
<td>0.08% (CI: -4.68%, 4.83%) p = 0.974</td>
</tr>
<tr>
<td>Managing patient concerns</td>
<td>67.3 (8.0)</td>
<td>67.3 (10.0)</td>
<td>1.99% (CI: -0.76%, 4.74%) p = 0.153</td>
<td>2.29% (CI: -0.36%, 4.95%) p = 0.089</td>
</tr>
<tr>
<td>Maintaining patient welfare</td>
<td>75.1 (4.8)</td>
<td>73.1 (5.9)</td>
<td>6.31% (CI: 1.17%, 11.45%) p = 0.017</td>
<td>6.65% (CI: 1.76%, 11.54%) p = 0.009</td>
</tr>
<tr>
<td>Differential diagnosis</td>
<td>70.6 (8.5)</td>
<td>64.3 (11.4)</td>
<td>-0.61% (CI: -5.50%, 4.29%) p = 0.805</td>
<td>-0.91% (CI: -6.14%, 4.33%) p = 0.730</td>
</tr>
<tr>
<td>Physical examination technique</td>
<td>66.4 (9.7)</td>
<td>67.0 (9.4)</td>
<td>-0.88% (CI: -5.36%, 3.59%) p = 0.694</td>
<td>-0.86% (CI: -5.64%, 3.91%) p = 0.719</td>
</tr>
<tr>
<td>Detecting abnormal findings</td>
<td>63.3 (8.9)</td>
<td>64.2 (8.6)</td>
<td>3.16% (CI: -1.69%, 8.00%) p = 0.197</td>
<td>1.74% (CI: -2.90, 6.39) p = 0.455</td>
</tr>
</tbody>
</table>

Table 11h: Mean (SD) scores expressed as percentage of total available marks for each skill domain. Unadjusted results are for Student t-test. Adjusted results are for linear regression. Statistically significant differences underlined and highlighted.
This study suggests that the multimedia resource is effective when used as a replacement for a proportion of clinical teaching. Students who received multimedia teaching had a better overall mark in the OSCE, passed more stations and were more likely to pass the examination overall. There was a striking difference in overall pass rate (90.0% in the intervention group and 64.5% in the control group). The mean difference in number of stations passed was 1.3 (12.4 vs 11.1 of 15) and the difference in the mean overall mark between the two groups was 3.2% (71.6% vs 68.4%).

Exposure to the multimedia materials seems to have the greatest impact on students at the low-scoring end of the class. It also seems to improve consistency of performance, reflected in the narrower distribution of overall marks and number of stations passed, and hence the narrower standard deviation for overall mark (SD 5.5% vs SD 6.7%) and number of stations passed (SD 1.6 vs SD 2.3). Both the higher mean overall mark and the narrower variance contribute to the observed difference in pass rate. Given that an important aim of undergraduate medical education is that all students reach a minimum standard of competence, the observation that multimedia learning had a greater impact on weaker students is important.

Whilst caution is needed in interpreting the data for secondary outcome measures (due to the smaller number of data points), this data suggests that the difference in overall performance was predominantly attributable to two (or potentially three) skill domains: differential diagnosis, making a management plan and (potentially) communication skills. Given the educational design, it is not surprising that differences were seen in differential diagnosis and management planning; although it is perhaps disappointing that there was not an observed improvement in physical examination technique and practical skills. It is possible that the multimedia tool is not effective in these domains; or that students in the control group (who spent more time in clinical settings) were able to develop these domains through other learning opportunities. It is also possible that the development of these skills requires practice over a longer period than the first two weeks of the placement.
The main limitation of this study is the sample size (64 students at a single institution in Uganda) and it is possible that more generalizable conclusions could be drawn from a larger study with more participants across a range of countries and institutions. This study took precautions to avoid mixing of the intervention and control groups although it is almost inevitable that some learning will have been shared between groups. As the effect of this would be to reduce the observed differences between groups, it is therefore possible that the study under-estimates the impact of the resource.

The study did not allow students to use the materials in a ‘real-life’ way: they were not allowed copies of the materials for personal use outside of multimedia tutorials and could not ask questions to tutors based on the multimedia materials. This has two implications: firstly, it cannot be assumed that other methods of delivering the multimedia materials (which do not involve this structured input) would produce the same results; and secondly, it is possible that the resource would have a greater impact with fewer restrictions on how students use it. Further work is needed to explore the impact of different models of delivery of multimedia materials. This study did not explore which elements of the educational design of the resource were associated with educational benefits. Whilst methodologically challenging, such information would be valuable to developers of future multimedia materials and would improve the generalisability of research into impact of multimedia materials. This study was only designed to assess educational benefit at an early stage of the student’s placement. We do not know how the two groups would have developed subsequently, and whether use of the resource has any impact on retention of knowledge and skills over a longer time period.

Both Mbarara University Department of Ophthalmology and Ruharo Eye Centre are well recognised (nationally, regionally and internationally) as training institutions, and have relatively well-developed human resource capacity (in terms of ophthalmologists and mid-level eye health personnel). It seems likely that the multimedia resource would have greater impact at institutions where teaching programmes are less well developed and where there are shortages of teaching/clinical staff to deliver face to
face teaching. Such shortages are common in developing countries and especially across sub-Saharan Africa (as described earlier in this thesis).

11.6 Conclusions

This study provides evidence that multimedia learning is an effective adjunct in Ophthalmology training for medical undergraduates; and seems to improve consistency of performance and have a greater impact on less able students. The main benefits of the resource seem to relate to performance in differential diagnosis and making a management plan.
12.1 Introduction

This chapter synthesises the principal findings, limitations and recommendations for further research for each objective and draws upon this synthesis to propose an algorithm for the development and implementation of e-learning materials in sub-Saharan Africa. This algorithm has potential for application in the development of future e-learning materials for health workers in sub-Saharan Africa, and indeed elsewhere.

12.2 Principal findings, limitations and recommendations for further research

12.2.1 E-learning in sub-Saharan Africa (objective 1: chapters 3-6)

**Objective 1:**
Understand and synthesise the issues affecting the development and implementation of e-learning for health workers, with a particular emphasis on sub-Saharan Africa.

Uptake of e-learning appears to be influenced by a range of interacting environmental, individual and resource factors. Qualitative data (in chapter 4 and 5) provides a holistic insight into these issues from a wide sample of health workers. A major strength of the data is the inclusion of non-medically qualified personnel (nurses, mid-level and primary care workers) and those working outside of major cities, who are poorly represented in the existing literature.

Access to computers and the internet, and the speed, reliability and cost of internet connections are significant constraints, especially in more rural areas. Inter-cadre differences emerge (with nurses reporting lower levels of access, skills and use of ICT
than mid-level health workers and doctors); and inter-institutional differences are also seen (with smaller, government hospitals less likely to have access, possibly related to a lack of international links). Shared internet facilities (such as internet cafes) are widely used.

Despite infra-structure challenges, technology is widely used by health workers and there is enthusiasm for better access to technology and health information. Reports from institutions (chapter 3) highlight that ICT is being incorporated into training curricula both as a curricular aim and teaching method. Information has a high value and many learners seem prepared to persevere in the face of constraints that would probably not be tolerated in other regions. Indeed, learners argue (chapter 5 and 10) that having useful information available on technological platforms may, in fact, act as a driver to the acquisition of hardware (the ‘chicken and egg’ conundrum). Practically, DVD for television emerged as a potentially useful format; although the advantages of producing materials on a ‘blend’ of technologies and ‘future-proofing’ so that materials can be adapted for other emerging technology platforms are also highlighted.

