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Refraction in Mozambique: Evaluations of Practice and Development of Competency Frameworks for Eye Care Personnel

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Title

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Abstract

Purpose

The development of competency- based education for optometrists and mid-level eye-care personnel has been identified as an important component in the elimination of avoidable blindness and vision impairment. The Mozambique Eye care Project (MEP) is a multi-institutional collaboration, which seeks to facilitate greater access to training in eye health professions, which will ultimately contribute to providing affordable and accessible eye care within the public health system in Mozambique. An important tenet of the MEP is to develop and enhance the refraction training of all existing (ophthalmic technicians) and new eye care personnel (four-year training of optometrists and eighteen-month training of ophthalmic technicians) and evaluate the outcome of the training. The overall aim of my research was to develop competency frameworks for ophthalmic technicians (OTs) and optometrists and provide recommendations for developing a comprehensive training plan for eye care service provision in the country.

Methods

A comprehensive evaluation of refraction competencies of OTs was conducted by the use of demographic and confidence levels questionnaire and theoretical and practical competency assessments. A competency assessment process was developed for the assessment of optometry students at UniLúrio, which consisted of direct observation of refractions on two clinic patients, a two-part theory exam consisting of short answer questions and an oral structured viva. Qualitative observations of the competency assessment process were also made. Factors affecting student performance were identified using semi-structured individual interviews with the course lecturers and a

course evaluation questionnaire with the students. A modified Delphi approach was used to develop competency frameworks for the two cadres, OTs and optometrists in Mozambique.

Results

Initial evaluations of the OTs demonstrated that their refraction confidence and competence levels varied depending on their training (location and duration), and their location of work (clinical load, availability of equipment and other eye care personnel). The only skill the OTs and trainees demonstrated competence in was correcting presbyopia. Only four optometry students out of fifteen were graded as competent in all the elements of the clinical competency exam. Analysis of data from lecturer interviews and student questionnaire yielded four dominant themes that were viewed as important determinants of student performance: student learning context; teaching context; clinic conditions and assessment; and the existing operating healthcare context. Two socially responsive competency frameworks for both cadres were developed using the modified Delphi approach.

Conclusion

These evaluations identified factors affecting the refraction competencies of the OTs and optometrists at UniLúrio while taking country-specific factors into context. The socially responsive frameworks developed will inform the evolution of standardised curricula for both OTs and optometrists.

Declaration page

I certify that this thesis which I now submit for examination for the award of Doctor of Philosophy, is entirely my own work and has not been taken from the work of others, save and to the extent that such work has been cited and acknowledged within the text of my work.

This thesis was prepared according to the regulations for postgraduate study by research of the Dublin Institute of Technology and has not been submitted in whole or in part for another award in any other third level institution.
The work reported on in this thesis conforms to the principles and requirements of the DIT's guidelines for ethics in research.

DIT has permission to keep, lend or copy this thesis in whole or in part, on condition that any such use of the material of the thesis be duly acknowledged.

Signature _____K Shah_____ Date 7th July 2015

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Michaami Dukhnam

Dedication

This thesis is dedicated to my mother, Hansa for her strength and wisdom.

Abbreviations List

AULP	Association of Portuguese Language Universities
BHVI	Brian Holden Vision Institute
C	Cylinder
CBE	Competency Based Education
COECSA	College of Ophthalmology of East, Central and Southern Africa
CSN	Centro de Saude (Health Center) Nhaconjo
D	Dioptre
DIT	Dublin Institute of Technology
GDP	Gross Domestic Product
GOC	General Optical Council
HCB	Central Hospital of Beira
HCC	Central Hospital of Chimoio
HCN	Central Hospital of Nampula
HDI	Human Development Index
HINARI	Health Inter Network Access to Research Initiative
HPI	Provincial Hospital of Inhambane

HR	Human Resources
HRC	Regional Hospital of Chicuque
HReH	Human Resources for Eye Health
IAPB	International Agency for the Prevention of Blindness
IHS	Institute of Health Sciences, Beira
J_0	Jackson cross-cylinder at axis 0^0
J_{45}	Jackson cross-cylinder at axis 45^0
LFTW	Light for the World
MECC	Mozambique Eye care Coalition
MEP	Mozambique Eye care Project
MISAU	Ministry of Health
MLEP	Mid-Level Eye Care Personnel
MSVI	Moderate to Severe Visual Impairment
NGO	Non Governmental Organisation
NHS	National Health System
RAAB	Rapid Assessment of Avoidable Blindness
RARE	Rapid Assessment of Refractive Error

RE	Refractive Error
OSCE	Objective Structured Clinical Exam
OT	Ophthalmic Technician
S	Sphere
SAQ	Short Answer Question
SD	Standard Deviation
SE	Spherical Equivalent
SP	Standardised Patient
TM	Traditional Medicine
TVET	Technical and Vocational Education and Training
UK	United Kingdom
UKZN	University of Kwa-Zulu Natal
URE	Uncorrected Refractive Error
US	United States
VA	Visual Acuity
VI	Visual Impairment
WCO	World Council of Optometry
WHO	World Health Organisation

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Chapter 1

Context and Background

Background

Approximately 285 million people worldwide live with visual impairment.[1,2]Of these, 39 million people are blind and 246 million have low vision.[1] The major cause of visual impairment is uncorrected refractive errors (43%); the main cause of blindness is cataract (51%) followed by uncorrected refractive errors (18.2%).[1] Approximately 90 per cent of the visually impaired live in low income settings.[1] Most (80%) of visual impairment can be prevented or cured and is referred to as avoidable blindness.[1]

The challenge of eliminating avoidable blindness is addressed by the global initiative VISION 2020: The Right to Sight, a joint programme of the World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB).[3] It calls for a three pillar approach namely, human resource development, infrastructure and technology, and the treatment of priority diseases. VISION 2020 recognises the poverty trap of people living with visual impairment, their likelihood of being excluded from basic health, education and social services and thereby their vulnerability to isolation, ill health and economic problems.[3] Many developing countries are unable to provide an effective level of eye health care to their population.

Addressing uncorrected refractive error (URE) is a priority within Vision 2020 as it can be treated by known, cost-effective means.[4] URE hampers education, limits employment opportunities, reduces productivity, and has been shown to impair quality

of life.[5] Provision of simple and effective eye health interventions including an eye exam by a skilled eye care practitioner and the provision of suitable spectacles can address the burden of URE.[6] This would ensure the best possible vision for all people, thereby contributing directly to improving quality of life and creating favorable economic, social and health conditions for individuals and society.[3] The importance of addressing URE has provided an impetus for the development of refractive error programmes within national eye care programmes to meet this need for refraction services.[7]

The Durban Declaration on Refractive Error and Service Development recognises a shortage and/or uneven distribution of eye care personnel trained in providing refractive error services as a major factor in dealing with avoidable blindness.[7] There is clear evidence that the number of eye care professionals is insufficient in many low and medium income countries.[8] Sub-Saharan Africa in particular is characterised by an extreme lack of eye care personnel and facilities.[9]

To address the need for refractive error services, many voluntary, optometry led organisations from developed countries have been providing refractive care, to individual patients in developing countries.[10] These are traditionally short-term vision camps that include the measurement of refractive error and dispensing of spectacles.[10] However, in the last seven years the approach has been criticized. The provision of direct clinical services by most foreign volunteers is counterproductive to the development of sustainable local services as it does not directly build local capacity.[10,11]

Presently, volunteer organisations are being encouraged to:

a) Strongly consider reprioritizing their work from direct care to developing human resources and infrastructure in accordance with national eye care plans and government priorities.[10,12]

b) Help in the training of mid-level eye-care personnel[1] by assisting in the establishment of training courses via partnerships with educational institutions and relevant government ministries.[12]

c) Identify the type, quantity and distribution of existing eye-care/ refraction providers in a country; analysing gaps in their existing knowledge and help provide them with professional education.[10]

d) Monitor and evaluate their outcomes.[10]

In a study in 2012 of volunteer organisations working in eye care in developing countries, eight (of the 41 organisations which replied) trained mid level eye-care personnel (MLEP) in refraction, 15 in the fabrication and/or dispensing of spectacles and four in the diagnosis and treatment of ocular disease, with many training personnel in more than one category.[12] Only two of these organisations that train in refraction evaluate the personnel's attainment of competencies and clinical performance.[12] It is important for any educational programme to measure student attainment of skills and

[1] The WHO in 2014 has classified all human resources for eye care, apart from ophthalmologists, cataract surgeons and optometrists, as allied ophthalmic personnel characterized by different educational requirements, legislation and practice regulations, skills and scope of practice, between countries and even within a given country.[13] Typically, allied ophthalmic personnel comprise opticians, ophthalmic nurses, orthoptists, ophthalmic and optometric assistants, ophthalmic and optometric technicians, vision therapists, ocularists, ophthalmic photographer/imagers, and ophthalmic administrators. For this thesis the term mid-level eye care personnel (MLEP) is used for all allied ophthalmic personnel.

knowledge. Without doing this, it is difficult to know whether the students' skills and knowledge are correct and/or appropriate or, indeed, if the intervention is effective.[12]

The Mozambique Eyecare Project (MEP) is a response to the critique of the lack of evaluation, and follows the trend towards human resource development. The MEP is an educational collaboration between the Dublin Institute of Technology (DIT), the Brien Holden Vision Institute (BHVI), the University of Ulster and Universidade Lúrio (UniLúrio), Nampula for the development, implementation and evaluation of a regional model of Optometry training for Mozambique and Lusophone Africa. The MEP has established Mozambique's first Optometry School in Universidade Lúrio, Nampula, Mozambique. An important tenet of the MEP is to assist in the refraction training of all existing and new eye care personnel (optometrists and ophthalmic technicians) and evaluating the outcome of the training.

In Mozambique in 2010 there were 17 Ophthalmologists and 34 qualified Ophthalmic Technicians (OT) available to manage the diverse eye health and refraction needs of the population of just under 25 million.[14] OTs are the mid-level eye care personnel (MLEP) in Mozambique. In 2011, 26 OTs qualified and a further 31 in 2012. The first indigenously trained optometrists started practicing in 2013.[15] There are now 28 optometry graduates, six working in UniLúrio being developed as faculty, nine in practice within the public health system and 13 new graduates about to enter the public health system.

VISION 2020 targets suggest each country should aim to achieve a ratio of one eye health care worker who can perform refractions per 100,000 people by 2010 and one per

50,000 people by 2020.[3] Based on the recommended VISION 2020 'figures', Mozambique would need at least 500 trained refractive personnel to serve its population of 25 million by 2020.[3] The MEP seeks to facilitate greater access to training in eye health professions, which will ultimately contribute to providing affordable and accessible eye care within the public health system in Mozambique. Unlike other eye care personnel optometrists will take primary responsibility for refractive services while concurrently supporting the detection and management of ocular disease.

Education and health care cannot be isolated from the health system, socio-cultural or economic context within which it occurs.[16] Any training needs to be structured to address priority eye care needs. Clinical professions are often concerned not just with knowledge acquisition, but attainment of skills and their application. This competency-based approach is increasingly being used as a conceptual device to talk about skill development in health professions. This thesis evaluates the training of optometrists and ophthalmic technicians in Mozambique through a framework of competency-based education.

1.2 Aim of the research

This research is a part of the MEP. The overall aim of the research is to develop competency frameworks for eye care service provision, concentrating on refraction, for OTs and optometrists and provide recommendations for developing a comprehensive training plan for eye care service provision, with an emphasis on refraction, in the country. This will be achieved by undertaking a comprehensive evaluation of refraction training of OTs and optometry students by exploring the

applicability of existing competency frameworks for the two cadres and taking into context country-specific factors that affect refraction competence.

The research has three principal objectives:

1) To gain knowledge of the existing provision of refraction services by an evaluation of the confidence levels and refraction competencies of OTs. This evaluation will provide an understanding of the impact of:

a) the variation in their training;

b) location of work (clinical load, availability of equipment and other eye care personnel);

c) clinical experience and

d) analysis of a refraction up-skilling course.

Apart from the ophthalmologists and the new graduate optometrists, the OTs are the only providers of refraction services, however their refraction knowledge and skills are unknown. This evaluation will provide the Ministry of Health and other stakeholders involved in the training of OTs with valuable information regarding existing refraction service provision for the National Eye Care Plan and how to tailor up skilling, continuing education and new training courses for the OTs.

2) To gain knowledge about the refraction training element of the optometry course at UniLúrio by:

a) Developing a competency assessment process and evaluating the competencies of graduating optometry students using the existing World Council of Optometry (WCO) competency framework and

b) Identifying the factors that affect the academic performance of optometry students.

The competency assessment process could inform the design of an 'exit' evaluation system that may be used or modified for use across optometry schools in other resource poor countries. Evaluating the students and recognising the factors that influence their performance would inform the course coordinators on how to better structure the course, the teaching and adapt the learning environment so that more future students can graduate as competent optometrists.

3) To help identify the relevant competencies OTs and optometrists in Mozambique must demonstrate with the overall aim of establishing competency frameworks for both cadres using a modified Delphi design study.

These frameworks could then inform the evolution of standardised curricula for both OTs and optometrists for eye care service provision, with an emphasis on refraction, in the country. This could in turn set standards for training and development for refractive error service delivery in developing nations. Figure 1.1 below demonstrates the objectives of the study

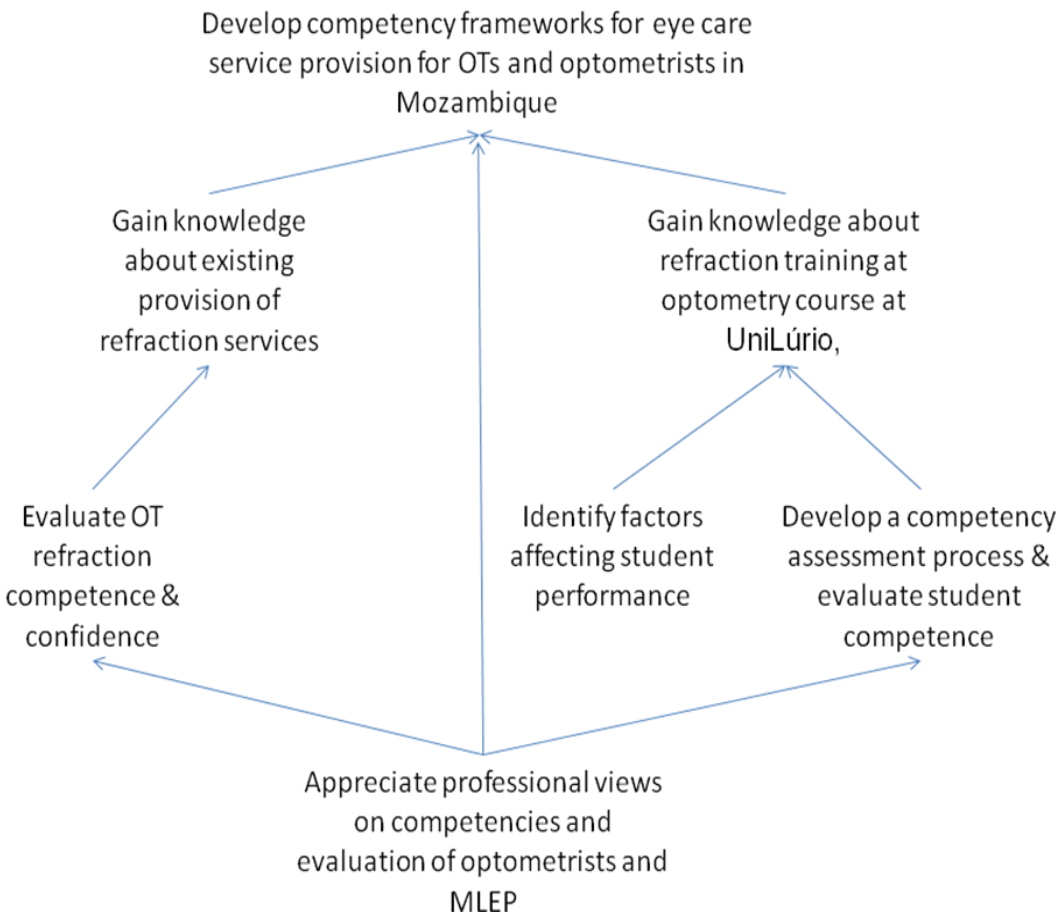

Figure 1.1: Objectives of the study

Abbreviations: OT: Ophthalmic technician; MLEP: Mid-level eye care personnel

1.3 Outline of the thesis

The thesis is addressed in three sections: Chapters two to six are the introductory chapters presenting the literature review and an outline of the methodological approach; chapters seven to ten focus on the three different strands of the research as defined in the aims, while chapter eleven comprises the conclusion section.

Chapter 2 provides detailed information on the country of Mozambique and the challenges it faces with regards to providing education, focusing on higher level education, to provide a context for the following chapters. Chapter 3 begins with an introduction to the causes and management of blindness and vision impairment worldwide, in Africa and in Mozambique. Chapter 4 specifically reviews human resource availability in the context of the health system. The eye care provision in Mozambique within the context of the Mozambican National Health System (NHS), levels of service delivery and the education of OTs (as mid-level eye care personnel) and optometrists are discussed. A key argument in this chapter is that assessments of performance of eye care personnel are needed to determine the effectiveness of any training.

Chapter 5 discusses the definitions of competence, the concept of competency-based education, and a description of the benefits and challenges of competency-based education in eye care. Chapter 6 provides an outline of the methodological approach used in the analytical chapters. A literature review on methods of assessment for clinical competence to identify the available research instruments that are applicable and appropriate to use in clinical evaluations is presented.

Chapter 7 presents the results of evaluations on the confidence and competence of 16 qualified and 31 trainee OTs in refraction, and investigates whether an upskilling programme was effective in developing their competence and confidence at refraction. Identification of the quantity and distribution of existing eye-care/ refraction providers (OTs in Mozambique) and analysing their knowledge of refraction skills is important to understand gaps in their existing knowledge and to help provide them with appropriate

training and professional education. The results of the evaluations are presented and discussed in relation to the participant demographic profile, confidence levels, clinical competencies and factors determined to influence the results observed.

Chapter 8 discusses the development of a competency assessment process for the first two cohorts of optometry students at UniLúrio, concentrating on refraction, and furthermore, explores the effectiveness of implementation of the process in the context of a low resource environment. The results of the development of the methodology and the clinical competency evaluation using the existing WCO competency model are presented. The reliability and validity of the methodology is discussed. It describes whether the methodology can be viable as a means to evaluate the exit competencies in refraction of the student optometrists in Mozambique.

Chapter 9 describes the factors affecting student performance taking into account feedback from the course lecturers and students. The results were analysed with the results from the student competency evaluations to understand the complexities surrounding the optometry student training and performance.

Chapter 10 explores the rationale, process and outcome of a competency framework development initiative to develop competency frameworks for eye care service provision, concentrating on refraction, for the two cadres, OTs and optometrists in Mozambique. It was informed by the principles and elements of social responsiveness.

Chapter 11 provides a summary of the research findings based on the aims of the study and highlights the contribution of the study. It identifies a number of key areas for

future research. A final discussion of the implications of establishing competency frameworks is also presented.

Chapter 2

Mozambique and its Education System

2.1 Introduction

This chapter introduces the country of Mozambique. It presents economic and social data including the human development indicators to foster a deeper understanding of the context in which education is provided. The history of the Mozambican education system is presented. It describes the structure of the education system and focuses on the challenges faced by the education sector at all levels.

2.2 Background

Mozambique is located in Sub-Saharan Africa and borders South Africa, Swaziland, Zimbabwe, Malawi and Tanzania(Figure 2.1 below). Administratively, Mozambique is divided into 11 provinces and 128 districts. The population in 2013, was 25.83 million with children below the age of 14 constituting 45% of the population and only 3% of the population aged 65 years and over.[17]

Thirty one point seven percentof the population live in urban areas.[18] The provinces of Nampula and Zambezia are the most populated provinces and account for 45% of the total population.[18] Niassa Province, despite being one of the biggest in the country, remains the least populated. On the other hand, Maputo City, the smallest province in size, presents the highest population density in the country. High population density in

some locations results in a higher demand on basic services, including health and education. The provinces of Mozambique are shown in Figure 2.2 below.

Figure 2.1: Mozambique's global position (www.emapsworld.com)

Figure 2.2: Map of Mozambique showing the 11 provinces (Vidliani 2014)

Mozambique obtained independence in 1975 from Portugal; however a civil war lasted throughout most of the eighties and only ended with the Rome peace accords in 1992. At this point Mozambique was listed as the poorest country in the world by the World Bank, with a gross domestic product (GDP) per capita of USD$80.[19] Natural disasters such as severe droughts, devastating cyclones and floods, occurring mostly in the central and southern provinces, added to the poverty of the country.

The destabilisation, economic downfall and natural disasters forced Mozambique to negotiations with World Bank and IMF, which resulted in structural re-adjustment measures through the Programme for Economic Recovery, published in 1987.[20] The economy was steered from socialist to a free-market economy. After establishing political stability with the democratic elections in 1994, the economy recovered with growth averaging between 6%-8% in the decade up to 2013.[21] The GDP per capita income was US$ 593 in 2013.[17] Services (including financial, education and health care) account for 50% of GDP followed by agriculture and industry with 29% and 21% respectively.[17] However, despite its economic growth rates poverty continues to be severe and widespread. As of 2014, 59.58% of the population still lives on less than US$1.25 a day.[22] Overall, Mozambique is still heavily dependent on foreign aid.

Africans make up 99.66% of the population with Europeans 0.06%, Euro-Africans 0.2%, and Indians 0.08%.[21] There are 16 main ethnic groups.[21] Portuguese was adopted as the national language, post independence with the aim of creating unity amongst the various ethnic groups with their different cultures and languages. Still only 10.70% of the population speak Portuguese as a mother tongue and only 30% speak it as a second

language.[21] The majority of the population speaks one of the 39 indigenous Bantu languages.[21]

According to the United Nations Human Development Index (HDI), a composite measure designed to provide an indicator of human well-being in terms of life expectancy, educational attainment and adjusted real income, Mozambique ranks 178 out of 187 countries in 2014.[22] Despite Mozambique remaining a country with low human development, between 1980 and 2013, Mozambique's HDI value increased from 0.246 to 0.393, an increase of 59.6%. Between 1980 and 2013, Mozambique's life expectancy at birth increased by 7.4 years, mean years of schooling increased by 2.5 years and expected years of schooling increased by 4.7 years. Mozambique's Gross National Income (GNI) per capita increased by about 71.1% between 1980 and 2013.[22] Mozambique is one of 40 developing countries that was identified by the report that has done better than expected in human development in recent decades.

However, key health indicators in Mozambique are low with the average life expectancy in 2014 at 52.6 years, below the sub-Saharan African average of 56 years.[21,23] Infant mortality rate is 62 per 1,000 live births, which is higher than the rate of 61 per 1,000 live births in sub-Saharan Africa.[17] There is high prevalence of infectious diseases such as malaria (responsible for 26% of annual deaths) and HIV/AIDS (prevalence rate of 10.8%).[23] These diseases are a cause of and contribute to poverty.

2.3 Education in Mozambique

It has been widely noted that education of the indigenous population was neglected during the colonial period such that, on the eve of Independence there was no higher education institution open to black Mozambicans and approximately 93% of the population was illiterate.[20] Due to political support from the Soviet Union, Cuba and East Germany, thousands of students were sent for secondary school and higher education to these countries.[24] The post-Independence government viewed as essential the expansion of education and particularly basic literacy programmes. The first years of Independence saw a massive expansion of both these literacy programmes and primary schooling.[20] Schools were built and large numbers of (mainly unqualified) teachers recruited.[25] Enrolment in primary education rose from 20 to 40% between 1975 and 1979 and illiteracy was reduced to 75% in 1980.[20] During this time Portuguese was the only medium of instruction. However, the majority of the population speak a local indigenous language first and only learn Portuguese in school. This has been stated as one of reasons why there were high school repetition and dropout rates.[25]

A National Education System was approved by parliament in 1982 and implementation started in 1983. A new institute, the National Institute for the Development of Education under the Ministry of Education (now the Ministry of Education and Culture) had the task to develop the curricula for the new education system that consisted of general education, teacher training and education, vocational-technical education, adult education, and higher education.[20]

The intensification of civil war (1977-1992) significantly constrained the success of this expansion. In 1989, 45% of the whole primary school network had been closed or destroyed and the illiteracy rate in 1990 was 60%.[26]

The Programme for Economic Recovery as demanded by World Bank and IMF led to a sharp drop in expenditure for education (from about 12% in 1980 to 4% in 1987).[20] In 1990 the government allowed the development of private education institutions at all education levels, which, more recently, have played an important role in the expansion of education at higher levels.

After winning the first multi-party election in 1994, the Mozambican Government faced an enormous education deficit. High absolute poverty levels and difficulties in accessing areas outside provincial capitals during the 20-year civil war caused enrolment to plummet, with gross enrolment in primary school at only 50 percent and net enrolment below 40 percent.[2] [25] Infrastructure was in very poor shape, and schools were completely absent in many rural areas. Schools often lacked inputs (teachers, books, supplies). Many teachers were not qualified to teach. The objective of Government policy since the end of the civil war has been to provide quality education for all with a focus on primary education.[25]

Since 2000, the Government has allocated about 5 percent of GDP to the education sector compared to an average of 4.7% in sub-Saharan African countries.[22,25] The

[2] Gross enrolment rate is the total enrolment in primary/secondary/higher education, regardless of age, expressed as a percentage of the population of official primary/secondary/higher education age. Net enrolment age is the ratio of children of the official primary school age who are enrolled in primary school to the total population of the official primary school age.

number of primary and secondary schools was increased significantly.[27] The causes of low enrolment were addressed by enacting an important set of reforms in 2004 including the abolition of fees and provision of free textbooks, increased funding for schools, increased number of teachers, a new curriculum and increasing the supply of teaching and learning materials.[25] This supply expansion was met with overwhelming demand. Gross enrolment in primary education rose from 34% percent in 1997 to 106.1 % in 2012 due to the enrolment of older children.[17,25] Huge improvements have been made in literacy, however rates among adults and females aged between 15-24 years old are lower than the median literacy rates in other sub-Saharan African countries as shown in table 2.1 below.[17]

Table 2.1: Literacy rates in Mozambique compared to other Sub-Saharan African countries.[17]

Region	Literacy rate %			
	Female (% of females ages 15 and above)	**Male (% of males ages 15 and above)**	**Female (% of females ages 15-24)**	**Male (% of males ages 15-24)**
Mozambique	36	67	57	80
Sub-Saharan Africa (median)	51	68	64	75

2.4 The structure of the education system

The Ministry of Education and Culture administers primary and secondary education and the Ministry of Higher Education Science and Technology has administered higher

education institutions since 2000. Formal education consists of three main streams and a parallel vocational and technical education stream.

Primary education: This is the first level of general education and lasts seven years. It is subdivided into two levels, the first covers grades one to five, and second grades six and seven. Primary education is compulsory for children after the age of six.

Secondary education: This is the second and third level of general education and lasts five years. It is divided into two cycles: the first cycle (lower secondary) lasts three years (grades eight to ten) and the second (upper secondary) encompasses grades 11 and 12.

Higher education: This is provided by five types of institutions: universities, higher institutes, polytechnics, colleges and academies. The first cycle of university education lasts four years and leads to the Licenciatura, (Licentiate) which is comparable to the honours degree in Southern African countries. Polytechnics, higher institutes, colleges and academies all offer the licenciate. The second (two-year master's degree) and third (four-six years doctoral degree) cycles of study are only available at universities.

Technical and vocational education and training: This is provided by technical schools and institutes at elementary (after grade five of primary education), basic (after grade seven of primary education) and at the middle level after grade ten of lower secondary. The training of teachers is at a basic level (three-year programme after grade seven of primary education) or middle level (one year programme after grade ten). Basic level

corresponds to the first cycle of secondary education and mid level is equivalent to the second cycle of secondary education.

The training of health personnel (apart from university based courses for example medicine, dentistry, optometry and pharmacy) is carried out at Health Science Institutes around the country.[28] Training is at an elementary level (after grade seven), basic (18 months after grade 10) or middle level (between 24-36 months after grade 10).[29]

The structure of the education system is presented in Table 2.2 below.

Table 2.2: The structure of the education system

Level of education in Mozambique		**Year of study**	**Age with intended entry at age 6**	**Level of Technical Education***
4th Level	Higher Education	13+	18+	
3rd Level	Upper Secondary	11-12	16-17	Middle
2nd Level	Lower Secondary	8-10	13-15	Basic
1st Level	Upper Primary	6-7	11-12	Elementary
	Lower Primary	1-5	6-10	

*Excluding the Health Science Institutes

The vast majority of primary students (95%) attend public schools. However, 30% of students attend private secondary schools. [25]

2.4.1 Challenges faced by the primary and secondary education sectors

The improvement in enrolment in primary education has, however, still left a large number of children out of school, in particular Mozambique's most vulnerable populations: girls and children in rural areas.[25] While physical access improved, efficiency did not, and retention and completion rates are low for primary education as demonstrated in table 2.3.

Table 2.3: Gross enrolment rate, completion rate and pupil-teacher ratio in primary secondary and higher education in Mozambique.[17]

Level	Gross enrolment rate (Total is the total enrolment in primary/secondary/higher education, regardless of age, expressed as a percentage of the population of official primary/secondary/higher education age)	Completion rate (total is the total number of new entrants in the last grade of primary/ secondary /higher education, regardless of age, expressed as percentage of the total population of the theoretical entrance age to the last grade of primary/secondary/ higher)	Pupil-teacher ratio
Primary	106.1% [a]	52.2% [a]	54.8 [a]
Secondary	25.9% [a]	7.5 [c]	47.0 [a]
Higher	4.9% [b]	No data	No data

[a] 2012 data [b] 2011 data [c] 2008 data

The completion rate, which is a key indicator for measuring the quality of education, remains low – nearly half of primary school aged children leave school before they complete grade five.[30] The impact of poverty and AIDS has placed additional responsibilities on schools. As a result, schools have to take on many of the functions that families traditionally performed in relation to children's education and care, such as providing health services and psycho-social assistance to orphaned and vulnerable children.[30]

The pupil: teacher ratio for primary education is high (54.8) compared to other sub-Saharan African countries (40.7) despite the increase in the number of teachers.[31] A large proportion of primary school teachers do not have adequate training, and double or triple-shift teaching has been introduced to cope with the shortage of classrooms and teachers.[30] The majority of schools are underfinanced with overcrowded and ill equipped classrooms.[30] An increase to financial, material and human resources directly benefiting schools is a priority in this context to improve student performance and increase retention and completion rates.

Enrolment and completion rates for secondary education also remain extremely low as demonstrated in Table 2.1 above. Post-primary education is not free, which means that school fees are charged. Economic reasons, such as the child having to work or not being able to afford books or school fees, are a principal factor for students to drop out of secondary school.[25]

The greater enrolment and retention at the primary level have increased secondary school enrolment. However, the network of public secondary schools is still limited particularly in the rural areas, increasing the pressure to expand secondary schooling.[32]

The quality of public secondary schools is perceived to be low.[33] The physical conditions of secondary schools, lack of classrooms, lack of furniture, functioning libraries, laboratories, computers and internet access have been cited as factors that affect student learning.[25] A lack of trained teachers especially in subjects such as mathematics and sciences, and the ratio of students to teachers are all concerns that have to be addressed. Analysing these major challenges facing the secondary sector has led to the formulation of the Education Strategic Plan by the Ministry of Education for the period 2012-2016.[32]

2.5 Higher education in Mozambique

The first higher education institution was created in 1962 by the Portuguese as a branch of the Portuguese universities, with the aim of serving mainly the children of settlers. This institution, called Estudos Gerais Universitários, was upgraded to the University of Lourenço Marques in 1968. Despite a Portuguese move to open up education for Africans in the late sixties and early seventies, only about 40 black Africans, less than 2% of the student body, had entered the University at independence in 1975.[34] Soon after independence the university was renamed Eduardo Mondlane University. The effects of the exodus of the Portuguese were reflected in a decrease in student number and staff. There were only 10 Mozambican academic staff in 1978.[34]

Following the change of the socialist policies to an orientation towards the free-market economy at the end of the eighties, legislation for higher education was introduced in the early nineties. The liberalisation of the higher education 'market' led to the creation of a number of private universities. In 1992, there were only three Universities, catering for 4,654 students. In 2011, there were 38 Higher Education institutions (including private), with 101,362 students enrolled.[32] Females constituted 38.3% of the students.[32] This number of students in higher education is expected to grow requiring considerable investment in higher education.[35] Despite the rapid growth of university places, students in higher education institutions represent a very small segment in relation to the population as a whole. The gross enrolment rate in higher education in 2011 was 4.9 % compared to the sub-Saharan African average of 8.1 %. [31]

The number of full-time academic staff is about 1,200, of which 15% have PhDs, 25% have masters, and 60% are holders of a first degree (bachelors or licentiate). These numbers indicate that there is still a need for high investment in staff training at the masters and PhD levels.[36]

UniLúrio, the focus of much of the research presented in this thesis, is one of the new public universities which opened in Nampula province in the north of Mozambique in 2007. Its Faculty of Health Sciences, shown in Figure 2.3 below, also offers courses in Dentistry, Pharmacy, and Nutrition. In 2008, the Mozambique Eyecare Project (MEP) established the optometry course at UniLúrio following discussions between the partners of the MEP. The mission of UniLúrio is to provide a high quality of education to the underserved three northern provinces of Mozambique, namely: Nampula, Niassa and Cabo Delgado.

Figure 2.3: Faculty of Health Sciences, UniLúrio

2.5.1 Challenges faced by the higher education sector

Despite the increase in the number of students entering higher education, graduation rates (total graduates over total number of students enrolled) are very low. In 2011, it was 11.3% in public institutions (down from 13.4% in 2005) and 8.4% in private institutions (down from 11.4% in 2005).[37] One of the factors is the lack of human, academic and financial resources at the higher education institutions. A considerable number of them had insufficient or no basic conditions to guarantee quality education, for example, laboratories, libraries and access to new technologies.[37]

The other challenge is the relevance of higher education to the country's development. There exists an imbalance between the areas of training and employment opportunities available. There is a lack of access in courses in priority areas such as engineering,

natural sciences, health and agriculture. The quality of graduates has also been recognised as being lower than regional and international parameters.[32]

Another challenge faced by Portuguese speaking institutions is the dominance of English in higher education and academia. For most students in Mozambique, English is a foreign language. It may be their third or even fourth language.[38] This dominance is placing huge pressures on non-English speaking institutes both in terms of teaching and research. Most academic journals and scientific websites use English and many universities encourage or even demand that their professors publish in English-medium journals as evidence of quality scholarship.[38] It is also a challenge for undergraduates, as most of the literature they require to study is in English.[39]

A 'Higher Education Strategic Plan' has been implemented to address these challenges faced by the sector.[32] The main objective of the plan is to "Promote equitable participation and access and meet the country's needs in a dynamic way, inherent to a developing society, by building and strengthening institutions with flexible, diversified and better coordinated programmes, in order to acquire and develop relevant knowledge, skills, research and innovation, and to strengthen the intellectual, scientific, technological and cultural capacity of students and graduates." [32] The main challenge will be to guarantee the quality and relevance of this level of education. Priority will be given to insisting on compliance with strict entry and career development criteria; strengthening institutions' capacity by improving, their physical conditions and the use of new technologies; complying with international standards through accreditation and promoting the use of student-centred competency-based learning methodologies.

The strategic plan for higher education in Mozambique appears to be in line with the view of what should be done to "deliver quality training in Africa" by the Association of African Universities.[40] The need to achieve international accreditation, revise curricula to match the skill demand in the labour market and foster and reward research activity is emphasised.[40]

2.6 Technical and vocational education and training

Due to the large number of students who do not enter or complete their secondary education, either due to financial reasons or due to poor academic performance and the limited number of secondary and post-secondary education institutes, Mozambique has increased access to technical and vocational education and training (TVET).[41] The number of students in TVET has been increasing steadily, from approximately 32,000 students in 2004 to over 45,000 in 2011, attending over 145 public and private institutions.[30] The challenge is to align the training with the human resource needs of the local labour market and the local economy. The development of curricula based on recognised competency standards has been recognised as a priority in the Higher education Strategic Plan 2012-2016.[32]

2.7 Conclusion

This chapter provides background information regarding the economic and social contexts specific to Mozambique. Education in Mozambique is characterised by poor retention and completion rates at all levels, high pupil-teacher ratios, lack of access at higher levels of learning, a need to align courses of higher education to the country's

development programme, and a lack of human, academic and financial resources. This thesis addresses the challenge of training professionals for eye health and assessing their competence against the backdrop of this general context. The next two chapters describe the rationale for this study by providing data on incidence of blindness and visual impairment worldwide and specifically in Mozambique, and the management of blindness and vision impairment by appropriate training of human resources.

Chapter 3

Incidence and Causes of Vision Impairment

3.1 Introduction

Up to date information regarding the magnitude of global, regional and country-specific vision impairment, and an analysis of the existing resources and services determines whether eye care providers are adequately addressing the demand for eye care.[42] This is turn informs the understanding of the skills and human resources needed for refractive error services and leads to effective planning of eye care programmes. This chapter provides a definition of blindness and vision impairment and reviews the magnitude and causes of vision impairment globally, in Africa (concentrating on Southern Africa) and then finally Mozambique.

3.1.1 Definitions

According to the WHO, there are 4 levels of visual function:[43]

- normal vision
- moderate visual impairment (visual acuity is <6/18 > 6/60)
- severe visual impairment (visual acuity <6/60 >3/60)
- blindness (visual acuity <3/60).

Moderate visual impairment combined with severe visual impairment are grouped under the term “low vision” or moderate and severe visual impairment (MSVI); low vision taken together with blindness represents all visual impairment (VI).

Refractive error is a manifestation of the relationship between the optical components of the eye (i.e., curvatures, refractive indices, and distances between the cornea, aqueous, crystalline lens, and vitreous) and the overall axial length of the eye. The four most common refractive errors are:[44]

- myopia (nearsightedness): where the light that comes in does not directly focus on the retina but in front of it, causing the image that one sees when looking at a distant object to be out of focus, but in focus when looking at a close object;
- hyperopia (farsightedness): where the light entering the eye reaches a focal point behind the retina, while accommodation is maintained in a state of relaxation; astigmatism: where the light entering the eye propagates in two perpendicular planes with different focus resulting in distorted vision;
- presbyopia: is a condition associated with aging in which the eye exhibits a progressively diminished ability to focus on near objects due to a loss of elasticity of the crystalline lens.