Skills in using technology are also relevant, and appear to be unevenly distributed across the health worker population. From learners’ reports, it seems likely that informal acquisition of the necessary skills will be possible for many, although some will need additional support. This mirrors comparative data presented from the UK, which highlights a group of (typically older, part-time) nurses who lack skills and confidence. Another interesting theme in the UK data, which was not clearly detected in Africa, was the impact of morale and work-life balance on uptake of technology based learning opportunities. At present, infra-structure concerns seem to predominate in the minds of many participants and these other more subtle themes may therefore become more apparent in sub-Saharan Africa as infra-structure develops.
Limitations

A major limitation of research in this field is the speed at which data (especially statistical data on access and use of technology) becomes outdated as technology rapidly advances. The geographical focus of research within sub-Saharan Africa was restricted: the health worker studies focused on Uganda and Tanzania, two neighbouring Anglophone countries in East Africa. It is possible that different data might emerge from other countries with a different geographical, historical, linguistic, economic, social and political context. In chapters 3 and 4, there were weaknesses in the development of the questionnaire which mean that caution is needed in interpreting results (particularly data on computer/student ratios (in chapter 3) and Likert items (in chapter 4).

The qualitative methods and question guides used in chapter 4 and 5 were developed to gather information relevant to e-learning using a framework approach; and the thematic framework developed for qualitative analysis was therefore influenced by the aims of the study. Whilst data were analysed comprehensively and new thematic categories were identified from the data and added to the framework as analysis progressed, it is possible that this approach may have mitigated against ‘unexpected’ issues being identified. Other approaches to analysing the data (such as grounded theory, described in chapter 1) which emphasise the need to build theory from data, are more likely to detect such unexpected themes, but correspondingly allow less scope to incorporate pre-existing theory and previous studies into study design. Practically, in applied research, grounded theory approaches may be more time-consuming and produce less focused research findings.

Furthermore, reflexivity (a technique of examining the impact of the researcher on the research) provides significant insights: it is almost inevitable that participants will have formed views about the author (in his role as interviewer) as a medically trained European visitor from an obviously different ethnic background and potentially formed mistaken beliefs about his power to leverage better access to technology. The interviewer’s background and previous experience will also have influenced his
approach to the study and it is possible that interviewees may have responded
differently to an interviewer of a different gender, ethnic or professional background.
Four arguments are made in mitigation: firstly, it is self-evident that e-learning in sub-
Saharan Africa requires investment in infra-structure and the very fact of research into
the topic (regardless of the background of the researcher) is likely to lead to some
assumptions about the power of the researcher and the research to leverage donor
funding (although the presence of a foreign interviewer might accentuate this);
secondly, the perception of the researcher as an ‘outsider’ provided a reason for
participants to explain statements that they perceived to be grounded in their culture
to someone who ‘did not understand’ (as evidenced by phrases like “In our
culture/setting here…”) and perhaps gave them greater confidence to criticise their
institution and current situation; thirdly, the author was careful throughout to avoid
accepting statements at face value and to probe more deeply into responses; and
fourthly, the transcripts confirm that respondents did indeed raise a wide range of
critical as well as supportive views including those that were critical of e-learning and
external donor support.

Recommendations for further research

Given the importance of ensuring access to reliable, up to date health information,
there is a need for regular monitoring of access, skills and use of technology amongst
the health workforce in sub-Saharan Africa as an aid to planning, strengthening health
systems and leveraging support. It is important that such research is inclusive of
different cadres, rural and urban areas and government, private-not-for profit and
private providers; and conducted to avoid selection bias (for example, by choosing
institutions for study through international links or using online returns). There is a
strong argument for parallel qualitative research; and this is perhaps a good
application of a mixed-methods approach. Given the speed at which data is likely to
become outdated, it may be more useful to draw conclusions about the underlying
trends and social and psychological phenomena underpinning them, which are likely to
persist over a longer period.
12.2.2 Developing e-learning materials (objective 2: chapters 7-10)

**Objective 2:**
Develop and pilot a new e-learning resource in eye health for health workers in sub-Saharan Africa using a quality improvement approach.

An approach to developing e-learning materials based on a quality improvement framework is described. Authorship drew upon the range of quantitative and qualitative insights described above. There was also particular value in exploring patient journeys so that learning needs derived from patients’ perspectives (which were often quite practically based) could be addressed in the materials.

Much was learnt from the process and it is likely that these lessons are applicable to the development and implementation of other e-learning projects in sub-Saharan Africa and elsewhere. It is unusual for a detailed description of development processes for educational interventions to be provided but this is, perhaps, one of the most readily generalizable applications of this work. A proposed process for development and implementation of e-learning materials is therefore presented at the end of this chapter.

**Limitations**

Development of the resource was a time-consuming and complex process which could, with hindsight, have been more efficiently managed. It is difficult to attribute any success (howsoever measured) to the development process itself, as other factors, such as the qualities of the team which developed the materials or features of the subject itself might equally account for this. This difficulty has been recognised in the context of evaluating other complex interventions.

This work did not include any analysis of cost or cost-effectiveness. Especially in resource constrained settings, this is likely to be an important concern. Clearly, the
development of e-learning materials requires initial financial and human resource commitment. *De-novo* implementation requires further inputs: investment in infrastructure (such as computers, DVD players, projectors and amplification equipment), tutor time, etc. In practice, it is more likely that materials will be adopted into existing educational programmes, where some infrastructure and tutor capacity already exists. Indeed, one potential advantage of e-learning is that, once developed, it can potentially be used across cadres, institutions and curricula, especially if the initial design and specification are sensitive to the likely demands of different users. Whilst this has the potential to ‘free-up’ tutor time, there may also be institutional resistance to new learning methods and support may be needed at institutional level to understand how materials can be used within and mapped to curricula. The cost-effectiveness is likely to depend partly on how development costs are met; how widely materials are adopted and how alternative educational activities (such as clinical exposure) are costed and financed.

**Recommendations for further research**

Describing the development processes used in e-learning projects should be encouraged; as this is likely to allow the emergence of a consensus view of how materials should be developed. Research with learners and patients can shape the design, content and delivery of e-learning materials and can feasibly be incorporated into resource development projects. Further research on development processes for e-learning materials may be useful: the evidence for a particular development process would be strengthened if it can be successfully applied to a range of different topics and situations. These recommendations are consistent with a broader approach to developing and evaluating complex interventions, which may provide a useful methodological framework for future research, emphasising the need for a coherent theoretical basis for the intervention, modelling and evaluation of process and outcomes, economic evaluation and careful attention to real-life implementation.
12.2.3 Evaluation of the e-learning resource (objective 3: chapter 11)

**Objective 3:**
Assess the impact of this resource on health workers’ clinical skills using a robust experimental design.

This work studied the impact of the materials on medical students’ clinical skills (as measured in a ‘low stakes’ OSCE) in a controlled trial. This is the first time that a statistically significant benefit from e-learning in health worker education is reported from sub-Saharan Africa. The study may even have under-estimated the likely real-life impact: students were assessed after only two weeks of access to the materials and were only allowed to use them in supervised sessions (whereas in real-life conditions, the materials would be available more flexibly and for longer periods); the materials were tested at institutions with a strong reputation for teaching so the control group exposure is likely to be of a high standard; and, as it was not possible to segregate the students outside of their placement, it is likely that there was at least some sharing of the information from the e-learning activity. E-learning appears to impact both the average mark and its distribution (reflecting a more consistent performance in the e-learning group). This suggests that the materials have a particular impact on weaker candidates (who move closer to a higher mean score). A further interesting observation (although not a primary endpoint) is the clinical skills which were most impacted by the e-learning: differential diagnosis, management planning and (possibly) communication skills.

The strengths of the methodology include the use of a scoring system based on the widely respected MRCP PACES examination. Philosophically, this reflects the fact that the purpose of undergraduate medical education is to develop broad professional competency which can be applied to different content domains; and practically, it means that there was less scope for the assessment design to favour the intervention group. The borderline group method used for standard setting also removes the
potential for authors to influence the pass mark. Indeed, this use of a generic assessment instrument for clinical skills has the potential for future application.

**Limitations**

This study involved a relatively small sample of students at a single institution; and therefore, whilst statistically significant effects were observed, it is unclear that this would be replicated in other populations (although some characteristics of the institutions suggest that greater effect sizes might be observed elsewhere). It also does not reflect the ecological use of e-learning materials and their effect on students as a community of learners, learning through shared experience and discussion. It is also difficult to draw generalizable conclusions from this study: whilst there is some discussion of the competencies which were impacted (albeit only as secondary outcome measures), it is not clear which features of the resource led to these improvements. It is also not clear whether there was any impact on knowledge retention or change in practice which would, from the work of Miller and Kirkpatrick\(^ {386-388,390-392} \) be more compelling.

**Recommendations for further research**

Clearly, stronger evidence would be obtained from a larger sample of students and institutions, and in the context of sub-Saharan Africa, such evidence is likely to help shape development policy and leverage donor investment. However, research should also produce more generalizable conclusions about the features of materials and design processes which contribute to improved outcomes; and a better understanding of the impact of e-learning on different educational endpoints (including the impact on clinical practice and knowledge and skills retention over time). The differential impact of the e-learning resource on clinical skill domains also warrants further study. It is unclear why this was this the case and how materials might be developed in future so
that they impact other skill domains where improvements were not seen in this study. A further avenue for research is the development and validation of a generic instrument for clinical skills testing which could be used in different specialty areas, by different cadres and at different stages of training. Such a validated instrument would be a powerful tool in evaluating e-learning materials and other educational innovations.

12.3 An algorithm for the process of e-learning

As discussed above, the algorithms below synthesise the experience gained through developing the e-learning resource and integrates lessons learnt throughout this thesis. As mentioned above, this algorithm which can be used in future e-learning projects is potentially one of the most generalizable outputs of this work.

Two algorithms are therefore presented:-

- Needs analysis and scoping (see fig 12a)
- Authoring, production, review, evaluation and implementation (see fig 12b)

12.3.1 Needs analysis and scoping

The aim of this stage is to define the need and scope of the resource, provide a broad specification and develop a strategy for development and implementation. See fig 12a.

New e-learning materials are shaped by a combination of existing knowledge (disease burden, evidence-based interventions, relevant clinical guidelines); consultation with stakeholders (such as educational institutions, learned bodies, donors, governmental and non-governmental organisations); research with patients (studying outcomes, systems, processes and perceptions of care within the current system); and research with health workers (studying learning needs, preferences and current practice). As
demonstrated in this work, there are potential reciprocal links between the
development of e-learning materials and associated research.

12.3.1.1  Understanding context and identifying resources

Before developing materials, it is important to understand the context in which they will be developed (including disease burden, policy environment, current systems and processes of care, workforce capacity, learner needs and preferences, routes to implementation) and to identify resources to support the development of materials (financial, sources of expertise, existing curricula and learning materials). Depending on the situation, it may be necessary to undertake further research or consultation with stakeholders if the knowledge to underpin these assessments is not already available.

12.3.1.2  Defining need

The need for the resource should be defined in terms of:-

- **Broad outcomes/competencies**
  *The knowledge, skills and attitudes that the resource will aim to develop.*

- **Target audience**
  *Those who are intended to use the resource.*

It may be useful to define a primary audience (the main intended audience) and secondary audience(s) (other groups which may benefit from sections of the materials). Development can then focus on the primary audience but the needs of other learners (for example, those who might use sections of the materials as learning objects) can be considered where this does not detriment the primary audience.
• **Educational purpose**

*Defining how the materials will be used within educational programmes/curricula.*

Materials can be used in a variety of educational settings including formal training (distance learning or blended learning, facilitated or self-directed group or individual study), ongoing training/professional development, within support-supervision programmes and/or for reference. The purpose of the materials influences design.

• **Integration with wider health systems interventions**

*Understanding how materials will fit within the wider health system.*

This includes considering how the knowledge, skills and attitudes to be developed are relevant to the needs of the health system, whether integration with other health systems strengthening activity is envisaged or feasible, and how implementation will avoid additional burden on health systems.

12.3.1.3 **Specification and strategy**

From the above definition of needs, a specification can be developed which covers the **broad structure** (for example, a didactic modular or ‘spiral’ resource based on specific learning objectives; or a reference resource); the **technical platform(s) to be used** (e.g. internet, CD-ROM, DVD for television, DVD-ROM) and **broad definition of content** (defining the range and depth of content).

Development then requires the co-ordination of a team of people with different skills and functions. This requires a **strategy** to define how the project will be financed, what human-resources (authors, advisors, reviewers, technicians) will be required and how they will be co-ordinated; and how materials will be implemented and evaluated.
Fig 12a: Development process—needs analysis and scoping.
12.3.2 Realisation, evaluation and implementation

The aim of this stage is to generate detailed plans, author the materials, gather multimedia assets and produce the resource. A process of review, piloting and evaluation can then be undertaken to refine the resource and provide insights to shape future e-learning materials, generate and answer research questions. See fig 12b.

12.3.2.1 Detailed content planning

From the broad specification developed in section 12.3.1.3, a more detailed plan of content can be developed. For didactic content, this can be done as learning objectives; and for reference content, as a content map which highlights topics to be covered and their relationships.

12.3.2.2 Scripting and storyboarding

For multimedia materials (combining audio and visual information), a script details the audio content, and a storyboard links audio to visual information (including illustrations, animations, subtitles and other on-screen textual information, clinical videos and photographs) and specifies how content is sequenced.

12.3.2.3 Planning clinical asset collection

For materials which include videos or photographs of patients (for example, to demonstrate abnormal clinical signs, clinical skills or practical procedures), careful planning is needed to cover ethical and practical issues: what clinical material is needed, where filming will take place, how patients will be recruited and consented.
Planning should focus on ensuring that material is collected as efficiently as possible and that disruption to clinical services is minimised.

12.3.2.4  **Multimedia asset generation and production**

Multimedia assets are components which are integrated and sequenced to create learning materials. Assets include:

- **voiceover** (recorded either informally or by a professional voice artist).
- **illustrations and animations**
- **clinical video and photographs**
- **reference text**

In the **production** stage, these elements are combined as specified in the storyboard or content map. **Usability testing** during production can help to ensure that materials are developed in a user-centred way.

12.3.2.5  **Review stages**

Several review stages can be incorporated, as appropriate, into the process. Potential approaches include:-

- **Author review** (the author team reviews and comments on the produced materials),
- **Informal review** (comments from an informal group of learners, expert advisors or other stakeholders),
- **Formal review** (formal piloting of the materials within an educational programme; and/or review by an external expert).
Using the principles of quality improvement, the review stage is part of an iterative process which identifies issues to be addressed through a further cycle (changing plans and revising storyboards) or making more fundamental changes to the resource specification. This means that any problems are corrected prior to implementation and may also identify new research questions.

12.3.2.6  **Formal research evaluation**

Impact can be measured in terms of the structures, processes or outcomes of care. This can provide evidence to justify investment in wide-scale implementation but should ideally lead to more generalizable conclusions, building the evidence-base, as discussed in section 12.2.3.

12.3.2.7  **Implementation**

**Implementation** means moving from a ‘pilot’ or ‘research’ project to a full-scale deployment. **Publicity** and **distribution** are important; and strategies for obtaining **feedback from learners and educators** should be developed. Ensuring **sustainability** means that adequate resources should be available for a full-scale deployment and to update and revise materials through further cycles of the algorithm.
Fig 12b: Development process – realisation, evaluation and implementation stages
12.4 Conclusions

This work demonstrates, for the first time, that e-learning can improve clinical skills in sub-Saharan Africa; and that the materials developed were broadly acceptable to health workers. The challenges of developing and implementing e-learning in this context are elucidated through qualitative and quantitative methods, leading to an algorithm which can be used and adapted for future use. Health workers in sub-Saharan Africa are ‘information poor’ and there appears to be enthusiasm for approaches (including e-learning) which might improve this. The algorithms for development of e-learning materials presented in this thesis can potentially be applied to future e-learning projects both in sub-Saharan Africa and elsewhere, and are an important, generalizable output of this work.