3.2 Causes of Visual Impairment

3.2.1 Global causes of Visual Impairment

WHO estimates from 2010 report the major causes of visual impairment are uncorrected refractive errors (42%) cataract (33%) and glaucoma (2%).[2] Table 3.1 below shows the causes of visual impairment in terms of the estimated numbers of people in 2010.[2]

Table 3.1: The causes of visual impairment in terms of estimated numbers of people in 2010

Eye condition	Blind* (millions)	Low Vision* (millions)	Visually impaired (Low vision + Blind)* (millions)	Percentage
Uncorrected refractive error	1.18	118.68	119.86	42
Cataract	20.08	74.10	94.18	33
Glaucoma	3.15	2.56	5.71	2
AMD	1.97	0.89	2.85	1
Corneal opacity	1.58	1.28	2.85	1
Trachoma	1.18	1.67	2.85	1
Diabetic Retinopathy	0.39	2.46	2.85	1
Childhood	1.58	1.28	2.54	1
Undetermined	8.27	43.10	51.37	18
Total	39.37	246.02	285.39	

*Using the definition of visual impairment outlined by the WHO which defines impairment according to presenting vision. And combining the two categories of moderate and severe <6/18 > 6/60 and <6/60 >3/60 and referring to them as low vision (<6/18>3/60) with blindness <3/60.[43]

3.2.2 Causes of Visual Impairment in Africa (Southern Africa)

In Africa in 2010, 26.3 million people were visually impaired representing 3.26% of the population.[2] A literature review of published and unpublished population based surveys of the incidence, prevalence and causes of blindness and MSVI from 1980 to 2012, in

Southern Africa was carried out to estimate the magnitude and regional variation in the prevalence of blindness and MSVI.[45] Table 3.2 below shows the proportion of blindness and MSVI by cause in 1990 and 2010, identified from the literature review, in six countries in Southern Africa.[9] No data were available for Mozambique.

Table 3.2: Proportion of blindness and MSVI by cause in 1990 and 2010 in Southern Africa

Condition		1990 Mean % (95%CI)	2010 Mean % (95%CI)
Cataract	Blind	34.0 (29.0 to 39.8)	31.2 (24.6 to 39)
	MSVI	24.2 (19.3 to 29.6)	17.8 (12.3 to 23.9)
Refractive error	Blind	13.2 (7.8 to 17.3)	13.5 (8.0 to 17.7)
	MSVI	45.9 (36.7 to 52.6)	46.7 (37.4 to 53.2)
Macula degeneration	Blind	6.9 (5.5 to 8.9)	9.7 (6.7 to 14.1)
	MSVI	2.8 (2.0 to 4.2)	4.8 (2.8 to 7.7)
Glaucoma	Blind	5.4 (4.2 to 7.3)	7.3 (5.2 to 10.4)
	MSVI	1.5 (1.1 to 2.3)	2.6 (1.8 to 4.0)
Diabetic retinopathy	Blind	2.9 (2.0 to 4.1)	3.4 (2.1 to 5.8)
	MSVI	1.7 (1.3 to 2.6)	2.5 (1.6 to 4.6)
Trachoma	Blind	1.6 (1.1 to 2.6)	0.69 (0.4 to 1.1)
	MSVI	0.85 (0.4 to 1.6)	0.47 (0.2 to 1.0)
Other causes/ unidentified	Blind	36.1 (30.1 to 42.4)	34.0 (27.1 to 42.2)
	MSVI	22.9 (18.4 to 28.6)	25.2 (19.7 to 32.4)

From the above table, nearly half of the MSVI prevalence in Southern Africa is due to URE. Visual impairment due to URE is potentially debilitating and limits the affected individuals' opportunities in education and employment.[10] This lack of opportunities can impose a substantial socioeconomic burden with a significant impact on societies

and individuals.[46] These findings indicate that URE is a significant problem and indicate the need for urgent implementation of cost-effective refractive services.

3.2.3 Magnitude and causes of visual impairment in Mozambique

There has been a paucity of published data on blindness and vision impairment in Mozambique. The National Plan for Ophthalmology (2007 – 2011) failed to afford sufficient emphasis to URE as a major cause of severe vision impairment.[47,48] An updated plan is currently in development, and is expected to be launched in 2015. There is no VISION 2020 committee or a VISION 2020 plan at a national or provincial level.

A rapid assessment of avoidable blindness (RAAB)[3] survey was conducted in Sofala, a province located in the central region of Mozambique, in 2012.[53,54] The RAAB study results showed that the prevalence of blindness (presenting VA <3/60, better eye) among those who are 50 years of age and older was 3.2 % [2.6 to 3.8; 95 % CI]; and that of visual impairment (presenting VA<6/18 in the better eye) was 17.5 % [CI: 16.3

[3] The Rapid Assessment of Avoidable Blindness (RAAB) and the Rapid Assessment of Refractive Error (RARE) have been developed as simple, rapid and scientifically rigorous survey methodologies when accurate and timely information is required. Rapid assessment methods are useful to prioritize the most affected regions, identify high risk groups and help develop targeted intervention for those who can benefit the most.[49] While they are not a substitute for conventional study methods, they have a wide range of applications in public health in needs analyses and monitoring interventions.[49] The RAAB provides data on the prevalence and causes of blindness focusing primarily on the prevalence of avoidable blindness, which is blindness due to cataract, refractive errors, trachoma, onchocerciasis, and other corneal scarring.[50] It covers individuals aged 50 years or more among whom the prevalence of visual impairment is higher.[49] RARE is a research method to conduct population based cross-sectional studies on refractive error to understand refractive error prevalence locally and to mount an appropriate health care response. Younger age groups, 15-49 years are selected for the survey, as refractive errors are a common cause of visual impairment in this age group. It has been described and applied previously in countries such as India and Eritrea.[51,52]

to 18.9]. This is higher than the published prevalence of blindness and visual impairment in neighbouring Tanzania and Kenya.[55,56] Cataract was identified as the leading cause of blindness (54%) and visual impairment (48%) in Sofala. URE was responsible for 29% of visual impairment among people aged 50 years and over. Other eye conditions identified as contributing to the prevalence of blindness were: glaucoma 23%, corneal scars 11% and trachoma 4%.[53]

With regards to refractive error prevalence, a study conducted among urban students between the ages 17 and 26 years found the prevalence of refractive error in Mozambique to be 17.8%, with myopia prevalence being higher (13%) than hyperopia at 4.8%.[57] A rapid assessment of refractive error (RARE) study was carried out in the Nampula district of Nampula province in north-eastern Mozambique on a total of 3457 respondents between the ages 15 and 50 years old.[58] The prevalence of vision impairment was 3.5%, with 65.8% of those visually impaired being 35 years of age and older. URE prevalence was 2.6% and was the primary cause of vision impairment among 64.5% of cases. The spectacle coverage for URE, defined as the proportion of need that was met by the respondent's own spectacles,[49] was 0%. Presbyopia prevalence was higher, at 25.8% with only 2.2% spectacle coverage. URE and presbyopia prevalence was lower than that reported in similar RARE studies in Eritrea (6.4% and 32.9% respectively) and India (4.3% and 63.7% respectively).[51,52]

The important finding to emerge from the RARE study is the paucity of spectacle coverage (almost zero coverage) among those exhibiting significant URE and presbyopia.[58] The significant majority of participants (69.4%) resided in urban areas, where one would expect better access to services relative to rural areas (Nampula city,

in which Nampula Central Hospital provides centralised eye health services, is located in Nampula District where the study was conducted). Looking at similar context provision in Eritrea and India, the coverage was under expectation. In Eritrea, the coverage was 22% for RE and 10% for presbyopia while in India, the coverage rates were marginally better at 29% and 19% for RE and presbyopia respectively.[51,52] While such coverage rates are still remarkably low, they still provide some semblance of an operational RE service, unlike the coverage rates in Nampula- 0% (URE) and 2.2% (presbyopia). These findings would support the view that a large proportion of the population in Mozambique do not appear to have access to eye health service delivery systems including refractive services for URE.

3.3 Conclusion

Collectively, the RARE and RAAB studies have demonstrated that the high proportion of treatable causes of visual impairment justifies further action to develop a coherent, comprehensive, affordable and accessible eye care service including refractive error services in Mozambique. Provision of eye care services have to be resourced and managed. The next chapter describes a health systems approach to manage visual impairment.

Chapter 4

Management of Vision Impairment

4.1 Introduction

This chapter reviews the management of vision impairment and the development of human resources to address URE. It focuses on the different levels of eye care service delivery and the related cadres in Mozambique. The training of available eye care personnel and the need for assessing their competence in refraction are also discussed.

4.2 Management of Vision Impairment

Collectively, the RARE and RAAB studies have demonstrated that the high proportion of treatable causes of visual impairment justifies further action to develop a coherent, comprehensive, affordable and accessible eye care service including refractive error services in Mozambique. Provision of eye care services have to be resourced and managed. In order to provide these services a health systems approach is increasingly being used. The WHO definition of a health system is 'all organisations, people and actions whose primary intent is to promote, restore or maintain health'.[59] A health systems approach allows the various health system actors (the public, the Ministry of Health, providers, financiers and regulators) to consider the activities of various stakeholders in the delivery of the overall purpose of the system.[60]

One of the essential elements of a health system approach is to consider the role of human resources and their education in the overall delivery of health outcomes.[61]

Comprehensive human resource planning should be based on the principles of provision of eye care as an integral part of the health care system at all levels.[62,63] The WHO global action plan 2014-2019 which aims to reduce the prevalence of avoidable visual impairment by 25% by the year 2019, is built using the health system approach, which encompasses the integration of eye care programmes and personnel, defined by their scope of practice, into the wider health care system at all levels (primary, secondary, and tertiary).[13] Scope of practice refers to the boundaries of individual practice for each of the health personnel.[64] It embodies competencies unique to that particular group as well as shared competencies that are common with other groups.

In a health systems approach, the interdependence of the health and education sectors is paramount.[61] Linking the training of the health personnel with the health delivery model above will determine the most efficient skill mix and personnel with clearly defined roles and the scope for task-shifting.[61] Task-shifting involves the rational redistribution of tasks, where appropriate, from highly qualified health workers to health workers with shorter training and fewer qualifications in order to make more efficient use of the available human resources for health.[65]

4.3 Human resources for eye health

Six cadres of human resources have been identified in Vision 2020 plans and appropriate to the sub-Saharan context:[9]

- ophthalmologists,
- ophthalmic clinical officers (or ophthalmic technicians in Lusophone Africa),
- ophthalmic nurses,

- cataract surgeons,
- optometrists and
- mid-level refractionists.

The WHO in 2014 has classified all the cadres apart from ophthalmologists, cataract surgeons and optometrists as allied ophthalmic personnel characterized by different educational requirements, legislation and practice regulations, skills and scope of practice, between countries and even within a given country.[13] For this thesis the term mid-level eye care personnel (MLEP) is used for all allied ophthalmic personnel.

Human resource development remains the major challenge to the successful expansion of refractive error services.[66] There is clear evidence that the number of eye care professionals is insufficient to effectively meet eye care needs in sub Saharan Africa.[9] Moreover, the inequitable distribution of eye care personnel between urban and rural areas has resulted in inequalities in service provision. While increasing the number of ophthalmologists should be a priority, this strategy in itself will not be sufficient to overcome the need for increased human resources due to the amount of time and costs involved.[67] Optometrists and MLEP are the cadres of eye care workers that are trained to correct refractive error to prevent visual impairment so the expectation is that adequate numbers will be trained and effectively deployed to reduce the prevalence of URE.[66]

Optometry has been recognised as an independent profession in primary eye care provision in most developed countries but its role is underdeveloped and unresolved in the majority of low income countries.[5] In recent years, optometry's role in the provision

of eye care, particularly in the elimination of vision impairment from refractive error has also been acknowledged by the WHO.[68]

In Africa until the mid 1990's, only four countries conducted Optometric-training programmes, South Africa, Ghana, Nigeria and Tanzania.[69] No training programmes existed to serve Lusophone and Francophone African countries. Since 1997, six more countries have established optometry courses.[70] However, the number of optometrists is inadequate to meet the growing demand for refractive error services.[9,71] In countries where optometry has been established there still exist gross inequities in access to eye care services.[70] The vast majority of the rural population still have no access to optometric services while graduates continue to remain largely centred in urban affluent areas.[70]

Due to the insufficient numbers of ophthalmologists and optometrists, MLEP are often responsible for the bulk of eye care service provision particularly in the rural areas where eye diseases are more prevalent.[72] Global health and blindness prevention organisations emphasise the importance of training programmes and the recruitment and retention of MLEP in remote communities.[73] Their scope of practice is dependent on the demand for eye care and corresponding human resource need. Their deployment has depended on local needs and perceptions, finances and health systems.[67]

The training of MLEP has been reported as 'being poorly defined'.[67] The WHO had produced a standard curriculum with broad outlines on an overview on blindness/ community eye care, clinical functions (including refraction) and eye health management functions with the expectation that contents of sub-topics would be

developed at a national level because they were country specific.[74] However no further progress on the implementation of the standard curriculum had been documented.[67] Currently there are several training courses, each with its own curriculum in place in sub-Saharan African countries.[75] Defining the role and training of MLEP remains a priority issue to address vision impairment.[75]

The advantages of using MLEP have been well-documented. They can, and do, perform some of the functions of the more traditional health professionals with specialist qualifications, with the advantages of lower entry educational qualifications and a shorter period of training.[72,76] However, for the past 20 years, the functions of this cadre have not been definitively outlined, and the competencies they require to provide high quality comprehensive eye care have not been yet been established.[67] Table 4.1 below summarises the advantages and disadvantages of using mid-level eye care personnel.[67,72,77,78]

Addressing the challenge posed by visual impairment from URE requires the development or strengthening of eye care cadres working together with defined scopes of practice and the integration of refraction services in the delivery of comprehensive eye care.

Table 4.1: Advantages and disadvantages of using mid level eye care personnel

Advantages of using mid-level eye care personnel	Disadvantages of using mid-level eye care personnel
1. Shorter professional training and training accessible to entrants with secondary school education.	1. Quality of care may suffer with poor clinical decision-making or poor supervision and evaluation of their practice
2. Requires smaller numbers of highly trained tutors and professionals	
3. Can be trained in dedicated training institutes without sophisticated equipment	2. Practice regulation can be absent
4. Training can focus on challenges relative to local context and thus not involved in international health labour dynamics	3. Cost of complications and poor treatment results may offset lower costs of training
5. Salaries after employment are considerably lower than traditional cadres	4. Risk of inter-professional conflict with cadres carrying out similar tasks
6. Can be more readily deployed and retained in remote and sparsely populated areas	

4.4 Eye Care provision within the Mozambican National Health System

4.4.1 Background

The health services in Mozambique have gone through a period of rapid expansion after the civil war. However, access to health care is still poor.[28] The health system is composed of public, private for profit and non-profit private sector. The public sector is the main provider with a network covering only about 60% of the population.[23]

The National Health System (NHS) is the largest provider of health care services. A network of 3 central hospitals, 7 provincial hospitals, 5 general hospitals, 26 rural hospitals, and 1179 district health centres and health posts under Government control compose the public health care system in Mozambique.[28] Over the past decade, the Mozambique Ministry of Health has prioritized expanding the overall number of facilities and enhancing facility capacity by transforming lower level health posts into health centres and increasing rural and district hospitals. During this time economic growth and increased development assistance has led to an increase in health sector spending, growing from less than USD$10 per capita in 2001 to approximately US$26 per capita in 2008, of which more than 70% is financed by external aid.[79]

Mozambique ranks among the highest human resource-constrained countries in the world, with four doctors and 41 nurses/100,000 people compared to a regional African average of 26 doctors and 120 nurses.[23] This is as a result of low levels of training, increased attrition, and rapidly-changing health needs. Health staff distribution around the country still shows considerable regional asymmetries. The career structures in Mozambique have been reviewed as a lopsided pyramid, in which the base (largely unskilled health workers) is too wide and the middle layers (mid-level health workers at progressively higher levels of education) are too narrow at present.[28]

4.4.2 Levels of eye care service delivery

The eye care service delivery system in Mozambique is comprised of three levels of care: primary, secondary and tertiary. This is in line with the recommendation from the WHO working group on refractive error to adequately manage URE.[80] Figure 4. 1 below demonstrates the levels of eye care service delivery and related cadres in Mozambique.

i) Primary level: Components of primary eye care include eye health education, symptom identification, visual acuity measurement, basic eye examination, diagnosis and referral for disease.[63] This is provided by nurses, traditional medicine practitioners in the community and community health care workers. Due to the lack of any trained elementary or basic level technicians for eye care, OTs, (mid-level workers) are also working at this level in health centres, district and rural hospitals. They are the only personnel at the primary level trained to carry out refractions.

Primary health care nurses are trained to either an elementary (after seventh grade) or basic level (after 10^{th} grade) and work at health centres, district and rural hospitals. Their knowledge of eye care is limited. However, they are the only health cadre working in eye care in health centres without an OT.

Traditional medicine practitioners in Mozambique typically hold positions of authority within their communities despite their lack of formal training.[81] More than 75% of the population use traditional medicine (TM) and often turn to traditional practitioners as the first point of call.[82]Mozambique has a legal framework for traditional medicine

practitioners and an association Associação dos Médicos Tradicionais de Moçambique (AMETRAMO).[81] The broad use of TM practitioners is often attributable to their accessibility and affordability. Although there are no published statistics detailing the number of healers in Mozambique, the number of healers is significantly greater in number than the 1000 doctors currently practicing in the country.[81] Involving traditional healers in eye care activities develops their existing capacities so that they can provide the best possible primary eye care within the structure of their relationship with patients and the community.[83]

Community health care workers are a cadre whose work and training is defined either by the government or NGOs working in eye care. They are instructed to refer patients with any eye abnormality to the nearest health facility. They support preventive health care and public health oriented projects. Presently, no data are available on their numbers.[28]

ii) Secondary level: This is the level to which patients who cannot be managed at primary level are referred. It includes management of anterior lid conditions, corneal and intraocular infections, primary open angle glaucoma and refractions. This is provided by OTs at rural, provincial and central hospitals. The recently graduated optometrists are now working in provincial and central hospitals at this level.

Ophthalmic Technicians: OTs were introduced in Mozambique in the mid-1980s.[84] Given the desperate shortage of ophthalmologists, their main purpose was to identify and treat patients with common eye conditions particularly in the rural areas where eye diseases are more prevalent and there are no or few ophthalmologists.[72] In Mozambique,

up until 2010 there were only 34 OTs.[14] Twenty six more OTs qualified in 2010 on an 18 month course in Mozambique.[15]

Optometrists: In Mozambique the exact scope of practice of optometry is not defined but the curriculum enables them to perform at least up to category three (detecting, diagnosing and managing ocular disease) of the WCO competency model.[85] Nine students graduated from UniLúrio in 2012, six in 2013 and 13 in 2014. Nine of them are working within the NHS within 13 just about to enter the NHS. These graduating students are the first three cohorts of qualified optometrists working without any supervision in practice and limited alternative refractive care.

iii) Tertiary level: The management of conditions requiring complex equipment and specialised staff is carried out at this level. Services are provided by ophthalmologists, optometrists (involved in pre and post-operative care) and OTs working in provinical and central hospitals. Ophthalmologists are physicians who specialize in the eye and visual system. They deliver medical and surgical eye care interventions as well as conducting refractions. At present there are only 10 trained Mozambican Ophthalmologists in the country along with 7 expatriates.[14] The VISION 2020 target is 4 ophthalmologists to a population of a million people.[3] Mozambique would need 100 ophthalmologists to serve its population of 25 million by 2020.

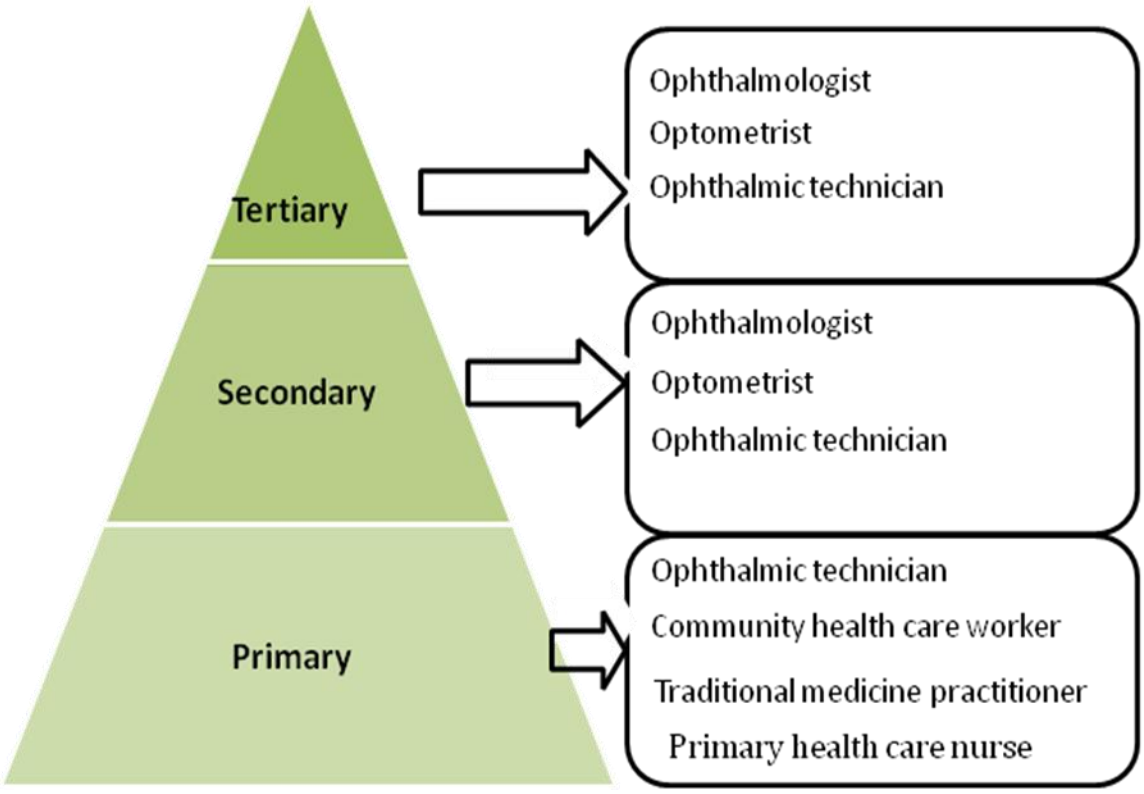

Figure 4.1: Levels of eye care service delivery and related cadres in Mozambique

4.4.3: Training of human resources for eye health in Mozambique

Training of health professionals is a shared responsibility between the Ministry of Education and the Ministry of Health (MOH).[86] The Ministry of Education licenses the training institutions and approves the training syllabus and recognises training diplomas or degrees obtained outside Mozambique. At the national level the Ministry of Health sets country health policy and the policies for the development of human resources for health and their training.[86] At a provincial level it is represented by the provincial health directorate whose function is to oversee the implementation of health policies, manage human resources, train mid-level, basic and elementary health cadres and provide health care including eye care services within its administrative boundaries and at district level. [86]

Human resources in the health sector in Mozambique are legally defined into seven divisions.[28] The training of health personnel is broadly designated as being at elementary, basic, medium and high level and is carried out at Health Science Institutes around the country. The importance of this legislation is that it helps manage career development and progression, and explains their scope of practice. Table 4.2 below shows the classification of the different eye care professionals.

A rural-based auxiliary technician or elementary nurse would have 12- month training after their 7th grade primary school. A rural or urban based assistant technician/ medical technician/ basic nurse would have 18- month training in general healthcare after their 10th grade high school. They would work in primary care.[28,87] There is no training in eye care for the auxiliary or assistant technicians. For Ophthalmic technicians as a mid-level

cadre (OTs) there is a further period of training. Some were trained in Cuba on a three year course directly after their 10th grade high school. The rest either trained as medical technicians or basic nurses (18-month course) on completion of their 10th grade to be selected for a further course to become mid level (24 month course in Mozambique or 12 month in Malawi).[72] All the OTs are working (and getting paid) at the level of health technicians. There is a differentiation at higher levels only for salary progression. An OT with a degree (in any specialty) is a specialized technician and an OT with an honors degree a Higher Level technician. However, the output of training institutions is insufficient to respond to the growing demand for a larger and better-trained workforce.

Table 4.2: Legislated eye care professionals as defined by health careers

Level of training	Division	Relevant eye care personnel
Elementary	Auxiliary technician	
Basic	Assistant/ Medical technician/ Nurse	
Middle	Health technician	OT
	Specialised technician	OT
	Specialised technician N2 (BA)	OT
	Higher level technician N1 (BA Honors)	OT
Higher	Physician and health specialist	Ophthalmologist

Abbreviations: OT: Ophthalmic Technician BA: Bachelor of Arts

Higher levels of medical training are at present offered at four faculties at the University Eduardo Mondlane, Catholic University of Beira, UniLúrio and UniZambezi.[88,89] Ophthalmologists work at the central and provincial hospitals in tertiary settings. Their

training involves six years at a medical school and four years post-graduate specialisation. The four-year training of optometrists at UniLúrio has not been included in this classification but it is likely to be under the classification of Higher level technicians N1 (BA Honors) comparable to a university trained pharmacist or dentist. Table 4.3 below gives the number of qualified eye care personnel working in the 11 provinces of Mozambique in 2011 compared to the V2020 targets.[3,90,91]

Table 4.3: Province and number of eye care personnel in 2011[90]

Province	Population served	Human Resource	V2020 Target by 2020[a]	Number working in 2011
Cabo Delgado	(1,605,549)	Ophthalmologists OTs	7 33	1 3
Gaza	(1,226,272)	Ophthalmologists OTs	5 25	0 6
Inhambane	(1,252,479)	Ophthalmologists OTs	6 26	1 4
Manica	(1,412,029)	Ophthalmologists OTs	6 29	1 4
Maputo city	(1,094,315)	Ophthalmologists OTs	5 22	6 9
Maputo Province	(1,205,553)	Ophthalmologists OTs	5 25	0 1
Nampula	(3,985,274)	Ophthalmologists OTs	16 80	2 8
Niassa	(1,169,837)	Ophthalmologists OTs	5 24	2 6
Sofala	(1,642,636)	Ophthalmologists OTs	7 33	2 4
Tete	(1,783,967)	Ophthalmologists OTs	8 36	1 4
Zambezi	(3,848,274)	Ophthalmologists OTs	16 77	1 7

[a] V2020 target ratio for ophthalmologists is 1: 250,000 by 2020[3]

V2020 target ratio for refraction personnel 1:50,000 by 2020[3]

4.4.4 Training and evaluation of OTs

The scarcity of health professionals with sufficient training, and lack of adequate knowledge of ocular pathology amongst the auxiliary and assistant technicians (medical technicians), motivated the Ministry of Health along with Light for the World (an eye care NGO) to develop a second training center in Beira to start specialist-training programmes in order to educate ophthalmic technicians. Thirty one students who previously trained as basic nurses or medical technicians went on the course in 2011. Candidates working in the districts were prioritized for the training. Upon completing the 18-month training, each of the students took up a guaranteed position as an ophthalmic technician in their own provinces. This has the added benefit that mid level workers readily relate to the communities they serve.[72]

The curriculum used for training OTs in 2010/2011 is based on one from 1996 when the last group of OTs qualified from Maputo. The training programme for the OT in Mozambique includes clinical and management competencies (Appendix A).[47,92] Refraction is a significant component of the daily work load of an OT and is also one of many skills that they need to perform their work effectively. In the Central Hospital in Beira in central Mozambique, in 2011 out-patient conditions seen at the hospital eye department, in order of prevalence, were refractive errors, conjunctivitis, cataract, ocular trauma and glaucoma.[93] In most provinces they are the only providers of refraction services (due to the limited number of Ophthalmologists and optometrists) within the national health system.

The knowledge and level of refraction skills of the existing OTs in Mozambique is uncertain because the duration, location and specifications of their training is known to be varied. The OTs that are working at present appear unlikely to have uniform skills, and are thought to be deployed in situations with different characteristics, especially with regards to equipment availability and support structures. No study to date has evaluated the refraction capacities of OTs or other MLEP in Africa.

Assessing the confidence and competence in refraction of trainee and qualified OTs, will provide valuable information on the existing provision of refraction services. Confidence in clinical skills has been used as a subjective indicator of clinical competence.[94] The information obtained will determine the skills and human resources to adequately address the demand for refraction services. This will lead to the overall aim of defining a competency framework for refraction service provision in Mozambique, for new OT curricula, relevant to the professional demands and practice. The development of competency frameworks and competency-based scopes of practice for all MLEP has been emphasised as a key component of the human resource strategy to address vision impairment from IAPB Africa.[75] This could be translated in other developing countries with similar health and human resource contexts to harmonise curricula for all MLEP training courses (ophthalmic clinical officers, ophthalmic technicians and ophthalmic nurses). This would enable a coordinated training and development model for all MLEP involved in refraction.

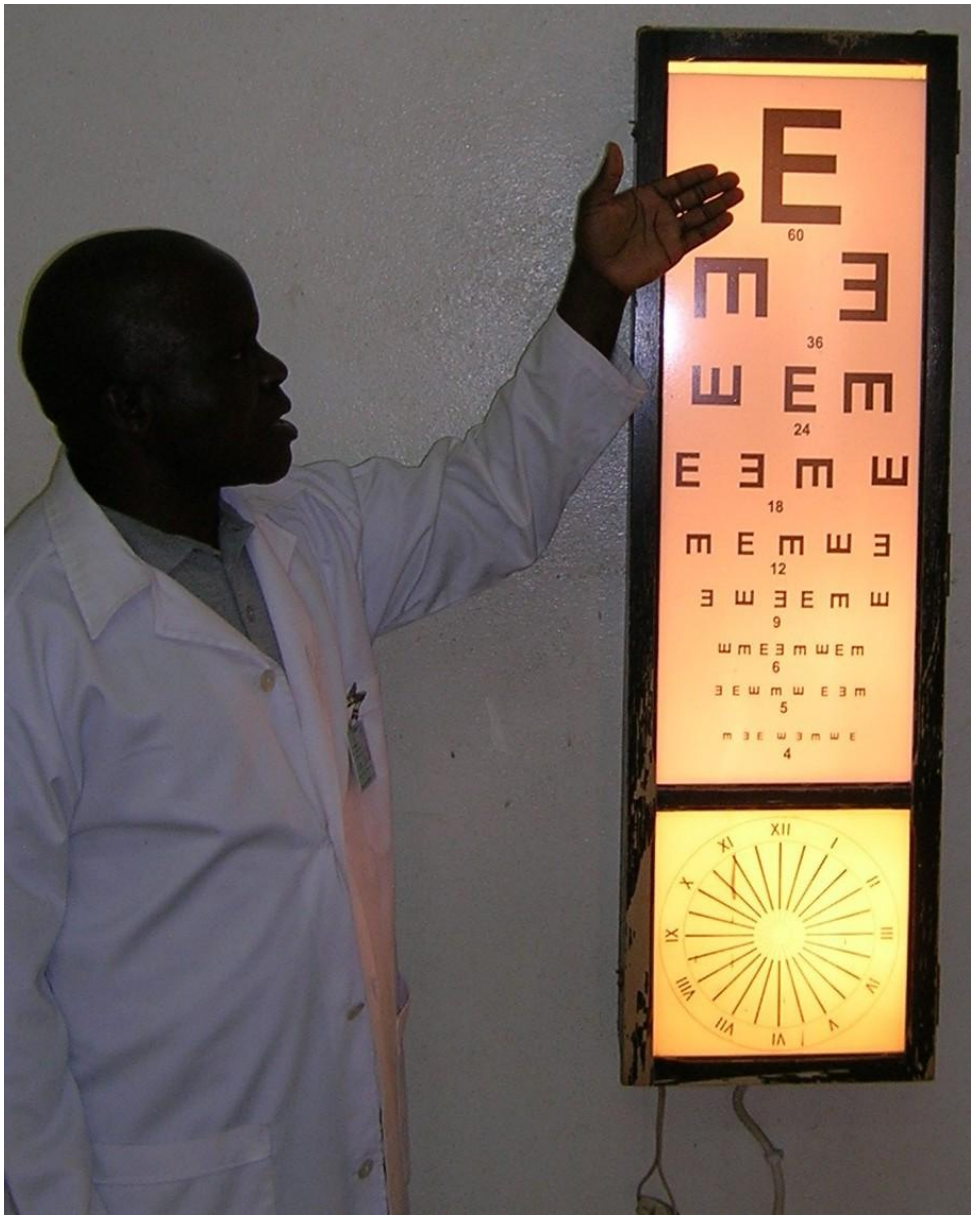

Figure 4.2 Ophthalmic technician with visual acuity chart

4.4.5 Training and evaluation of optometrists

The four year course for the optometrists at UniLúrio was based on a curriculum developed by the Brien Holden Vision Institute with competencies drawn from the optometry courses of the Dublin Institute of Technology (DIT), University of KwaZulu-

Natal (UKZN) and the competency-based model of the World Council of Optometry (WCO) (Appendix B). [85,95,96] The WCO 'Competency-Based Model of Scope of Practice' includes four categories of clinical care: optical technology services, visual function services, ocular diagnostic services and ocular therapeutic services.[85] To be defined as an optometrist, a practitioner must provide the services in the first two categories, the entry-level threshold for the practice of optometry worldwide. In Mozambique the exact scope of practice of optometry is not defined but the curriculum enables them to perform at least up to category three (diagnosis). The course includes basic and clinical science modules and significant clinical components from semester five of the third year.

Initially the MEP proposed a model of optometric training that comprised a four year two-tiered university-level training programme to ensure a rapid generation of trained personnel to serve at a primary level within the health system, whilst creating a career and referral pathway to higher levels of care.[97] This multiple entry and exit model was being implemented in Malawi and Eritrea.[7]

The first intake of 16 students, enrolled on the course in Mozambique, had to take a preparatory semester to remediate inadequacies in secondary school education that are manifest in some applicants to higher education. [98] However, legislative reform in Mozambique implemented in 2009 resulted in a full four year Bachelor's degree in optometry being the minimum recognised qualification allowable at university level in Mozambique.

The students on the optometry course were assessed progressively by two means: continuous assessment (formative) and a final end of module exam (summative). The theory exams (both formative and summative) included a combination of multiple choice questions, short-answer questions and case analysis. The regulations stipulated by the university were as follows for the theory exams:

Those with marks less than 50% in the continuous assessment were not allowed to sit the final exam and had to repeat the module.

Those with marks between 50-75% were allowed to sit the final exam.

Those with marks more than 75% were exempt from the final exam.

The final mark was an average of the continuous assessment and final exam with a 50% overall pass mark. If the continuous assessment mark was greater than 50% but their final assessment mark wasn't, students were allowed to re-sit the final exam

Students are allowed to carry up to two modules into the next year of the programme as long as the modules are not pre-requisite for the following year as demonstrated in Appendix B. If they are pre-requisite or more than two modules are failed, they are not allowed to proceed.

For the clinical exams in years three and four the pass mark is 75% and judged as a combination of continuous assessment and final assessment. Every patient encounter was graded, by the clinic supervisor, for the continuous assessment. If a student failed the continuous assessment (average less than 75%), they were not allowed to progress.

From the first intake of 16 students only nine students entered the final year of the programme, and six from the second intake of 24 students. External evaluations of competencies of the graduating optometrists from UniLúrio, Mozambique using the WCO framework [85] and identifying factors affecting student performance will lead to the establishment of locally relevant competency frameworks for national optometry curricula and establish scope of practice with an increased emphasis on refraction services, eye disease detection and referral and eye health promotion in a developing country context. The framework could be adapted for use for optometry students in other developing countries with similar health and human resource contexts. The harmonisation of optometry curricula and establishment of competency standards across the 17 established optometry institutions across Africa (programmes include three-year Diploma in Optometry, four-year Bachelor of Optometry and five-year Doctor of Optometry) has been identified as a key human resource for eye health strategy for the International agency for the prevention of blindness (IAPB) Africa as the scope and practice of optometrists are currently poorly understood by policy makers.[75]

Figure 4.3: Optometry student demonstrating an anterior eye examination

Figure 4.4 Optometry students at UniLúrio

4.5 Conclusion

OTs and optometrists are an integral part of refraction service delivery in Mozambique. Forming teams of complementary cadres of eye care providers, working in one location or geographically spread, these personnel will provide accessible and timely eye care, either as a carer where training and facilities allow, or as a referrer in a chain of escalating care. This concept has crystallised as one of the key strategies underpinning the VISION 2020: The Right to Sight initiative to eliminate avoidable blindness.[3]

A health systems approach for an effective eye care delivery system needs eye care cadres working together with defined scopes of practice. The development of a clear set of competencies will define the training requirements and scope of practice of OTs and optometrists in refraction service provision. This competency-based approach will specify the health problems to be addressed, identify the requisite competencies required of graduates, tailor the curriculum to achieve competencies and assess achievements and shortfalls. This in turn will assist the human resource development goal of V2020 by ensuring that the education of new eye health care workers is responsive to the needs of the health care system. This along with adequate resources, infrastructure and supportive supervision will ensure that the cadres can implement their training and have the opportunity of providing high quality eye care.[67] The next chapter explores the benefits and challenges of competency-based education (CBE) and the implications of CBE and assessment for developing countries.

Chapter 5

A literature review of competence, competencies and competency based approach to education

5.1 Introduction

Improvements in global health can be realized through the development of a workforce that has been educated and trained to promote health and to care for those with disease.[99] The development of competency- based education for eye care personnel has received increased attention as a means for optimizing the education and training of eye health professionals and has been identified as an important component in the solution to avoidable blindness and vision impairment.[67,75,100] Many health care programmes such as ophthalmology[101] and optometry[102], now base their curricula on competencies. Clinical professions are often concerned not just with knowledge acquisition, but attainment of skills and their application.[103]

The first section of this chapter will outline the definitions of competency and follows with a description of CBE and how this can be distinguished from the more traditional approaches to training health professionals. It is followed by a discussion on implications of CBE for developing countries.