Future research directions include strengthening evaluation methods and developing research which allows generalizable conclusions to be made about how e-learning materials should be developed and implemented; incorporating cost-effectiveness measures and gathering longitudinal qualitative and quantitative data about access, skills and use of technology and health information to better inform policy and practice. A better understanding of how e-learning fits in the context of health systems strengthening and support-supervision is a priority.

E-learning is a rapidly evolving area marked by advances in infra-structure, technical and educational innovation (recent examples include smart-phones, social networking and the growth of open-access educational materials and courses). It is therefore likely that an understanding of underlying themes, trends and theory, and how they might apply to new innovations, will be more useful than ‘quotable statistics’.

There is potential for innovative approaches such as e-learning to overcome some of the difficulties experienced by health workers in rural areas (a recognised policy priority). However, one area of concern is the extent to which e-learning might exacerbate existing differentials in access to health information.
Finally, the development process described in this thesis is resource intensive. Pragmatic compromises may be required if materials are to be developed within financial specifications acceptable to funders. However, it should be highlighted that, in the longer term, research is likely to lead to more effective and efficient development methods and better implementation; and should not be neglected. One promising approach is to find methods which efficiently and effectively build research into resource development projects, learning from the action research approach in educational research.
Appendix A: Additional information for chapter 9

This appendix contains more detailed information about the content of ‘Ophthalmology – Multimedia Learning for Health Workers Worldwide – Africa’ including the narrative review of curricula and detailed specifications for modular and reference content.

A1: Narrative review of curriculum recommendations

- Table A1 (i): para-ophthalmological (mid-level) health workers
- Table A1 (ii): ophthalmology trainees and continuing professional development
- Table A1 (iii): medical students

A2: Modular content – detailed specifications

- Table A2 (i): Part 1: Basic Eye Care Skills – Modules 1 and 2
- Table A2 (ii): Part 1: Basic Eye Care Skills – Module 3
- Table A2 (iii): Part 2: Common eye problems – Module 4-6
- Table A2 (iv): Part 3: Refractive problems and optics – Module 7

A3: Reference content – detailed specifications

- Table A3a (i) – (ii): Atlas of eye disease
- Table A3b (i) - (ii): Prescribing information
<table>
<thead>
<tr>
<th><strong>Target audience</strong></th>
<th><strong>Summary</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Training curricula for para-ophthalmological (mid-level) workers</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **JCAHPO and ICO**  
International Core Curriculum for Ophthalmic Assistants *(2009)*<sup>525</sup> | Ophthalmic assistants  
(defined in curriculum as entry-level staff who perform ophthalmic procedures under the appropriate direction or supervision of someone who is qualified to practice in ophthalmology) | International competency-based curriculum divided into introductory, basic and advanced skills. Seeks to develop five core competencies: (i) Patient care, (ii) Medical knowledge, (iii) professionalism, (iv) technical and scientific skills, (v) community and health services.  
At the **introductory and basic levels**, topics include ethical and legal issues, communication skills, administration, basic science (anatomy and physiology), pharmacology, microbiology, clinical assessment (visual acuity, fields, vital signs, history taking, pupil responses, lensometry, keratometry, tonometry, colour vision, Schirmer’s test, examination, optics and refraction, biometry), recognition of diseases and ocular manifestations of systemic disease. **Advanced skills** include low vision, ophthalmic imaging, refractometry, ocular motility, contact lens counselling and continuing professional development. |
| **ICO**  
Principles and guidelines of a curriculum for para-ophthalmic vision specialist education *(2006)*<sup>526</sup> | Defines two groups of para-ophthalmic worker of relevance to sub-Saharan Africa:-(i) Community based ‘mid-level’ personnel, (ii) Hospital based eye care personnel. Also provides curricula for orthoptists (who primarily assess ocular motility disorders) and ophthalmic technicians (US focused cadre of ophthalmologists’ assistants). | Presents specimen curricula for both groups based on existing programmes.  
Curriculum for **community based personnel** (adapted from WHO Western Pacific Region Training Curriculum). Modules cover: (1) Blindness (including prevention, avoidable and unavoidable blindness, primary eye care/prevention, eye health of special groups); (2) Normal eye and common eye disorders (including clinical skills (history, visual acuity, basic examination, tonometry, fundoscopy, communication skills, (3) epidemiology, programme/resource management and screening; (4) training methods; (5) equipment, maintenance, asepsis and sterilisation. An **advanced course** then covers topics including refraction, ocular motility and low vision, health systems research/epidemiology, care and rehabilitation of the blind, orthoptics, pharmacology, minor surgery, diagnostic procedures and microbiology.  
Curriculum for **hospital based personnel** includes ethics, professional behaviour and medical/ophthalmic terminologies; human and ocular anatomy and physiology; instruments and equipment; orientation to clinical environments (ward, theatre, clinic); optics and refraction; interpersonal relationships; common eye diseases (divided primarily anatomically); pharmacology; microbiology; biochemistry; ophthalmic emergencies; community ophthalmology; refraction; medical record-keeping; sterilisation and asepsis; postoperative assessment; history taking; clinical examination. |

**Table A1 (i): Narrative review of curriculum recommendations – (i) para-ophthalmological (mid-level) health workers**
<table>
<thead>
<tr>
<th>Target audience</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Training curricula for medically qualified ophthalmology trainees</strong></td>
<td></td>
</tr>
<tr>
<td>ICO</td>
<td>Based on <strong>six competencies</strong>: (i) patient care, (ii) medical knowledge, (iii) practice-based learning and improvement, (iv) inter-personal and communication skills, (v) professionalism, (vi) systems-based practice.</td>
</tr>
<tr>
<td>Principles and guidelines of a curriculum for education of the Ophthalmic specialist. (2006)</td>
<td><strong>Medically qualified doctors undertaking training in ophthalmology</strong></td>
</tr>
<tr>
<td></td>
<td>Defines basic level, standard level and advanced level goals (to be attained at the end of the 2nd, 3rd and 4th year of postgraduate training respectively).</td>
</tr>
<tr>
<td></td>
<td>Lists <strong>learning objectives</strong> in the following categories: optics; retinoscopy and refraction; cataract and lens; contact lens; cornea, external diseases and refractive surgery; glaucoma; neuro-ophthalmology; ophthalmic histopathology; oculoplastic surgery and orbit; paediatric ophthalmology and strabismus; vitreoretinal disease; uveitis; ocular oncology; low vision rehabilitation; ophthalmic practice and ethics.</td>
</tr>
<tr>
<td>RCOphth</td>
<td><strong>UK based specialty trainees.</strong></td>
</tr>
<tr>
<td>Curriculum for Ophthalmic Specialist Training (Published 2007)</td>
<td><strong>Defines outcomes</strong> in terms of (i) what the ophthalmologist is able to do (clinical assessment, investigation, management, practical, surgical/laser skills, health promotion, communication and information handling); (ii) how the ophthalmologist approaches their practice (basic and clinical sciences, attitudes, ethics and responsibilities, decision making, reasoning and judgement; (iii) the ophthalmologist as a professional (role in the health service, continuous professional development). These core competencies are expected to be attained early in training. Also lists areas where trainees can undertake further study (including sub-specialty areas and wider health topics).</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3. Continuing professional development (for medically qualified and para-ophthalmological (mid-level) workers</strong></td>
<td></td>
</tr>
<tr>
<td>ICO</td>
<td>Emphasises the need for development of theoretical knowledge, technical and surgical skills based on a professional development plan which includes a variety of learning methods (including audit, meetings, courses and self-education).</td>
</tr>
<tr>
<td>Principles and guidelines of a curriculum for continuing medical education in ophthalmology (2006)</td>
<td><strong>Defines basic level</strong> (for para-ophthalmic personnel), standard level (for ophthalmologists and residents) and advanced level (for experienced ophthalmologists and sub-specialists) learning goals.</td>
</tr>
<tr>
<td></td>
<td>Lists learning objectives in the following categories: cornea, external diseases and refractive surgery; cataract; neuro-ophthalmology; paediatric ophthalmology; vitreoretinal; uveitis; glaucoma.</td>
</tr>
</tbody>
</table>