5.2 Definitions of competence

Whilst the notion of competence is being used to guide planning and design of healthcare training it is also important to recognise that it is a nebulous concept defined in different ways by different people.[104] Three concepts form the basis of various approaches to defining competence:

(a) generic approach: This approach focuses on the individual and the underlying attributes such as knowledge or critical thinking capability that enable individuals to perform well.[104] It provides the basis for transferable or more specific attributes.[105] It focuses on the individual.[106] With this approach, context is ignored and it is assumed that these general underlying attributes can be applied to different situations.[106] Generic competencies are perceived as important by several professions and the names of competency domains are similar.

(b) behavioural approach: In this approach, competence is a description of an action, behaviour or outcome in a form that is capable of demonstration, observation and assessment. Its focus is more on performance than on knowledge and it is concerned more with what people can do rather than with what they know.[105,106] It focuses on the task related to the job rather than on individuals' personal traits.[104]

(c) holistic approach: This brings together the generic and behavioural approach combining the general underlying attributes of the practitioner with the context in which these attributes might be applied and are described as a range of general attributes such as knowledge, skills and attitudes appropriate for professional practice.[105]

This integrated and holistic approach aligns with the definition of competence provided by the General Optical Council in the UK: "Competence (plural competences) has been defined as the ability to perform the responsibilities required of professionals to the standards necessary for safe and effective practice. A competency will be a combination of the specification and application of a knowledge or skill within the occupation, to the appropriate standard".[107] The healthcare professions have adopted the holistic approach to competence.[108] For this thesis I have used the holistic approach of competence.

A competency can only be defined within a given set of conditions. What is competent in one country or organisation might not be appropriate in another.[108] Competence is contextual, reflecting the relationship between a person's abilities and the tasks he or she is required to perform in a particular situation in the real world.[109] The definition of competence is inextricably bound to local political, social, economic circumstances, technological and environmental issues and factors,[110] to health needs, to the availability of resources, and to the structure of the health care system.[108] Common contextual conditions include the practice setting, the local prevalence of disease, the nature of the patient's presenting symptoms, the patient's educational level, and other demographic characteristics of the patient and of the physician.[109]

5.3 Evolution of educational models

The educational models for health service providers have been evolving for over a century, influenced by the changing health environment (due to technological, epidemiological, demographic and social changes). There are three main 'generations'

of educational models for careers such as medicine, dentistry, nursing and pharmacy.[61] The first generation, launched at the beginning of the 20th century, taught a science-based curriculum.[111] Around the mid-1990's the second generation introduced problem-based instructional innovations.[111] This emphasised the notion of apprenticeship and linked education, provision of care and research. A third generation, systems-based learning, tries to establish links between the education of new professionals, societal needs and health system demands in a globalised world. It aims to develop a culture of socially responsible professionals. It focuses on patient- and population- centeredness and a competency-based curriculum to improve the performance of health systems.[61] Figure 5.1 demonstrates the reforms in health education over the three generations.[61]

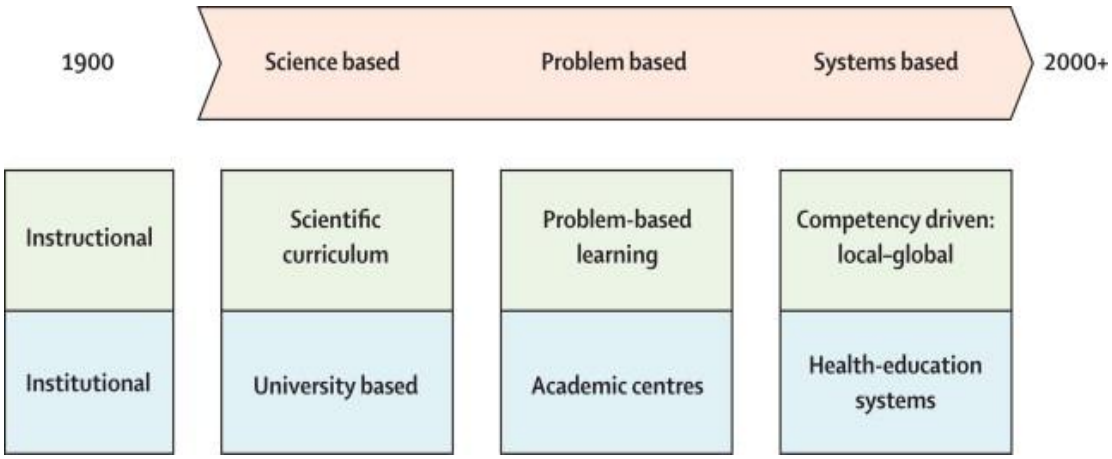

Figure 5.1: Reforms in health education

5.4 Competency- based education

Traditional education criteria are organised around knowledge objectives that tend to emphasise the instructional process regardless of the product of the programme. Traditional methods are increasingly being replaced by CBE which takes the opposite

position: educational outcomes guide all curriculum decisions, and curriculum processes are secondary.[112] The comparisons between the traditional teacher centred, didactic, lecture based teaching and the student-centred competency based system that defines the desired outcome of training, the outcome driving the educational process, is demonstrated in Table 5.1 below.[112]

Table 5.1: The competencies-based training approach to learning compared with traditional approaches

	Competencies-based training approach	**Traditional**
Driving force for curriculum	Outcome-knowledge application	Content- knowledge acquisition
Driving force for process	Learner	Teacher
Evaluation	Criterion-referenced	Norm- referenced
Goal of educational encounter	Knowledge application	Knowledge acquisition
Programme completion	Variable time	Fixed time

Competency- based education provides a measure of quality in that it can assist in clarifying, for both teachers and students, the expected learning outcomes. Goals and objectives are statements that focus on the goal-state or end-product.[108] Specific competencies serve to align course content to the application of knowledge and skills, allow for criterion-based assessment and enable students to learn to proficiently accomplish their expected tasks.[108]

It is important to ensure that healthcare professionals are competent. However, in order to do so, the required competencies have to be identified. A competency framework describes the competencies thought to be central to effective performance and is commonly used to support the development of healthcare professionals.[113] The definition of competencies in a framework will lead to clarity on which cadres are expected to be able to achieve which competencies. Competency frameworks can inform education curricula, inform the design and delivery of education programmes and provide the basis for evaluation, on-going continuing education and development programmes. They can define the scope of practice by setting training and practice standards, and the legislative base of practice. While there are a number of benefits derived from clearly defining scope of practice, frameworks can also reproduce conventional practices and limit innovation.[114] Recognising the constraints a framework can impose is an important step to promote better practice among professions.

5.4.1 Competency-based education for Optometry

The training of optometrists is turning towards competency based education. Competencies now form the basis of training programmes in educational establishments

in the UK, Ireland, South Africa, US and Australia.[107,115,116,117] For a practitioner to be registered as an optometrist, he or she has to show by some means of assessment that they are competent in the criteria listed. In 2005 the World Council of Optometry (WCO) adopted the 'Competency-Based Model of Scope of Practice' defining competencies for optometrists. It includes four categories of clinical care to reconcile the disparities in definitions and scope of practice around the world: [85]

1. Optical Technology Services: Management and dispensing of ophthalmic lenses, ophthalmic frames and other ophthalmic devices that correct defects of the visual system.
2. Visual Function Services: Investigation, examination, measurement, diagnosis, and correction/ management of defects of the visual system.
3. Ocular Diagnostic Services: Investigation, examination and evaluation of the eye and adnexae and associated systemic factors to detect, diagnose and manage disease.
4. Ocular Therapeutic Services: Use of pharmaceutical agents and other procedures to manage ocular conditions/disease

To be defined as an optometrist, a practitioner must provide the services in both categories 1 and 2 at a minimum. This has become the entry-level threshold for the practice of optometry worldwide. However the relevance of the borders between these categories has to be defined by local academics and regulators taking into account availability of resources and trained eye care personnel.

Optometry has been recognised as an independent profession in most developed countries with the advent of the universally accepted competencies, but its role is

underdeveloped and unresolved in the majority of low income countries.[70] The definition of competencies and scopes of practice may ensure that optometrists become an accepted part of a truly comprehensive health care team.[102]

5.4.2 Benefits and challenges of CBE

There are various advantages of CBE. The focus is on the end-product, on whether the student can use their learning to solve problems, perform procedures, communicate effectively or make good clinical decisions.[99] CBE emphasises the results of education rather than the processes.[99] The commitment to outcomes in the curricula, with the emphasis on graduate abilities, can fulfil the eye care personnel's societal contract to prepare clinicians to serve their patients and communities.[108] CBE promotes a true continuum of education. By defining competencies and milestones for each stage of education and practice, CBE can promote vertical and horizontal integration of training programmes, from community eye care workers, to MLEP, to optometrists and continuing professional development.[118] The advantages of competency-based education are applicable to low-income countries.[119]

There are, however, some disadvantages of competency based education.[120,121] For CBE to be practical and effective new educational technologies are required.[118] These include new teaching techniques, new modules, and new assessment tools. This requires significant investments in teaching and infrastructure, and perhaps even a larger workforce.[118] If applied inappropriately CBE can result in de-motivation, a focus on minimum acceptable standards, increased administrative burden and a reduction in the educational content.[120] Reflective practice can be ignored by reducing professional

practice to an exhaustive list of competencies.[122,121] The ideal is a model of professional education that recognises both basic standards and continuing professional development.[123]

5.5 Why is competency-based education and assessment a valid approach? Implications for CBE in Mozambique

To achieve 'Western' standards of training, African universities, historically, have had a tendency to adopt curricula from the West.[119] Over the last half a century however, major global pedagogical shifts have occurred in education without African universities keeping pace.[119] The lack of human resources coupled with socioeconomic and political instability has all contributed to the inertia. Moreover, the educational standards were not aligned to the availability of local resources (e g educational and infrastructure), which resulted in graduates emigrating further reducing the human resources available in developing countries.[124]

As more attention is being placed on relevant educational outcomes, there will be a tendency to copy the desired competencies that are being defined in developed county settings.[61] Competency in domains such as professionalism and communication are sensitive to the context of the individual and their culture. Many of the specific competencies that are promoted presume the presence of a functional health care system and an education system in which those competencies can be nurtured and fully appreciated.[99] This is not the case in many developing countries. Systems based approach with CBE involves the appreciation of and engagement with the relevant environments to produce suitable curricula.

CBE can map the specific eye health needs of the populations to a set of competencies for the eye health workforce to be trained.[99] The description of these health needs can be driven by academics and stakeholders who are responsible for the health of the population such as the Ministry of Health. Competencies will need to be context-specific and take into account the availability of faculty and local resources (diagnostic and therapeutic instruments at the professional's disposal). In other words, competency based education guides decisions about what graduates of the educational programmes must be able to do, in order to address the key health issues of the community.

One of the consequences of implementing a CBE system is that skills that were once considered the domain of only select cadres could potentially be "task shifted" to other cadres if they are able to perform the same skill competently. The lack of trained ophthalmologists in Mozambique has been highlighted in Chapter 4. The advantages of task-shifting (rational redistribution of tasks from ophthalmologists to other cadres) using lesser trained and qualified OTs, who are more likely to live and work in rural areas, and can relate to the communities they serve have also been described. Defining competencies for optometrists and OTs will give them a sense of professional identity and encourage recognition and respect from other health professionals.[72] It will provide information to employing organisations (Ministry of Health in Mozambique), regulating authorities and education and training institutes on the roles and responsibilities of the two cadres.[16]

5.6 Conclusion

This chapter has given an overview on the definitions of competence, along with the benefits and challenges of CBE and implications for developing countries. As was shown in Chapter 4 there is minimal eye care education in Mozambique. The development of sufficient personnel to address Mozambique's eye care needs rests on an efficient and effective training system. The requirement is not to produce more human resources, but to produce more human resources that are competent to address the eye care needs of the population. As optometry and other eye care education programmes move towards competency-based curricula and practice, educators require appropriate tools to support the acquisition and assessment of competencies. The next chapter describes the development of the methodology to assess clinical competence and develop a competency framework.

Chapter 6

Methodological Approach

6.1 Introduction

In this section the key methodological approaches used in this thesis are introduced. All of the individual analytical chapters (Chapter 7 to Chapter 10) have their defined methods and data analysis section. The first section of this chapter aims to identify and appraise the evidence base for assessment tools used primarily in evaluating refraction skills of eye care personnel by conducting a literature review. The second section provides a brief outline of the development of the course evaluation questionnaire for optometry students and qualitative interviews with lectures to evaluate factors affecting optometry student performance. The final section reviews consensus development methods for the development of competency frameworks.

6.2 A literature review of methods of assessing clinical competence

This review begins with a brief outline of the aims of assessment. The tools available for both formative and summative assessments are discussed, with particular reference to those used in assessing competencies in eye care. The problems of subjectivity and assessor variability associated with traditional teacher-led assessments are highlighted. Methods which have attempted to overcome these problems, such as the use of checklists and training are then discussed.

Miller's pyramid conceptualises the essential facets of clinical competence.[103] The base represents the knowledge components of competence 'knows' (basic facts). One level up, Miller describes the ability to use knowledge in a particular context as 'knows how'. At a higher level, 'shows how' reflects the ability to act appropriately in a practical situation and describes hands-on behaviour in a simulated or practice situation. The 'does' level refers to actual performance in day to day practice. The different levels of clinical competence are illustrated in Figure 6.1 below.[103]

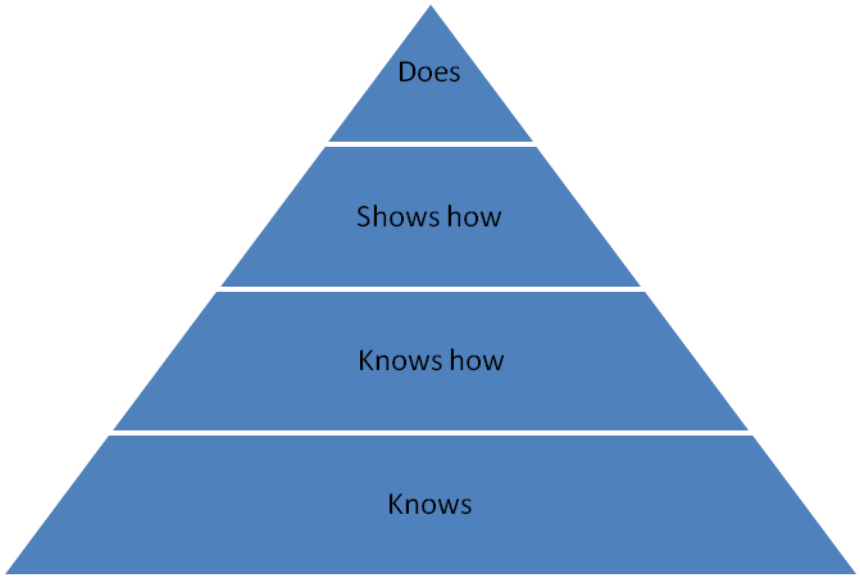

Figure 6.1: Miller's pyramid of clinical competence

6.2.1 What is Assessment?

Assessment is an integral part of the educational process at any level and in any discipline.[125] It can be used to facilitate learning and provide information to the student about their performance in addition to formal recognition of attainment of knowledge or skills. Assessment tasks that enable a student to demonstrate ability should be fair, open

and equitable for all candidates, make appropriate demands of candidates, be practical to implement and administer and provide results in a reasonable period of time.[126] A good assessment procedure considers the type of assessment and the role of assessors.

6.2.1.1 Types of Assessment

Assessments are usually classified as summative or formative.[125] Summative assessments are designed to evaluate knowledge and provide formal recognition. They are usually used at the end of a course or unit and often used to determine student progression. When assessment is used for summative purposes, the score at which a student will pass or fail has to be defined.[127] Formative assessments are used as more of a diagnostic tool to provide feedback about the student's progression, which can be reflected upon in order to make any required improvements. Formative assessments are usually not used for formal recognition, but to aid the learning process.[125]

Two types of testing are usually employed to assess skills: norm-referenced and criterion-referenced.[128] Norm referencing involves comparing one student with others. It is frequently used in examination procedures if a specified number of candidates are required to pass as in some college membership examinations. Performance of an individual is described relative to the positions of other candidates.[127] As such, variations in the difficulty between tests are compensated. However, differences in the abilities of student cohorts sitting any single test are not accounted for. Therefore, if a group is above average in ability, those who might have passed in a poorer cohort of students will fail.

In criterion-referenced testing, tests are designed to ensure that a student has obtained mastery in an area of knowledge or skill. A clear standard needs to be defined, below which a practitioner would not be judged fit to practice. In this case, the minimum standard acceptable is decided before the test.[127] The credibility of the results of any standard setting exercise will be enhanced if the method produces standards that are consistent with the purpose of the test and based on expert judgement informed by data about examinee performance. Norm referencing is clearly unacceptable for clinical competency licensing tests, which aim to ensure that candidates are safe to practice.[103]

6.2.1.2 Assessors

The validity of any assessment process depends on assessors and their understanding of the process.[125] Assessors have to design, administer and grade assessments.[129] Assessors need to be trained to accurately observe students' clinical performance so that they can make appropriate assessment decisions.[129] They must be competent in the areas they are to assess and they should continually update their knowledge and skills. The use of multiple raters with defined rating scales increases reliability.[127]

In competency-based assessment in optometry and related eye care professions, assessors need to be familiar with the entry-level competency standard for the profession. [129,130] Assessors could be clinicians from a highly trained and skilled eye care cadre with the relevant experience and a high level of competence in the areas they are to assess. They should have a clear understanding of what is required of the eye care professional, both at the point of entry to the profession and their future role as an

experienced practitioner, as well as the ability to assess whether the candidate's performance meets that requirement.[129]

6.2.1.3 Checklists and rating forms

The use of standardised checklists and rating forms aims to maintain objectivity of assessments of a number of students conducted by various examiners.[127] Checklist items tend to capture whether the skill was performed and are typically scored as “done” or “not done” and the marking is said to be analytic. Checklist score can improve with assessor experience.[131] However, only criteria that are easy to define may be included on the marking sheet at the expense of equally or more important criteria that are more difficult to define and measure.[132] Rating forms are more broadly formulated items that require more holistic judgment of the associated item or interpretation of actions. The literature recommends using both, with checklists used to identify specific elements of content or skill that must be demonstrated and global ratings used for providing a measure of process aspects (e.g. patient education skills, general approach to a task).[132]

6.2.2 Assessment methods for competency-based assessments

Competency-based assessment is the assessment of a person's competence against prescribed standards of performance.[109] If an occupation has established a set of entry-level competency standards, then these prescribe the standards of performance required of all new entrants to that occupation. Competency-based assessment is the process of determining whether a candidate meets the prescribed standards of performance, i.e. whether they demonstrate competence.[105]

All methods of assessment have strengths and weaknesses.[131] The use of several different assessment methods over time can partially compensate for flaws in any one method.[131] Five criteria for determining the usefulness of a particular method of assessment have been identified: reliability, validity, impact on future learning and practice, acceptability to learners and faculty, and costs (to the individual trainee, the institution, and society at large).[133]

An ideal assessment tool would have to be reliable and valid.[127] Reliability is a measure of the reproducibility or consistency of a test, and is affected by many factors such as examiner judgments (inter-rater, examiner experience), inter-case (candidate) reliability, inconsistency of patient performance and reliability of rating scales.[103] Inter-rater reliability measures the consistency of rating of performance by different examiners. The use of multiple examiners across different cases improves inter-rater reliability.[127] Validity refers to the ability of the assessment to measure what it is supposed to. No valid assessment methods that measure all facets of clinical competence have been designed.[127] Other factors e.g. the feasibility of running and resourcing the examination are also important in a developing country context.[134]

6.2.2.1 Assessment of "knows" and "knows how"

The base of Miller's pyramid represents the knowledge components of competence: knows (basic facts) followed by knows how (applied knowledge). These can be assessed with basic written tests of clinical knowledge such as multiple-choice questions.[127] Although time consuming to set, these tests have high reliability, because of the large number of items that can be easily tested and marked.[135] They are a reliable

and reproducible way of assessing factual knowledge but not clinical skills.[127] However, criticism exists of the validity of multiple-choice question. Many people argue that only trivial knowledge can be tested in this way.[127] By giving options, candidates are cued to respond and the active generation of knowledge is avoided.[127]

Other test formats have been used to assess factual knowledge. Short answer questions, essays and oral examinations are still popular in the training of optometry students in UK [136] and Europe.[137] However they have been criticised on grounds of unreliability. Essays are difficult to mark consistently[138] and orals are unreliable due to the lack of standardisation of questions, insufficient judges, and insufficient testing time.[139]

6.2.2.2 Assessment of "shows how"

Direct observation of students, the use of standardised patients (SP) and objective structured clinical examination (OSCE) are commonly used to test the 'shows how' component.[140,141]

Direct observation: Direct observation of clinical examinations is a common component of assessment of university optometry students MLEP.[129,130] Such examinations are increasingly challenged on the grounds of authenticity and unreliability.[127] However, direct observation of a candidate by a trained assessor using a standardised checklist or rating scale addresses the reliability issue and has been shown to be as reliable as an OSCE. [142] However it does not deal with the lack of standardisation.[103]

Standardised patients (SP): The use of standardised patients versus real patients remains an area of interest.[102] Simulations are the norm in North America.[134] Extensive training of the patient to ensure reproducibility and consistency of scenarios is carried out.

Given the high reliabilities required of the North American licensing tests, the high costs of training can be justified.[143] Objective structured clinical examination: As a potential solution to the concerns of reliability of other evaluation formats, the OSCE has gained increasing importance on both sides of the Atlantic and South Africa. [117,129,143] The final assessment for pre-registration students of optometry in the UK is in the form of an OSCE.[144] Candidates rotate through a series of stations based on clinical skills applied in a range of contexts. Wide sampling of cases and structured assessment improve reliability.[145] OSCE's are scored using tools which break down performance into a series of discrete items or competencies [132] and adapting these checklists to include elements of global rating (e.g. excellent/ good/ satisfactory/ poor /very poor).[132] Each OSCE requires the development of a new set of marking criteria. However, this examination format is expensive and time and resource –intensive relative to other assessment formats.[127]

6.2.2.3 Assessment of "does"

The real challenge lies in the assessment of an eye care personnel's actual performance in the consulting room. Any attempt at assessment of performance has to balance the issues of validity and reliability. Various qualitative and quantitative methods have been reported in the literature for assessing performance in clinical practice that include direct observation of patient-provider interactions, record abstraction, clinical vignettes, standardised patients and interviews with patients and providers.[146] The clinical findings obtained require a comparison against established 'gold standard' findings for determining the eye care personnel's diagnostic accuracy.[140]

Student portfolios and logbooks have been reported in the literature to promote reflection on learning, and encourage students to integrate and assess evidence of their own learning. [147,148] Portfolios include documentation of a procedure being performed, feedback received and provide evidence that learning has occurred. For portfolios to be maximally effective, adequate instruction and close mentoring is required about its use and monitoring and evaluation of the contents.[109] Logbooks are used by the pre-registration optometry student in the UK in order to provide evidence of the type and quantity of patients seen and identify areas for experience.[149]

6.2.3 Methods used for competency evaluation in this study

Overall, the search of the ideal assessment of clinical competence which is both valid and reliable remains controversial.[127] Multiple methods of assessment can provide the data that are needed to assess trainees' learning needs and to identify and remediate inadequate performance by clinicians.[134] The specific methods used in the evaluations of the OTs and optometrists are discussed further in chapters seven and eight.

6.3 Development of methodology to assess factors affecting optometry student performance

A mixed-methods research design was chosen for this section of the study to ensure comprehensiveness, including increased confidence in the findings and ensuring the views of the different stakeholders (lecturers and students) are taken into account.[150] The qualitative information can help explain factors underlying relationships in a quantitative study.[150] For this study, this involved a course evaluation questionnaire which was completed by students (qualitative and quantitative data) and semi-structured individual interviews which were conducted with the course lecturers (qualitative data only).

6.3.1Course evaluation questionnaire

Feedback from students has always played an important role in the maintenance of quality and standards in higher education.[151] Some of the main purposes of student feedback are to enhance the students' experience of learning and teaching, and to contribute to monitoring and review of quality and standards. Obtaining feedback from students is an essential requirement of reflective teaching, allowing teachers to refine their practice and to develop as professionals.[151]

Many methods can be used to obtain feedback, both qualitative and quantitative. Quantitative feedback (for example, through closed questions in questionnaires) can be used to provide 'evidence' that something is working effectively or not and such evidence will normally be required for quality assurance purposes. The open ended

questions in questionnaires complement the quantitative data by identifying issues not covered by the closed questions, either by elaborating and explaining some of the findings from closed questions, or identifying new issues.[152]

Questionnaires have their advantages as they include everyone, are versatile (can be adapted for diverse situations), easy to administer and complete, and results can be easily quantified and analysed (depending on the design of the instrument).[151] However, feedback through questionnaires is generally considered to be relative or indicative rather than absolute.[153,154] It may for example be affected by factors such as the timing of the distribution (end of term compared to mid- term). Closed questions in questionnaires are also less exploratory in nature as they generally result in findings the researcher is expecting.

The importance of student feedback to teaching is one reason why formal mechanisms for collecting and processing it are now used in most universities.[151,155] The development and piloting of the course evaluation questionnaire used in this thesis is described in detail in chapter 9.

6.3.2 Interviews with course lecturers

Qualitative research methods involve the systematic collection, organisation, and interpretation of textual material derived from talk or observation. It is used in the exploration of meanings of social phenomena as experienced by individuals themselves, in their natural context.[156] The main methods for collecting qualitative data are through

individual interviews, focus groups, observations and action research.[157] Interviews can be structured, unstructured or semi structured depending on their degree of flexibility.

In a structured interview, a tightly structured guide of predetermined questions is used, with a limited range of responses. The same questions are asked in the same way to all interviewees with no scope for follow-up questions to responses that warrant further elaboration. They are essentially verbally administered questionnaires.[158] Consequently, they are relatively quick and easy to administer and may be of particular use if clarification of certain questions are required. If the interview schedule is too tightly structured this may not enable the phenomena under investigation to be explored in terms of either breadth or depth.[157]

Conversely, an unstructured interview involves the researcher wanting to know more about a specific topic without there being a structure or a preconceived plan or expectation as to how they will deal with the topic. This allows the discussion to cover areas in great detail. An interview guide can be developed that encompasses general themes rather than specific questions.[159] However, this approach requires a greater amount of time and the data obtained may be markedly different and difficult to analyse.[157]

In a semi-structured interview, an interview guide is developed by the researcher that lists the questions or issues that are to be explored in the course of the interview. This ensures that the same basic lines of inquiry are pursued with each person interviewed to make the best use of the time during the interview. Therefore, the information provided in semi-structured interviews, as conducted herein, is more uniform ensuring

comparability of the data. The open ended nature of the questions (requiring more than a yes/no answer) defines the topic under investigation but provides opportunities for both interviewer and interviewee to discuss some topics in more detail.[157] This method gives the researcher the freedom to probe the interviewee to elaborate or to follow a new line of inquiry introduced by what the interviewee is saying.[157] Open-ended responses enable the researcher to understand and capture the interviewees' points of view without predetermining them through prior selection of questionnaire categories. However, they can be time consuming and the interview guide has to be carefully planned so as not to make the questions leading.[157]

Interviews may be conducted face to face, on-line or over the telephone. Whilst face to face interviews allow the researcher to explore the reactions and behaviour of the interviewees, to clarify questions if needed, to use visual aids and assess nonverbal communication, they can be time consuming and costly.[159] Face-to face semi-structured interviews were considered most appropriate in this research as there were no traveling costs involved. They were used to explore the personal exchanges of views of individual lecturers with regards to student performance and are described in detail in chapter 9.

6.4 Competency framework development

As defined in chapter 5 a competency framework describes the competencies thought to be central to effective performance and is commonly used to support the development of healthcare professionals.[113] There are various methods of framework development. Structured group methods, also called consensus development methods for framework

development include the nominal group technique, the consensus development conference and the Delphi technique.[160] In the nominal group technique experts (usually nine to twelve in number) meet face to face, express their own ideas prior to a group discussion to clarify and evaluate each idea, and reach consensus through an iterative process using ranking.[160] In a consensus development conference, a group of experts (in the defined area of interest) is recruited to attend a meeting in order to deliberate the subject under discussion.[161] Similar to the nominal group technique, in the consensus development panel the participants meet. However, in contrast to the nominal group technique, the consensus development panel does not offer participants time to express their own decisions before the group discussion takes place. Feedback on the group discussion is not provided and the approach is not structured.[161] For this study the Delphi technique, described below, was deemed the most suitable as it has been widely used in health research within the fields of education and training, and developing frameworks for clinical practice.[160] Moreover, face to face interaction with a group of international experts was not feasible.

6.4.1 The Delphi technique

The Delphi technique is a means of tapping the knowledge, expertise or opinions of a category of people who have been defined as having specialist knowledge, experience or expertise.[162] The classical Delphi method is characterised by four key features: [162]

1. Anonymity of Delphi participants: allows the participants to freely express their opinions without undue social pressures to conform from others in the group.
2. Iteration: allows the participants to refine their views in light of the progress of the group's work from round to round.

3. Controlled feedback: informs the participants of the other participant's perspectives, and provides the opportunity for Delphi participants to clarify or change their views.
4. Statistical aggregation of group response: allows for a quantitative analysis and interpretation of data.

A classical Delphi study is one that is true to its origins and has the four characteristics. A modified Delphi is one where the technique is effectively modified to meet the needs of the given study.[162] The Delphi technique has been previously applied to the development of competency frameworks and curricula for optometry and medical sub specialities.[163,164]

In this study, a modified technique, whereby a draft document of competencies was generated using literature review, observations and primary research data rather than from an initial round of the Delphi technique, was used in order to reduce the number of rounds in our study. This method has been described in detail in chapter 10.

6.5 Ethics

Ethical approval was granted for the study under the MEP by DIT's ethics committee. Further ethical approval in Mozambique was sought. Ethics approval was granted for the evaluation of refraction competencies of ophthalmic technicians by the National Ethics Committee of Mozambique (Comité Nacional de Bioética para Saúde). The research followed the tenets of the Declaration of Helsinki.

Chapter 7

Evaluations of refraction competencies of ophthalmic technicians in Mozambique

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In press, 2015

7.1 Background

Mozambique is characterised by an extreme paucity of eye care personnel as described in chapter 4. To achieve VISION 2020 targets Mozambique would need at least 500 trained eye care workers who can refract to serve its population of 25 million by 2020.[3] In 2011 when this study commenced, there were 17 Ophthalmologists and 34 qualified Ophthalmic Technicians(OT) in the country.[14]

In January 2011 the Ministry of Health (MISAU) supported by Light for the World (eye care NGO) started an 18-month OT training programme in Beira. The aim was to educate additional OTs to address the need for eye health professionals with sufficient training. BHVI and DIT have supported the refraction component of the course by providing educational material (the BHVI refraction manual) and personnel to deliver the limited refraction component of the course. Thirty one students working as nurses or medical technicians (18- month training) were enrolled on the course. Curricula to train MLEP vary significantly across countries based on local need.[78] The emphasis is on a shorter training duration due to a lack of other trained personnel.[72] The curriculum was adapted from the Institute of Health Science (IHS) OT curriculum from 1996.

The course outcomes are broad with no defined list of refraction competencies. They state that the OT should be competent in managing refractive errors and prescribing spectacles. The course syllabus for refractive error includes a module on refractive error and anomalies of accommodation (Appendix A). The refraction component consisted of 40 hours of theory and 40 hours for practical sessions however this was condensed to a three-week period (two 20-hour weeks of theory, one 40-hour week of practical sessions) within the overall curriculum. There was no known validation of the programme. The students completed a portfolio stating they had completed five refractions to make them eligible for the final clinical evaluation. However, competency in refractive error was not assessed during their training. There was no framework in place to evaluate refraction skills. This was the first known evaluation of OTs refraction competencies.

As identified in chapters 4 and 5, the development of competency-based education for MLEP has been identified as an important component in the solution to avoidable blindness and vision impairment.[67,75] The functions of MLEP have not been definitively outlined, and the competencies they require to provide high quality comprehensive eye care have not yet been established.[67] To our knowledge, only one study has evaluated and reported on the refraction capabilities of MLEP even though a major part of their responsibility involves refractive care.[165] It appears, therefore, that the refractive competencies of MLEP remain largely undetermined.[67]

A desk review was conducted with reports and direct communication from non-governmental organisations (NGOs) and personnel working in eye care and in training OTs in Mozambique.[47,90] Electronic searches of Google Scholar, ERIC database,

HINARI and PubMed were made using the following search terms qualified with "Africa" "sub-Saharan Africa" and "Mozambique": ophthalmic technician, ophthalmic clinical officer, MLEP and refraction. Other terms searched were optometry and ophthalmic technician in Cuba and competencies and competency-based education in MLEP in low income countries and inadequate documentation about the refraction skill level of the OTs in Mozambique.

Refraction, even though it is only a minor element of the existing OT curriculum comprises a very significant component of their daily workload. In the Central Hospital of Beira in 2011, out-patient conditions seen by the OTs in order of prevalence, were refractive errors, conjunctivitis, cataract, ocular trauma and glaucoma.[93] Hence, the question arises on the relevance and length of the refraction component in the context of conditions they treat in their day-to-day work. The study is designed based on the fact that in 2011 OTs were the only cadre providing a refraction service. The evaluation was conducted not in relation to just what they were trained on, but in relation to their practice, where they are expected to cater to refraction needs.

The knowledge and level of refraction skills of the existing OTs in Mozambique is uncertain because the duration, location and specifications of their training is known to be varied. The OTs that are working at present appear unlikely to have uniform skills, and are thought to be deployed in situations with different characteristics, especially with regards to equipment availability. Assessment of their competencies using a competency framework which was validated for MLEP doing refraction was deemed appropriate and necessary.[16]Identification of the quantity, distribution and role of OTs in Mozambique, and determination of their refraction skills are important steps to

understand gaps in their existing knowledge, and necessary to inform training and professional education.

This study was designed to assess the confidence and competence in refraction of trainee and qualified OTs in Mozambique, and investigates whether an upskilling programme is effective in developing their confidence and competence at refraction. The overarching aim of this research was to inform the development of a nationwide programme of OT mentoring, upskilling and leading to the establishment of clinical competency standards, for the new OT curricula, relevant to the professional demands.

7.2 Methods

All 31 trainee and 34 qualified OTs who work at health centres and hospitals in all 11 provinces in Mozambique, providing primary eye care to the populace were invited to participate in the study, which was conducted in collaboration with the Ministry of Health (MISAU) and Universidade de Lúrio in Mozambique. The evaluations took place in ten health facilities (two central, two provincial, one rural hospital and five regional health centres) in the four provinces of Nampula, Sofala, Manica and Inhambane in Mozambique between January and October 2011. Sixteen OTs out of a total of 34 and all 31 trainees agreed to participate and were enrolled into the first part of the study evaluating the existing competence and confidence levels of the cadre. This represented a 100% participation rate in the ten study sites. The assessment of the trainees was conducted in the second semester of their internship, following completion of their theoretical and practical refraction training, within the respective provinces.

The upskilling training concentrated on theory (two days) and practice (eight days) of objective (retinoscopy) and subjective refraction. It was carried out in two provinces for two weeks each in January and June 2013, on 11 of the original 47 participants, by three experienced optometry lecturers from UniLúrio. All the OTs working in the two provinces where the upskilling was carried out were invited with a 100% participation rate in Inhambane (four OTs) and 78% in Sofala (seven of the nine OTs). The numbers were limited to allow for each optometrist trainer to supervise three to four OTs. Retinoscopes, trial lens cases with trial frames and cross-cylinders were obtained for all the participants. Post-upskilling evaluations were carried out on completion of the training period. Informed consent was obtained from each participant, and the research was conducted in accordance with the tenets of the Declaration of Helsinki.

A mixed methods approach was used to assess OT confidence and competence, including questionnaires to assess participant background and confidence in refractive techniques, practical assessments to evaluate clinical competency, and theory examinations to determine underlying theoretical knowledge. They were all administered for the initial evaluations and post upskilling training.

7.2.1 Background questionnaire (Appendix C)

OTs were asked to complete a background questionnaire designed to elicit information about their demographic profile. It included their educational background, training history, professional rank, years of working experience within eye care, and workload to

get an indication of how their refraction skills vary depending on their training background, location of work and experience.

7.2.2 Confidence levels questionnaire (Appendix D)

The confidence levels questionnaire was adapted from a previously piloted and validated questionnaire used in evaluations of MLEP in India. [165] The OTs were asked to rate their confidence in performing 13 different refraction tasks. A five-point Likert scale was used to assess confidence (1 - never confident, 2 - sometimes confident, 3 - not sure, 4 - almost always confident and 5- always confident).

7.2.3 Practical Assessment (Appendix E)

Methods of assessing performance were reviewed in order to identify the performance indicators and develop the criteria required for the assessment. Two frameworks of evaluations have been used in this study:

a) A competency-based theoretical framework: The refraction competencies for this study were based on a curriculum designed to train nurses or those with a suitable non-nursing tertiary education, into MLEP.[16] This competency framework was validated prior to implementation as being appropriate to meeting educational standards of MLEP in Papua New Guinea.[16]

b) An expert practitioner approach: Various qualitative and quantitative methods have been reported in the literature for assessing competence in clinical practice that include direct observation of patient-provider interactions, record abstraction, clinical vignettes, standardised patients and interviews with patients and providers.[146] Direct observation by an expert optometrist using actual clinic patients was preferred for this as the refraction competencies of OTs were entirely unknown. To assess refraction competence it was essential to have a competent clinician from a highly trained eye care cadre. In the absence of any local experts, the selection criteria for the expert were clinical optometry experience, ability to communicate in Portuguese, familiarity of the health context and availability for placement in Mozambique. The researcher with 10 years clinical and public health experience in optometry, and experience in the training and evaluation of pre-registration optometry students in the UK, met the criteria to carry out the evaluation of the OTs.

Practical competency assessments were carried out as each OT performed refractions on two clinic patients. Retinoscopes and cross-cylinders were available for all the evaluations. To establish a consistent standard and to maintain fair and accurate practical assessments in certifying the OTs and trainees as competent in refraction, a practical exam guide and checklist was used. The checklist was designed to uniformly assess the student on each aspect of refraction including; case history, measuring visual acuity (VA), retinoscopy, best vision sphere, cross cylinder refraction, +1 blur test, binocular balance, near refraction, and determining final prescription. Competency for near refraction was assessed on the OT's ability to calculate the best addition in order to see N8 as per the patient's distance mean spherical equivalent, age and visual symptoms.[166]

For each procedure the knowledge, set-up, communication, procedure steps, record keeping and accuracy were graded. Accuracy for both retinoscopy and sphero-cylindrical refraction was examined. Refractive errors were analysed using power vector analysis. The power vectors are represented as Sphere equivalent (SE), Jackson cross cylinder at axis 0 with power J_0 and Jackson cross cylinder at axis 45 with power $J_{45.}$ A variance of +/-0.50D spherical equivalent and cylinder was set as the limit of acceptability for retinoscopy and subjective refraction, based on the literature of repeatability and reproducibility of refractive values.[167,168,169]

The Dreyfus and Dreyfus model of skill acquisition was selected as it could provide suitable anchors for the skill scale and relate to the changes expressed by the OTs. In this model the practitioner moves through five stages: 1- novice; 2- advanced beginner;3-competent; 4 proficient; 5-expert.[104] In order to obtain an overall pass for the practical assessment, OTs were required to demonstrate satisfactory competence (skill was well developed, they can work unsupervised and address complications) in each component of the refraction procedure. For this evaluation the focus was on whether the OT could demonstrate competence rather than proficiency, and whether upskilling moved the OTs from novice to advanced beginners or competent. Hence only grades 1, 2 and 3 were used.

7.2.4 Knowledge of Refraction exam

A theory exam was conducted for each participant to assess their refraction-related knowledge. The exam was set by external examiners working in the refraction training

of MLEP and comprised technical questions on the theoretical aspects of refraction, patient management and specific refraction tasks. Each section comprised a checklist of items that covered the competencies, with marks associated with each item. Participants were graded by the assessor as competent or not based on a pass mark of 50% for each section. This was based on the literature of theoretical evaluations of competencies of optometry students.[129]

The competency in practical assessment was combined with the information gathered in the knowledge of refraction exam. Only those OTs who demonstrated competence in both were graded as competent overall in that discipline.

Poorly equipped eye departments can account for a lack of confidence amongst eye care personnel in performing ophthalmic assessment.[170] As a means to explain potential confidence and competency deficiencies among participants in different clinical settings, an analysis of equipment available at each health facility, including an inventory and an assessment of the functionality of the equipment was also performed. This included a visual check and a review of calibration and maintenance procedures.

Data were inputted into SPSS (Version 21.0). Reliability of the confidence levels survey and competence assessment was measured by Cronbach's alpha. Shapiro-Wilk test was used to test the distribution of the data. As the distribution was not normal, non-parametric tests were used. Kruskal-Wallis test was used to investigate relationships between the confidence and competence levels and the different training institutions and OTs location of work. The Mann- Whitney U test was used to compare results between

the trainees and qualified OTs pre-training. Wilcoxon signed ranks test was applied to compare the results of confidence and competence levels pre- and post training. A p-value of <0.05 was considered statistically significant.

7.3 Results

7.3.1 OT Background

The 16 qualified OTs were trained at different institutions across three different countries. Seven (43.8%) studied in Cuba on a three-year training programme, two in Malawi (12.5%) on a one-year training programme, and seven (43.8%) in Mozambique. Of those trained in Mozambique, two completed (12.5%) an 18-month programme, and five (31.3%) completed a two year programme. The refraction component varied across the training programmes, from theory only (Malawi and Mozambique 18 month course) to theoretical and practical training (Mozambique two year and Cuba three year course).

The OTs ranged in age from 37 to 49 years, with a mean ± standard deviation of 43(±5) years. Their clinical experience averaged 13 (±6) years. The average number of daily refractions conducted routinely by participants was 15 (±8), from an average daily total of 25(±8) patients examined daily in an eye clinic. OTs at central and provincial hospitals conducted more daily refractions (18+/-8) relative to those at rural hospitals (15) or local health centres (8+/-2).

The 31 trainee OT participants originated from nine (out of 11) provinces across Mozambique, ranging in age from 26 to 48 years. The mean age was 33 (±6.) years. All trainees were previously qualified as nurses (21) or medical technicians (10) in Mozambique. The range of years worked within the health system was between 1 and 16 years, with a mean of 7 (±4) years.

The results of the equipment audit and the eye care personnel working in refraction are presented in Table 7.1 below.

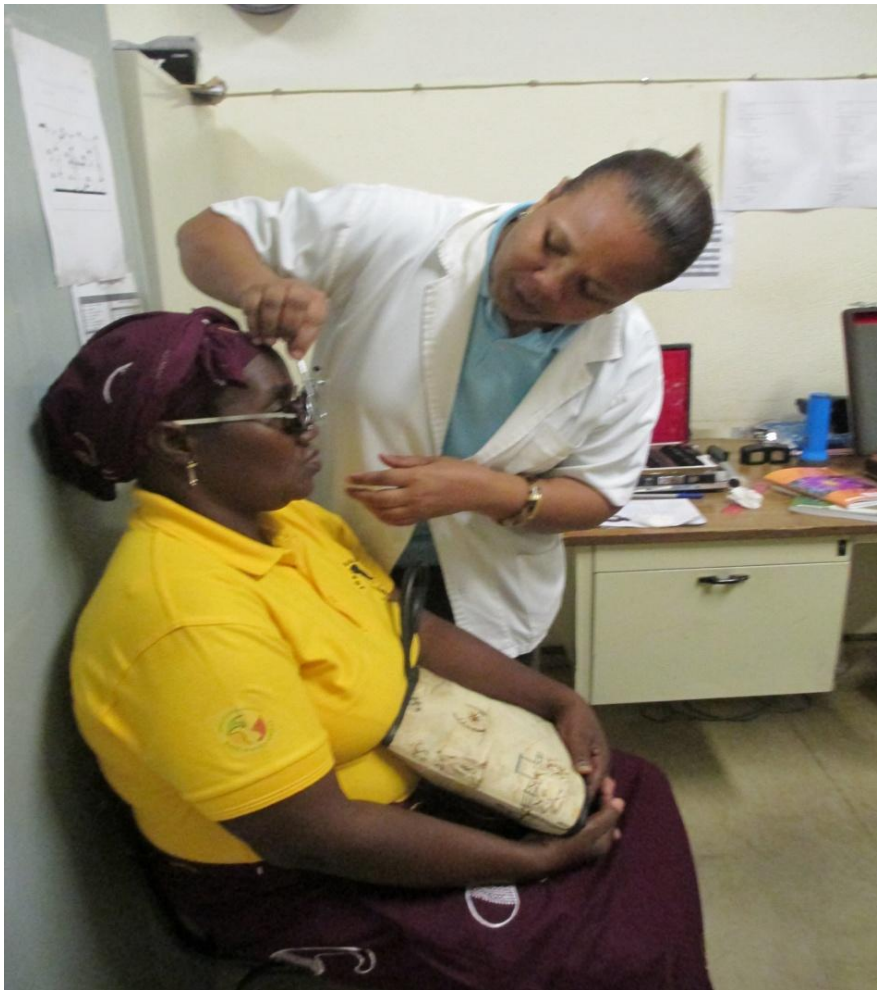

Figure 7.1: Ophthalmic technician practicing subjective refraction

Table 7.1: Situational analysis of refraction equipment and eye care personnel providing refraction at 10 eye clinics

Location		Number of							
		OTs	**Ophthal-mologists**	**VA Charts**	**Trial cases and frames**	**Retinosc-opes**	**Auto-refractors**	**Cross-cylinders**	**Lens-meters**
Central and Provincial hospitals	HCN	3	2	6	5	1	1†	0	1 †
	HCB	2	2	7	3	2	1 †	1	1 †
	HPC	2	1	4	2 ‡	1	1 †	0	0
	HPI	2	0	2	2	1	1 †	0	1†
Rural Hospitals	HRC	2	0	3	2	0	0	0	0
Health Centres	CSN	1	0	2	1	0	0	0	0
	CSD	1	0	1	1	0	0	0	0
	CSMunhava	1	0	1	1	0	0	0	0
	CSMuhala	1	0	1	1	0	0	0	0
	CS25	1	0	1	1 ‡	0	0	0	0

Abbreviations: HCN: Central Hospital of Nampula; HCB: Central Hospital of Beira; HPC: Provincial Hospital of Chimoio; HPI: Provincial Hospital of Inhambane; HRC: Rural Hospital of Chicuque; CSN: Centro de Saude (Health Center) Nhaconjo; CSD: Centro de Saude Dondo; CSMunhava: Centro de Saude Munhava; CSMuhala: Centro de Saude Muhala; CS25: Centro de Saude 25 de Septiembre; VA, visual acuity; OT Ophthalmic technician.

† Not calibrated ‡ one broken trial frame

7.3.2 Confidence levels survey and competency evaluations

All participants reported they were confident with and were graded competent at history taking and visual acuity at distance and near, measuring the inter-pupillary distance, using a pinhole, using the trial lens set, and referring patients. Low confidence levels were reported for retinoscopy, sphero-cylindrical refraction, binocular balancing and +1.00 blur test. All the qualified OTs and 27 trainees were graded as competent in correcting presbyopia. However, none of the participants (qualified OTs and trainees) were graded competent at retinoscopy, sphero-cylindrical refraction, +1.00 test and binocular balance and determining the final prescription. Only one qualified OT was graded as an advanced beginner (grade 2) at retinoscopy and cross-cylindrical refraction and six as advanced beginners for best sphere and determining the final result. Theory of refractive error, retinoscopy, subjective (sphero-cylindrical refraction and lack of awareness of the concept of accommodation and binocular balancing) emerged as the principal gaps in the theoretical knowledge possessed, by all participants.

The detailed findings of the confidence levels survey and practical competency assessment comparing trainee to qualified OT, their location of work and training are presented in tables 7.2 and 7.3 below. Confidence levels are graded from 1-5 and competence levels from 1-3. The results of the theory exam to determine underlying refraction knowledge are presented in Table 7.4 below. The reliability of the confidence levels survey is 0.7 and the practical and theoretical competence assessment 0.76 (Cronbach alpha)

Trainee OTs compared to qualified

As demonstrated in Table 7.2, the qualified OTs expressed greater confidence with performing retinoscopy (p=0.00) and determining the final prescription (p=0.00) compared to the trainees. They demonstrated greater competence with best sphere (p=0.00) and determining the final prescription (p=0.00) as indicated in Table 7.3. There was no significant difference in knowledge of refraction between the two groups as demonstrated in Table 7.4.

Location of work with respect to clinical load, referral structures and equipment

Those who worked in central and provincial hospitals examined a greater number of patients and expressed greater confidence for retinoscopy (p=0.00), sphero-cylindrical refraction (p=0.05) and determining the final prescription (p=0.00) than those who worked in rural hospitals or local health centres as shown in Table 7.2. They demonstrated greater competence for best sphere (p=0.00), determining the final prescription (p=0.00), and knowledge in the theory of retinoscopy (theory exam p=0.04) as indicated in Tables 7.3 and 7.4.

Location of training with respect to length and refraction content of course

Those who trained in Cuba stated greater confidence levels in retinoscopy (p=0.00) compared to those who trained in Mozambique and Malawi as shown in Table 7.2. They also demonstrated greater competence levels in best sphere (p=0.00) and determining the final prescription (p=0.00) as indicated in Table 7.3. There was no significant difference in the theory exam between those trained in Cuba and those trained in Mozambique and Malawi.

Table 7.2: Mean self-reported confidence levels OT's and trainees (maximum possible score = 5.00) and significance to experience, location of work and training

Skill	Self – reported confidence n=47 Mean (SD)	Qualified OT n=16 Mean (SD)	Trainee OT n=31 Mean (SD)	Difference between qualified and trainee† p-value	Location of work‡ p-value	Location of training‡ p-value
Performing retinoscopy	1.16 (0.38)	1.44 (0.51)	1.03 (0.18)	0.00	0.00	0.00
Performing best spherical refraction	3.11 (1.52)	3.69 (1.66)	2.81 (1.34)	0.55	0.08	0.15
Performing sphero-cylindrical refraction	1.85 (1.02)	2.38 (1.5)	1.58 (0.50)	0.16	0.05	0.18
+1.00 test and binocular balance	1 (0)	1 (0)	1 (0)	1	1	1
Determining the final prescription	3.4 (1.6)	4.31 (1.35)	2.94 (1.52)	0.00	0.00	0.09

Abbreviations: OT Ophthalmic technician; SD Standard deviation

†Mann-Whitney test $p<0.05$ ‡ Kruskal- Wallis test $p<0.05$

Table 7.3: Mean competence levels OT's and trainees (maximum possible grade = 3.00) and significance to experience, location of work and training

Competency	**Level of competence n=47 Mean (SD)**	**Qualified OT n=16 Mean (SD)**	**Trainee OT n=31 Mean SD**	**Trainee compared to qualified OT † p-value**	**Location of work‡ p-value**	**Location of training‡ p-value**
Performing retinoscopy	1.02 (0.15)	1.06 (0.25)	1 (0)	0.16	0.24	0.13
Performing best spherical refraction	1.13 (0.40)	1.38 (0.50)	1 (0)	0.00	0.00	0
Performing sphero-cylindrical refraction	1.02 (0.15)	1.06 (0.25)	1 (0)	0.16	0.24	0.13
+1.00 test and binocular balance	1 (0)	1(0)	1 (0)	1	1	1
Near refraction	2.91 (0.28)	3 (0)	2.87 (0.34)	0.14	0.53	0.61
Determining the final prescription	1.13 (0.34)	1.38 (0.50)	1 (0)	0.00	0	0

Abbreviations: OT Ophthalmic technician; SD Standard deviation
†Mann-Whitney test $p<0.05$ ‡ Kruskal- Wallis test $p<0.05$

Table 7.4: Mean theory exam score OT's and trainees (maximum score = 100%) and significance to experience, location of work and training

Theory exam	Mean total mark n=47 Mean (%) (SD)	Qualified OT: Mean total mark n=16 Mean (%) (SD)	Trainee OT: Mean total mark n=31 Mean (%) (SD)	Trainee compared to qualified OT† p-value	Location of work‡ p-value	Location of training‡ p-value
Refractive error	86% (19)	86% (16)	85% (22)	0.73	0.12	0.51
Retinoscopy	23% (23)	17% (17)	26% (26)	0.24	0.04	0.55
Subjective	53% (17)	57% (9)	51% (20)	0.54	0.14	0.54

Abbreviations: OT Ophthalmic technician; SD Standard deviation

†Mann-Whitney test $p<0.05$ ‡ Kruskal-Wallis test $p<0.05$

7.3.3 Upskilling

Eleven qualified practicing OTs were upskilled. Three of the OTs had been trainees during the first part of these evaluations and had since been working a year in practice. The work experience of the other eight OTs averaged 18(+/-5) years. The age range of the 22 patients refracted during the evaluations was between four to 62 years (mean +/- SD, 40.8+/-18.7 years). Refractive error measurements ranged from -7.00D to +6.00D (mean +/-SD, -0.26+/-3.32D).

Post- upskilling, all demonstrated a statistically significant improvement in both the confidence levels and competence for performing retinoscopy (p=0.00), sphero-cylindrical refraction (p=0.01 for confidence and p=0.00 for competence) and +1.00 blur test and binocular balance (p=0.00) and higher competence levels in best vision sphere (p=0.00) and determining the final prescription (p=0.00).

In the competency of 'determining the final prescription', pre-training mean confidence level was high but mean competency level low. Post-training, a significant improvement in the mean competency level was observed, indicating a good response to the practical training. Theoretical knowledge of refractive error was good pre-training and didn't improve, but the knowledge of the skills required to correct the refractive error: retinoscopy (p=0.00) and subjective refraction (p=0.01), did improve significantly. There was no significant relationship between the location of training and location of work with the post upskilling confidence and competence level scores.

Overall, post training, all of the participants were competent at history taking, measurement of VA and correcting presbyopia. Three OTs were graded as competent at retinoscopy, four at best vision sphere and determining the final prescription, and one at cross-cylindrical refraction and binocular balancing. Only one OT failed the theory exam for retinoscopy. All the others passed for all the modules. The results of the evaluation post upskilling are as demonstrated in Table 7.5.

Figure 7.2: Upskilling training provided to the ophthalmic technicians visual by an optometrist from UniLúrio

Table 7.5: Mean score qualified OTs pre- and post upskilling and significance of upskilling

	Skill	Mean (SD) Pre-training n=11	Mean (SD) Post-training n=11	p-value†
Confidence levels questionnaire (maximum value 5)	Performing retinoscopy	1.27 (0.47)	2.27 (0.91)	0.00
	Performing best spherical refraction	3.00 (0.63)	3.91 (1.3)	0.11
	Performing sphero-cylindrical refraction	1.82 (0.601.02)	2.82 (1.17)	0.01
	+1.00 test and binocular balance	1 (0)	2.27 (0.91)	0.00
	Near addition	5 (0)	5 (0)	1.0
	Determining the final prescription	3.00 (0.771.6)	3.64 (1.36)	0.59
Practical competency assessment (maximum grade 3)	Retinoscopy	1.09(0.30 15)	2.09 (0.71)	0.00
	Best vision sphere	1.36 (0.50)	2.27 (0.65)	0.00
	Sphero-cylindrical refraction	1.09 (0.30)	1.82 (0.60)	0.00
	+1.00 test and binocular balance	1 (0)	1.82 (0.60)	0.00
	Near refraction	3 (0)	3 (0)	1.0
	Determining the final prescription	1.18 (0.44)	2.18 (0.75)	0.00
Theory exam (Maximum value 100%)	Refractive error	80% (15)	88% (16)	0.99
	Retinoscopy	32% (22)	80% (25)	0.00
	Subjective	57% (16)	71% (17)	0.01

Abbreviations: OT Ophthalmic technician; SD Standard deviation

†Wilcoxon signed ranks test $p<0.05$

7.4 Discussion

This is the first study to report on the refraction capabilities of MLEP in Africa, even though a major part of their responsibilities involves refractive care. A clinical evaluation of refractive error comprises of two key criteria, objective refraction (which requires minimal participation from the patient) and subjective refraction (based on the patient's feedback on different trial lenses). None of the participants in the original evaluations reached competency standards in objective (retinoscopy) or subjective (cross-cylindrical refraction and binocular balance) refraction and determining the final prescription and therefore needed upskilling. Hence, the existing level of performance of the OTs is not sufficient for provision of adequate refraction services. The upskilling demonstrates that the extra two week training was effective in developing OTs confidence and competence in both objective and subjective refraction.

The skills of both the qualified and trainee OTs appear limited to the most basic components of spectacle refraction, and fail to extend beyond the simplest of spherical or presbyopic errors. This presents a significant restriction on the capacity of the current refractive error service providers to detect and manage everyday refractive problems such as astigmatism. The lack of awareness of methods to control accommodation during the refractive examination, further erode the possibility that OTs might determine an accurate prescription and thereby appropriately manage presenting refractive complaints. The lack of competency in objective methods represents another important limitation, which is likely to pose difficulties in basic cases, and especially in more complex refractions, such as those involving paediatric and low vision cases, or in those with communication issues.

The results may be explained by a number of critical factors including inadequate refraction training and practical experience, and location of work with regards to poor equipment availability, peer support and clinical load. The relatively small sample size, however, limits the generalisability of these factors. Further research, on evaluations of refraction competencies of a statistically significant sample size of OTs, is necessary for these results to be representative of all OTs.

Cuban trained OTs displayed a more comprehensive refraction skill set (greater competence levels in best sphere and determining the final prescription) compared to those who trained in Mozambique and Malawi. This could be accounted for the longer training time of their course (3 years) compared to the others and a greater focus on aspects of refraction compared to the Malawi and Mozambique training programmes.[92,171]

Confidence levels and competence are also related to the location of work with regards to clinical load, supervision and referral structures and the range of equipment available.[170] Mozambique has three central hospitals in Maputo, Beira and Nampula. Every province also has a main referral provincial hospital. The background questionnaire and situational analysis of refraction equipment and eye care personnel revealed that those working in local health centres worked on their own without any peer support or supervision from other OTs or ophthalmologists, and with very little refraction equipment beyond the basic acuity chart and trial frame and case. They saw a lower number of patients due to lower population numbers in the catchment areas where they worked. The lack of experience, existing support structures, refraction equipment

and reduced capacity to use the equipment is reflected in their poorer performance in competence in the majority of refraction related tasks. If the minimum desirable level of equipment isnot available in the hospital or health centre, then competencies achieved in training will quickly be lost, and the effectiveness of training eroded over time.[172] It is essential; therefore, that equipment availability is extended to include at least the equipment mentioned in table 7.1 (visual acuity chart, trial case and frame, retinoscope, cross-cylinders and lensmeter) for training purposes, and in the health centres and hospitals to which OTs are posted for clinical practice.

For current OT trainees the three week training programme is insufficient to develop competence in anything apart from managing presbyopia. In the absence of an accurate objective refraction, the level of accuracy for presbyopia competence for this study has been redefined to the nearest 0.25 dioptre in order to see N8.[166] Qualified OTs demonstrated greater degree of competence in some of the clinical skills compared to the trainees presumably due to their increased practical experience.

On completion of the two week upskilling course, the overall results demonstrated a significant improvement in confidence levels and competence levels of the clinical skills that were practiced, irrespective of the original training and location of work of the OT. Only 11 OTs completed the training, hence the reduced sample size limits the weight of the evidence. It was recognised that a two week upskilling course was brief and there still remains a significant gap between the confidence and competence of the OTs and that required for a fully competent MLEP providing refraction services.

As demonstrated by the results from the upskilling training, the current training programme is in need of reform so as to increase the emphasis on, and time allocated to, refraction training. This should include both increased time to assimilate theoretical concepts, and substantially increased time and resources for practical experience during training. The training needs to be administered by competent practitioners, such as optometrists with clinical experience and more in-depth knowledge of refraction. A mid-level course training nurses to be competent in refraction in a similar context in the Gambia is of six month duration. [42]

The combination of self assessment (confidence levels) and objective assessment provided a comprehensive methodology for evaluation of the OTs. Reliability analysis showed good reliability of the confidence level survey (Cronbach's ά is 0.7), practical and theoretical competency assessment (Cronbach's ά is 0.76).[173] However, there are several factors that need to be considered in assessing the implications of our study.

Direct observation of practice, by an optometrist, in the assessment of refraction performance of MLEP has been documented.[130] However, this methodology is increasingly challenged on the grounds of authenticity and unreliability due to examiner related bias. [127] This relates to variations in expert observer judgment where one person's judgement in the assessment of clinical skills, without explicit criteria and training, is likely to be subjectively biased.[174] Providing the examiner with a standardised checklist increased the reliability.[142] The other factors to take into account with direct observation are patient variance and the 'Hawthorne effect' where practitioners will behave differently when being observed.[171]The only way of controlling the Hawthorne effect is using unannounced standardised patients for clinical

competency evaluations.[140] In this study using standardized patients could not be justified due to high costs of training to ensure reproducibility and consistency of scenarios.[127] Further research comparing the methods used in this chapter, with the use of record abstraction, clinical vignettes and standardised patients, to determine what the most practical, cost-effective and acceptable options for competency assessment are, in a low-resource environment, is required.

In this study, the setting of practical competency standards was from a literature review of best practice.[104] The expert optometrist's refraction results are considered as the benchmark. [175]Refractive errors were analysed using power vector analysis based on the literature. [167,176] A variance of +/-0.50D spherical equivalent was set as the limit of acceptability for retinoscopy and subjective refraction, according to accepted norms.[168,167] The theory exam was marked in terms of content and difficulty. Absolute standards are most appropriate for tests of competence, where the purpose is to establish that the examinees know enough for a particular purpose.[177] However, in the long run a more systemic approach to standard setting needs to be adapted. Standards should be consistent with the purpose of the test and based on expert judgement informed by data about examinee performance.[177]

In rural areas of low-income regions, the prevalence of presbyopia is high and the most common reason for requiring spectacles.[178] Due to the lack of personnel refracting in Mozambique, the level of accuracy for presbyopia competence for this study has been redefined. Moreover, dispensing skills were not assessed as the spectacle supply system is limited apart from in the larger central and provincial hospitals.

Confidence in clinical skills has been used as a subjective indicator of clinical competence. [94]However due to the mixed scales used in this study there was inadequate information to examine a relationship between perceived (confidence level) and actual (competence) refraction skill.[94] For this study, the confidence level questionnaire was principally designed to help the OTs analyse their work practice and identify their upskilling needs. Further research is needed using best practice templates for studying self-assessment and its relationship to competence for OTs.

A limitation of this study was the lack of correction of Type 1 errors for the repeated use of all the Mann-Whitney, Wilcoxon and Kruskal Wallis statistical tests.[179] This increased the number of statistically significant p values introducing false positives. The recommendation is to make appropriate p value adjustments (e g Bonferroni adjustment) to compensate for a possible increased risk in committing Type 1 errors when multiple outcome measures are used.[179] The other alternative is to use a parametric paired t-test. However for the data set the Shapiro-Wilk test for normality showed that the distribution was not normal therefore non-parametric tests were used.

Another limitation to this study was the delay of over a year between the original evaluations and upskilling due to the logistical preparations required to organise the training and the absence of a control group. This raises the question to what extent upskilling actually improved competence and confidence. The results from the original evaluations were used as pre-training ratings rather than evaluating the OTs pre-upskilling. There is evidence that confidence and competence improve with increased experience as the OT is able to practice and become more comfortable with the skill.[180] Moreover the improved competence post-upskilling could be due to memory retention

and recall bias rather than improved understanding. The recommendation for any further upskilling is to use a control group to act as a comparison group when the results are evaluated. A continuing education, monitoring and evaluation framework has been recommended to ensure that OTs become competent and maintain competence in performing accurate refractions leading to better eye care.

7.5 Conclusion

This evaluation and training arose out of a perceived need to provide a better refraction service in Mozambique because of the absence of any other eye care personnel. The study met its objectives of assessing the confidence and competence in refraction of trainee and qualified OTs in Mozambique and identified factors affecting their ability to provide a comprehensive refraction service.

The results from these evaluations demonstrate the need for robust and standardised curricula with a defined list of competencies for refraction and the practice of these competencies with adequate supervision. The curricula has to include an increased emphasis on refraction, and comprehensive and effective instruction by experienced practitioners, to optimise the level of competence that can be achieved before the OT emerges into clinical practice. The need for better institutional infrastructure, equipment and supervision in practice has to be addressed. Only when OTs become competent in the provision of refractive services can they address the significant issue of avoidable visual impairment as a consequence of URE in Mozambique.

Chapter 8

Development of a clinical competency-based assessment system for optometry students in Mozambique

8.1 Background

The World Council of Optometry's (WCO) Concept of Optometry states: "Optometry is a health care profession that is autonomous, educated, and regulated (licensed/registered), and optometrists are primary health care practitioners of the eye and visual system who provide comprehensive eye and vision care, which includes refraction and dispensing, detection/diagnosis and management of disease in the eye, and the rehabilitation of conditions of the visual system".[85] The General Optical Council's (GOC) revised competencies for registration as an optometrist in the United Kingdom (UK) state that "trainee optometrists should have the ability to refract a range of patients with common optometric problems by objective and subjective means. S/he should also be able to make appropriate prescribing and management decisions based on refractive and ocular motor status".[107] Typically, a clinical evaluation of refractive error comprises two different approaches: objective refraction (which requires minimal participation from the patient) and subjective refraction (based on the patient's feedback on different trial lenses). An objective refraction is vital in obtaining a starting point, and is crucial in determining refractive errors with very young patients or those who have difficulty communicating.[181] The results of the subjective refraction are important both to the optometrist and to the patient, because most patients judge all aspects of the eye care they have been provided based on the clarity and comfort of their prescription.[182]

As described in Chapter One, The Mozambique Eye care Project (MEP) is a higher education partnership for the development, implementation and evaluation of a model of optometry training at Unilúrio in Mozambique. The four year course for the optometrists was based on a curriculum developed by the Brien Holden Vision Institute with competencies drawn from the optometry courses of the Dublin Institute of Technology (DIT), University of KwaZulu-Natal (UKZN) and the competency-based model of the World Council of Optometry (WCO).

Competencies are seen as a framework for entry level skill into the profession of optometry in most countries. Students have to show by some means of assessment that they are competent in the areas listed. This may be by specific examination or some form of continuing assessment programme.[116] Literature on methods to assess clinical competency have existed in medicine for many years, [102,127] however, little published research exists for optometry. [,129,183] In the UK, the GOC describes the required competencies in detail, however, it does not specify the method of assessment. This is left to the respective training institutions and professional organisations responsible for assessment and certification.[183]

The validity and reliability of competence assessment tools along with methods of assessment of optometry students in the UK, Europe and USA has been discussed in chapter 6. No valid assessment methods that measure all facets of clinical competence have been designed.[127] Other factors including the feasibility of running and resourcing the examination are also important in a developing country context with fewer academic resources.[134]

URE has been identified as a major cause of visual impairment worldwide.[2] The results from the RARE and RAAB study described in Chapter three indicate the need for comprehensive eye care including refractive error services to counter the burden of URE in Mozambique. The only providers of refraction services within the national health system in Mozambique are ophthalmic technicians however the previous chapter has demonstrated the need for upskilling to make them competent at refraction.[184] In the absence of alternative refractive care provision, refractive error management was deemed the most important responsibility at present of the Mozambican optometrist.

The aim of this chapter is two-fold: to develop a competency assessment process that is practical to implement, and keep staffing and resourcing costs at sustainable levels within the context of limited academic resources; and to understand the effectiveness of the process in terms of its reliability and validity. Furthermore this will determine whether the methodology can be viable as a means to evaluate the exit competencies, concentrating on refraction, of the student optometrists in Mozambique and inform the design of an exit evaluation system that may be used or modified for use across optometry schools in developing countries.

8.2 Methods

This consisted of two components, firstly, the development of the competency assessment methods and process, and secondly, the implementation of the assessment process.

8.2.1 Development of assessment methods

Information was gathered from a literature review of assessment of clinical competencies of optometry students.[137,144,185, 186] A focus group discussion was conducted with two lecturers from Unilúrio responsible for the clinics of the first cohort of students, and three of the course developers. Four members of the group, two from South African and one each from Canada and Colombia, had extensive experience in undergraduate optometry education particularly in curriculum design, teaching and developing and conducting assessments. The primary intention was to develop the assessment methods for evaluating competencies of the optometry students, concentrating on refraction, before they graduated, which would be feasible given the challenges that existed for a new programme in a low academic resource context. The investigator informed the participants about the objective of the focus group. They were asked how best to evaluate the optometry students competencies as the standard necessary for entry to the profession in Mozambique. The discussion was recorded by the investigator. The main themes of the discussion were extracted.

8.2.2 Implementation of the assessment process

Subjects

All 15 students (nine from the first intake, cohort A, and six from the second, cohort B) who had progressed to the final semester in their fourth year were invited to participate in the study. Subjects consented to their inclusion in the study, and confidentiality of the results was maintained throughout.

8.2.2.1 Competency assessment

a) Direct observation: Students undertook an eye examination of two real patients one a presbyope the other a pre-presbyope under observation of two examiners for each patient. A detailed task-specific checklist (Appendix F part 1), was used to grade each skill. The checklist, adapted from one in use at the optometry clinic of UKZN, was used in the grading of final year students as they saw patients in the general clinic. Clinical performance was assessed for communication, history and symptoms, vision and visual acuity (with pinhole if necessary), pupil distance, assessment of pupil responses, cover test, ocular motility, near point of convergence, externals, retinoscopy, best sphere, cross cylindrical refraction, binocular balance and near vision, final prescription, ophthalmoscopy, advice, recording, management and time keeping.

Equipment: The research equipment used in the study comprised:

- Visual acuity chart (3 metre phoroptor chart with duochrome and cross-cylinder targets).
- Streak retinoscope
- Trial lens set and frames / phoroptor
- Cross cylinders +/-0.25D and +/-0.50D
- +/-0.25DS and +/-0.50Ds flippers
- Torchlight
- Cover stick
- Slit lamp
- Ophthalmoscope

The time allowed was 50 minutes. If the examiner considered that the examination was difficult, (due to a complex refraction greater than 6.00DSE, low vision with best corrected decimal visual acuity <0.4, pathology, patient being illiterate or unable to communicate in Portuguese) they could allow an additional fifteen minutes. Examiners were to consider the difficulty of the patient in their marking of the student.

b) Two part theory exam:

i) Short answer questions (SAQ) (one hour):

This consisted of six case slides. Five of the patient cases had a colour photograph of an ocular condition, and one comprised a binocular vision scenario in which the patient history and clinical data were presented. The student was examined on recognition (signs and symptoms), judgment (differential diagnosis and extra tests necessary), refraction management and decision making skills (e. g referral, low vision appliances) for the five cases with a photograph; and a diagnosis and treatment plan for the binocular vision case. The cases were standardised in terms of content (of the number of identically mapped competencies assessed) and difficulty for both cohorts taking into account the depth of coverage of a topic expected in the students' answers and the amount of time required to answer a question to the appropriate standard. Model answers were prepared ranking the importance of the different components using guidance from best practice tools in optometry, and graded using a checklist (Appendix F part 2).[185,187,188]

ii) Structured oral viva (half hour): This consisted of an oral viva of three case studies from the students' portfolio: one low vision, one binocular vision and one pathology patient, and the management of their refractive error. A checklist with a set of questions was used to elicit the student's knowledge and rationale in the management of the topic under examination as well as their ability to communicate this knowledge. (Appendix F part 3) The checklist comprised of the competencies to be assessed and was adapted from checklists used in optometry registration exams in the republic of Ireland and the UK.[189,190]

For both theory exams, each question/case was first marked independently out of 10 by two examiners and then averaged to give a final score. Students who passed both the theory and the clinical exam were deemed competent to refract. This was determined by the members of the focus group. The methods of clinical competence assessment of optometry students based on Miller's pyramid of evaluation are illustrated in figure 8.1 below.

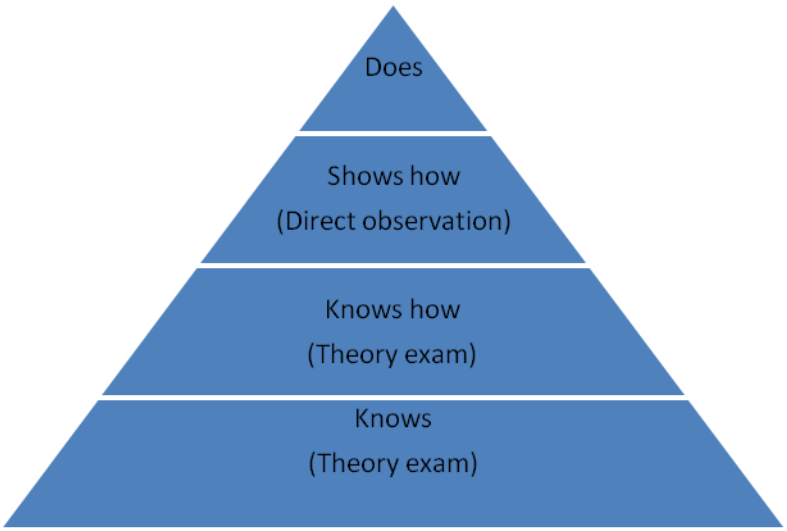

Figure 8.1: Methods of assessing clinical competence based on Miller's pyramid [103]

8.2.2.2 Qualitative observations

In addition to the assessments, qualitative observations of the competency assessment process, by the examiners, were used to provide information to the university and rest of the faculty regarding the possible reasons for the results. This would enable the faculty to have the opportunity to learn from this and improve teaching as a consequence.

Data analysis

Data were entered on to an SPSS database (version 21, IBM Corporation, Armonk, NY) and analysed for inter-rater agreement and consistency between the students and the examiners with Cohen's kappa statistic. Descriptive statistics were produced and the difference in performance between the first and second cohort were analysed using a Mann Whitney U test. A significance value of $p < 0.05$ was adopted throughout the analysis.

Refractive error analysis

Refractive errors were analysed using power vector analysis which allows tha statistical analysis of optical prescriptions.[176]The clinical observation of sphere(S), cylinder (C) and axis (ά) were converted into a Fourier series which lends itself to calculations of sums, differences and averages. The power vectors are represented as Sphere equivalent (SE), Jackson cross cylinder at axis 0 with power J_0 and Jackson cross cylinder at axis 45 with power $J_{45.}$ Power vector form was obtained by conversion of sphero-cylindrical notation in Microsoft office Excel spreadsheet as follows:

A spherical lens of power M (equal to the mean SE=S+C/2)

Jackson cross-cylinder at axis 0 with power J_0 (equal to = -C/2 cos 2ά)

Jackson cross-cylinder at axis 45 with power J_{45} (equal to =-C/2 sin 2ά)

A variance of +/-0.50D spherical equivalent and cylinder was set as the limit of acceptability for retinoscopy and subjective refraction, based on the literature of repeatability and reproducibility of refractive values.[168,169]

Examiners

The researcher, as an external optometrist examiner, and four of the Unilúrio lecturers, as internal optometrist examiners, were provided training by the course developers on the use of the standardised checklists along with the performance criteria and competency standards necessary for the students to exhibit entry level competency on graduation. Two of the internal examiners assessed the practical competency (one for each cohort), and two the theory. All examiners had were experienced optometrists from the UK, Spain and Colombia, with an average of thirteen years in practice.