**Table A1 (ii):** Narrative review of curriculum recommendations – (ii) ophthalmology trainees and continuing professional development
<table>
<thead>
<tr>
<th>Target audience</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICO</strong> Principles and guidelines of a curriculum of ophthalmic education of medical students <em>(2006)</em>[^30]</td>
<td>Medical students (defines ‘basic level’ (expected of all graduating medical students), ‘standard level’ (the level of an ophthalmology elective) and ‘advanced level’ (for students planning to seek further training in ophthalmology).</td>
</tr>
<tr>
<td><strong>ICO</strong> Handbook for medical students learning ophthalmology <em>(2009)</em>[^31]</td>
<td>Medical students undertaking placements in ophthalmology</td>
</tr>
</tbody>
</table>

*Table A1 (iii): Narrative review of curriculum recommendations – (iii) medical students*
### Module 1: Checking the visual acuity

**Rationale:** Visual acuity (measuring what both eyes can see) is vital for assessing and treating most eye conditions and is the starting point of every visit to the eye clinic. Eye workers need to be able to perform this task quickly and accurately. However, it is a skilled procedure with many potential pitfalls.

**Content:** Introduction to the concepts of visual acuity and visual field; description of technique of checking and recording visual acuity using a 6 metre Snellen Chart and E-chart for illiterate patients; brief descriptions of other methods of assessing acuity (such as LogMAR in adults and Bristol, Cardiff, Sheridan Gardiner and Lea Symbol tests in children).

<table>
<thead>
<tr>
<th>Learning objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define visual acuity.</td>
</tr>
<tr>
<td>Describe the principles of recording visual acuity.</td>
</tr>
<tr>
<td>Demonstrate how to set up and use the Snellen chart.</td>
</tr>
<tr>
<td>Demonstrate the correct method for measuring visual acuity.</td>
</tr>
<tr>
<td>Demonstrate the correct method for testing projection.</td>
</tr>
<tr>
<td>Demonstrate the use of the E chart for patients who cannot read letters.</td>
</tr>
<tr>
<td>Demonstrate methods of assessing visual acuity in children.</td>
</tr>
</tbody>
</table>

### Module 2: Assessing the eye

**Rationale:** Eye care revolves around good clinical skills. Without asking appropriate questions and examining the eye carefully, workers will not reach a correct diagnosis and management plan. This module teaches how basic equipment can be used to perform a thorough eye examination, and describes some of the extra equipment and tests which are useful in some cases.

**Content:** Introduction to common presenting problems in ophthalmology; technique of history taking and need for a patient, professional approach; basic anatomy of the eye and orbit; clinical examination technique (including lid eversion, pupillary responses, swinging light test and direct ophthalmoscopy); descriptions of specialist equipment (slit lamp microscope, visual field tests, indirect ophthalmoscope, tonometers, trial frame and lenses).

<table>
<thead>
<tr>
<th>Learning objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the stages of an eye assessment.</td>
</tr>
<tr>
<td>Describe how to take a history.</td>
</tr>
<tr>
<td>Recognise commonly used instruments (torch, magnifying glasses, ophthalmoscope, slit lamp microscope, tonometer, visual field analyser).</td>
</tr>
<tr>
<td>Demonstrate how to perform a systematic examination of the eye.</td>
</tr>
<tr>
<td>Describe additional tests which are needed in some patients (slit lamp examination, tonometry, refraction, assessing squint, examining visual fields, indirect ophthalmoscope examination).</td>
</tr>
</tbody>
</table>

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Table A2 (i): Multimedia resource modular content – Part 1: Basic Eye Care Skills – Modules 1 and 2.
<table>
<thead>
<tr>
<th>Module</th>
<th>Rationale and content</th>
<th>Learning objectives</th>
</tr>
</thead>
</table>
| Module 3: Practical procedures | **Rationale:** Eye workers are called upon to perform a number of practical procedures. It is important that they are given the opportunity to develop the correct technique. | - Describe when it is necessary to irrigate the eye.  
- Explain the need for prompt irrigation after chemical injuries.  
- Demonstrate the correct technique for irrigating the eye.  
- Discuss the advice to be given after the eye has been irrigated. |
| | **Irrigating the eye** | - List the different types of eye medicines and their actions.  
- Discuss the need to read the prescription carefully and check the expiry date of eye medicines.  
- Demonstrate the correct technique for instilling eye drops.  
- Demonstrate the correct technique for applying eye ointment. |
| | **Administering eye drops and eye ointment** | - List the reasons for applying eye pads and eye shields.  
- Demonstrate how to make an eye pad.  
- Demonstrate how to apply an eye pad.  
- Demonstrate how to make an eye shield.  
- Demonstrate how to apply an eye shield.  
- Demonstrate how to remove an eye pad and eye shield. |
| | **Applying an eye pad and eye shield** | - List the reasons for bandaging the eye.  
- Demonstrate the technique of bandaging the eye. |
| | **Bandaging the eye** | - Describe the purpose of tonometry.  
- Demonstrate how to perform applanation tonometry.  
- Demonstrate how to perform Schiotz tonometry.  
- Describe the situations when tonometry should not be done. |
| | **Measuring the intra-ocular pressure** | - Define epilation and describe when it is required.  
- Demonstrate the method of epilation. |
| | **Epilation of eyelashes** | - Describe the reasons for using an artificial eye.  
- Describe the method of inserting and removing an artificial eye.  
- Discuss how to counsel the patient about artificial eyes. |
| | **Inserting and removing an artificial eye** | - List the reasons for applying eye pads and eye shields.  
- Demonstrate how to make an eye pad.  
- Demonstrate how to apply an eye pad.  
- Demonstrate how to make an eye shield.  
- Demonstrate how to apply an eye shield.  
- Demonstrate how to remove an eye pad and eye shield. |
| | **Applying an eye pad and eye shield** | - List the reasons for bandaging the eye.  
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- Demonstrate how to make an eye shield.  
- Demonstrate how to apply an eye shield.  
- Demonstrate how to remove an eye pad and eye shield. |
| | **Applying an eye pad and eye shield** | - List the reasons for bandaging the eye.  
- Demonstrate the technique of bandaging the eye. |
| | **Bandaging the eye** | - Describe the purpose of tonometry.  
- Demonstrate how to perform applanation tonometry.  
- Demonstrate how to perform Schiotz tonometry.  
- Describe the situations when tonometry should not be done. |
| | **Measuring the intra-ocular pressure** | - Define epilation and describe when it is required.  
- Demonstrate the method of epilation. |
| | **Epilation of eyelashes** | - Describe the reasons for using an artificial eye.  
- Describe the method of inserting and removing an artificial eye.  
- Discuss how to counsel the patient about artificial eyes. |
| | **Inserting and removing an artificial eye** | - List the reasons for applying eye pads and eye shields.  
- Demonstrate how to make an eye pad.  
- Demonstrate how to apply an eye pad.  
- Demonstrate how to make an eye shield.  
- Demonstrate how to apply an eye shield.  
- Demonstrate how to remove an eye pad and eye shield. |
| | **Applying an eye pad and eye shield** | - List the reasons for bandaging the eye.  
- Demonstrate the technique of bandaging the eye. |