8.3 Results

8.3.1 Development of assessment methods

The key themes extracted from the focus group, and which informed the development of the assessment methods included:

i) The methodology should be appropriate to provide an assessment of optometry students' knowledge, skills, behaviours, attitudes and values, undertaken in a clinical context. The WCO global competency model would be used as the framework for the assessment, concentrating on the elements of competencies and performance criteria essential for the practice of refraction.

ii) The existing literature on different assessment procedures suitable for use in optometry was discussed.[137,144,185,186] The two most commonly cited method of evaluation of clinical competencies, identified from the literature review, are the direct observation of students performing these clinical skills and OSCEs. However there is little published literature on the use of OSCEs in Africa. In a review of the economic feasibility of OSCEs in undergraduate medical studies, only 17 of the 1075 publications were from Africa.[191] A study comparing six assessment methods for their ability to assess medical students' performance and their ease of adoption with regard to cost, suitability, and safety, in South Africa, revealed OSCEs to be the most costly.[192]

The focus group made recommendations on the most suitable methods for competency assessment in Mozambique. The competencies would be assessed using:

a) Practical clinical competency exams: The practical clinical competency exam had to be constructed to maximise validity and reliability against the time and cost of running and resourcing the exams. Hence, OSCEs and the use of standardised patients were ruled out due to lack of academic resources and examiners. All the students would have a portfolio and be signed off on the relevant competencies that would make them

eligible for the final clinical examination. The portfolio included a list of competencies to be attained, the educational objectives and the expected levels of performance. Procedure and patient encounter counts were checked to ensure adequate exposure. Students were required to:

- Perform the eye examination in a methodical and logical manner
- Perform any tests using the correct technique and demonstrate and understanding of the significance of each test
- Select and perform procedures appropriate to the patient's condition and abilities
- Complete the eye examination record as appropriate, and indicate their final prescription and advice to the patient at the conclusion of the eye examination

Ophthalmoscopy and an external exam were also included as the presence/absence of pathology would indicate the level of best corrected visual acuity and help in the management of the patient. A pass-fail cut-off score of 75% as stipulated by the university and backed by literature[193] was maintained by the participants of the focus group discussion. The skills were weighted according to their importance for safe, effective clinical practice based on the literature.[143] The weightings are reflected in the results in Table 8.1 with 100% being the overall score.

b) Theory exams: To cover the background knowledge required for the competent practice of refraction, two theory exams would be set, SAQs and a structured oral viva. Both exams would be double marked using checklists. The overall pass mark for this was set at 50%, as stipulated by the university, backed by literature,[129] and agreed upon by the focus group, with each section contributing equal weight. The pass marks for the

practical and theory element vary based on best practice and experience of the focus group participants.

iii) Qualitative observations of the competency assessment process, by the examiners, would lead to feedback being provided to the faculty. This would develop an understanding of the results from the clinical evaluations of the optometry students.

Students would have to pass both the practical and theory exams to be considered competent.

8.3.2 Practical competency assessment:

Thirty patients were examined (mean age 37.6 years; standard deviation 18.4 years; age range 7 to 72 years; 16 male [53%] and 14 female [47%]) by nine students from the first cohort and six students from the second cohort.

Fourteen patients had low refractive error (sphere within +/-0.75) and seven had best corrected decimal visual acuity <0.4. Refraction results from the two graders were averaged. Inter-rater K value was >0.6 for all skills showing a good strength of agreement between the two raters.[194] The only significant inter-cohort difference was in binocular balance and near visual acuity. Table 8.1 summarises the mean marks with the standard deviation for both cohorts for every technique and the inter-cohort difference. Figure 8.2 indicates the total number of students passing every skill.

Table 8.1: Results of practical competency assessment

Technique/ (Weighting %):	Mean mark (SD)		p value *	Total number of students demonstrating competency N=15	Number of students demonstrating competency	
	Cohort A	Cohort B			Cohort A (N=9)	Cohort B (N=6)
Communication/ (4%)	4 (0)	3.8 (0.6)	0.08	15 (100%)	9(100%)	6(100%)
History and Symptoms/ (10%)	8.2 (1.9)	7.5 (2.6)	0.49	14 (93%)	8 (89%)	6(100%)
Vision/ Visual acuity with old Rx/ (5%)	4.7 (0.7)	4.8 (0.4)	0.90	15 (100%)	9(100%)	6(100%)
Pupillary distance/ (2%)	1.3 (1)	2 (0)	0.07	11(73%)	5 (56%)	6(100%)
Pupil responses/ (2%)	1.8 (0.5)	1.8 (0.6)	0.84	13 (87%)	8 (89%)	5 (83%)
Cover test/ (2%)	1.6 (0.8)	1.8 (0.6)	0.22	10 (67%)	6 (67%)	4 (67%)
Ocular motility/ (2%)	1.8 (0.5)	2 (0)	0.24	14(93%)	8(89%)	6(100%)
Near point of convergence/ (2%)	1.2 (1)	1.7 (0.8)	0.14	9 (60%)	4 (44%)	5(83%)
External Exam/ (5%)	4.2 (0.9)	3 (2)	0.19	10(67%)	7 (78%)	3(50%)
Retinoscopy/ (10%)	6.8 (3)	5.5 (3.6)	0.30	9 (60%)	6 (67%)	3(50%)
Sphere/ (10%)	4.9 (2.8)	5.8 (2.9)	0.33	6 (40%)	3 (33%)	3(50%)
Cross-cylinder/ (10%)	2.6 (2.4)	3.9 (2.8)	0.17	4 (27%)	1(11%)	3(50%)
Bin balance and near VA/(4%)	1.2 (0.9)	2.3 (1.3)	**0.02***	4(27%)	1(11%)	3(50%)
Final prescription and auxiliary tests/ (4%)	2.6 (1.6)	2.4 (1.6)	0.52	7(27%)	4 (44%)	3(50%)
Advice to patient/ (4%)	2.4 (1)	2.1 (1.6)	0.88	5 (33%)	2 (22%)	3(50%)
Ophthalmoscopy/ (10%)	5.8 (2)	4.7 (3.3)	0.45	6 (40%)	3 (33%)	3(50%)
Recording/ (4%)	2.8 (0.9)	2.2 (1.2)	0.12	11 (73%)	7 (78%)	4 (67%)
Management and time keeping/ (10%)	4.9 (2.6)	4.4 (3)	0.68	4(27%)	1(11%)	3(50%)
Total score (100%)	62.8 (13.9)	61.7 (20.9)		4(27%)	1 (11%)	3 (50%)

Abbreviations:

* Mann Whitney U test SD: Standard Deviation

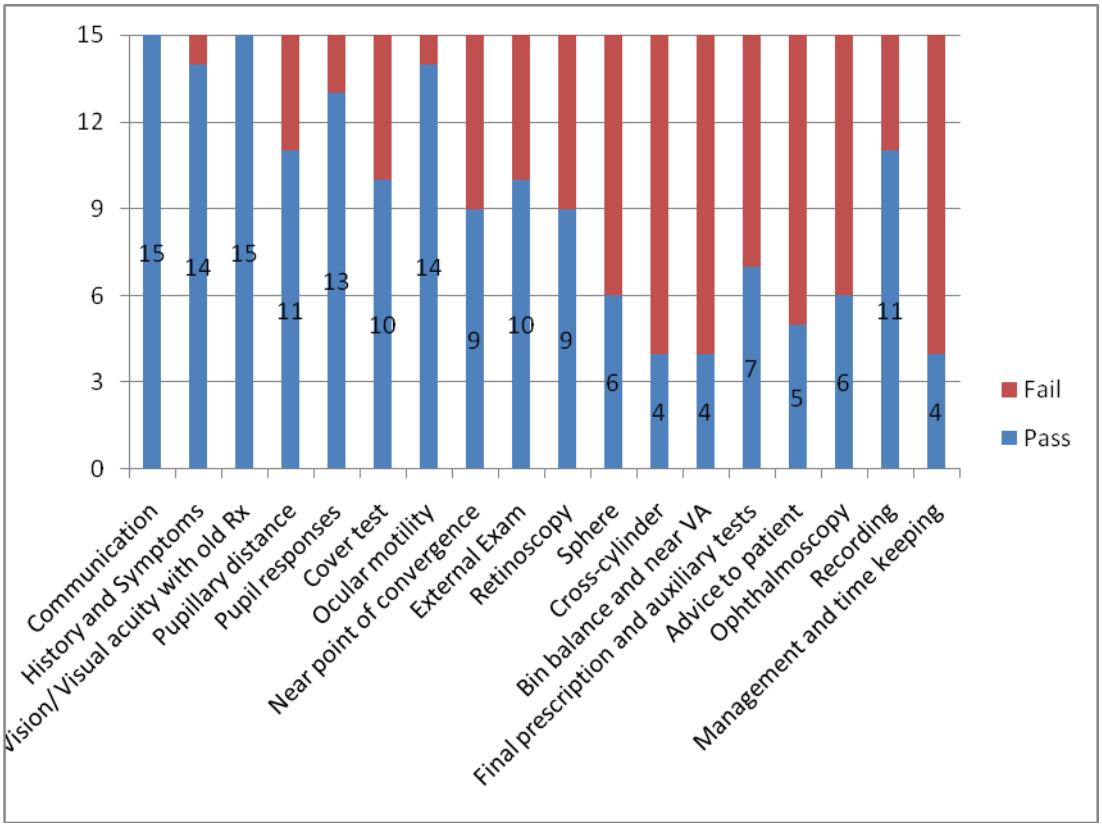

Figure 8.2: The number of students passing every skill

Figure 8.3: Optometry student practicing his clinical routine

Concordance in retinoscopy findings and spectacle prescription between the examiner and the students

Refractive error assessment findings were reported for both eyes of 30 subjects. Of these four eyes of two patients had high refractive error (SE 6.00D or more) which were not detected by the students. For sphere and sphere equivalent, concordance, between the examiner and the student, for spectacle prescription was 73% and retinoscopy was 65%. The results for cylinder were 63% for spectacle prescription and 55% for retinoscopy. For near correction concordance was 93%.

Table 8.2 illustrates the strength of agreement in diagnosing subjective refractive error. Very good agreement (k=0.81-1.0) was observed in diagnosing presbyopia between the examiner and the students. This indicated high precision in diagnosing presbyopia. Moderate agreement (k=0.41-0.60) was found in diagnosing spherical equivalent, sphere and cylinder.

Table 8.2: Strength of agreement in diagnosing refractive error

Prescription	**Agreement (%)**		**Strength of Agreement (kappa)**
	Spectacle prescription	Retinoscopy	
Spherical equivalent	73%	65%	Moderate (k=0.46)
Sphere	73%	65%	Moderate (k=0.42)
Cylinder	63%	55%	Moderate (k=0.41)
Near spherical equivalent	93%		Very good (k=0.91)

8.3.3 Theory exam

Table 8.3 demonstrates the number of students passing the two sections of the theory exam. There was no significant difference between cohort A and cohort B for the theory exam. The inter-rater agreement for the theory exam was greater than 0.6 indicating good agreement.

Table 8.3: Results of the theory exam

Exam	Mean mark (SD)		p value*	Inter-rater Kappa	Number of students demonstrating competency N=15
	Cohort A	Cohort B			
Short answer question/ 10	6.4(2.0)	6.9(1.8)	0.16	0.77	13 (87%)
Oral viva/10	5.4(1.6)	5.6(1.7)	0.31	0.74	11 (73%)

Abbreviations: SD: Standard Deviation * Mann Whitney U test

8.3.4 Qualitative observations of clinical assessment

The examiners noticed certain factors in play during the assessments. 11 students did not carry out binocular balance tests. For both retinoscopy and subjective refraction, there was a lack of clarity with the instructions, with poor fixation targets being presented. The students had difficulty detecting a retinoscopy reflex in the patients with high myopia. They could not control the subjective response of patients whose response pattern was poor. They took too much time on history and symptoms resulting in less time for refraction and other tests. Overall ten students did not relate patient symptoms to management.

8.4 Discussion

The aim of this study is to evaluate the design of a competency assessment process and gain an understanding of the effectiveness of the process for assessing clinical competency concentrating on refraction. Before the clinical evaluations were carried

out, all the students had a portfolio and had been 'ticked off' for all the competencies including retinoscopy, sphero-cylindrical refraction and binocular balance tests. However, no periodic monitoring of the portfolio had been carried out apart from counting patient encounters, and there had been no checking of whether the students' reflections remained meaningful and constructive. From the results of these assessments, it appeared that the portfolio served to reflect the procedure being performed and audit skills acquisition rather than check on quality or even proficiency.

Overall only four students passed the clinical competency assessment. Refractive error measurement is the primary responsibility of an optometrist. In refractive error reproducibility studies refractive findings obtained by one or more expert optometrists have been considered as the benchmark.[195] The results for concordance, between the examiner and the students, mask the real results as almost half the patients had very low refractive error (+/-0.75DS). Hence the students' final result matched their low ametropia. Published results for optometrists have shown 95% concordance for both spherical equivalent and cylinder.[195] For optometry students, the only published study found on a literature search involved first year students and reported 73% concordance for spherical equivalent, 68% for sphere and 85% for cylinder.[196] The qualitative observations identified some of the factors that led to the students failing. These were communicated to all the lecturers in a feedback session. This input to the lecturers, isolated in a developing country context, has enabled them to learn how to refine student training.

There are several factors that need to be considered in assessing the implications of our study. One of the principal issues affecting the students' clinical performance was the

lack of standardisation of patients.[142] Seven students saw patients with severe, untreated pathology and complex refractive errors. The mix of patients being tested and the complexity of skills being assessed can result in a lack of reliability. SPs are people who are simulating real patients with defined criteria to provide students with consistent and equivalent assessment experiences.[197] Unannounced SPs with completed SP checklists as a record of the encounter have been regarded as the gold standard for quality measurement in clinical practice.[140] Overall, the high costs of training and expertise to ensure reproducibility and consistency of scenarios could not be justified by the local faculty in the context of student evaluation in Mozambique.[127] The recommendation is to integrate a degree of standardisation for future student evaluation. A focus group discussion by the faculty to set the criteria for standardization is proposed. The criteria could include patient age, range of refractive error (if complex then every student should get a complex case), best corrected visual acuity, past experience of optometric exam, absence or presence of pathology and ability to communicate in Portuguese. This will facilitate the selection of patients that meet defined criteria, by faculty, for competency evaluations without incurring an increase in cost and ensure that the marks on the assessment correlate well with the assessment of the students over their entire course.

The methodology of directly observing real clinic patients is increasingly challenged on the grounds of authenticity and unreliability due to examiner and patient variance.[127] Inter-rater reliability measures the consistency of rating of performance by different examiners.[127] The use of two trained raters, for every practical and theoretical exam, with good inter-rater agreement (kappa greater than 0.6) helped to increase consistency.[194] Providing the examiners with a standardised checklist increased the

reliability of direct observation and this has been shown to be as reliable as an OSCE.[142] A 'Hawthorne' effect occurs when a student or practitioner behaves differently because they are being observed. This effect can have a positive impact on student performance.[198] However, the effect is inevitable with any methodology involving direct observation.[146]

For the theory exams, SAQs and an oral viva were used; examination formats the students were familiar with. SAQs are an appropriate test of the application of knowledge.[134] They were designed to assess problem solving and data interpretation skills when faced with common clinical management problems. The oral exam was based on the students' case records, and examined the knowledge, values and attitudes that informed the student's management of the patients. The issue of reliability and validity in this study was addressed by using two trained raters with good inter-rater agreement and checklists for both exams.

As a potential solution to the concerns of reliability and validity of the other assessment methods, the OSCE has gained increasing importance on both sides of the Atlantic.[199] The OSCE has found its place in the assessment of clinical competency in medicine and optometry in the UK, US, Australia and in health science courses in South Africa. [117, 129,132,144,185] Wide sampling of cases and structured assessment improve reliability,[145] but the OSCE is expensive and labour-intensive. [127,183] The OSCE has also drawn some criticism for its lack of validity since complex skills, requiring an integrated professional judgment, become fragmented by the relatively short station length (generally 5–10 min).[200] In Mozambique, due to the lack of standardised patients and expertise among the faculty to implement and grade OSCEs, they were not considered a

feasible assessment method for a new course in a low resource environment. Moreover, it was an examination format the students were not familiar with. Direct expenses of an OSCE include the cost of training standardised patients, examiners, support staff, development of scoring tools and venue costs dependent on the number of stations. However, these costs can be reduced by the use of volunteer faculty, volunteer patients and using students as raters.[191] In this study, no cost analysis of the current assessment methods compared to the use of OSCEs was carried out. Further research is required on the cost of implementing the OSCE (materials, examiners and patients or patient simulators), and the reliability and validity offered, compared with the other methods, in a low resource environment.

In this study, the setting of competency standards was stipulated by the university, backed by a literature review and agreed upon by the focus group (75% clinical and 50% theory).[129193] Absolute standards are most appropriate for tests of competence, where the purpose is to establish that the examinees know enough for a particular purpose, in this case exit examinations.[177] However, the exams for the two cohorts were not identical as they contained different patients and cases. As a result percentage scores did not reflect the same level of knowledge. However, in the long run, a more systematic, transparent approach supported by a body of published research, to standard setting and pass-fail criteria needs to be adapted. This involves evaluating the content and difficulty of the examination.[177] Standards should be consistent with the purpose of the test and based on expert judgement informed by data about examinee performance.[177]

The examiners were all experienced and competent optometrists. The use of multiple examiners is a means that has been shown to enhance reliability.[127] The use of external and internal examiners, however, presents potential issues that need to be addressed in the competency assessment process. The external examiner, being unknown to the students, has to base decisions regarding the competence of students on a very short period of observation that may not be representative of the students' overall performance.[201] Conversely, as the second examiner was internal and had worked with the student for an extended period of time, a socialisation process could have occurred which may have influenced the examiner's judgement. [201,202] To counteract both these situations, the examiners were all given explicit criteria and training in the use of checklists, performance criteria and competency standards.[203] The ideal proposed for an exit evaluation, is a group of external assessors, accredited for suitability by a professional body of optometrists, trained at the required level with experience in competency teaching and evaluation.[202] They should all be competent in the area they are to assess and familiar with the competency standards. The selection of examiners in Mozambique will evolve over time as more students graduate, a professional body is formed and accreditation to become an assessor offered.

The use of standardised checklists and rating forms aims to maintain objectivity of assessments across student competency assessments conducted by various examiners.[127] Checklist items tend to capture whether the skill was performed and are typically scored as "done" or "not done" and the marking is said to be analytic. Rating forms are more broadly formulated items that require more holistic judgment of the associated item or interpretation of actions. The literature recommends using both, with checklists used to identify specific elements of content or skill that must be demonstrated and global

ratings used for providing a measure of process aspects (e.g. general approach to a task).[127,132] For this study the clinical competency checklist was already in use at UniLúrio. The checklists for the theory exams were adapted from best-practice tools for optometry students.

To ensure that both students and examiners are aware of what is required in the course of the competency-based assessment process, it was recommended that suitable instructions be provided. To achieve this, student and examiner manuals should be developed. The examiners' manual would contain guidelines for the preparation of assessments and for the use of the marking sheets for the clinical examinations.' The students' manual would provide information regarding the content of the theory exam and the checklist for the clinical examinations before the examinations.[129]

A limitation of this study was the lack of correction of Type 1 errors for the repeated use of all the Mann Whitney statistical tests.[179] This increased the number of statistically significant p values introducing false positives. The recommendation is to make appropriate p value adjustments (e g Bonferroni adjustment) to compensate for a possible increased risk in committing Type 1 errors when multiple outcome measures are used.[179]

There are other limitations to the study of assessment methodology. Our sample of 15 students was small but represented 100% of the final year optometry students. The study concentrated on refraction. We did not set out to assess dispensing, contact lens fitting, diagnostic and therapeutic skills which are all part of the competency skill set of an optometrist.[85] There were various reasons for this. For dispensing, the spectacle

supply system at the university had not been established when the students graduated so their exposure to dispensing was restricted. Once the students have graduated and started working within the national health system, their access to contact lenses, diagnostic equipment and therapeutics is limited apart from in the larger central and provincial hospitals. Hence refractive error measurement was deemed the most important responsibility at present of the Mozambican optometrist. Moreover, there is little or no supervision once they've graduated. In the absence of alternative refractive care provision, emphasis had to be placed on ensuring they were competent in their refraction routine. However, this assessment methodology could be expanded to include the additional elements in a more comprehensive "suitability to practice" exit competency assessment.

8.5 Conclusion

As optometry continues to move towards competency based curricula, educators require appropriate tools to support the assessment of competencies. Overall, the methodology of direct observation, SAQ's and an oral structured viva has shown good inter-rater reliability with the use of standardised checklists. The main recommendation is the provision of clear guidelines to the faculty for the standardisation of patients during exams for the evaluation to be reliable and repeatable. More data on the use of OSCEs and standard setting are required before the methodology can be adapted for use in optometry schools with similar academic resource limitations.

The next chapter aims to identify the factors affecting student performance from the perspective of the course lecturers and students, and explain the inter-cohort difference

in the results obtained from the competency evaluations. This would inform the course coordinators on how to better structure the course, the teaching and adapt the learning environment so that more future students can graduate as competent optometrists.

Chapter 9

Factors affecting the academic performance of optometry students in Mozambique

Shah K, Naidoo K, Bilotto, Loughman J**.** Optometry and Vision Science. In press, 2015

9.1: Background

Chapter 4 gave an overview of the public health system in Mozambique which has gone through a period of rapid expansion after a long civil war.[28] Access to health care, however, and eye health care in particular, is still poor.[28] The need to prioritise the training of additional human resources for eye health, including optometrists with the skills to manage the problem of URE has been established from the RARE and RAAB studies mentioned in Chapter 3. [53,58]

There are many composite elements to the development of sustainable eye health structures, and appropriate education for eye health workers remains a key determinant of successful eye care development. The challenges faced by the education system in Mozambique, at all levels, primary, secondary and higher education, have been highlighted in chapter 2. There are currently 95 students enrolled in the optometry degree programme in UniLúrio, Nampula in northern Mozambique. However, from the first intake of 16 students only nine students graduated the programme, while only six graduated from the second intake of 26 students. This low graduation rate is attributable to a combination of sub-standard academic performance and student drop out. One student dropped out from the first intake and four from the second. Appendix G gives an outline of the students' progression through the optometry course. Medical courses in Mozambique and science- based courses in other Sub-Saharan African countries

have reported similar graduation rates.[28,89,204]

Initially the MEP proposed a model of optometric training that comprised of a four year two-tiered university-level training programme. The first intake of 16 students, enrolled on this course, had a take a preparatory semester to remediate inadequacies in secondary school education that are manifest in some applicants to higher education. [98] However legislative reform in Mozambique implemented in 2009 resulted in a full four year Bachelor's degree in optometry being the minimum recognised qualification allowable at university level in Mozambique. Hence the second intake of students did not have a preparatory year but extra courses in basic sciences, English and Portuguese in their first year.

There has been a considerable increase in the literature on factors that affect academic performance in recent years,[205] but little that is specific to optometry undergraduates.[206] Most of the published studies about teaching and learning in clinical courses have been conducted in North America and Europe, which are not directly applicable in developing countries due to the inevitable differences in curricula and education systems. Much of the recent research on student learning and performance in higher education has been summarised in terms of a 3P model of student learning: presage, process and product. [207,208,209,210] Presage defines the learning context including the learning environment (curriculum design, academic resources and student-faculty interactions) and student characteristics (ability, motivation and the quality of secondary education obtained). Process factors pertain to the students' approach to learning, while the product aspect is focussed on the learning outcomes. It is also recognised that

lecturers' conceptions of both teaching and learning also affect student learning outcomes.[211]

The implementation of the optometric training programme in Unilúrio has required the partnership to face a number of key challenges. These include faculty recruitment (Portuguese or Spanish speaking), academic resource provision, the lack of awareness of, and student preparedness for, optometry education in a country with no prior experience or knowledge of optometry and a challenging healthcare environment.

This chapter concentrates on the students' and lecturers' perceptions of the learning context (curriculum, assessment methods, educational resources and student capacity), teaching context (lecturer background, experience, knowledge and support) and their impact on student performance within the fledgling optometry programme in Mozambique. The student performance is contextualised by an evaluation of the refraction competencies of all 15 students in the final semester of their fourth year in Unilúrio, just prior to completion of the degree.

The aim of this chapter is to identify factors affecting the academic performance of optometry students in Mozambique. The use of semi-structured interviews is useful for more in-depth lecturers' views on factors affecting student academic performance.[204] Feedback from students has always played an important role in the maintenance of quality and standards in higher education.[151] The validity of student ratings is supported by the existence of a positive relation between student evaluation of the course and student achievement. [212] This research will inform the course coordinators and partners on how to better structure the teaching and adapt the learning environments so that, in

future, student retention rates are higher and more students can graduate as optometrists that are competent in refraction amongst other important skills.

9.2 Methods

Nine lecturers and 15 students (nine from the first intake, cohort A, and 6 from the second, cohort B) were recruited to the study comprising the entire faculty and all students of the first two years of the programme. The research was conducted according to the tenets of the Declaration of Helsinki.[213] Clinical competency assessments were carried out on the students as described in chapter 8, semi-structured individual interviews were conducted with the course lecturers (qualitative data only), and a course evaluation questionnaire was completed by students (qualitative and quantitative data). The results of the qualitative and quantitative evaluations were combined to understand the complexities surrounding the optometry student training and performance, and bring together the perceptions of the two stakeholders (lecturers and students).[150]

9.2.1 Competency assessments:

The methods for the competency assessments have been described in detail in chapter 8.2.

9.2.2 Semi structured interviews with course lecturers

All nine lecturers were interviewed face to face by the researcher and recorded. The interviews were conducted using a topic guide informed by teaching and learning

literature. [209,211] They began with a conversation about their educational background, clinical and teaching experience. The concept of teaching and learning were explored with questions on student capacity to learn (entry requirements, student feedback), course content (curriculum and any local circumstances that have to be considered for teaching this course and its contents), learning environment (resources available to support teaching and learning), and assessment. The aim was to obtain information relevant to student performance and the challenges that students face in the context of studying a new clinical course (optometry) in a developing country.

9.2.3 Course evaluation questionnaire for students

Existing questionnaires in use at the optometry faculties of two universities, University of Kwa-Zulu Natal (UKZN) and Dublin Institute of Technology (DIT) were used as the basis for the course evaluation questionnaire. It was reviewed for its relevance to Mozambique, by the researcher and the optometry course developers at the Brien Holden Vision Institute, and translated into Portuguese (Appendix H). It comprised 30 items broken down into four key areas which included: learning (4 questions); the lecturers (8 questions); learning resources and environment (6 questions), and assessments (7 questions). The questionnaire also required the student to grade the overall difficulty or ease of the optometry programme and contained four open-ended questions that gave the students an opportunity to comment more openly. The questionnaire was designed based on teaching and learning literature, and was based on the assumption that student performance (exam results and progression) is a function of:[212]

a) Learning experience of the course module

b) Lecturer teaching and support

c) Availability of learning resources

d) Clarity of assessments and feedback

The questionnaire used a five-point Likert scale, with response categories including: strongly disagree (1); disagree (2); neutral (3); agree (4); strongly agree (5). Likert scales are ordinal measures representing the categories in an inherent order (more to less) and do not indicate interval properties (the magnitude of difference). [155] A mean score greater than three indicated agreement with the statement.[212] It was piloted to 16 students from the first intake of Optometry students and 24 students from the second intake of students from Unilúrio after completion of their first optometry module vision and community in the second semester of their first year. All participants were assured that their inclusion in the study was entirely voluntary and that they could withdraw their consent at any time.

Minor amendments were made to the piloted questionnaire with the addition of certain items (evaluation of the students' clinical experience) with the final questionnaire having 48 items broken down into evaluation of five key categories: the lecturers (9 questions); the overall learning experience (14 questions); assessments (6 questions); learning resources and environment (8 questions), and the optometry programme in general (3) (Appendix I).The questionnaire also asked the student to grade the course overall and contained seven open-ended questions, two on prior preparation for the programme and five on general comments that gave the students an opportunity to comment more openly. The final questionnaire was administered to all the students

(nine students from cohort A and six students from cohort B) a week before their final exams in their final year.

9.2.4 Data analysis

All data records were entered into a Microsoft Excel spreadsheet and arranged in categorical or numerical form as required, before being imported into SPSS version 21 (version 21, IBM Corporation, Armonk, NY)for the quantitative statistical analysis. Descriptive statistics were computed for the clinical competency assessment and the differences in performance between cohort A and B were analysed using a Mann Whitney U test (significant $p<0.05$).

Reliability analyses were carried out using Cronbach's alpha on the responses from the administered pilot and final questionnaire.[173] Measures of central tendency and dispersion, (mean and standard deviation of scores), associated with each Likert scale statement in the questionnaire were calculated. A Mann Whitney U test was conducted to compare the 2 cohorts (9 students from cohort A and 6 students from cohort B) to see if there was any difference in their responses ($p<0.05$) which might account for any difference in student performance. The null hypothesis is that there is no significant difference between the two cohorts. If the test statistic (z) is negative we know that the results of the first cohort were less than the second.

For the qualitative questions on the student questionnaire similar words and statements were highlighted while analysing the response, themes were identified and the

frequency of each theme was counted. Codes from the data extraction were entered into SPSS and analysed using descriptive statistics.

For the lecturer interviews, the data extracts were transcribed verbatim, translated into English, read, coded, categorised and analysed thematically. The assigned themes were utilised for data presentation and representative quotes selected. In order to improve the credibility of the data, member checking was used.[214] This involved the data being presented to a focus group of four lecturers from UniLúrio to confirm the credibility of the themes and whether the overall account was realistic and accurate. Participants' comments were incorporated into the final narrative. The study was approved by the research ethics committee at the Dublin Institute of Technology.

9.3 Results

The results were divided into three groups: (a) students' competency exam results (b) results from lecturers' interviews and (c) results from students' questionnaires.

9.3.1 Student competency assessments

Table 8.1 and figure 8.2 from Chapter 8 summarize the results of the clinical competency exams. One student (11%) was graded as competent in all the elements of the refraction clinical competency exam from the nine students in cohort A and three (50%) from the six students in cohort B. Eight students from the first cohort and three from the second cohort failed to demonstrate competency in binocular balance, cross-cylindrical refraction and management and time keeping. There was a significant

difference in the results of binocular balancing between the two cohorts with students from cohort B carrying out the procedure and performing better (p=0.02).

9.3.2 Interviews with the course lecturers

Four dominant themes emerged from the lecturer interview data that were viewed as important determinants of student performance from the lecturers' perspective:

1) Student learning context
2) Teaching context
3) Clinic conditions and assessment
4) Existing operating healthcare context

The themes are presented below with illustrative quotes from the nine lecturers (L1-L9).

Theme 1: Student learning context:

This theme highlighted the influence of the learning environment and student capacity to engage with learning.

i) Learning environment: There were inadequate teaching and learning resources for both cohorts. When asked about any additional supports that might be put into place to better help both the faculty and the students to enhance the overall learning experience, some common themes were identified: The need for more lecturers and training on clinical skills for staff and students; and more teaching and learning resources.

'More personnel available for support in clinic'. (L1,L3,L4,L5,L6)

'More training, seminars and workshops for clinical practice for the lecturers and students'.(L2,L8)

'More books' (L2, L5) and a 'digital library'. (L4, L8)

'The teaching has to be creative and resourceful. Translating English lecture notes in Portuguese and examining students in Portuguese was initially difficult'. (L1)

'It is hard to read the assignments from the students. They all use the same one or two books; sometimes not even good books, just because they are in Portuguese.'(L5)

ii) Student capacity to engage with learning: The overall view was that the students were highly motivated and capable of successfully completing the course but certain factors were affecting their performance. These included:

a) Student academic background and current entry requirements: Inadequate student preparation and insufficient pre-requisite knowledge of science and maths seemed to be the main reason the students had difficulty grasping the contents of some modules. None of the lecturers were aware of the entry requirements for the course as the university had never been open about how they selected students. All were aware that the students had completed university entry exams in maths, physics, biology and chemistry. The predominant view was that the current entry requirements especially for the first two cohorts were low but for the subsequent cohorts they were getting higher. The lecturers highlighted the need to adapt their teaching to students' academic level; five said they had to change the pace of delivery.

'Their base in basic sciences and maths is quite low so it takes longer to explain things. I make more effort on topics they are going to deal with in everyday situation'. (L3)

'They lack some basis of maths e g without a calculator most of them don't do any kind of calculations, even the more basic ones. And even when they have a calculator some of them lack the basic principles to do the right arithmetic. Some more knowledge of Portuguese would be great. They misspell a lot, I cannot correct them all. If I did I would not do anything else'. (L4)

'I had to slow down my speed of teaching and lower my expectation on how much they knew. They lack basic skills in core subjects. You have to be very patient and resourceful'. (L5)

'The admission level is very low. For newer intakes the university has changed something and now we are receiving better prepared students.' (L4, L6, L8, L9).

b) Lack of prior knowledge of the course and optometry practice:

There was no evidence of students getting career guidance on optometry. Moreover they had unclear ideas of what their work as an optometrist would entail.

'Most of the first cohort did not apply for optometry but for medicine and nutrition but did not get through'. (L1)

'Of course if they had a better basic education it would be easier to deal with the programme even more if we think that they still don't know what is going to be their final work in the Mozambican society'. (L3)

'The difficulty for the students when they were admitted is they lacked prior knowledge of the course'. (L7)

c) Course workload and manageability: All the lecturers agreed the course load was manageable. Two lecturers said the course load was intensive but necessary as some of the students had very low basic skills. When asked what course curriculum they were

currently using, they all replied they were using the approved curriculum with minor amendments.

d) Student motivation: The predominant opinion was that the students were highly motivated.

'Most of the students have a lot of interest and motivation as they are helping their community'. (L2, L3)

'In general students are motivated and engaged in the class. I think they value the fact that they can study for a qualified profession. Some also just want to have a good job. (L6)

Theme 2: Teaching context:

This theme was contextualised by the teaching practice of lecturers and student-faculty interactions.

i) Teaching practice of lecturers:

This comprised of the lecturers' academic background and prior clinical and teaching experience. Their clinical experience varied from no experience to 12 years. Only one Colombian lecturer had any prior teaching experience. When the lecturers were recruited there had been no faculty training or prior pedagogic skills assessment. This affected teaching and learning, and created confusion among students as different methods were used to carry out the same clinical test, and different levels of importance

were assigned to the various tests, with some refraction tests being omitted completely. The general view was that the Colombian lecturers gave more importance to diagnosis of ocular disease and therapeutics, and less to binocular balancing tests and dispensing. All the lecturers stated the need for a set protocol for tests in clinics that the lecturers have to follow.

'We need a protocol. In Colombia they do not carry out binocular tests regularly so the students get confused when we ask them to carry them out' (L4)

'*All lecturers need to be at the same level clinically. We should all pass through an induction process where everyone has the same basic clinical level and knowledge of the protocol before starting to teach*.'*(L1)*

'We can cause confusion just from our different ways of doing things e g everyone has their own way of measuring pupillary distance. We have to give the students a clear protocol'. (L3)

'A little bit of pedagogic experience would help. A lot of the differences are due to practical and professional experience of the lecturer. I attempt to clarify the contradictions with other lecturers and abide by the given protocol'. (L6)

ii) Student-faculty interactions

The predominant view was that the lecturers provided support by coaching and guiding students.

Our time here is to support them. They come and find us in their free time. It's different from being at home where there were many more lecturers and many more students. (L2)

The students and lecturers have very close relationships. The students call us on our mobiles if they have any doubts. We have to hold their hands. (L3)

Theme 3: Clinic conditions:

The factors identified included clinic supervision and feedback, assessment methods and the lack of standardised patients.

i) Clinic supervision and feedback: The shortage of faculty and time for supervision and feedback were deemed to have an influence on student performance. There was insufficient time to address clinical errors so that students could learn from them.

'Most of the clinics I had to supervise nine students on my own. I was exhausted. There was no time for feedback. I was called upon for other duties whilst I was supervising so sometimes the students would be left on their own'. (L1)

'There is not enough time dedicated to student supervision. I am usually jumping around saying today I will evaluate this test for this student and next week I will grab this student. We need more lecturers involved in direct contact with the students in clinic'. (L5)

'It's very difficult to evaluate the clinic. Most days there are 6 or more students to 1 lecturer. It's not enough. Most days I will evaluate one student, then I will get interrupted, something might not be working, and then there is never time for feedback for the other students. Sometimes the refraction or management of the patient is so bad you can't talk in front of the patient. I write it in their feedback sheet, but I don't know if they read them. I hope they do'. (L6)

'They always make the same mistakes with cross-cylinder by not giving clear instructions and moving the axis of the cylinder until the patient says the vision is better'. (L5)

ii) Assessment: Every patient examination by each student was routinely graded as a 50 minute 'mini-test' and the results used for formative assessment. This made the students very nervous in following the protocol, caused many students to allocate time poorly, with exaggerated emphasis on history and symptoms, insufficient time for refraction and other tests, leading to a failure to address the patient's primary concerns. Grading scales were used by all the lecturers for the practical assessments. The lecturers mentioned the exams were set with appropriate levels of difficulty.

'We are very strict. If a mediocre student passes, that's a bad 'product' of the university'. (L1 L2, L3, L5)

'Every patient the students see is a test. They are always under a lot of pressure and more interested in finishing the protocol than in managing the patient. The tests should be less frequent with a lot more time for feedback'. (L7, L9)

iii) Patients: Other influences included a lack of patients, especially in the first few months of clinical sessions (affecting cohort A primarily) and principally in the binocular vision clinic. Students had to bring their own patients either from their visits to the 'communities' or their friends. The lack of standardisation of patients especially during assessments affected performance.

'Initially students brought friends and family members for eye exams. On some days there would be no patients at all'. (L1)

'Students do not invite patients from the 'community' if they think they have a severe problem, as they are scared of getting a lower mark'. (L2)

'We don't see many patients in the binocular vision clinic. Patients don't turn up after the initial consultation. The students need good exposure and experience with treating e g amblyopia but there are very few children in the clinics and the ones we see don't turn up for follow-up appointments'. (L4)

Theme 4: Existing operating healthcare context:

This was contextualised by the nature of optometry practice, the eye health conditions in Mozambique and the patient role and experience of healthcare.

i) Nature of optometry practice: The optometry course needed to be adapted to better address the needs of the population and this was observed to have affected student performance. It was suggested that students need to better understand barriers that exist to access of eye care (cost, accessibility, awareness, religion, culture, language etc) and take into account existing eye care services (scope of practice of ophthalmic technicians and ophthalmologists, and the role of traditional medicine practitioners).

'*The course needs to be tailored to address the needs of the community and include aspects of local knowledge for students to communicate with the patients and give appropriate advice'. (L9)*

ii) Eye health conditions in Mozambique: Three of the lecturers expressed doubts on whether the students were capable of treating the eye health conditions of patients they would see in an eye clinic.

'They should attend an advanced refraction course concentrating on dispensing, binocular vision and low vision'. (L1, L2)

'There is no supervision once the students graduate. The challenge for them once they graduate is how many patients they will be able to manage. Will they be able to provide spectacles, manage pathology'? (L3)

iii) Patient role and experience of healthcare: The predominant view was that there was a lack of public health awareness in eye care and by the time the patients came to the clinic their eye conditions were advanced to the point that little treatment could be offered.

'We have to increase awareness of eye care within the population especially in the case of prevention'. (L1, L2, L3 L5, L7, L9)

'We should be carrying out school screenings and having presentations in the communities about eye care'. (L9)

The factors affecting student academic performance to emerge from the lecturer interviews are presented in Figure 9.1 below.

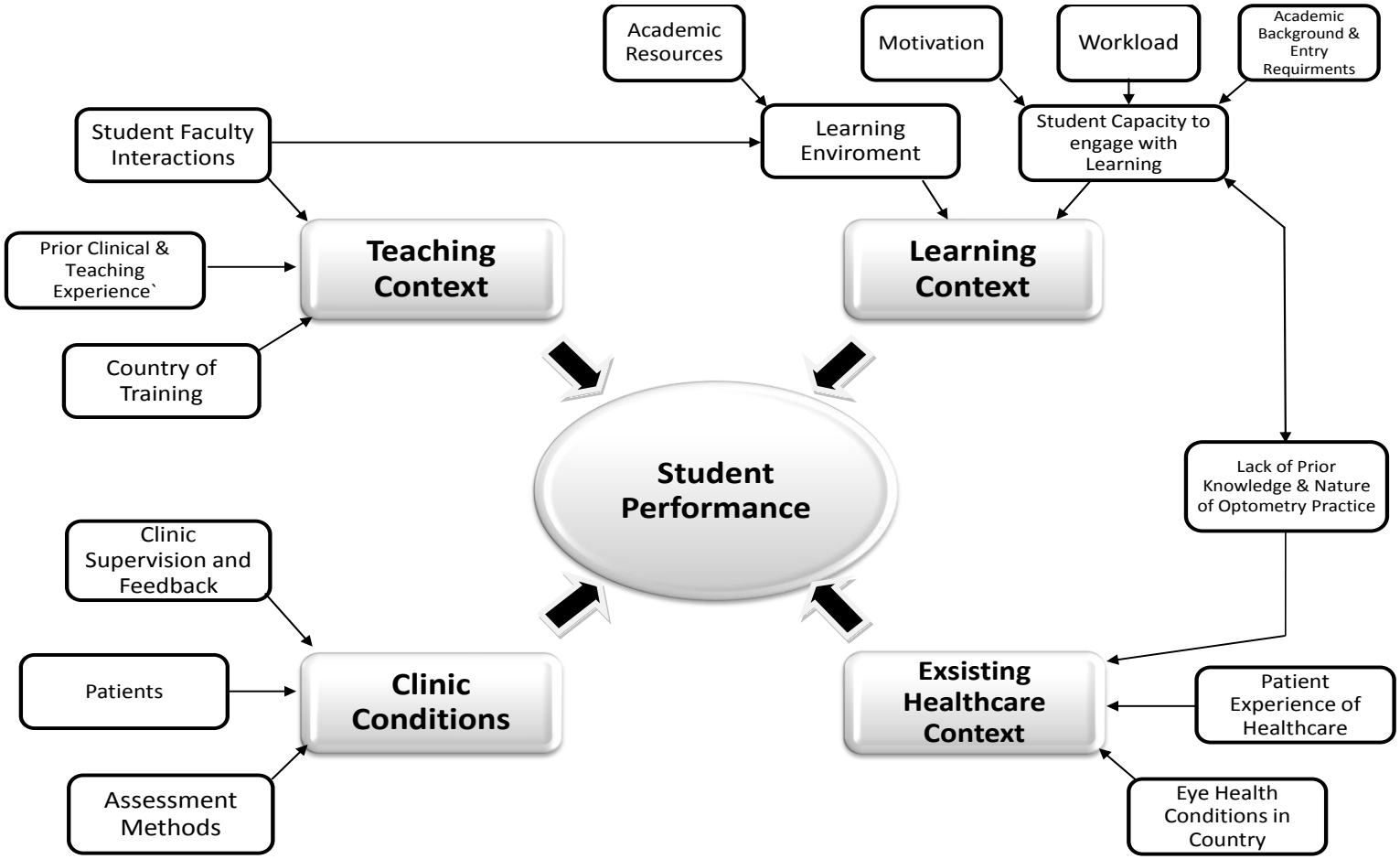

Figure 9.1: Themes emerging from lecturer interviews

9.3.3 Student evaluation questionnaire

Reliability analyses of the 30 variables of the pilot and 48 variables of the final questionnaire revealed a Cronbach's alpha of 0.89 for the pilot and 0.86 for the final questionnaire indicating good construct reliability.[173]

Table 9.1 below summarises the results with measures of mean and standard deviation for the factors for cohort A and cohort B, Mann- Whitney test statistic, z, and the p value of statistical difference between the two cohorts. A high value of the mean indicated strong agreement with the statement in the questionnaire. A high value of the standard deviation indicates that individual scores are highly dispersed from the mean.

Figure 9.2: Supervision in optometry clinic

Figure 9.3: Optometry student in clinic

Table 9.1: The mean, standard deviation and p value* of the student evaluation questionnaire

Agreement scale **1=Strongly disagree 5=strongly agree**	**Mean (SD) Cohort A**	**Mean (SD) Cohort B**	**z**	**p value***
Lecturers				
The lecturers had sufficient knowledge of the content/area that they were teaching	3.89 (0.93)	4.12 (0.41)	-0.49	0.62
The lecturers related to me in ways that promoted mutual respect	4.22 (0.67)	4 (0.63)	0.67	0.50
The lecturers stimulated my interest in the programme	3.67 ((1.11)	4 (0.63)	-0.45	0.65
The lecturers were well prepared	3.89 (1.17)	4 (0.63)	0.19	0.85
The lecturers provided adequate opportunities for questions and class discussion	3.89 (1.36)	4 (1.10)	0	1
The lecturers were available to offer support outside of lecture times	4 (0.71)	4.67 (0.52)	-1.81	0.07
The lecturers provided useful feedback on my progress of the courses throughout the programme	3.22 (1.09)	3.83 (0.75)	-0.97	0.33
The lecturers showed genuine concern for the students and their learning	3.56 (1.23)	4 (0.89)	-0.51	0.61
Learning				
The modules gave a detailed description of the theoretical aspect of the course	3 (1.12)	3.83 (0.98)	-1.54	0.12
The workload was manageable	2.33(1.22)	3.33(0.82)	-1.59	0.11
I had enough time for self-study during the programme	1.89 (1.78)	1.78 (1.89)	-1.06	0.29
The overall content of the programme was appropriate to the practice of optometry	4.11 (0.6)	4.33 (0.52)	-0.71	0.48
The content was at an appropriate level for an optometry degree	4 (0.71)	4.33 (0.52)	-0.94	0.35
The basic science courses delivered in the first year were adequate background to the professional and clinical course	3 (1.32)	3.83(0.98)	-1.26	0.21
There was a clear understandable link between the courses	3.11 (1.17)	4.17 (0.75)	-1.80	0.07

Agreement scale **1=Strongly disagree 5=strongly agree**	**Mean (SD) Cohort A**	**Mean (SD) Cohort B**	**z**	**p value***
The theoretical knowledge is adequately linked to the practice of optometry	3.89 (0.93)	4 (0.63)	-0.07	0.95
The clinical work was well coordinated with the material covered in lectures and/or seminars	3.67 (1.12)	3.83 (0.98)	-0.26	0.80
I was able to apply the theoretical concepts from lectures to the clinical situations	4 (0.71)	4 (0)	0	1
There was enough time allocated for the clinical aspect of this programme	2.89 (1.17)	4 (0)	-2.17	**0.03***
The level of clinical training is adequate	3.67 (0.87)	3.83 (0.98)	-0.53	0.59
I feel confident about my clinical skills	4.22 (0.67)	4.33 (0.52)	-0.27	0.79
Assessment				
There was a good link between what we learnt in class and what we were assessed on	3.67 (1.12)	4.17 (0.41)	-0.80	0.42
The way my progress was assessed (assignments, exam, practical) gave a fair reflection on my knowledge and understanding	3 (1.5)	4 (0)	-1.27	0.21
The in-class tests and assignments prepared me for the final exams	3.67 (0.87)	4.33 (0.52)	-1.61	0.11
I received constructive criticism on my performance in assessments	3.56 (1.24)	4.5 (0.55)	-1.82	0.07
I received timely feedback on my performance in assessment	2.67 (1.41)	4 (0.63)	-1.84	0.07
Equipment, resources and infrastructure				
There was adequate access to equipment needed to complete assignments	4.11 (0.6)	4 (0.10)	-0.13	0.89
Equipment used was reliable and in working order	4.11 (0.6)	4.17 (0.41)	-0.15	0.88
There was adequate opportunity to use the equipment within the specified clinic time	4.33 (0.5)	4.33(0.52)	0	1
The lecture and tutorial rooms were adequate for the programme	3.89 (0.33)	4 (0.63)	-0.42	0.67
The laboratories were appropriate for the programme	4.56 (0.53)	4.17 (0.75)	1.05	0.29
The library (facilities/resources) were adequate	2.78 (1.30)	3 (1.26)	-0.38	0.71
The teaching resources (course manuals and PowerPoint) were adequate	3.22 (0.97)	4.17(0.41)	-2.05	**0.04***

Agreement scale **1=Strongly disagree 5=strongly agree**	**Mean (SD) Cohort A**	**Mean (SD) Cohort B**	**z**	**p value***
Programme in general				
In general, this was an excellent programme	3.67 (0.5)	4.17(0.41)	-1.83	0.07
Overall, the programme exceeded my expectations	3.67 (1)	3.83 (0.75	-0.31	0.75
I would recommend this programme to others	3.89 (1.27)	3.83 (0.75	0.57	0.57

*Significant at $p<0.05$

As the questionnaires were completed anonymously, there was no way of determining the thoughts of students that failed the competency evaluations. The results from the open-ended questions of the questionnaire and the key results from table 9.2 are explained in detail below:

Grading the course and prior preparation

Three (20%) students graded the course as extremely difficult, 11 (73%) as somewhat difficult and one (7%) as neither easy nor difficult. When asked about what preparation was necessary to take the programme, two (13%) said English; two (13%) sciences and maths; and eight (53%) mentioned information about the course and its curriculum. Thirteen (87%) respondents indicated that the requirements of the course were not made clear to them before starting the course.

Category 1: Lecturers

The students agreed that the lecturers had sufficient knowledge, were well prepared, provided feedback and adequate opportunities for questions, and were available to offer support outside of lecture times (mean scores greater than four). There were no statistically significant differences in perceptions of lecturers between the two cohorts. When asked how the lecturers can improve on teaching the programme, the most common responses included suggestions to provide student support (80%): listen to the students, help weaker students, to understand and be patient with the students when they have difficulties.

Category 2: Learning

The students were in agreement that the overall content of the programme was appropriate, the clinical work was well-coordinated and they felt confident with their clinical skills. However, only five (33%) students found their workload manageable and 14 (93%) stated that they did not have enough self-study time during the programme. Nine (60%) students stated that basic science courses delivered in the first year provided adequate background to the professional and clinical components of the course.
The only statistically significant difference to emerge between cohorts related to whether there was enough time allocated for the clinical aspect of the course ($p=0.03$). Only three students from nine (33%) from cohort A thought there was enough time allocated for the clinic compared to all six (100%) from cohort B. Some of the factors mentioned in response to the open-ended question on how the learning process can be improved included: 'More time in clinics and tests' (20%); 'more lecturers' (20%); 'connecting theoretical lectures to clinical practice' (13%); and 'more relevant course notes' (13%).

Category 3: Assessment

The students agreed that assessments were of a reasonable content and level. There was no statistically significant difference between the two cohorts. Eleven (73%) students agreed that the way progress was assessed (assignments, exam, practical) gave a fair reflection of their knowledge and understanding, while nine (60%) agreed that they received timely feedback on their performance in assessment. Six students (40%) suggested that the student assessment system could be improved by reducing the quantity of 'mini-tests', while one student (14%) mentioned that more time should be given to the students in clinic.

Category 4: Equipment, resources and infrastructure

The students reported that the equipment was reliable, and was adequately accessible for clinics and assignments. The laboratories, lecture and tutorial rooms were adequate. However the library facilities were deemed inadequate by eight students (53%). There was a statistically significant difference (p=0.04) between the two cohorts in relation to their reported adequacy of the teaching resources. Only five students cohort A (55%) graded them as adequate compared to all six (100%) from cohort B. In relation to improving resources, better library resources were mentioned by one student (7%), while eight (53%) said that the availability of resources was good with no comments from the other six.

Category 5: Programme in general

There was broad agreement among the students that the programme exceeded their expectations. Some of the factors mentioned in response to the question about what they liked most about the programme included the clinical experience (40%), availability of clinical resources (27%), experience of working with an international faculty (27%) and lecturer support(7%).

9.4 Discussion

It was originally anticipated that the optometry students would have sufficient English language skills for the programme to be implemented through English. The teaching

resources originally available through the partners were in English. Although English is taught routinely in secondary school education in Mozambique,[216] it was quickly noted that student language skills were insufficient, and that the education programme would need to be conducted in Portuguese, or Spanish (an education link between Mozambique and Cuba exposes students to the Spanish language which is readily understood by Mozambicans). English materials, therefore, were urgently translated into Portuguese and made available to faculty. It is unsurprising, therefore, that the learning environment emerged as an important factor affecting student learning. This issue was addressed after the piloting of the questionnaire for cohort A.

The inadequacy of the library facilities was established from both the interviews and questionnaires. A common challenge faced by members of the Association of Portuguese Language Universities (AULP) is providing access to up-to-date and relevant academic literature. [217] There are limited optometry related text books available in Portuguese or Spanish and 55 computers at the optometry campus at UniLúrio for over 700 students. Recurrent power outages, security issues and restrictions in internet connectivity, however, meant access was limited even when the computers were functioning. These deficiencies in libraries and information technology, common in other universities in sub-Saharan Africa, deny students the possibility of bypassing older learning methods to benefit from the rapidly advancing developments in internet-based learning.[218] In today's world of on-line journals, databases, textbooks and other learning resources, internet connectivity takes on even greater significance.[219] With some notable exceptions like the Health Inter Network Access to Research Initiative (HINARI), created by the World Health Organization, Education for Health and Rural and Remote Health Care, most current on-line journals are not free for students in

Mozambique.[219] Universities need more computer facilities on campus, better internet infrastructure, faster internet connections and the professional expertise to help students to access on-line resources. [217,219] The students have to be encouraged to learn English, as the worldwide language of optometry, given that most books and research journals only publish in English, and graduates will have an ethical responsibility for continuous professional development to ensure their clinical practice is informed by relevant research.

As described in Chapter 2, the education system in Mozambique is mainly characterised by weak performance as a whole, high grade repetition, high dropout rates, high pupil-teacher ratios and a low percentage of qualified teachers.[17,30,220] The pupil - teacher ratio in 2012 for primary school was 54.8 pupils per teacher, and 47 pupils per teacher for secondary school.[17] The variable and generally weak level of secondary education in Mozambique has necessitated the incorporation of a science focused preparatory year at two medical schools in Mozambique, which affords students from poorer areas and weaker secondary schools the opportunity to study further education. [98,218] This study has established that student preparation for the course, especially the low basic level of maths and sciences, was not ideal at the time of entry to the programme. A preparatory year is therefore recommended to strengthen and homogenise student knowledge.

Admission and selection processes of students in health sciences have been identified as critical factors to address academic success and student retention rates.[219,221] Selection of students is a challenge for health professions schools everywhere, particularly when criteria are shaped by social policy initiatives such as uneven distribution of health workers.[219] To have graduates work throughout the country, there is a responsibility to

recruit and select students from all the provinces. The pedagogical director in UniLúrio stated that students were selected on their geographical origin rather than a minimum mark. This has resulted in the new optometry graduates working in seven of the eleven provinces in Mozambique at present, which is positive and indeed necessary given the paucity of resources in all provinces, in particular the more rural locations. To ensure that students with the necessary competencies are accepted in to the programme, it is recommended that the selection process is made more transparent, and that more stringent admission criteria are applied compared to the present level.

Only one student had selected optometry as their first choice in response to a demographic questionnaire in 2010 administered to 27 students from the first two cohorts.[222] Thirty percent (eight) of the students had chosen medicine and 22% (six) nutrition.[222] The profession of optometry did not exist in Mozambique and the course of optometry was only newly available to secondary school graduates for consideration. Moreover, the social standing of an unfamiliar profession might not rank highly compared to doctors, who are usually well-respected within the community.[223] The lack of proper career guidance could result in poor academic performance.[204] The university, students and graduates should endeavour to increase awareness of the programme. Appropriately planned career guidance, course outlines in a prospectus, and study guides for all the taught modules would also assist in generating increased secondary school interest in optometry, and will assist students to make better informed decisions and choose degree programmes suited to their ability and interests.

The mean number of course contact hours for the two cohorts varied. Cohort A had their curriculum squeezed from eight semesters to seven semesters due to a university

strategy called ‘re-alignment’. They averaged 37 hours a week of contact time (minimum 30 maximum 44). For cohort B it was 32 hours (minimum 24 and maximum 42). Approximately 55% of the course was theoretical, 45 % practical. In courses allied to medicine in the UK, the average number of contact hours is 23.[224] The literature on student workload is largely centred on a time-based calculation of workload.[225] Workload is defined as the number of contact hours for classes plus the time spent on independent study.[226] No data were available on the number of hours spent on independent study hence only the contact time was taken into account for this study. A curriculum review in 2013 has reduced the contact hours to 29 (minimum 24 maximum 32) with 49% theory and 51% practical. Some of the factors involved in the greater number of hours in the curriculum included poor secondary school education, inadequate entry level, and the inclusion of courses in Portuguese, English and basic sciences in the first two semesters to account for the dropped preparatory year for cohort B. Further research on the time students spend on independent study in resource poor contexts would provide the course developers with information on how to better structure the curriculum. Increasing the average university entrance scores would ensure that the enrolled students have better ability to cope with the workload.[225] A reduction in the number of contact hours, however, would seem a prudent recommendation to the university based on international trends and norms for allied healthcare education programmes.[224]

Optometry is still a developing profession in most Spanish and Portuguese-speaking countries (including Spain, Portugal and other Latin American countries), with varying scope of practice challenges. It was difficult, therefore, to attract suitably qualified and experienced Spanish or Portuguese language optometrists with the necessary skills who

were available for long term contributions to such culturally- and professionally - challenging assignments. Due to the lack of faculty training or pedagogic skills assessment pre-recruitment, the staff did not have equivalent clinical competencies. Every country has a different approach to optometry so different lecturers also have different expectations, different training and different perspectives as to training priorities.[227,228,229] In Colombia, the scope of practice for optometrists includes the evaluation, diagnosis, prognosis, treatment and rehabilitation of vision problems. They are allowed the use of pharmaceuticals for diagnosis and treatment.[227] Spain and Portugal do not allow the use of pharmacological agents. The focus of their courses is refraction and optics. [228,229]

Cohort A had most of their clinics with Colombian lecturers, hence have benefitted from good diagnostic and therapeutic knowledge at the expense of binocular balancing tests for refraction and dispensing. It is, therefore, unsurprising that the lack of clinical and pedagogical experience of the recruited faculty members appears to have impacted student academic performance. Although efforts were made to provide continuous clinical education to faculty, this study highlights the need to more comprehensively address this salient issue. Clinical training for skills that lecturers are not competent in is recommended. Competent staff enhance student learning, hence faculty should be encouraged to seek opportunities for continuing professional development as well as in the area of teaching and learning.[230] The challenge is for the students to understand that there are different ways of carrying out the same procedure as long as they are all methodologically correct. Students should be encouraged to seek to benefit from the different schools of thought.

The ratio of students to clinical demonstrators recommended by the course developers was 4:1 but for Cohort A it sometimes ranged up to 9:1. One of the main roles as clinic supervisor is to provide constructive feedback to motivate students and to communicate that their competence and skills are developing.[205] If students are observed regularly, flawed techniques or lack of understanding can be observed and corrected. Students working in clinic can experience a gap between theory and practice.[231] To enable students to bridge this gap, the clinic supervisors have to support the student both in addressing the patients concern and developing the student's professional practice. This could be achieved by increasing the ratio of supervisors to students and allocating feedback time after every patient seen.

The clinical experience of the first intake of students was compromised relative to subsequent intakes in terms of the quality and level of exposure to patients in clinic. This was an inevitable problem given the lack of awareness of optometry in the country and within the community the student clinic serves. Increasing the awareness of the existence of the optometry clinic resolved these issues for cohort B, as is evidenced in the statistically significant difference in reported satisfaction with the clinical aspects of the programme between the two cohorts. It is realistic to expect that this pattern will continue to improve over time as the clinic builds a database of patients available for student examination and assessments.

A valid, reliable student assessment system is another critical challenge facing African schools.[219] A 'mini-test', where every patient encounter in the final year was graded, was used as a way of formative assessment; however this increased the pressure on the student to complete the full protocol in 50 minutes. This also had an indirect effect of

students selecting patients with low/no refractive error, as they knew they were getting assessed. The lack of standardised patients and lack of practice on patients with moderate/high refractive error has posed challenges in student competency development.[127] As the clinic database has developed the practice of students self-selecting their patients has now ceased.

There is no literature on the frequency of clinical assessment in optometry clinics in developing countries. In this context, the university set the criteria that every patient had to be assessed as is the case in medical courses in Mozambique.[232] Due to the resource constraint of a lack of supervision and the range of patients seen, it is recommended that in the first semester of clinical practice the students concentrate on a problem-focused eye exam, addressing the patient's concern. Broader domains of competence (e.g. history, communication, patient advice) could then be assessed to develop the students' professional practice.

However, despite the apparent challenges, the lecturers stated that student motivation was high, and they operated an 'open-door' approach for student support with the students calling on them in their free time and even weekends. There is agreement in the literature that supporting students is an important function of the lecturer.[233] Adapting the system to be based on individuals students' learning needs [233] by having tutorials and regular feedback sessions,[233] would address the students expectations of lecturer support.

The difficulties of a long journey to the hospital, lack of appointments and the expense deters patients from attending medical facilities. It would be expected that students

would see a lot of patients with severe, untreated pathology or complex refractive errors. For other patients in the eye clinic at UniLúrio, this was their first eye test. Their interpretation of the practitioner's questions, their lack of past experience and inability to discriminate small differences can all lead to inappropriate feedback.[234] When the students examined these patients, usually in the context of a 'mini-test', it resulted in poor performance as they were difficult patients to manage. To ensure competence in managing these patients, the optometry students' training has to be contextually relevant, i.e. to the type of conditions and patients they encounter e.g. low vision, high refractive errors and binocular vision. Competence in objective techniques is vital for students pre-graduation.

One of the primary goals of optometric practice is to improve community health. It is necessary, therefore, to ensure that graduates in practice would be sensitive to the real-world situation. Public health and health promotion are part of the curriculum. Both cohorts of students participated in school screenings, and took part in the "One Student/One Family" programme where each student is allocated to work with families from a local community to provide guidance and advice regarding eye health.[235] Eighty percent of the population in these communities still lacks access to modern health care and rely on indigenous doctors and traditional remedies.[235] Students learn about community life and health and in turn transmit information to families about modern health care. However the lack of faculty to supervise the students has limited the students' scope of practice. It is recommended, therefore, that the programme seek to encourage more public sector exposure by working in the community or at tertiary health facilities under supervision.

The existing WCO framework that has been used for teaching and assessing the optometry course does not address issues related to the local health and resource context in Mozambique. Adapting it to develop a locally relevant framework would better address the eye care and refraction need and lead to better appreciation of what students need to learn in order to practice competently. The optometry course needs to be adapted continually to best address Mozambique's specific needs. Once the students have graduated and started working within the national health system, there is little or no supervision, so emphasis has to be placed on making them competent and confident in their refraction routine. Understanding the health system and partnering with all stakeholders including ophthalmologists, ophthalmic technicians and traditional medicine practitioners in eye care will define their scope of practice and eventual work within the national health system.

There are some limitations to this study. The data related to the performance of only 15 students and responses from those students and nine lecturers from one university. They, however, represent 100% of the final year students across two successive cohorts and the entire faculty when the evaluations took place. Moreover the study has concentrated on factors affecting the teaching, learning and existing healthcare context and did not take other demographic factors into account.

9.5 Conclusion

The scope of practice for a Mozambican optometrist has not yet been defined. Our study demonstrates the need for a nationally defined list of core competencies, reflecting local eye health needs, social contexts and the challenges to be addressed due to the lack of

resources and equipment, in which all optometry graduates should be proficient prior to graduating.

These formative evaluations have allowed us to explore and better understand the complex nature of the factors that have affected optometry students' academic performance in the only optometry training programme in Mozambique. The optometry programme was designed, planned and implemented by external partners. The findings have helped the university and course partners to address the challenges faced and implement strategies and interventions to have a positive impact on the performance level of the students.[4]

More research needs to be conducted to see if these factors are representative of the optometry students from the new optometry departments in developing countries with similar healthcare context and uncertain scope of practice. Measures need to be put in place earlier, by the lecturers and the universities, to ensure that the training they offer results in competency attainment for refraction.

The next chapter describes the development of the competency frameworks for refraction service provision in Mozambique.

[4] The entrance scores for all the optometry students have been made available to the researcher and the course faculty since this evaluation took place. The mean mark (standard deviation) of cohort A was 6.7 (1.2) and cohort B was 7 (0.77) out of a maximum of 10. There was no significant difference in the entrance marks of the two cohorts (p=1) using analysis of variance test statistic on SPSS 21).

Chapter 10

Development of socially responsive competency frameworks for ophthalmic technicians and optometrists in Mozambique

Shah K, Naidoo K, Loughman J. Clinical and Experimental Optometry. In press, 2015

10.1 Background

The eye health work-force shortage in sub-Saharan Africa and Mozambique has been highlighted in Chapter 4. The development of competency- based education and competency frameworks for eye care personnel has been identified as an important component of the human resource strategy to address vision impairment in Africa as described in chapters 4 and 5 of the thesis.[75] The challenge lies in developing and adapting competency frameworks for local effectiveness rather than to adopt models from other contexts that might not be relevant.[61]

Social responsibility of an educational institution implies awareness of duties regarding society and the tem social responsiveness engagement in a course of actions responding to social needs.[236] The social responsiveness of medical schools has received increased emphasis as the first step towards social accountability.[237] It is defined as a capability by which an educational establishment responds to societal needs and acts proactively to meet those needs.[238] The WHO has defined the social accountability of medical schools as having the obligation to direct their education, research, and service activities towards addressing the priority health concerns of the community, the region, or nation they have a mandate to serve. [239]The visual impairment statistics, critical shortage of human resources and gross inequities among different sectors of the population in sub-

Saharan Africa has prompted eye care institutions to underpin their curricula in a framework of social responsiveness.[70]

Chapter 7 of this thesis explained in detail the evaluations of the refraction skills of the OTs. The results revealed that their competencies were affected by inadequate levels of training at different institutions, work experience and their location of work in reference to the availability and standards of equipment, the clinical load and support structures available. They needed up-skilling to make them competent in performing retinoscopy and correcting astigmatism. Due to the context of limited eye care and differences in training programmes for the OTs, there is an urgent need for standardisation in training and accreditation. The study supported the need to develop a competency framework to inform the design of new curricula and upskill existing OTs.

The results from the evaluations on the competencies of the optometry students were discussed in Chapter 8. Chapter 9 identified factors affecting the students' academic performance using semi-structured interviews with the course lecturers and a course evaluation questionnaire for the students. It was recognised that a framework originating in one context in which competencies can be achieved, had to be adapted to better address the eye care and refraction need in Mozambique based on the local circumstances. The necessity to adapt the existing framework arises because of the need to pay attention to existing healthcare contexts including eye health conditions and patient role in and experience of healthcare; the role of traditional medicine; and the availability of, or lack of support from, other eye care personnel.

The overall aim was to develop, using a Delphi methodology, a comprehensive framework of socially responsive competencies for both OTs and optometrists. This in turn would inform the evolution of curricula for both cadres in Mozambique. The advantages of a competency framework include setting practice standards for individual practitioners by providing a structure to measure their skills and abilities, support their training, inform continuing education and professional development.[16] It provides information to employing organisations (Ministry of Health in Mozambique), regulating authorities, education and training institutions, and the general public on the roles and responsibilities of eye care personnel.[16]

10.2 Methods

Chapter 6 gave an overview on the commonly used consensus methods for framework development. The Delphi technique has been previously applied to the development of competency frameworks and curricula for optometry and medical sub specialities.[163,164] In this study, a modified technique, whereby a draft document of competencies was generated using literature review, observations and primary research data rather than from an initial round of the Delphi technique, was used in order to reduce the number of rounds in our study. A diagram demonstrating the modified Delphi technique is presented in Figure 10.1 below.

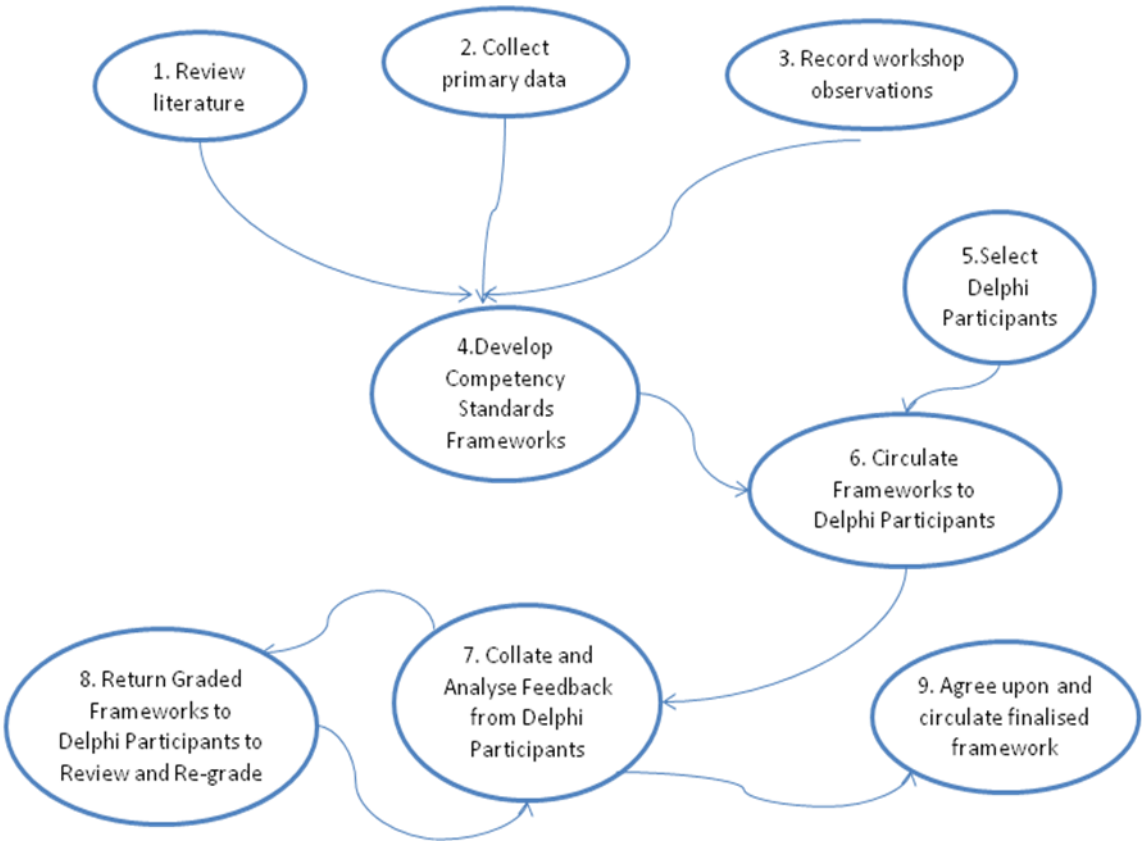

Figure 10.1: Steps in the Modified Delphi technique

Steps 1, 2 and 3) Information was gathered from an extensive literature review of existing education models for optometrists and MLEP, principles and elements of social responsiveness, and eye and health care needs in the region. This information was collated with observations from a competency development workshop organised by the College of Ophthalmology of East, Southern and Central Africa (COECSA) and primary research data, collected from the evaluations of the OTs and optometrists from Chapters 7, 8 and 9 of this thesis.

The first document of the Mozambique- specific competencies was drafted using the information garnered from the steps above by the researcher and reviewed and approved by two faculty members who had experience with the Delphi technique. It was informed by the principles and elements of social responsiveness. [237,240] The development of competencies for this framework was based on Mark Albanese's five theory-based criteria for educational competencies.[108] The competencies should:

a) Focus on the performance of the end-product or goal-state of instruction, to ensure the course content is aligned to the application of knowledge and skills.

b) Reflect expectations that are an application of what is learned in the immediate instructional programme

c) Be expressible in terms of measurable behaviour

d) Use a standard for judging competence that is not dependent upon the performance of other learners facilitating criterion-based assessment

e) Inform learners, as well as other stakeholders about what is expected of them.

Based on the WCO Global Competency Model, the draft framework contained a hierarchy of steps identifying core competencies.[85] These included units of competencies, elements and performance criteria. The draft framework consisted of scales for quantitative statistical analysis and comment boxes for qualitative data collection. Participants used a 9-point Likert scale (0 = not essential, 9 = essential) to rate the importance of each element and performance criteria (Table 10.1) with a free-text option to modify or suggest additional competencies and performance criteria. Data were entered in an Excel spreadsheet.

Step 4) A framework development stage was conducted with the primary objective to complete the draft framework and to grade the performance criteria of one set of competencies for the OT and optometrist cadres within the context of a low-resource environment and the legislative constraint of the length of their courses. The development panel included three optometrists and an ophthalmologist (two males and two females). Three had worked in training optometrists and/or OTs in Mozambique. Two had experience in working with developing competency based curricula, one for the optometrists at Unilúrio, the other for the OTs at the IHS. Their mean (standard deviation) number of years in teaching was nine (seven) and in clinical practice was eleven (6.3). The framework development participants were excluded from the full-panel study. The participants were also asked to provide clarity to the instrument by identifying any incongruence or vagueness that might hinder interpretation of the framework, and identify required corrections to the proposed competencies.

Step 5) For this study a convenience sampling technique was used to provide perspectives from optometrists, MLEP and ophthalmologists involved in academia, experts working in public health and social responsiveness, and the training of MLEP and optometrists in a developing world context. Research participants were selected on the basis of their expertise, including knowledge and experience of the issues under investigation, familiarity with the local context in Africa especially Mozambique and their capacity and willingness to participate. The various stakeholders (course coordinators from Unilúrio for the training of the optometrists and the Institute of Health Sciences for the OTs) who would eventually implement the framework were also invited.

Thirteen experts received an electronic invitation and an informed consent form via e-mail. The invitation included (a) a clear description of the study; (b) a list of expectations of participants; (c) length of time required; (d) voluntary commitment or informed consent requirements and; (e) information regarding the right to withdraw from the study at any time. Of those invited to participate, 10 responded, of which seven had experience of working within the eye care sector in Mozambique.

Step 6, 7 and 8) The frameworks were distributed by email to the Delphi participants for the first round of scoring and comment. The results of the first round of frameworks were then analysed. For each statement, the mean rating was calculated together with the percentage of respondents scoring the competency above 5 (neutral point for a likert scale from 0 to 9). As the literature on the Delphi technique does not stipulate a set level at which consensus is judged to have been reached, this was chosen based on what has been used in other similar studies.[163] In order for competencies to be automatically approved into the framework, two criteria had to be met. First the mean score for that competency had to be greater than five, and second, more than two-thirds of Delphi experts had to rate the competency greater than six. In order for a competency to be rejected outright, one of two criteria needed to be met, either that the mean score for that competency was less than five, or if more than two-thirds of Delphi experts had scored that competency less than five. The comments were coded for qualitative analysis

In the second round the frameworks were returned to the panellists in a similar format to round one. The summarised scores of each performance criteria with means and the individual respondents score were highlighted. This allowed participants to verify that

their round one responses did indeed reflect their opinions and were given the opportunity to change their round one response now that the other research participant's answers had been shared with them. The round two frameworks, when completed, were returned for analysis. Where required, all borderline competencies would be returned to the panellists for a third round, in a similar format to round two until consensus was reached (2/3 majority) regarding their inclusion in the framework.

Step 9) The final frameworks which were agreed upon by consensus were then circulated to the relevant stakeholders for implementation.

10.3 Results

There is little evidence-based information directly related to eye care and/or to MLEP in low income countries. Thus literature were sought about eye health and education; [67,241,242,243,244] competencies and competency-based training; [16,101,102,108, 242,245] curricula for mid-level or allied eye health personnel; [244,246,247]; regional eye and health care needs [53,58,215] and socially responsive medical education. [239,240]OT training requirements from Ministry of Health in Mozambique (MISAU) were sourced and reviewed.[92] For the optometrist cadre, frameworks from the WCO, UK General Optical Council, and departments of optometry at DIT and UKZN were all consulted. [85,107]

The overwhelming consensus from the participants at the COECSA competency development workshop was that refraction was a core component of the MLEP workload and needed more specific course outcomes.[248] Additional competencies were proposed (e.g. population/ public health, including eye health promotion; technical and

research and training) with a strong emphasis on social responsiveness designed to enable students to acquire an understanding of the refraction and eye health needs of their communities.

The core expectations of what is required of eye care personnel were regarded as generic competencies and skills. The draft list of competencies was collated under the section headings: 1- patient history; 2-patient evaluation; 3- patient management; 4-community; 5-technical; 6- research and training. Based on the WCO Global Competency Model, the draft framework contained a hierarchy of steps identifying core competencies.[85] These included:

Units of competencies - major components of the activities within a profession;

Elements - sub-divisions of units, the 'lowest logical, identifiable and discrete sub-groupings of actions and knowledge, which contribute to and build a unit'. The units and the elements in each unit define the professional responsibilities and functions of the eye care service provider.

Performance criteria - accompany elements and are, 'evaluative statements specifying the required level of performance,' that can be used by an assessor to determine whether a person performs to the level required for the profession.

The draft framework consisted of these six units of competence, 19 elements and 80 performance criteria.

Social responsiveness in the draft framework is addressed by:

Element 4.1 addresses the need to engage in actions responding to social needs.