### Part 2: Common eye problems

<table>
<thead>
<tr>
<th>Module</th>
<th>Rationale and content</th>
<th>Learning objectives</th>
</tr>
</thead>
</table>
| **Module 4:** Red, irritated and painful eye | **Content:** The concept of inflammation; recognition and treatment of causes of red eye: conjunctivitis (acute conjunctivitis, conjunctivitis of the newborn, chronic allergic conjunctivitis, trachoma), corneal ulcer (bacterial, fungal, herpetic and Mooren’s ulcers), acute glaucoma, iritis, keratitis (superficial and stromal keratitis), episcleritis and scleritis, endophthalmitis, sub-conjunctival haemorrhage; clinical pointers to distinguish ‘serious causes’ and ‘self-limiting’ causes. | - Describe ‘inflammation’.  
- List important conditions causing a red eye, describe their clinical features and treatment.  
- Discuss how to identify patients with serious eye problems and treat them safely. |
| **Module 5:** Loss of vision | **Content:** The concept of the visual pathway; definitions of blindness and low vision; recognition and treatment of causes of loss of vision: **Refractive error** - hyperopia, myopia, astigmatism; **Opacities** - cataract (senile, congenital, secondary, traumatic), corneal scars (including symblepharon, staphyloma, phthisis, vitamin A deficiency and xerophthalmia, squamous cell carcinoma of conjunctiva, pterygium, keratoconus, solar keratopathy), vitreous haemorrhage; **Retinal disease** – diabetic retinopathy, age-related macular degeneration, retinal detachment, macular hole, hypertensive retinopathy, haemoglobinopathies (e.g. Sickle Cell, HbS), retinal artery and vein occlusions, pigmentary retinopathies (retinitis pigmentosa), inflammation of the choroid and retina (posterior uveitis/choroiditis, choriodoretinitis, retinitis); **Optic nerve disease** - chronic glaucoma, optic atrophy, papilloedema, onchocerciasis; **Loss of vision in children** – retinoblastoma, eye screening, amblyopia, examining children, education. | - Define loss of vision, blindness and low vision.  
- Describe the visual pathway.  
- Describe how to interpret clinical tests for loss of vision and make a safe diagnosis and treatment plan.  
- Describe the common diseases causing loss of vision, their clinical features, treatment and prevention.  
- Discuss important issues related to children with loss of vision. |
| **Module 6:** Eye injury | **Content:** Recognition and treatment of common eye injuries: foreign bodies and corneal abrasions, lid lacerations, chemical and thermal burns, penetrating injuries, blunt injuries, orbital injuries; prevention of eye injury, first aid for burns. | - Describe the main patterns of eye injury.  
- Describe how to prevent eye injury. |

**Table A2 (iii):** Multimedia resource modular content – Part 2: Common eye problems– Module 4-6.
Module 7: Prescribing glasses

Rationale: Refractive error is a common cause of vision loss worldwide. Low cost spectacles are increasingly available but many do not have access to an optometrist or optician who can provide them. It is important to teach eye workers how to provide the correct spectacles to patients. This module teaches a simple, pragmatic technique using basic equipment available in many eye clinics.

Content: This module is presented in two stages, recognising that whilst some of the primary audience (mid-level eye health workers) need to be able to perform simple refraction, this is not likely to be relevant to non-specialist doctors (although they are usually expected to understand refractive error and the principles underpinning their treatment).

Underlying concepts: refraction and refractive errors (emmetropia, myopia, hyperopia, astigmatism, aphakia, pseudophakia), converging and diverging lenses, cylindrical and spherical lenses, lens power and focal length, near and distance vision, accommodation and presbyopia.

Practical applications: simplified subjective refraction with spherical lenses, using nearest point of clear vision to provide glasses for presbyopia, confirming emmetropia in people with eye strain.

Learning objectives:
- Define refractive error.
- Discuss the role of opticians, optometrists and refractionists.
- Describe the bending of light – called refraction – by plus and minus lenses.
- Describe refraction by the cornea and the lens of the eye.
- Describe accommodation.
- Describe the refractive states of the eye – emmetropia, hyperopia, myopia, astigmatism.
- Describe presbyopia.
- List the groups of people who may wish to be assessed for glasses.
- Demonstrate how to correct refractive errors for distance vision.
- Demonstrate how to correct presbyopia.
- Demonstrate how to confirm emmetropia in patients with eye strain.

**Rationale:** Learners will be introduced to a wide range of eye conditions in the tutorials. Bullet-point summaries and photograph slide shows for each condition will be included for review and reference, organised by anatomical structure.

<table>
<thead>
<tr>
<th>Lids and Lashes</th>
<th>Lids and Lashes</th>
<th>Lids and Lashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ectropion</td>
<td>Entropion</td>
<td>Trichiasis</td>
</tr>
<tr>
<td></td>
<td>Blepharitis</td>
<td>Proptosis</td>
</tr>
<tr>
<td></td>
<td>Lesions on the lids</td>
<td>Dysthyroid eye disease</td>
</tr>
<tr>
<td></td>
<td>Facial palsy</td>
<td>Orbital and periorbital cellulitis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lids and Lashes</th>
<th>Lids and Lashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ptosis</td>
<td>Lesions on the lids</td>
</tr>
<tr>
<td></td>
<td>Dysthyroid eye disease</td>
</tr>
<tr>
<td></td>
<td>Facial palsy</td>
</tr>
<tr>
<td></td>
<td>Orbital and periorbital cellulitis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lacrimal apparatus</th>
<th>Lids and Lashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasolacrimal duct obstruction</td>
<td>Lesions on the lids</td>
</tr>
<tr>
<td>Dacryocystitis</td>
<td>Dysthyroid eye disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conjunctiva</th>
<th>Lids and Lashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute conjunctivitis</td>
<td>Lesions on the lids</td>
</tr>
<tr>
<td>Chronic allergic conjunctivitis</td>
<td>Dysthyroid eye disease</td>
</tr>
<tr>
<td>Trachoma</td>
<td>Facial palsy</td>
</tr>
<tr>
<td>Neonatal conjunctivitis</td>
<td>Orbital and periorbital cellulitis</td>
</tr>
<tr>
<td>Squamous cell carcinoma of conjunctiva</td>
<td>Facial palsy</td>
</tr>
<tr>
<td>Pterygium</td>
<td>Pinguecula</td>
</tr>
<tr>
<td>Pinguecula</td>
<td>Subconjunctival haemorrhage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cornea and Sclera</th>
<th>Lids and Lashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial and fungal corneal ulcers (suppurative keratitis)</td>
<td>Lesions on the lids</td>
</tr>
<tr>
<td>Herpetic (dendritic) ulcers</td>
<td>Dysthyroid eye disease</td>
</tr>
<tr>
<td>Mooren’s ulcer</td>
<td>Facial palsy</td>
</tr>
<tr>
<td>Superficial keratitis</td>
<td>Orbital and periorbital cellulitis</td>
</tr>
<tr>
<td>Stromal keratitis</td>
<td>Squamous cell carcinoma of conjunctiva</td>
</tr>
<tr>
<td>Bullous keratopathy</td>
<td>Pterygium</td>
</tr>
<tr>
<td>Solar keratopathy</td>
<td>Pinguecula</td>
</tr>
<tr>
<td>Corneal scarring</td>
<td>Subconjunctival haemorrhage</td>
</tr>
<tr>
<td>Phthisis</td>
<td>Staphyloma</td>
</tr>
<tr>
<td>Staphyloma</td>
<td>Symblephaton</td>
</tr>
<tr>
<td>Keratoconus</td>
<td>Corneal abrasion</td>
</tr>
<tr>
<td>Corneal abrasion</td>
<td>Scleritis</td>
</tr>
<tr>
<td>Solar keratopathy</td>
<td>Episcleritis</td>
</tr>
<tr>
<td>Keratoconus</td>
<td>Xerophthalmia</td>
</tr>
<tr>
<td>Corneal scarring</td>
<td>Measles and the eye</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anterior chamber and iris</th>
<th>Lids and Lashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypopyon</td>
<td>Lesions on the lids</td>
</tr>
<tr>
<td>Hyphaema</td>
<td>Dysthyroid eye disease</td>
</tr>
<tr>
<td>Acute (angle closure) glaucoma</td>
<td>Facial palsy</td>
</tr>
<tr>
<td>Iritis</td>
<td>Orbital and periorbital cellulitis</td>
</tr>
<tr>
<td>Iris bombe and secondary glaucoma in iritis</td>
<td>Squamous cell carcinoma of conjunctiva</td>
</tr>
<tr>
<td>Pupil responses</td>
<td>Facial palsy</td>
</tr>
<tr>
<td>Afferent pupil defect</td>
<td>Orbital and periorbital cellulitis</td>
</tr>
<tr>
<td>Swinging light test</td>
<td>Subconjunctival haemorrhage</td>
</tr>
<tr>
<td>Efferent pupil defect</td>
<td>Facial palsy</td>
</tr>
</tbody>
</table>