Element 6.1 addresses the need for research which has been emphasised by the WHO definition of social accountability.[239]

Element 6.2: Training is in response to the existing health care context and priority health issues. There are no other personnel providing eye care and carrying out refraction in Mozambique.

10.3.1 Development stage

The panellists reported that the draft framework took approximately one hour to rate. They made several recommendations. The main recommendation was to split the framework into two separate competency frameworks for the two cadres with the optometry framework being more comprehensive. For the optometrists, there was agreement on the inclusion of all of the elements and performance criteria.

For the OTs, elements 2.3: ability to assess oculomotor and binocular function; 3.2: ability to manage patients with an anomaly of binocular vision; and 3.3: ability to advise on and prescribe low vision devices were removed as all the framework development participants agreed that this was beyond the scope of training within an 18 month mid-level training course.

For both frameworks minor amendments were made. They included changing the first unit of competency from patient history to communication and adding an extra element (element 1.2) and four related performance criteria; and additions of performance criteria to elements 2.2, 3.1.2 and 3.4. All the additions have been annotated with the symbol † in Table 10.1 below.

The frameworks comprised six competencies, 20 elements and 88 performance criteria for optometry, and six competencies, 17 elements and 65 performance criteria for OTs. The development revisions helped to clarify and to organise better the full-panel frameworks for round one.

10.3.2 Modified Delphi Round 1 and 2

Eight panellists out of ten graded both the optometry and OT draft frameworks. One graded only the OT draft framework and one only the optometry draft framework.

10.3.2.1 Optometry framework

There was a 100% (9 responses) return for round one framework and 89% (8 responses) in round two. Panel consensus from the seven working in Mozambique and the two from outside deemed that all competencies were required. Hence it was deemed that the optometrists should be able to perform all of the identified tasks independently at the end of their training programme.

The dominant themes to emerge from the Delphi participants qualitative statements on how they graded the optometrists' competencies included the collective view that there is a need to ensure competency in binocular vision, and low vision and to encourage graduates to access continuing education. Three of the Delphi participants mentioned that they were setting high standards for the optometrists when they graduated as they would not have access to supervision once they were in practice. Overall, the optometry framework was kept in its entirety with all the competencies, elements and performance criteria.

10.3.2.2 OT framework

There was a 100% return (9 responses) for round one framework and 89% (8 responses) for round two. Overall, there was consensus that assessing refractive status by objective and subjective means is seen as a necessary component of the skill-set of the OT. For the OTs four performance criteria achieved a mean score of less than five (indicating disagreement), and, for which, more than two-thirds of the panellists responded less than five. Hence, one element and four performance criteria were removed, all of which were related to optical dispensing. There were no borderline competencies. The dominant themes emerging from the qualitative statements included the need for provision of community eye care, and that objective and subjective refraction were deemed as being significant portions of their training.

Table 10.1 below shows the competency elements and performance criteria, and the corresponding scores at the end of round two for the optometrists and OTs. The competency units of communication (1), community (4), technical (5) and research and training (6) were a priority for both cadres with average scores >7 for all performance criteria. The main differences between the OT and the optometry framework are the competencies in dispensing (excluded from the framework by the main panel), and treating binocular vision and low vision (excluded by the framework development panel). The final frameworks (Appendix J) were circulated for implementation in the only Mozambican optometry training institution (Unilúrio), and the curriculum review committee at the Institute of Health Sciences for the national OT training programme.

Table 10.1: Results from the Delphi competency framework for optometrists and OTs

Unit of Competence	Element	Average grade (SD): Optometrist	Average grade (SD): OT	Performance criteria	Average grade (SD): Optometrist	Average grade (SD): OT
1.Communication	1.1 The ability to communicate effectively with a diverse group of patients with a range of optometric conditions and needs.	8.7 (0.5)	7.8 (0.5)	Ability to obtain and accurately records the reasons for the patients visit.	8.5 (0.7)	7.1 (2.8)
				Ability to obtain a clinical history from a patient prior to examination and treatment.	8.8 (0.5)	7 (2.8)
				Elicits and accurately records the relevant information required for diagnosis and management.	8.4 (0.7)	7.6 (2.7)
	1.2 The ability to impart information in a manner which is appropriate to the recipient. †	8.2 (0.7)	7.7 (0.7)	Employs modes and methods of communication which take into account the physical, emotional, intellectual and cultural background of the patient. †	8.5 (0.7)	7.6 (1.6)
				Understand the patient's expectations and aspirations. †	8.4 (0.7)	7 (0.7)
				Discusses with patients the importance of systemic disease and its ocular impact. †	8.1 (0.6)	7.1 (1.5)
				Ability to impart to patients an explanation of their physiological or pathological eye condition. †	7.8 (0.8)	7.4 (1.6)
2: Patient evaluation	Formulates an exam plan 2.1 Performs distant and near visual acuity tests	9 (0)	9 (0)	Selects appropriate visual acuity test according to patient's age, cooperation, ability, mobility and any cultural and special needs.	8.6 (0.7)	7.1 (2.9)
				Positions and aligns patient at the correct distance from the test chart.	8.5 (1)	7.2 (2.8)
				Changes distance from test chart if appropriate.	8.8 (0.4)	7.3 (2.1)
				Ensures the chart is correctly illuminated for test purpose.	8.6 (0.7)	7.4 (1.4)
				Instructs patient clearly, including wearing of current optical	8.4	7.3

				correction appropriate to the test distance.	(0.9)	(2.8)
				Understands the use of specialist charts for distance and near vision, and the effect of lighting, contrast and glare.	8.6 (0.7)	7.3 (2.9)
				Ensures correct use of occluder.	8.5 (0.9)	7.6 (2.9)
				Ensures correct use of pinhole.	8.4 (1.1)	7 (1.6)
				Accurately records results and patient responses.	8.4 (0.9)	7.7 (2.7)
				Knows the expected norms for vision for different ages.	8.6 (0.9)	6.8 (1)
	2.2 Assesses refractive status.	8.5 (0.7)	7.7 (0.7)	Demonstrates the knowledge, understanding and skills required of an individual to measure the refractive error.	8.6 (0.7)	7.6 (2)
				Ability to implement an examination plan by knowing all the procedural steps, instructing the patient, and accurately recording the results.	8.5 (0.7)	7.1 (2.2)
				Ability to accurately perform retinoscopy on spherical and astigmatic eyes.	8.7 (0.9)	7.2 (2.1)
				Ability to accurately determine the subjective refraction using the best vision sphere, cross-cylindrical refraction, binocular balancing and +1.00 blur test.	8.6 (0.7)	7.7 (1.9)
				Ability to accurately determine near refraction.	8.6 (0.7)	7.8 (3.1)
				Ability to accurately record final prescription.	8.7 (0.7)	7.8 (2.2)
				Ability to utilise appropriate pharmacological agents for refraction within scope of practice. †	7.7 (1.4)	6.8 (2.7)
	2.3 Ability to assess oculomotor and binocular functions.	8.1 (0.8)		Demonstrates ability to assess/determine: Eye alignment and the state of fixation using objective and subjective tests with suitable targets.	8.4 (0.7)	
				The quality and range of the patient's eye movements.	8.4 (0.7)	
				The status of sensory fusion.	8.1 (0.8)	

				The adaptability of the vergence system.	8.1 (0.8)	
				Status and function of accommodation in relation to expected age norms.	8.7 (0.7)	
				Stereopsis in relation to expected age norms.	8 (0.8)	
	2.4 Ability to assess the eye and ocular adnexae.	8.2 (0.3)	7.5 (1.1)	Ability to assess the health of the eyes with an external exam.	8.4 (0.9)	7.9 (0.8)
				Ability to assess central and peripheral fundus.	8 (0.8)	8 (1.4)
	2.5 Ability to assess central and peripheral sensory visual function and the integrity of the visual pathways.	8.1 (1)	7.4 (1.1)	Ability to assess pupil function.	8 (0.8)	7 (0.9)
				Ability to assess the visual field, analyse and interpret the result.	8.3 (0.5)	7.1 (1)
				Ability to perform tonometry.	8 (1)	7.5 (1.1)
				Ability to assess colour vision.	8.1 (1)	7.4 (1.1)
3: Patient management	3.1 Management of refractive error	9 (0)	7.4 (1.6)	Interprets and analyses findings to establish and record an accurate diagnosis and explain diagnosis to patient.	8.6 (0.5)	7.3 (1.6)
	3.1.1 Prescribes spectacles.	8.6 (0.7)	7.7 (1.2)	Confirms patient's existing use of optical correction and identifies the type of spectacle prescription by inspection and neutralisation of lenses.	8.5 (0.7)	7.6 (1.3)
				Measures optical prescription of spectacles, including distance, intermediate, near and prismatic corrections using a focimeter.	8.6 (0.7)	7.6 (1.4)
				Assesses the suitability of spectacles as a form of correction for the patient and explains the financial implications.	8.5 (0.9)	7.7 (1.2)
				Applies the patient's refraction, visual requirements and other findings to determine the spectacle prescription.	8.6 (0.3)	7.2 (1.2)
				Identifies the presence of myopia, hypermetropia or astigmatism from the prescription.	8.4 (0.4)	7.8 (1.3)

	3.1.2 Dispenses optical prescriptions accurately.	9 (0)	4.5 (2.7)	Measures the patient's inter-pupillary distance and demonstrates an understanding of the significance.	8.9 (0.7)	7.1 (1.8)
				Dispenses the appropriate ophthalmic lens and ensures frame design and material is appropriate, in accordance with the patient's prescription for vocational and recreational needs. ‡	8.7 (1)	4.7 (2.3)
				Adjusts the appliance and instructs the patient in the proper use and maintenance of the appliance and of any adaptation effects which may be expected. ‡	8.6 (0.9)	4.5 (2.7)
				Demonstrates the ability to measure for bifocals or varifocals. †,‡	8.5 (0.9)	4.2 (2.8)
				Demonstrate the ability to set the correct optical centre distance for generating prism by decentration. †, ‡	8.4 (0.9)	4.2 (2.9)
	3.2 The ability to manage patients with an anomaly of binocular vision and accommodation.	7.9 (1)		Formulates a visual therapy treatment plan.	8 (0.9)	
				Manages adult patients with heterophoria/ heterotropia.	7.7 (0.8)	
				Manages patients presenting with an incomitant deviation.	7.7 (0.8)	
				Manages children at risk of developing an anomaly of binocular vision	7.9 (1)	
				Manages children with an anomaly of binocular vision.	7.9 (1)	
				Treats patients with accommodative, vergence, ocular motilities, strabismic and amblyopic anomalies.	7.6 (1.1)	
				Administers appropriate therapy for learning disabilities and visual processing.	7.4 (1.2)	
				Instructs patient in the use and maintenance of vision training equipment.	7.4 (1.2)	
				Prescribes appropriate optical devices.	8.3 (0.8)	
				Sets goals of the vision therapy programme and criteria for	7.6	

				completion.	(1)	
				Monitors progress and recognises completion of the vision therapy programme.	7.5 (0.9)	
	3.3 The ability to advise on and prescribe low vision devices.	8 (0.8)		Recognises the rehabilitative needs of the patient with respect to the disability.	8.3 (0.4)	
				Demonstrates knowledge of a range of low vision devices.	8.1 (0.6)	
				Prescribes low vision devices suited to the patient's visual requirements and functional needs.	7.9 (0.7)	
				Instructs the patient in the use of the low vision device.	8 (0.8)	
				Monitors the success of the low vision device and prescribes additional or alternative devices.	8.9 (0.7)	
				Informs the patient of other rehabilitative / social services and refers if necessary.	8.8 (0.5)	
	3.4 Referral.	8.5 (0.7)	7.4 (1.6)	Demonstrates the ability to make a judgment regarding referral and an understanding of referral pathways.	8.6 (0.3)	7.3 (2.9)
				Recognises and discusses with the patient the need for referral to other professionals for assessment and/or treatment.	8.5 (0.7)	7.4 (2.9)
				Ability to write an appropriate referral letter. [a]	8.5 (1)	7.2 (2.8)
4.Community:	4.1 Demonstrates the ability to apply population health approaches.	8.5 (0.7)	8 (0.7)	Promotes information on matters of visual health, and welfare (including the need for regular eye examinations).	8.4 (0.9)	7.2 (2.8)
				Provides advice on eye protection in the home, at work and in recreational pursuits.	8.4 (0.5)	7.89 (1.3)
	4.1.1 Demonstrates the ability to promote issues of eye and vision care to the community	8.5 (0.9)	8 (0.7)	Identifies various eye health promotion activities, prioritises, plans, implements and evaluates them in the community.	8.5 (0.9)	8 (0.7)
	4.1.2 Demonstrates the ability to understand factors	8.5 (0.7)	8.1 (1.2)	Demonstrates understanding of the demography and epidemiology of health conditions affecting the community and the population. (Assess eye health needs taking into account the cultural and	8.4 (0.7)	8 (1.4)

	affecting the community's needs for refraction services.			social setting of the patient).		
				Identifies and solves problems specific to the community/area in which service is offered.	8.4 (0.5)	8.3 (0.9)
				Advises on how to prevent harmful local practices and beliefs.	8.6 (0.7)	8.4 (0.7)
				Demonstrates understanding of, and tries to overcome barriers to access to eye care.	8.6 (0.7)	8.1 (1.2)
				Demonstrates initiative to and ability to collaborate with other health workers and communities to identify potential eye health problems and work out strategies to alleviate them.	8.5 (0.7)	7.7 (1.7)
				Demonstrates ability to work in a low resource environment.	8.6 (0.7)	7.9 (1.4)
	4.1.3 The ability to conduct regular monitoring and evaluation (internal and external) of refraction services for all stakeholders.	8.5 (1)	7.9 (1.2)	Ability to conduct static and outreach refraction screening services.	8.5 (1)	7.9 (1.2)
				Demonstrates ability to interpret information from monitoring and evaluation of blindness prevention programmes.	8.3 (0.7)	7.6 (0.9)
5. Technical	5.1 The responsibility to correctly use and maintain instruments and equipment.	8.3 (0.8)	7.4 (1.3)	Demonstrates competency in the use of refraction equipment including focimeters and retinoscopes.	8 (0.7)	7.3 (2)
				Demonstrates knowledge of maintenance, calibration and repair procedures of refraction equipment.	7.9 (0.8)	7.4 (1.3)
				Demonstrates responsibility for the ordering of equipment and replacement of malfunctioning equipment.	8.3 (0.8)	7.5 (1.4)
6. Research and Training	6.1 The ability to apply research concepts to eye health problems and suggest solutions to identified problems.	8.3 (0.8)	7.5 (1.3)	Initiates and conducts operational research relevant to the local eye programme/interventions.	8.1 (0.9)	7.3 (2.1)
				Manages and utilises hospital information systems to improve the eye services and programmes.	8.9 (0.9)	7.4 (1.3)
				Demonstrates the ability to conduct local data collection and evaluation exercises.	8.3 (0.7)	7.5 (1.3)
	6.2 The ability to teach and participate	8.4 (0.9)	7.6 (1.3)	Demonstrates the ability to supervise and train other health workers in eye health care activities.	8.4 (1.2)	7.4 (1.1)

	in training of other eye health workers.			Demonstrates the ability to plan for his/ her own continuing education.	8.4 (0.3)	8.3 (0.9)
				Demonstrates the ability to train primary level health personnel in the community.	8.4 (0.9)	7.56 (1.3)
				Demonstrates the ability to conduct training for, supervising of, and supporting student optometrists and ophthalmic technicians.	8.4 (1)	7.2 (1.4)

Abbreviations

OT: Ophthalmic technician SD: Standard deviation †Additions to framework after the development stage ‡The performance criteria that did not meet the level of consensus for the OT framework after round two.

10.4 Discussion

The competency frameworks will facilitate the design of training and development courses with distinct roles for both cadres. They will lead to refinement of programme competency lists and content, development of baseline measures, and performance standards, and evaluation of educational outcomes. This will prevent confusion in terms of scope of practice. With the creation of OTs that are fully competent at refraction and optometrists that can carry out dispensing, binocular vision training and low vision therapy, the eye care needs of patients can start to be better addressed.

The Delphi consensus was to include competency 2.2: objective and subjective refraction as a primary component of the mid-level OT course. However, original evaluations had demonstrated that the current OT 18- month course with an 80 hour refraction component is insufficient to develop competence in anything apart from managing presbyopia. The recommendation to the IHS is to improve the refraction-training component of the current OT programme, in terms of quality and length of time devoted to the theoretical and practical aspects in order to facilitate students to achieve the competencies in the timeframe available.

The competencies of community and research and training, proposed at the COECSA workshop, were informed by elements of social responsiveness. [240] They respond to the eye health needs of the communities served, identify the determinants of eye health of the population, promote eye health at individual and community levels, and encourage research relevant to local eye programmes. The extent to which students will engage in the community will be an important indicator of social responsiveness.[249] Due to the lack of basic and ancillary workers with knowledge of eye care in Mozambique element

6.2 was proposed.[28] Training health personnel in eye care will assist the OTs and optometrists in the provision of primary eye care. These competencies along with the technical competency are what differentiate this framework from the existing WCO framework, Australian and South African frameworks.

For OTs as mid-level personnel there are no competency frameworks in place in sub-Saharan Africa. The aim of the COECSA workshop was to establish competency frameworks leading to harmonisation of mid-level curricula. The definition of the roles to be undertaken and the competencies to be attained reflect the eye health need and the available resources. The optometrists along with the OTs would be the primary provider of eye care in a country with very limited human resources and a paucity of dedicated equipment.

The competency frameworks at present concentrate on refraction. Both the RARE and RAAB studies in Mozambique indicated the need to address URE.[53,58] Systems are not yet in place for the optometrists to prescribe contact lenses and further research to identify their scope of practice in diagnosis, management and treatment of ocular disease is required for a fully comprehensive framework for eye care provision for optometrists in Mozambique. For the OTs the framework was adapted to their practice as primary eye care providers providing refraction services. On average 60% of the patients an OT examined in an eye clinic daily were for refraction, hence refractive error measurement was deemed the most important responsibility at present of the Mozambican eye care professional.

There is no universally accepted uniform process for the use of a Delphi technique[250].The number of participants, rounds and level of consensus sought is

dependent upon the purpose of the research and resources [162] The reported level of consensus in the literature ranges from 51% to 80% [250]. The level of consensus chosen at 66% of respondents rating the competency 6 or more (agreement on Likert scale), was based on literature from similar studies.[163] This ensured that when one person consistently graded the competencies lower than the other panellists, the overall result was not affected as demonstrated by the greater variance in the standard deviation for the OT group compared to the optometry group.

The Delphi group size does not depend on statistical power but rather on group dynamics for arriving at consensus among experts. The literature recommends 10-18 experts on a Delphi panel.[251] Selecting research participants is a critical component of Delphi research since it is their expert opinions upon which the output of the Delphi is based. The requirements for "expertise" include: i) knowledge and experience with the issues under investigation; ii) capacity and willingness to participate; iii) sufficient time to participate in the Delphi; and, iv)effective communication skills.[252] The sample comprised of most of the available experts familiar with the Mozambican context. It is acknowledged that the use of a convenience sampling method for panel selection may have led to hidden bias. However, due to the limited number of people with expertise in the field of eye care education in developing countries, random sampling was not an option.

The use of the four person framework development panel was to take into account the legislative constraint of the length of the respective courses. OTs and optometrists have different levels of training. Grading a framework for each cadre ensured clarity of the competencies for the respective cadres. However, splitting the draft framework into two prior to the rest of the panel affected the eventual competencies. Including all the

participants in the rating process and having the full panel make the decision to omit would have increased the validity of the process.

A limitation of this study was the potential lack of impartiality of the panellists who were working in Mozambique. It is likely that participants were willing to engage in discussions as they were more likely to be affected directly by the outcome of the process. Their commitment was related to their interest and involvement with the competency frameworks. The balance of panellists with expertise but impartial to the finished research is difficult to achieve.[253]

Another potential limitation of the Delphi technique is researcher influence on the formulation of the initial statements. Traditionally, round one is used to generate ideas and the panel members are asked for their responses to or comments about an issue. The modified Delphi procedure used in the current study was based on methods applied in other studies to develop competency frameworks for optometrists and medical sub-specialities.[163,164] It was recognised that this approach could bias the responses or limit the available options. To minimise this limitation the initial statements were based on a review of the previous literature on current best practice regarding eye care, education, competencies of health and eye care personnel, social responsiveness, observations from a competency workshop and feedback from the researchers' supervisors. Moreover, the Delphi panel had opportunities to refine and add further competencies.

The lack of input from the community, the end users of eye care services, who were not directly consulted about their needs and priorities, was another issue that arose from the study. Instead, information from the literature review and barriers to access to services was used to identify patient needs.[215] The barriers of lack of felt need, distance to travel

and lack of awareness have been addressed in element 4 of the framework by requiring that health promotion and community outreach are part of their competency skill set. However, the barrier of costs, identified as the most significant, would need to be addressed by careful planning by policy makers. [215] Further the course includes competencies to enable graduates to work in partnership with their communities to adapt eye care services to meet local needs and expectations.

There has been an active debate in the literature on the validity and reliability of the Delphi technique.[254,255] As the panels participating in the study are representative of the group and the area of knowledge, then content validity can be assumed.[253] When consensus is achieved, it can be argued that there is evidence of concurrent validity, in that the experts themselves have agreed upon, the requisite skills.[254] The validity was further enhanced by the high response rate achieved. The continuous verification throughout the Delphi process by the use of successive rounds can improve the validity and reliability of the results.[250,251]

The challenges lie in the implementation of the framework and the task of addressing ongoing competency and retention of clinical knowledge post-qualification. The development of faculty and support to develop teaching and assessment capacities will require adequate resources and personnel.[256] The public should also expect practitioners to maintain an acceptable standard of practice (ongoing competence) that build on their initial knowledge and abilities (entry level competence), especially as a practitioner's independence of practice increases. The decay of competency can be slowed by access to continuing education or workplace supervision by mentors.[257] Forming and strengthening the role of professional associations can help promote high standards of practice and empower health professionals.[172]

Understanding both the applications and the limits of competency frameworks is important in individual, programme, and organisational assessment. The frameworks are working documents, to be continually refined and evaluated to ensure that competencies are adjusted to meet changing eye health needs and priorities; infrastructure, equipment, professional recognition, policy and legislation are in place; there are effective systems for supportive supervision and continuing professional development; and any other required improvements or adjustments can be made. [16,77] The definition of competencies in and of itself, however, does not guarantee quality of education.[120] Processes to measure education quality include certification examinations, which provide verification of clinical knowledge, student course evaluations, and measures of the care they provide. However, such information would only be available some time after implementation of the frameworks, emphasising the importance of a mid-term review of the framework to determine effectiveness.

10.5 Conclusion

In this research, a modified Delphi technique was used to seek views on the requisite competencies for OT and optometrist training. The Delphi framework provides a comprehensive tool to develop and organise outcome-based curricula. It will standardize curricula for training of OTs and optometrists with an emphasis on responding to societal eye health needs. The versions of the competency frameworks that were agreed after the Delphi, have now been circulated to relevant stakeholders (UniLúrio and IHS) to refine programme competency lists and content; to develop baseline measures, and performance standards; and to evaluate educational outcomes.

The competency frameworks were developed specifically for OTs and optometrists in Mozambique with a Mozambique-focused Delphi panel. Addressing the limitations of bias introduced by the development panel, the small number of panellists and the lack of input from the community could lead to the adaptation of the competency frameworks for use in other developing countries using an overall methodology that includes primary research data and the modified Delphi approach. A socially responsive, competency-based approach could enable a coordinated training and development model for all eye care personnel.

Chapter 11

Conclusion

11.1 Summary

The global eye care workforce is insufficient to achieve the global target of eliminating blindness and visual impairment by 2020. The eye health workforce is much smaller in Sub-Saharan Africa than in other regions of the world.[9] This emphasises the need for an increase in the number of eye care personnel and improvement in the quality of their training to address avoidable blindness and in particular URE. The development of competency- based education for eye care personnel has received increased attention as a means for optimising the training of eye health professionals and has been identified as an important component in the solution to avoidable blindness and vision impairment.[67,75,100]

To address the need for human resource development, many developing countries have undertaken expansion of their workforce through the training of basic and ancillary health workers.[61] The lack of Ophthalmologists in Mozambique has necessitated the training of OTs.[28] Competency-based training of OTs would identify the key requisite skills allowing for task-shifting and task sharing with the ophthalmologists and newly qualified optometrists. This would enhance service delivery at all levels of care.

The extent to which the evaluations detailed in this thesis and the subsequent OT competency framework influences eye care practice depends on their adoption by the Institute of Health Sciences. Educational programmes are obligated to prepare their graduates to meet the evolving demands in the work place. A comprehensive,

competency-based education ensures that OTs have the ability to apply their knowledge, judgment, and skills in their practice roles.[118].Competency based training of OTs can potentially make a valuable contribution to unmet eye care needs in Mozambique.

Competency-based models of education already exist in optometry in the UK, Ireland, USA, South Africa and Australia.[107,115,116,117] However, in view of the huge diversity of health and educational systems between these countries and Mozambique, the challenge was to adapt competency-based goals for local effectiveness rather than adopt models from other contexts that might not be relevant. Education and health care cannot be isolated from the health system, socio-cultural or economic context within which it occurs.[16] Any training needs to be structured to address priority eye care needs, and reflect the available resources and equipment.

The new frameworks with an emphasis on social responsiveness can now be mapped onto the present curricula for both cadres Social responsiveness of an educational institution implies engagement in a course of action responding to social needs.[236] Social responsiveness is addressed by the competencies of community and research and training.[240] The competencies respond to the eye health needs of the communities served, identify the determinants of eye health of the population, promote eye health at individual and community levels, and encourage research relevant to local eye programmes. Due to the lack of basic and ancillary workers with knowledge of eye care in Mozambique, the element of training was proposed. Training community health workers in eye care will assist the OTs and optometrists in the provision of primary eye care.

Defining competencies and adapting curricula to local context can help ensure that optometrists and OTs are appropriately trained to reduce avoidable causes of visual impairment. In addition, concentrating on competencies helps differentiate the role of the optometrists from the OTs within the eye care service delivery structure in Mozambique, develop the linkage of referral, and provide a structure for future competency evaluation of these two cadres.

11.2 Contributions of the research

The overall aim of this thesis is to develop competency frameworks for OTs and optometrists and provide recommendations for developing a comprehensive training plan for eye care service provision in the country. In the introductory chapters an in-depth analysis of several topics is presented. The history of Mozambique, its education system and the burden of blindness and VI is described. The lack of sufficiently trained eye care personnel is emphasised; hence the training of OTs and optometrists is vital to address visual impairment from URE The move towards competency-based curricula for optometry and other eye care education programmes is described. The literature review discussed the broad methods available for competency-based assessment, with particular focus on assessing optometry students and MLEP.

There is no known study assessing the refraction competencies of MLEP in Africa even though a major part of their responsibility involves refractive care. The confidence and competence of 16 qualified and 31 trainee OTs in refraction was evaluated. On average 60% of the patients the OTs examine in an eye clinic daily are for refraction. Initial evaluations demonstrated that the qualified OTs' confidence and competence levels in refraction varied depending on the OTs training (location and duration), and their

location of work (clinical load, availability of equipment and other eye care personnel). The only skill the OTs and trainees demonstrated competence in was correcting presbyopia. For the trainees their three-week refraction training was insufficient to develop competence in objective or subjective refraction.

Due to the lack of alternative refractive care, the need to upskill OTs to be competent at objective and subjective refraction was recognised and two week upskilling training carried out. Post upskilling results demonstrated significant positive impact on confidence and competence levels. The current training programme is in need of reform so as to increase the emphasis on, and time allocated to, refraction training. Due to the differences in training programmes of the existing OTs it was recommended that any future training needs to be robust and standardized. The lack of equipment, both in training and in practice, was emphasised in this study. If the minimum desirable equipment is not available in the hospital or health centre, then competencies achieved in training will quickly be lost, and the effectiveness of training eroded over time.[172] The importance of developing a competency framework for refraction to create minimum standards of practice, and inform the design of new curriculum or up skilling and continuing education for the existing OTs was established.

There are now several schools of optometry in Africa.[70] This is the first study informing the design of an 'exit' evaluation system that may be used or modified for use across optometry schools in these countries, evaluating the refraction competencies of the optometry graduates from these new schools and analysing factors affecting their performance. Guidance on the selection of assessment methods would lead institutions to adopt models that can be sustained locally giving due regard to the limited resources available. The results of the development of a competency assessment process and the

implementation of the process, for the first two cohorts of optometry students at UniLúrio, are presented. The methodology consisted of direct observation of two clinic patients, short-answer questions, an oral structured viva and observations of clinical practice with the use of two trained assessors for each cohort and standardised checklists. However the lack of standardisation of patients (some healthy emmetropes, some low vision patients with complex refractive errors) compromised the reliability of the results. Clear guidelines on the standardisation of patients for exams were recommended.

The results of the competency assessment indicated that only four students from the fifteen assessed passed the clinical refraction competency exam. The observed reasons for failure were communicated to the lecturers in a feedback session. This has enabled the faculty to refine student training. Research to determine the most practical, cost-effective and acceptable options for the assessment of exit competencies for optometrists in a developing country context is required as the use of OSCEs become popular as valid and reliable clinical competency assessment tools.[132] A transparent approach to standard setting, supported by research, needs to be addressed for further evaluations.

With regards to the low graduation rate of optometry students, factors affecting the academic performance of the first two cohorts of optometry students in Mozambique were identified using a course evaluation questionnaire (student perspective) and semi-structured interviews (lecturers perspective). The results were contextualised into four themes: learning context and the student capacity to engage with learning, teaching context, clinic conditions and operating healthcare context. It was recognised that the WCO framework used for the optometry course and student evaluation had to be

adapted to better address issues relating to the health and resource context in Mozambique.

The results from these evaluations have informed the university and course coordinators on how to better structure the course, the teaching and adapt the learning environment so that more future students can graduate as competent optometrists. Recommendations include investment in more computer facilities on campus, more stringent and transparent admission criteria, appropriately planned career guidance, an increase in the number of faculty and faculty training, a curriculum review and more public sector exposure for the students by working in the community or at tertiary health facilities. There is very little or no supervision when they graduate so emphasis has to be placed on making them competent and confident in their refraction routine. Understanding the health system and partnering with all stakeholders including ophthalmologists, ophthalmic technicians and traditional medicine practitioners in eye care will define their scope of practice and eventual work within the national health system.

The results from the evaluations of the OTs and optometrists emphasised the need for a locally relevant framework of competency standards for refraction. An important contribution of this thesis is recognising that a framework originating in one context in which competencies can be achieved, had to be adapted to better address the eye care and refraction need in Mozambique based on the local circumstances. A two round modified Delphi approach with 10 experts led to the development of two socially responsive competency frameworks with distinct roles for both cadres to prevent confusion in terms of scope of practice. The main differences between the OT and the optometry frameworks are the competencies in dispensing, treating binocular vision and low vision. The Delphi consensus was to include the element of assessing refractive

status as a primary component of the mid-level OT course. The biggest priority is to train the OTs to acquire this competency. That would involve increasing the length of the current 18 month OT course to include all the elements of objective and subjective refraction and providing upskilling training for existing OTs. The Delphi has provided recommendations for developing a comprehensive standardised training plan for eye care service provision, with an emphasis on refraction, in the country. The versions of the competency frameworks that were agreed have now been circulated to the training institutions for optometrists and OTs (UniLúrio and IHS). The frameworks could be adapted for use in other developing countries using an overall methodology that includes primary research data on refraction competencies of the existing personnel, and a consensus methodology with relevant stakeholder involvement taking into account existing healthcare contexts.

11.3 Further research

These areas have been identified by this thesis:

An immediate area of research is adaptation of the competency framework to comprise all the competencies and elements necessary for scope of practice as an optometrist and an OT, and the determination of methods to evaluate these competencies. These elements would include identifying, managing and treating ocular disease and managing and fitting contact lenses for an optometrist, and minor surgery and eye health management for the OTs in Mozambique. The methods used in this thesis to evaluate the optometrists' and OTs' refraction competencies should be compared with the use of OSCEs and standardised patients to determine the most practical, cost-effective and acceptable options for the assessment of competencies for optometrists and OTs. The

framework and evaluation methods could then be adapted for the optometry graduates from the new universities in sub-Saharan Africa and MLEP in their institutions to ensure that their training has equipped them with the competencies necessary to provide a comprehensive eye care service.

The recommendations on developing OT competence consisted of revising the OT training programme, providing minimum refraction equipment, offering regular supervision,providing a referral structure and a programme to monitor and evaluate the changes to the competencies of OT resulting from these developments.. Further research on the relative value and impact of the suggested changes would indicate whether the revised programme improved their competence and what changes made the most difference to their competence.

This study has provided recommendations to the university and course developers on the factors affecting optometry students' academic performance. Further research on whether the implementation of the recommendations results in better student retention and graduation rates needs to be conducted. This research would study the impact of these factors and indicate to what degree they affect student performance. This would inform the university on how to best allocate scarce academic resources without compromising training.

A further area of research is to determine the cost-benefits of training OTs in providing rural eye care in relation to their clinical performance capacity. A cost-benefit analysis compares the resources spent on an intervention to the benefits gained or resources saved as a result of the intervention.[258] It is used to inform health planners and policy makers how limited resources should be allocated. The advantages of training OTs to

refract competently include their deployment in rural and remote locations in their own provinces.[72] Studies are demonstrating that it is difficult to retain other trained eye care personnel in remote locations.[78] Based on the limited number of optometrists that exist, it may be envisaged that the training of OTs to address the bulk of the burden of URE in rural areas would be economically justifiable.

11.4 Implications of the research

The competency frameworks have emerged from a context of limited refraction service provision. In a continuing process of refinement, the frameworks should be evaluated for relevance and relative importance to the everyday work of optometrists and OTs and adjusted to meet changing eye health needs and priorities. Health care evolves with advances in knowledge and technology. The competencies should change in response to societal needs. As more optometrists graduate and the present OTs are up skilled and new OTs trained in refraction, then the frameworks have to be modified and adapted to improve course teaching (including appropriation of increased time to competencies deemed more important or difficult to acquire) and assessment, and/or plan continuing or refresher education.

The challenges of teaching and assessing competency based education lie in the implementation of the framework. There is a scarcity of qualified teachers who are essential for training the OTs and optometrists. The short-term placement of expatriate lecturers has proved successful in UniLúrio and now half the faculty is Mozambican. They require information, training and support to facilitate the implementation of this competency-based curriculum and develop valid and reliable assessment methods.[259]

The consistent application of valid standards and establishment of appropriate assessment of student learning are essential for the maintenance of competence.[256]

The limits of competency frameworks also have to be acknowledged. The competency approach can ignore reflective practice and limit innovation by reducing professional practice to an exhaustive list of competencies.[122,121] If applied inappropriately it can result in de-motivation, a focus on minimum acceptable standards, increased administrative burden and a reduction in the educational content.[120] The development of frameworks reflects the view of what constitutes 'best practice' at the point in time they were created and does not engage with any dynamic context. Mechanisms to support the introduction of new and innovative ideas that offer contrasting perspectives for practice have to be made available once competency frameworks are adopted and implemented.[114] This emphasises the importance of regular reviews of the frameworks to determine effectiveness

A review of the current OT curriculum is taking place in March 2015 with two optometrists on the panel. The intention is to change the curriculum to a competency-based curriculum, incorporating this framework with its emphasis on refraction. The scope of practice document for an optometrist in Mozambique is being developed incorporating the optometry competency framework with its emphasis on social responsiveness. These are important steps towards addressing the burden of UREin Mozambique.

11.5 Publications arising from this research

a) Shah K, Naidoo K, Chagunda M, Loughman J. Evaluations of refraction competencies of ophthalmic technicians in Mozambique. Journal of Optometry. In press, 2015.

b) Shah K, Naidoo K, Bilotto, Loughman J**.** Factors affecting the academic performance of optometry students in Mozambique. Optometry and Vision Science. In press, 2015.

c) Shah K, Naidoo K, Loughman J**.** Development of socially responsive competency frameworks for ophthalmic technicians and optometrists in Mozambique. Clinical and Experimental Optometry. In press, 2015.

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Appendix A

Ophthalmic Technician Training Course, Institute of Heealth Sciences, Beira 2010-2011

The training program for an OT has to enable them to perform the following acticities:

i) Clinical functions:

- Diagnose and manage common eye conditions and emergencies
- Manage (treatment or referral) common eye conditions.
- Carry out simple surgery for removing foreign bodies and chalazia.
- First aid for common eye conditions
- Select, prepare patients for surgery, assist with surgery, arrange surgery, and provide postoperative care
- Recognise and refer conditions requiring Ophthalmologic care
- Testing vision, refraction, orthoptics, and low vision.
- Providing spectacles for all types of refractive error including presbyopia and post-cataract patients.

ii) Management

- Maintenance of instruments and equipment and health information systems
- Manage medical stock and dispensing and production of spectacles
- Manage an eye clinic, including record and stock keeping

Objectives of the module on refractive error:

To support the student with knowledge and skills in identifying and managing the most common refractive erros.