**Table A3a (i):** Multimedia resource reference content – Atlas of eye disease
<table>
<thead>
<tr>
<th><strong>Atlas of eye disease</strong></th>
<th><strong>Lens and vitreous</strong></th>
<th><strong>Vitreous</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lens</strong></td>
<td>Cataract</td>
<td>Vitreous haemorrhage</td>
</tr>
<tr>
<td></td>
<td>Complications of cataract surgery</td>
<td>Vitreous detachment</td>
</tr>
<tr>
<td></td>
<td>Congenital and childhood cataract</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Retina and choroid</strong></th>
<th><strong>Diseases of retinal blood vessels</strong></th>
<th><strong>Other diseases of the retina and choroid</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diabetic retinopathy</td>
<td>Age-related macular degeneration</td>
</tr>
<tr>
<td></td>
<td>Hypertensive retinopathy</td>
<td>Retinal holes and tears</td>
</tr>
<tr>
<td></td>
<td>Sickle-cell retinopathy and other haemoglobinopathies</td>
<td>Retinal detachment</td>
</tr>
<tr>
<td></td>
<td>Retinal artery occlusion</td>
<td>Macular hole</td>
</tr>
<tr>
<td></td>
<td>Retinal vein occlusion</td>
<td>Inflammation of the choroid and retina</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retinoblastoma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pigmentary retinopathies (retinitis pigmentosa)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Optic nerve</strong></th>
<th><strong>Optics</strong></th>
<th><strong>Eye injury</strong></th>
<th><strong>Other eye conditions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic glaucoma</td>
<td>Hyperopia (hypermetropia)</td>
<td>Lid laceration</td>
<td>Squint</td>
</tr>
<tr>
<td>Congenital glaucoma</td>
<td>Myopia</td>
<td>Foreign bodies</td>
<td>Comitant squint</td>
</tr>
<tr>
<td>Optic atrophy</td>
<td>Astigmatism</td>
<td>Corneal abrasion</td>
<td>Incomitant squint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Burns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Penetrating injury</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blunt injury</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Orbital rim fractures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Orbital floor (blowout) fractures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Amblyopia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Endophthalmitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HIV and the eye</td>
</tr>
<tr>
<td>Papilloedema</td>
<td>Aplhakia and pseudophakia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onchoderciasis</td>
<td>Presbyopia</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table A3a (ii) :** Multimedia resource reference content – Atlas of eye disease (continued)
### Rationale:
Many eye workers work in isolated areas with limited access to reference information. This section includes reference information about commonly used eye medications as an aid to safer prescribing.

<table>
<thead>
<tr>
<th>Prescribing Information</th>
<th>1. Treatment and prevention of eye infections</th>
<th>1.1 Antibacterials</th>
<th>1.2 Treatment of trachoma</th>
<th>1.3 Treatment of corneal ulcers</th>
<th>1.4 Treatment of fungal corneal ulcers</th>
<th>1.5 Treatment of neonatal conjunctivitis</th>
<th>1.6 Treatment of orbital and pre-septal (peri-orbital) cellulitis</th>
<th>1.7 Treatment of endophthalmitis</th>
<th>1.8 Preparing intravitreal antibiotics for endophthalmitis</th>
<th>1.9 Administering intravitreal antibiotics for endophthalmitis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antibacterials (antibiotics) and antiseptics given as eye drops and ointment</strong></td>
<td></td>
<td>Tetracycline ointment</td>
<td>Chloramphenicol drops/ointment</td>
<td>Gentamicin drops</td>
<td>Preparing fortified gentamicin drops</td>
<td>Ciprofloxacin drops/ointment</td>
<td>Povidone-iodine drops</td>
<td>Fusidic acid drops</td>
<td>Combination eye drops containing steroid and antibacterial</td>
<td></td>
</tr>
<tr>
<td><strong>Drugs used for other eye infections</strong></td>
<td></td>
<td>Antifungal drops</td>
<td>Natamycin drops/ointment</td>
<td>Econazole drops/ointment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drugs used to treat Herpes virus infections</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drugs used to treat onchocerciasis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table A3b (i): Multimedia resource reference content – Prescribing information
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Drugs/Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Treatment with steroid eye drops</td>
<td>Dexametasone eye drops, Prednisolone eye drops</td>
</tr>
<tr>
<td>2.2</td>
<td>Treatment with steroid tablets</td>
<td>Prednisolone (oral)</td>
</tr>
<tr>
<td>2.3</td>
<td>Other drugs used for allergic conjunctivitis</td>
<td>Sodium cromoglicate eye drops/Nedocromil eye drops, Chlorphenamine (oral), Cetirizine (oral), Loratadine (oral)</td>
</tr>
<tr>
<td>3.1</td>
<td>Drugs used to dilate the pupil</td>
<td>Tropicamide drops, Atropine drops/ointment, Phenylephrine drops</td>
</tr>
<tr>
<td>3.2</td>
<td>Local anaesthetic drops</td>
<td>Amethocaine</td>
</tr>
<tr>
<td>3.3</td>
<td>Corneal stains</td>
<td>Fluorescein</td>
</tr>
<tr>
<td>4.1</td>
<td>Treatment of chronic (open angle) glaucoma</td>
<td>Pilocarpine drops, Latanoprost drops</td>
</tr>
<tr>
<td>4.2</td>
<td>Treatment of acute (angle closure) glaucoma</td>
<td>Acetazolamide (oral), Brinzolamide drops, Timolol drops, Brimonidine drops</td>
</tr>
<tr>
<td>5.1</td>
<td>Treatment of Vitamin A deficiency</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Treatment of diabetes mellitus</td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>Treatment of age-related macular degeneration</td>
<td></td>
</tr>
</tbody>
</table>

Table A3b (ii): Multimedia resource reference content – Prescribing information (continued)
Appendix B:
Additional analyses for chapter 10

Questionnaire data is presented here for each module in fig B1a – B1i.
(Q1) The length of the tutorial was

FTL = Far too long, TL = Too long, AR = About right, TS = Too short, FTS = Far too short

Fig B1a: Questionnaire responses for each module – question 1
(Q2) The amount of detail was

FTL = Far too much, TL = Too much, AR = About right, TS = Too little, FTS = Far too little

**Fig B1b:** Questionnaire responses for each module – question 2
(Q3) The information in the tutorial was

FTL = Far too complicated, TC = Too complicated, AR = About right, TS = Too simple, FTS = Far too simple

Fig B1c: Questionnaire responses for each module – question 3
(Q4) I understood the voice of the narrator

SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree

Fig B1d: Questionnaire responses for each module – question 4
(Q5) The videos and pictures of clinical cases were clear

SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree

Fig B1e: Questionnaire responses for each module – question 5
(Q6) I understood the animations and illustrations

SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree

Fig B1f: Questionnaire responses for each module – question 6
(Q7) I enjoyed watching this tutorial

SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree

Fig B1g: Questionnaire responses for each module – question 7
(Q8) I would recommend this tutorial to another person training in eye health

SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree

Fig B1h: Questionnaire responses for each module – question 8
(Q9) I feel more confident in my skills after watching the tutorial

SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree

Fig B1i: Questionnaire responses for each module – question 9
Appendix C:
Additional analyses for chapter 11

C1. Alternative analyses for missing data

As discussed in section 11.4.2, one student had an incomplete dataset (with missing marks for two criteria on their mark sheet for one station (practical skills – fundoscopy). In the primary analysis, this student’s score for the missing criteria was estimated from their mean score for the other practical skills criteria in this station. This sensitivity analysis shows the effect of other methods of estimating this student’s performance.

C1.1 Number of stations passed

The student was assessed as an overall ‘clear pass’ for the station. Therefore, their mark would not affect the pass mark for the station (as they were not in the borderline group). The pass mark for this station from the borderline group method was 50.1%. Even if the student had been awarded no marks for the two missing criteria, their mark would have been 50.9%. (Note that the only student who scored no marks for the two criteria where this student’s marks were missing was awarded an overall ‘clear fail’ in the station making this extreme scenario practically implausible.)

Therefore, this student could not have failed the station and the conclusions drawn from the primary analysis about the effect of the intervention on number of OSCE stations passed are unaffected by assumptions about this student’s missing marks.

C1.2 Overall pass-fail

It follows from the above that the student’s overall pass/fail result is unaffected by any assumptions about this student’s missing marks.
C1.3 Overall mark

The student in question was ranked 2 of 61 (from the top) in their class for grade point average; and 8 of 61 (from the top) for performance in this station (based on marks for criteria where complete data is available). This places them well inside the top quartile of the class on both measures.

Six different methods of dealing with the missing marks are presented below:-

1. Assume that the student’s performance in the missing criteria was equivalent to:-
   a. the lower quartile of the ‘clear pass’ group
   b. the median of the ‘clear pass’ group
   c. the mean of the ‘clear pass’ group
   d. the upper quartile of the ‘clear pass’ group

2. Omit the student’s entire dataset from the analysis (so that \( n = 29 \) in the intervention group and \( n = 31 \) in the control group) and perform linear regression. (It would not be appropriate to perform this analysis using the T-test as the groups are no longer balanced with respect to baseline characteristics as the other member of the matched pair is still included in the analysis).

3. Omit both members of the matched pair with the missing data (so that \( n = 29 \) in the intervention group and \( n = 30 \) in the control group)

The results of these analyses are shown in table C1a.
<table>
<thead>
<tr>
<th>Method of estimation</th>
<th>This student’s overall mark based on this method</th>
<th>Mean score for intervention group based on this method</th>
<th>Mean score for control group based on this method</th>
<th>t-test result</th>
<th>Linear regression result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary analysis</td>
<td>74.54%</td>
<td>71.580%</td>
<td>As for primary analysis</td>
<td>3.155%</td>
<td>2.959%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CI: 0.030%, 6.279%, p=0.048</td>
<td>CI: 0.032%, 5.885%, p=0.048</td>
</tr>
<tr>
<td>Omit the student</td>
<td>Not applicable</td>
<td>Not applicable*</td>
<td>As for primary analysis</td>
<td>Not applicable*</td>
<td>3.101%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CI: 0.132%, 6.070%, p=0.041</td>
<td>CI: 0.187%, 6.139%, p=0.038</td>
</tr>
<tr>
<td>Omit both students in matched pair</td>
<td>Not applicable</td>
<td>71.478%</td>
<td>68.071%</td>
<td>3.407%</td>
<td>3.163%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CI: 0.264%, 6.550%, p = 0.034</td>
<td>CI: 0.187%, 6.139%, p=0.038</td>
</tr>
<tr>
<td>Assume performed at lower quartile of ‘clear pass’ group for missing criteria</td>
<td>74.22%</td>
<td>71.569%</td>
<td>As for primary analysis</td>
<td>3.144%</td>
<td>2.948%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CI: 0.021%, 6.267%, p = 0.049</td>
<td>CI: 0.019%, 5.877%, p=0.049</td>
</tr>
<tr>
<td>Assume performed at median of ‘clear pass’ group for missing criteria</td>
<td>74.22%</td>
<td>71.569%</td>
<td>As for primary analysis</td>
<td>3.144%</td>
<td>2.948%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CI: 0.021%, 6.267%, p = 0.049</td>
<td>CI: 0.019%, 5.877%, p=0.049</td>
</tr>
<tr>
<td>Performed at the mean of the ‘clear pass’ group</td>
<td>74.38%</td>
<td>71.574%</td>
<td>As for primary analysis</td>
<td>3.149%</td>
<td>2.953%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CI: 0.025%, 6.273%, p = 0.048</td>
<td>CI: 0.026%, 5.881%, p=0.048</td>
</tr>
<tr>
<td>Performed at the upper quartile of the ‘clear pass’ group</td>
<td>74.79%</td>
<td>71.588%</td>
<td>As for primary analysis</td>
<td>3.163%</td>
<td>2.967%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CI: 0.0369%, 6.289%, p = 0.047</td>
<td>CI: 0.043%, 5.892%, p=0.047</td>
</tr>
</tbody>
</table>

*Unadjusted analyses not performed (as groups no longer matched with respect to baseline characteristics)

Table C1a: Sensitivity analysis calculations for other methods of estimating missing data.
C2. Paired analyses

In the primary analysis, the intervention and control groups were analysed as independent samples. However, it is also possible to do the analysis as ‘paired data’. This is potentially more efficient but has the disadvantage that data from ‘incomplete’ pairs cannot be included in the analysis.

In this study, students were allocated to matched pairs based on the timing of their ophthalmology placement, grade point average and gender. The allocation protocol did not allow students who had their ophthalmology placement at different times to be allocated to the same matched pair.

As a result of the allocation protocol, there was an odd number of students in each teaching group. This means that data from four students who sat the examination (two in the intervention group and two in the control group) is lost from this analysis as there is not another member of the matched pair to compare. A further three students (two in the intervention group and one in the control group) were sick on the day of the examination, resulting in three further incomplete matched pairs, resulting in data being lost for three further students who sat the examination (as there is no matched pair to make a comparison). This reduces the effective sample size from 61 students (30 in the intervention group and 31 in the control group) to 54 students (in 27 matched pairs).

As a secondary analysis, the dataset was analysed as matched pairs using a paired samples t-test. For these students, the mean overall percentage scores were 72.2% (SD 5.17%) for the intervention group and 69.3% (SD 6.43%) for the control group (Difference in mean = 2.79%, CI: -0.324%, 5.90%, p = 0.077).

These values are similar to the independent samples results, and so both methods give similar results (in terms of differences in mean scores). The wider confidence intervals are attributable to the smaller effective sample size.
Appendix D:
Details of addenda

The following electronic addenda are attached:

The sleeve art for the DVD is appended on the next page.

Disc 1 (DVD)

Disc 2 (DVD)

Disc 3 (CD-ROM)
Electronic copies of questionnaires and assessment instruments (chapters 3, 4, 10 and 11).
Electronic copy of Standard Operating Procedures for Clinical Filming (chapter 9)
Ophthalmology: Multimedia learning for health workers worldwide is a pioneering new teaching and learning package in Ophthalmology, developed for eye health professionals in Africa to meet the VISION 2020 challenge of eliminating avoidable blindness worldwide by the year 2020.

It includes over seven hours of video tutorials covering essential clinical skills and major eye diseases, supported by an atlas of eye conditions and a list of common eye medicines.

The package can be used for formal teaching and self-directed learning, and combines high-quality clinical videos from eye clinics in Uganda and Tanzania, with specially developed illustrations and animations to illustrate important concepts.

Contents

1. Checking the visual acuity
2. Assessing the eye
3. Practical eye procedures
4. The red eye
5. Loss of vision
6. Eye injury
7. Prescribing glasses

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Kilimanjaro Christian Medical Centre, Moshi, Tanzania
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International Centre for Eye Health, UK

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Nic Blackwell (OCB Media, UK)
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