At the end of the module the student should be able to:

1. Explain the basic physiology of the eye
2. Identify refrative errors
3. To describe the most important factors in refraction
4.Explain the accommodative system anomalies
5. Prescribe Spectacles

Syllabus for refractive error

Unit	Module Content	Theory (hours)	Practice (hours)	Total
1	**1. Introduction to Optics** 1.1. Properties 1.2 Reflection of light 1.3 Refraction of Light 1.4 Spherical lenses 1.5 Cylindrical lenses	4	4	8
2	**2. Optics of the human eye** 2.1 The eye as an optic system 2.2 Characteristics of the optical media and its refractive power 2.3 Retinal Image formation	2	2	4
Unit	**Module Content**	**Theory (hours)**	**Practice (hours)**	**Total**
3	**3. Refractive Errors** 3.1 Emmetropia 3.2 Ametropias 3.2.1. Myopia 3.2.2. Hypermetropia 3.2.3. Astigmatism 3.2.4. Aphakia/ anisometropia 3.2.5. Presbyopia 3.3 Clinical refraction 3.3.1 Objective refraction technique: retinoscopy 3.3.2 Subjective refraction technique 3.3.3 Prescription of spectacles for children	10	10	20
4	4. **Clinical Anomalies of Accommodation** 4.1 Accomodative Insuficiency 4.2 Accomodative paralysis 4.3 Accomodative spasm 4.4 Convergence/ Accomodation Ratio 4.5 Clinical Refraction Practice and spectacle effects on the accommodation and convergence	4	4	8
	TOTAL	**20**	**20**	**40**

Appendix B

Optometry Curriculum UniLúrio

Grou	Disciplines	Semesters							
		1º	2º	3º	4º	5º	6º	7º	8º
Complement.	Physics applied to Optometry[a]	****							
	Mathematics applied to Optometry[a]	****							
	IT	****							
	English	****							
	Portuguese		*****						
	Biostatistics[a]		*****						
	Epidemiology			****					
	English II		*****						
Basic	Ethics[a]	****							
	Ocular Anatomy and Physiology[a]	****							
	Physical and Geometrical Optics[a]		*****						
	Biology[a]	****							
	Microbiology[a]		*****						
Specific	Vision and Community	I	II	III	IV	V	VI	VII	VIII
	Pathology[a]		*****						
	Ocular Physiology		*****						
	Introduction to Optometry[a] Biochemistry		***** *****						
	Ocular Physiopathology[a]			****					
	Pharmacology				****				
Professional	Public health and Community Optometry				****				
	Clinical Optometric Procedures 1[a]			****					
	Introduction to Low Vision[a]				****				
	Physiological Optics[a]				****				
	Ophthalmic Optics and Dispensing 1[a]			****					
	Ethics and Professionalism [a]				****				
	Ocular morphology			****					
	Dispensing Optics[a]				****				
	Basic Ocular Disease[a]			****					

	Ocular Disease I (anterior eye)					****			
	Binocular Vision and Ocular Motility[a]					****			
	Clinical Optometric Procedures 11					****			
	Preclinic					****			
	Paediatric Optometry							****	
	Contact Lenses I[a]					****			
	Visual Perception and Neurophysiology					****			
	Ocular Pharmacology					****			
	Investigative methods						****		
Clinics	Ocular Disease II (posterior eye and neurologic conditions)						****		
	Clinical Optometric Procedures III						****		
	Clinical Optometry I						****		
	Anomalies of Binocular Vision and Treatment						****		
	Analysis of Clinical Cases							****	
	Clinical Optometry II							****	
	Low Vision and Rehabilitation							****	
	Contact Lenses II						****		
	Occupational Optometry							****	
	Optometry and Clinical Medicine (Systemic Disease)							****	
	Optometric Management							****	
	Project							****	
	Clinical Optometry III								****
	Project								****

[a] Pre-requisite courses. Have to be passed before student can progress.

Appendix C

Background Questionnaire for Ophthalmic Technicians

FULL NAME	
AGE	
GENDER	
INSTITUTION	
DISTRICT/REGION	
CONTACT PH. #/EMAIL	

1. What are your educational and health care qualifications and when did you receive them?

2. What position do you currently hold in your institution?

3. How long have you been in this position?

4. What is the population of your institutions catchment area?

5. On average, how many patients do you refract per week?

6. How many times a week do you perform refraction? (e.g. daily; twice a week, three times a week etc.)

7. Other comments: _____

Appendix D

Confidence Levels Questionnaire

Name of Candidate: _____ Date: _____

The purpose of this questionnaire is to establish your confidence levels in refraction, to identify areas which you find difficult to understand or procedures you have difficulty performing. The Mozambique Eye Care Project will then try to further train and mentor you to strengthen any problem areas identified.

All this information will be kept confidential. The data will only be used for research purposes.

TASKS & SKILLS	**RATING OF CONFIDENCE LEVEL**				
	1	**2**	**3**	**4**	**5**
	Never confident with the technique	**Sometimes confident to perform the technique**	**Not sure**	**Almost always confident to perform the technique**	**Always very confident**
Taking patient case histories					
Measuring visual acuities at distance					
Measuring the interpupillary distance (PD)					
Using a pinhole test					
Using a trial lens set					
Performing retinoscopy					
Determining the best spherical refraction					

TASKS & SKILLS	1 Never confident with the technique	2 Sometimes confident to perform the technique	3 Not sure	4 Almost always confident to perform the technique	5 Always very confident
Performing sphero-cylindrical refraction (with sphere and Jackson cross-cylinder)					
Binocular balancing and +1.00 test					
Determining the final distance prescription					
Measuring visual acuities at near					
Determining and prescribing a near addition					
Referring patients with potential eye disease					

Please place a ✓ in the column which best describes your confidence level for each skill

Please also answer the following questions as completely and honestly as you can:

1. *Which part(s) of performing refraction do you find most easy to perform? Why?*

2. *Which part(s) of performing refraction, if any, do you have difficulty in performing? Why?*

3. *Do you have any concerns about using your refraction skills and conducting refractions at your work place (hospital / eye clinic)?*

   □ *Yes* □ *No*

   If yes, what are these concerns?

   What (if anything) can be done to make things easier for you?

4. *Is there a particular topic that you would like to have more information on or help with?*

Thank you for completing this survey

Appendix E

Practical assessment checklist

Case history				
Time guide	5 minutes	**Novice**	**Advanced Beginner**	**Competent**
Set up	• Greets the person warmly • Seats the person comfortably • Sits facing the person			
Instructions and Explanations	• Listens to the person • Asks open-ended questions • Does not use technical terms • Asks questions in a logical way • Shows attentiveness to the person's response			
Procedure Steps	Needs to question and document: • Chief complaint with information on frequency, onset, laterality, duration, cause, how do eyes feel, and involvement of vision, • Other complaints Past ocular history including medication, surgery and its result			
Record Keeping	• Records above information			
Accuracy	• Records all above information accurately			

Measuring Visual Acuity (VA)				
Time guide	5 minutes	**Novice**	**Advanced Beginner**	**Competent**
Set up	• Chooses appropriate VA charts • Adjusts the lighting (if possible)			

	• Uses the correct test distance • Positions the patient at eye level with the chart			
Instructions and Explanations	• Provides correct, clear and efficient instructions • Explains that this test is a measure of their vision • Reassures the patient they are doing the right thing/performing well • Encourages patient to keep trying			
Procedure Steps	Measures and records: • VA for the right eye • VA for the left eye • Binocular VA Note: *During the procedure the student should check the patient's occluded eye is completely occluded with no pressure on the eye, and that the test eye is wide open*			
Record Keeping	• Records VA in 6/6 notation for right eye, left eye and both eyes • Specifies for each VA measurement if it is: distance or near, monocular or binocular, aided or unaided, etc			
Accuracy	• Records all above information accurately (within 4 letters)			

Retinoscopy				
Time guide	10 minutes	**Novice**	**Advanced Beginner**	**Competent**
Set up	• Measures PD • Adjusts trial frame including: PD, height, temples, tilt • Adjusts lighting (if possible) • Aligns the retinoscope on the visual axis • Uses right eye for patient's right eye and vice versa • Uses appropriate working distance lenses: +2.00D for 50cm, +1.50D for 67cm, etc.			
Instructions and Explanations	• Explains to patient: "these lenses are going make things look blurry" • Instructs patient to "look at the big E (or light)" • Reassures patient they are looking in the right place			
Procedure	• Puts lenses for working distance into the trial frame			

Steps	• Instructs patient to look at the target • Rets right eye and then left eye • Removes working distance lenses • Records Ret Rx and VA for each eye Note: *Check students are using large steps*			
Record Keeping	• Records ret result and VA for the right and left eyes • Records results in negative cyl form.			
Accuracy	• Achieves ret result accurately (within 0.25DS, 0.25DC and 10°)			

Measuring PD				
Time guide	1–2 minutes	**Novice**	**Advanced Beginner**	**Competent**
Set up	• Uses an appropriate PD rule • Looks at the patient at eye level (seated or standing) • Positions the PD ruler correctly on the patient's face			
Instructions and Explanations	• Provides correct, clear and efficient instructions • Explains that this test is to measure the distance between their eyes • Asks the patient to look at their finger appropriately			
Procedure Steps	• Seats patient at their eye level • Explains the test to the patient • Places the PD rule on patient's face. • Closes right eye and asks patient to look at their left finger placed their under left eye • Aligns the 0 of the PD ruler with the limbus of the patient's right eye • Opens the right eye, closes left eye, and asks patient to look at finger under right eye • Reads off measurement			
Record Keeping	• Records PD, for example PD 56mm			
Accuracy	• Measures and records PD accurately (within 1mm)			

Best Vision Sphere (BVS)				
Time guide	10 minutes	**Novi**	**Adva**	**Co**

		ce	nced Beginner	mpetent
Set up	• Measures PD and adjusts trial frame appropriately *(this would have been done for retinoscopy)* • Adjusts lighting (if possible) • Occludes left eye first • Uses the correct starting lens for unaided VA - If 6/18 or better: ±0.50DS - If worse than 6/18: ±1.50DS - If worse than 6/60: ±3.00DS or ±5.0			
Instructions and Explanations	• Explains to patient that this test will help to find the clearest lenses to see the chart with • Gives patient an appropriate target to look at • Reassures patient and encourages them to keep trying			
Procedure Steps	• Begins testing on the right eye • Determines the best lens for the right eye and inserts that into the trial frame • Repeats procedure for the left eye • Records BVS Rx and VA for each eye and both eyes together • Note: *Make sure student starts with a plus lens*			
Record Keeping	• Records BVS result • Records VA with BVS for right eye, left eye and binocularly			
Accuracy	• Determines BVS accurately (within 0.25DS)			

Jackson Cross-cylinder				
Time guide	10 minutes	**Novice**	**Advanced Beginner**	**Competent**
Set up	• Uses clean lenses • BVS and/or retinoscopy results in the back cells of the trial frame			
Instructions and Explanations	• Starts with right eye first • Gives an appropriate target (preferably a round letter, one line better than BVS acuity) • Explains to patient: "I am going to present 2 views, both will be blurry. Please tell me which appears clearer" • Reassures patient, and encourages them to			

	keep trying			
Procedure Steps	• Scopes and determines astigmatism axis • Determines cylinder power • Refines the axis • Rechecks the sphere • Maintains the spherical equivalent to control accommodation			
Record Keeping	• Records the sphero-cyl result • Records and VA for right eye, left eye and binocularly • Records the Rx in minus cyl form			
Accuracy	• Determines cross-cyl Rx accurately (within 0.25DS, 0.25DC and 10°)			

+1 Test and Binocular Balance				
Time guide	5 minutes	**Novice**	**Advanced Beginner**	**Competent**
Set up	• Places BVS or sphero-cyl results in the back cells of the trial frame • Adds +1.00DS to both eyes • Uses clean lenses			
Instructions and Explanations	• Explains to patient: "This is to find the most comfortable lenses, to make sure both eyes are working together." • "We are first going to make your vision very blurry"			
Procedure Steps	+1.00 DS test: • Ensures both patient's eyes are open • Inserts+1.00DS lenses binocularly into trial frame • Measures binocular VA with +1.00 DS lens (should be 2 to 4 lines worse) • If VA is not at least 2 lines worse, adds more plus (in +0.25 DS steps) until at least 2 lines of blur • Slowly decreases the power of the lenses in front of both eyes in –0.25 DS steps until the VA stops improving • Conducts binocular balance (if VA similar for right and left eyes) Binocular balance: • Measures VA for right eye and left eye separately • Ensures that VA is equal between the eyes			

	• VA for each eye should be the same as the best corrected VA of the right and left eyes before the +1 test			
Record Keeping	• Records final distance Rx for each eye • Records VA for right eye, left eye and binocularly			
Accuracy	• Determines final distance Rx accurately (within 0.25DS, 0.25DC and 10°)			

Near refraction				
Time guide	5 minutes	**Novice**	**Advanced Beginner**	**Competent**
Set up	• Starts with distance prescription in trial frame • Selects age-appropriate near add to begin with • Adjusts trial frame for near PD • Uses clean lenses • Conducts test with both eyes open • Uses a working distance of 40cm or the patient's preferred working distance			
Instructions and Explanations	• Explains to patient that there is a difference between near and distance Rx and now is the time to test for the most appropriate near Rx			
Procedure Steps	• Holds up age-appropriate near add (over distance Rx in trial frame) • Refines the near add • Tests the patient's range of clear vision at near • Ensures patient's preferred working distance is in the middle of the range of vision • Demonstrates and explains the near Rx to the patient			
Record Keeping	• Records the near add or near Rx and VA binocularly			
Accuracy	• Determines near Rx accurately (within 0.50DS)			

Determining the final prescription				
		Novice	**Advanced Begin**	**Competent**

			ner	
Set up	• Only corrects ± 0.75D, unless specific symptoms • Adjusts Rx if >2.00D difference between eyes • Only prescribes if visual acuity improves by at least one line with the new prescription • Changes to astigmatic correction should be <– 1DC			
Instructions and Explanations	• Explains the options for lens types and spectacle types (e.g. ready-mades vs. custom-mades) • Explains the advantages and disadvantages of near vision readers vs. bi/multifocal spectacles			
Procedure Steps	• Explains prescription and need for specs • Demonstrates the difference in VA with and without prescription • Shows examples of relevant lens and spectacle types (if possible) or draws diagrams to explain			
Record Keeping	• Records final prescription given (distance and/or near) • Records lens type(s), spectacle type(s), PD and usage for the spectacles dispensed			
Accuracy	• Records all above information accurately			

Referring to the guide above, observe and record the overall competence of each skill:

EXAM SECTION	GRADING			COMMENTS
	Novice	Advanced beginner	Competent	
HISTORY TAKING				
MEASURING VISUAL ACUITY				
BEST VISION SPHERE				
RETINOSCOPY				
CROSS CYLINDER REFRACTION				
BINOCULAR BALANCE AND +1.00DS				

NEAR REFRACTION				
DETERMINING THE FINAL PRESCRIPTION				
REFERRAL				

SECTION C: OVERALL ASSESSMENT

COMPETENT: Does not usually require supervision, but may need help occasionally. Needs more work on one/or two specific skill area/s only.

ADVANCED BEGINNER: Able to perform the skill under supervision. Needs further tuition and practice in a number of areas.

NOVICE: Unable to perform the entire procedure under supervision

Appendix F

Part 1: Optometry student competency assessment checklist

	Communication, History and Symptoms				
	Comments	Marks			Total
1) greet the patient, maintain courtesy & respect		0	1		
2) maintain attentiveness, eye contact, interest		0	1		
3) obtain complete information					
demographics (age, sex, race)		0	1		
reason for consult (chief complaint)		0	1	2	
occupation (specific visual requirements)		0	1	2	
ocular history (refractive)		0	1	2	
ocular history (health)		0	1	2	
other visual complaints & symptoms		0	1	2	
personal health status & history		0	1		
social history (smoking, driving, etc.)		0	1		
last eye & medical exams		0	1		
medications		0	1		
allergies		0	1		
family ocular history		0	1		
family health history		0	1		
4) ask questions in a logical and efficient order		0	1	2	
5) record properly with standard abbreviations		0	1	2	/24
Overall performance/ Knowledge					P(18)
	Vision and Visual Acuity				
1) test set-up & performance					
explain purpose / instructions		0	1		
select proper target		0	1		
provide full (F) illumination for far		0	1		

obtain distance unaided VA (monocular and binocular		0	1	2	
		0	1	2	
obtain distance aided VA if pertinent (mono and bino)*		0	1		
provide bright (F+) illumination for near		0	1		
select appropriate testing distance for near		0	1	2	
obtain habitual near VA (monocular and binocular					
2) smooth & efficient testing		0	1		
3) obtain accurate results		0	1		/15 (if Rx)
push for maximum possible VA		0	1		/13 (if no Rx)
observe patient during VA evaluation		0	1		
4) record results properly using standard units					P (11.25 or 9.75)
Overall performance/ Knowledge					
	Near point of convergence				
1) test set-up & performance					
explain purpose/ instructions		0	1		
use transilluminator as fixation target (dim)		0	1		
provide full (F) illumination		0	1		
point transilluminator at patient's forehead		0	1		
move light at proper height (10° below primary gaze)		0	1		
		0	1		
move transilluminator at proper speed		0	1		
note abnormal / re-evaluate receded NPC		0	1		
2) smooth & efficient testing					/10
3) obtain accurate results & record properly		0	1	2	P (7.5)
identify break/recovery, deviating eye, supp.					
Overall performance/ Knowledge					
	Cover test				
1) test set-up & performance					
explain purpose / instructions (keep target clear & single)		0	1		
		0	1		
with habitual Rx		0	1		
provide full (F) illumination for far		0	1		
unobstructed view at distance					

provide bright (F+) illumination for near		0	1		
near distance = 40 cm		0	1		
single letter target 1 or 2 lines above best VA		0	1		
maintain 2-3 sec. cover per eye		0	1		
both unilateral & alternating tests performed		0	1		
alternate occlusion quickly during alt phase		0	1		
observe for recovery after final uncover		0	1		
measure phoria / tropia objectively (if pertinent)*		0	1		
2) smooth & efficient testing		0	1	2	
3) obtain accurate results					
identify phoria vs. tropia		0	1		
identify direction/magnitude of deviation		0	1		/13 if ortho
identify recovery correctly (if phoria)		0	1		
identify intermittent vs. constant (if tropia)		0	1		/18 if phoria
identify laterality (if tropia)		0	1		/20 if tropia
4) record results properly		0	1		
Overall performance/ Knowledge					P(9.75-13.5-15)

	Ocular motility				
1) test set-up & performance					
explain purpose / instructions		0	1		
instruct pt. to indicate pain or diplopia		0	1		
provide full (F) illumination		0	1		
test distance = 40 cm.		0	1		
use transilluminator as fixation target (dim)		0	1		
keep light reflex on corneal apex		0	1		
evaluate pursuits in 8 gaze positions		0	1		
observe inferior gazes adequately (hold lids as needed)		0	1		/10
2) smooth & efficient testing		0	1		P (7.5)
3) obtain accurate results & record properly		0	1		

Overall performance/ Knowledge					
	Pupil Responses				
1) test set-up & performance					
explain purpose/ instructions		0	1		
dim room lights (minimum to see pupils)		0	1		
instruct patient to fixate a non-accommodative target		0	1		
estimate max pupil size (dim light under chin)		0	1	2	
test direct response (3 x 3 sec phase with max light ODS)		0	1	2	
swinging light test (2 phases, adequate rhythm)		0	1	2	
adjust routine (e.g. anisocoria) if pertinent		0	1		
2) smooth & efficient testing		0	1		/12 if normal
3) obtain accurate results		0	1		/13 if anisocoria
4) record results properly					P (9-9.75)
Overall performance/ Knowledge					
	PD Measurement				
1) test set-up & performance					
explain purpose/ instructions		0	1		
remove Rx		0	1		
position at patient's eye level		0	1		
position at 40 cm		0	1		
provide appropriate near point target		0	1		
measure far/near PD		0	1	2	/10
2) smooth & efficient testing		0	1		
3) obtain accurate results & record properly		0	1	2	
Overall performance/ Knowledge					P (7.5)

	Retinoscopy				
1) test set-up & performance					
explain purpose/ instructions		0	1		
prepare phoropter: clean, align, level, PD		0	1	2	
position & align patient		0	1		

provide red/green target		0	1		
dim room illumination		0	1		
control accommodation of non-tested eye		0	1		
check patient ability to view chart throughout procedure		0	1		
obtain post retinoscopy VA		0	1		
2) smooth & efficient testing		0	1	2	
3) obtain accurate results OU		0	1		
sphere/cylinder: 0 if > 0.50D; 1 if </= 0.50		0	1		/15
cylinder axis: 0 if > 10 degrees; 1 if </= 10 degrees		0	1		
4) record results properly					P (12)
Overall performance/ Knowledge					
	Subjective (Best sphere)				
1) test set-up & performance					
explain purpose/ instructions		0	1	2	
adequate room illumination (F)		0	1		
determine max-plus sphere for best VA		0	1	2	
2) smooth & efficient testing		0	1	2	
3) obtain accurate results		0	1	2	
4) record results properly		0	1		/10
Overall performance/ Knowledge					P (7.5)

	Subjective (Cross-cylindrical refraction)				
1) test set-up & performance					
explain purpose/ instructions		0	1		
adequate room illumination (F)		0	1		
target for crossed cyl: 3 lines above VA or multiple dots		0	1		
		0	1	2	

crossed cyl: axis & cylinder refined correctly		0	1	2	
2) smooth & efficient testing					
3) obtain accurate results		0	1	2	/12
sphere/cylinder:		0	1	2	
cylinder axis:		0	1		P (8)
4) record results properly					
Overall performance/ Knowledge					

	Subjective **(Bin Balance/ Near Vision testing)**				
1) test set-up & performance					
explain purpose/ instructions		0	1		
adequate room illumination (F)		0	1		
binocular balance (one of the following)					
appropriate fog (at least +0,50)					
(VG or Polaroid)					
target of 3 lines above VA					
add + to better seeing eye until equality					
(RG)					
add - until R/G equal or first green					
final binocular fog & determination of best VA		0	1	2	
near vision testing					
provide best VA target		0	1		
set phoropter for near work		0	1		
choose appropriate tentative add (plano if non-presb.)		0	1		
perform NRA/PRA to sustained blur points		0	1		
2) smooth & efficient testing		0	1		
3) record results properly		0	1		/10
Overall performance/ Knowledge					P (7.5)

	Final prescription and auxiliary tests

1) record final prescription as per patient need		0	1	2	/4
2) recommend auxiliary tests		0	1	2	
Overall performance/ Knowledge					P (3)

2

	Direct Ophthalmoscopy				
1) test performance					
explain purpose/ instructions		0	1		
direct fixation at distance (non-accommodative target)		0	1		
screen for media transparency		0	1	2	
2) smooth & efficient testing		0	1		
3) obtain & document findings accurately					
C/D (within 0.1 unless assessment is questionable)		0	1	2	
ONH profile (with drawings)		0	1		
neuro-retinal rim		0	1	2	
disc & margin appearance		0	1		
venous pulse		0	1	2	
lamina cribosa		0	1		
HR/AS status		0	1	2	
macula/ fovea		0	1	2	
media/vitreous		0	1		/21
record results with standard abbreviations		0	1	2	
Overall performance/ Knowledge					P (16)
	Externals				
1) test set-up (can be done before time starts)		0	1		
2) Examine in logical and effective way					

lids, lid margins, lashes, puncta, tear meniscus		0	1	2	
bulbar/palpebral conjunctiva		0	1	2	
cornea		0	1	2	
VH - anterior chamber depth		0	1	2	
iris		0	1	2	
conical beam to check A/C		0	1	2	
lens		0	1	2	
3) smooth, efficient testing		0	1		/18
4)record accurate results appropriately		0	1		
5) keep adequate view in eval.'s observation device		0	1		P (13)
Overall performance/ Knowledge					

	Advice to patient				
1) Did the student clearly explain the reason for the symptoms?		0	1	2	/4
2) Did the student correctly advise how their case should be managed?		0	1	2	P (3)
Overall performance/ Knowledge					

	Management and time keeping				
Did the student manage the patient in the time provided?					
Recommended time:					/10
Case History 7 min.					P (7.5)
Externals and Ocular Health 18 min.					
Refraction 25 min.					

Part 2: Short Answer Question

Student Name:

Date:

Image No: *Anterior Uveitis*

Signs and symptoms: (Maximum 2 marks for 4 stated)

Pain
Photophobia
Redness
Blurred vision
Keratic precipitates
Aqueous flare

Possible diagnosis (1 mark)

Anterior Uveitis

Differential diagnosis: (Maximum 2 marks for 4 stated conditions)

Keratitis,
Conjunctivitis
Corneal trauma,
Foreign bodies in the cornea,
Acute forms of glaucoma
Scleritis

Management: (3 marks)

Cycloplegic to break posterior synaechie (1)
Topical steroid eg prednisilone (1)
Refer to determine exact cause. (1).

Possible associated systemic conditions: (2 marks for any two conditions)

Ankylosing spondylitis
Reiter's syndrome
Psoriatic arthritis,
Inflammatory bowel disease,
Fuch's
Other relevant

Total Mark /10

Part 3: Binocular Vision Oral

Student Name:
Student Number:
Examiners:

Topic	Mark
Significance of signs/symptoms in binocular vision assessment: Location, innervation and actions of extra ocular muscles Classification of binocular vision anomalies (heterophoria versus heterotropia; concomitant versus incommitant deviations) Methods of assessment of binocular vision Fusional reserves, fixation disparity and sensory and motor fusion Binocular vision anomalies associated with, or arising from, systemic disease or neurological abnormality	/5
Appropriate management of binocular vision anomaly/anomalies: Including influence of refractive error, Implications of spectacle prescription Environment Referral for medical treatment and the urgency of referral	/5
TOTAL MARKS (Max 10)	

Appendix G

Progression of students in Optometry course at UniLúrio

Cohort A: 16 students

2009 16 students progress to 2010		
2010 13 students progress to 2011 1 student leaves	Subject failed[5]	Number of students failing
	Pharmacology Epidemiology Clinical Procedures Physiological Optics Pathology Biochemistry	1 1 1 2 1 1
2011 9 students progress to 2012	Subject failed	Number of students failing
	Binocular Vision Clinical Procedures Contact lenses	2 2 3
2012 9 students in their final year		

Cohort B: 26 students

2010 26 students pass		
2011 11 students progress to 2012 3 students leave	Subject	Number of students failing
	Biochemistry Introduction to Optometry English Physiological Optics Pathology Geometrical and Physical Optics Epidemiology Clinical Procedures	11 4 4 6 3 3 1 1 1
2012 6 students progress to 2013 1 student leaves	Subject	Number of students failing
	Binocular Vision Clinical Procedures Contact lenses Ocular Disease	1 1 4 1
2013 6 students in their final year		

[5] All students have failed more than one course.

Appendix H

Student Evaluation Questionnaire

of Introduction to Optometry

Dear Student,

The objective of this anonymous survey is to obtain your views on the past semester.

Your feedback will enable the Lecturer and the University to review the module and find ways to improve it.

Some questions will ask you to rate your experience – please do this by placing a cross (X) in the appropriate box or filling in a box.

Other questions will ask you to write down your thought, please write them down in the space provided.

Lastly, please respond after giving careful and honest thought to each question.

---

1) **Looking back over the last semester, and using the scale below please rate this module**
   (e.g. if you felt this module was 'Very Easy', write 5 in the box)

   1 = Extremely difficult

   2 = Somewhat difficult

   3= Neither easy nor difficult

   4 = Somewhat easy

   5= Very easy

   ☐

2. How did your previous education prepare you for this programme?

_____
_____
_____

3. LEARNING

	Question	A STRONGLY DISAGREE	B DISAGREE	C NEUTRAL	D AGREE	E STRONGLY AGREE
3.1	I thought this module was well organised.					
3.2	I had a clear idea of what knowledge I would gain from the module					
3.3	I found that the information from this module helped my understanding of the material in other modules.					
3.4	I found the workload for this module was manageable.					

4. LECTURER

	Question	A STRONGLY DISAGREE	B DISAGREE	C NEUTRAL	D AGREE	E STRONGLY AGREE
4.1	I found that the lecturer was well prepared.					
4.2	I found that the lectures were well delivered					
4.3	I found that I could understand the language used in these lectures.					
4.4	The lecturer made appropriate use of teaching resources (chalkboard, overhead projector, audio-visual aids etc) to deliver the					

	module					
4.5	The lecturer encouraged questions and class discussion.					
4.6	The lecturer was available to offer support outside of lecture times.					
4.7	The lecturer gave me feedback on my progress					
4.8	The lecturer made clear the objectives of the module					

5. RESOURCES/ENVIRONMENT

	Question	**A STRONGLY DISAGREE**	**B DISAGREE**	**C NEUTRAL**	**D AGREE**	**E STRONGLY AGREE**	**F NOT APPLICABLE**
	I found that the following resources were **appropriate** for this module:						
5.1	Lecture/tutorial rooms						
5.2	Laboratories						
5.3	Equipment						
5.4	Library facilities/references						
5.5	Course notes						
5.6	PowerPoint Slides						

6. ASSESSMENT

	Question	A STRONGLY DISAGREE	B DISAGREE	C NEUTRAL	D AGREE	E STRONGLY AGREE
6.1	A schedule and description of module assessments was provided at the beginning of the module					
6.2	Instructions on assessment tasks were clear and specific.					
6.3	I found that assessment tasks were returned within a reasonable time frame.					
6.4	The lecturer provided constructive feedback on tests and assignments					
6.5	As a result of the tests and assessments I felt more confident about the final end of semester exam.					
6.6	I think there is a good link between what we learn in the module and how we are assessed.					
6.7	I think that the way my progress is assessed (assignments, tests, exam marks) gives a fair reflection of my knowledge					

For the last part of their questionnaire, we would like to capture some of your thoughts. Please write in the spaces provided or on the back of this page if you need more space.

7. How do you think the lecturer could improve his/her delivery of this module?

_____
_____
_____

8. Overall, how do you think this module could be improved?

_____
_____
_____

9. Any other general comments/ observations/suggestions?

_____
_____
_____

Thank you for taking time to answer this questionnaire….!

Appendix I

Student Exit Evaluation Questionnaire

Optometry Programme

Dear Student,

The objective of this anonymous survey is to obtain your views on the Optometry programme you are graduating from.

Your feedback will enable the Lecturer and the University to review the programme and seek improvement.

Some questions will ask you to rate your experience – please do this by placing a cross (X) in the appropriate box or filling in a box. Other questions will ask you to write down your thought, please write them down in the space provided.

Lastly, please respond after giving careful and honest thought to each question.

---

1. Based on your experience during the course, how would you rate the overall difficulty or ease of this programme? Please insert a tick next to your answer from the scale provided below.

1 = Extremely difficult

2 = Somewhat difficult

3= Neither easy nor difficult

4 = Somewhat easy

5= Very easy

Student development

2. What preparation or background was necessary to take this programme?

_____

3. Were the requirements for entering the programme made clear to you before starting the course?

_____

3. LECTURERS

	Question	**A STRONGLY DISAGREE**	**B DISAGREE**	**C NEUTRAL**	**D AGREE**	**E STRONGLY AGREE**
4	The lecturers had sufficient knowledge of the content/ area that they were teaching					
5	The lecturers related to me in ways that promoted mutual respect					
6	The lecturers stimulated my interest in the programme					
7	The lecturers were well prepared					
8	The lecturers provided adequate opportunities for questions and class discussion					
9	The lecturers were available to offer support outside of lecture times					
10	The lecturers provided useful feedback on my progress of the courses throughout the programme					
11	The lecturers showed genuine concern for the students and their learning					

12. How can the lecturers improve on teaching this programme?

LEARNING

	Question	A STRONGLY DISAGREE	B DISAGREE	C NEUTRAL	D AGREE	E STRONGLY AGREE
13	The modules gave a detailed description of the theoretical aspect of the course					
14	The workload was manageable					
15	I had enough time for self-study during the programme					
16	The overall content of the programme was appropriate to the practice of optometry					
17	The content was at an appropriate level for an optometry degree					
18	The basic science courses delivered in the first year were adequate background to the professional and clinical course					
19	There was a clear understandable link between the courses					
20	The theoretical knowledge is adequately linked to the practice of optometry					
21	The clinical work was well coordinated with the material covered in lectures and/or seminars					
22	I was able to apply the theoretical concepts from lectures to the clinical situations					

23	There was enough time allocated for the clinical aspect of this programme					
24	The level of clinical training is adequate					
25	I feel confident about my clinical skills					

26. How can the learning process in the programme be improved

ASSESSMENT

	Question	**A STRONGLY DISAGREE**	**B DISAGREE**	**C NEUTRAL**	**D AGREE**	**E STRONGLY AGREE**
27	There was a good link between what we learnt in class and what we were assessed on					
28	The way my progress was assessed (assignments, exam, practical) gave a fair reflection on my knowledge and understanding					
29	The in-class tests and assignments prepared me for the final exams					
30	I received constructive criticism on my performance in assessments					
31	I received timely feedback on my performance in assessment					

32: How can the programme assessment systems be improved?

EQUIPMENT, RESOURCES AND INFRASTRUCTURE

	Question	**A STRONGLY DISAGREE**	**B DISAGREE**	**C NEUTRAL**	**D AGREE**	**E STRONGLY AGREE**
33	There was adequate access to equipment needed to complete assignments					
34	Equipment used was reliable and in working order					
35	There was adequate opportunity to use the equipment within the specified clinic time					
36	The lecture and tutorial rooms were adequate for the programme					
37	The laboratories were appropriate for the programme					
38	The library (facilities/resources) were adequate					
39	The teaching resources (course manuals and PowerPoint) were adequate					

40. How can the equipment, resources and infrastructure be improved to ensure a better learning experience for the students?

PROGRAMME IN GENERAL

	Question	A STRONGLY DISAGREE	B DISAGREE	C NEUTRAL	D AGREE	E STRONGLY AGREE
41	In general, this was an excellent programme					
42	Overall, the programme exceeded my expectations					
43	I would recommend this programme to others					

For the last part of their questionnaire, we would like to capture some of your thoughts. Please write in the spaces provided or on the back of this page if you need more space.

44. What would you like to tell the future students about this programme?

_____

45. What did you take away from your experience in this programme throughout the years?

_____

46. How did this programme change you?

47. What did you most like about this programme?

48. Is there anything else that you would like to tell us about the programme/ lecturers/ course content/ facilities or resources?

Thank you for taking time to answer this questionnaire….!

Appendix J

Table 1: Results from the Delphi competency framework for optometrists

Unit of Competence	Element	Performance criteria
1.Communication	1.1 The ability to communicate effectively with a diverse group of patients with a range of optometric conditions and needs.	Ability to obtain and accurately records the reasons for the patients visit.
		Ability to obtain a clinical history from a patient prior to examination and treatment.
		Elicits and accurately records the relevant information required for diagnosis and management.
	1.2 The ability to impart information in a manner which is appropriate to the recipient.	Employs modes and methods of communication which take into account the physical, emotional, intellectual and cultural background of the patient.
		Understand the patient's expectations and aspirations.
		Discusses with patients the importance of systemic disease and its ocular impact.
		Ability to impart to patients an explanation of their physiological or pathological eye condition.
2: Patient evaluation	Formulates an exam plan 2.1 Performs distant and near visual acuity tests	Selects appropriate visual acuity test according to patient's age, cooperation, ability, mobility and any cultural and special needs.
		Positions and aligns patient at the correct distance from the test chart.

		Changes distance from test chart if appropriate.
		Ensures the chart is correctly illuminated for test purpose.
		Instructs patient clearly, including wearing of current optical correction appropriate to the test distance.
		Understands the use of specialist charts for distance and near vision, and the effect of lighting, contrast and glare.
		Ensures correct use of occluder.
		Ensures correct use of pinhole.
		Accurately records results and patient responses.
		Knows the expected norms for vision for different ages.
	2.2 Assesses refractive status.	Demonstrates the knowledge, understanding and skills required of an individual to measure the refractive error.
		Ability to implement an examination plan by knowing all the procedural steps, instructing the patient, and accurately recording the results.
		Ability to accurately perform retinoscopy on spherical and astigmatic eyes.
		Ability to accurately determine the subjective refraction using the best vision sphere, cross-cylindrical refraction, binocular balancing and +1.00 blur test.
		Ability to accurately determine near refraction.
		Ability to accurately record final prescription.
		Ability to utilise appropriate pharmacological agents for refraction within scope of practice.

	2.3 Ability to assess oculomotor and binocular functions.	Demonstrates ability to assess/determine: ▪ Eye alignment and the state of fixation using objective and subjective tests with suitable targets.
		▪ The quality and range of the patient's eye movements.
		▪ The status of sensory fusion.
		▪ The adaptability of the vergence system.
		▪ Status and function of accommodation in relation to expected age norms.
		Stereopsis in relation to expected age norms.
	2.4 Ability to assess the eye and ocular adnexae.	Ability to assess the health of the eyes with an external exam.
		Ability to assess central and peripheral fundus.
	2.5 Ability to assess central and peripheral sensory visual function and the integrity of the visual pathways.	Ability to assess pupil function.
		Ability to assess the visual field, analyse and interpret the result.
		Ability to perform tonometry.
		Ability to assess colour vision.
3: Patient management	3.1 Management of refractive error	Interprets and analyses findings to establish and record an accurate diagnosis and explain diagnosis to patient.
	3.1.1 Prescribes spectacles.	Confirms patient's existing use of optical correction and identifies the type of spectacle prescription by inspection and neutralisation of lenses.
		Measures optical prescription of spectacles, including distance, intermediate, near and prismatic corrections using a focimeter.
		Assesses the suitability of spectacles as a form of correction for the patient and

		explains the financial implications.
		Applies the patient's refraction, visual requirements and other findings to determine the spectacle prescription.
		Identifies the presence of myopia, hypermetropia or astigmatism from the prescription.
	3.1.2 Dispenses optical prescriptions accurately.	Measures the patient’s inter-pupillary distance and demonstrates an understanding of the significance.
		Dispenses the appropriate ophthalmic lens and ensures frame design and material is appropriate, in accordance with the patient’s prescription for vocational and recreational needs.
		Adjusts the appliance and instructs the patient in the proper use and maintenance of the appliance and of any adaptation effects which may be expected.
		Demonstrates the ability to measure for bifocals or varifocals. ,
		Demonstrate the ability to set the correct optical centre distance for generating prism by decentration. ,
	3.2 The ability to manage patients with an anomaly of binocular vision and accommodation.	Formulates a visual therapy treatment plan.
		Manages adult patients with heterophoria/ heterotropia.
		Manages patients presenting with an incomitant deviation.
		Manages children at risk of developing an anomaly of binocular vision
		Manages children with an anomaly of binocular vision.
		Treats patients with accommodative, vergence, ocular motilities, strabismic and amblyopic anomalies.
		Administers appropriate therapy for learning disabilities and visual processing.

		Instructs patient in the use and maintenance of vision training equipment.
		Prescribes appropriate optical devices.
		Sets goals of the vision therapy programme and criteria for completion.
		Monitors progress and recognises completion of the vision therapy programme.
	3.3 The ability to advise on and prescribe low vision devices.	Recognises the rehabilitative needs of the patient with respect to the disability.
		Demonstrates knowledge of a range of low vision devices.
		Prescribes low vision devices suited to the patient's visual requirements and functional needs.
		Instructs the patient in the use of the low vision device.
		Monitors the success of the low vision device and prescribes additional or alternative devices.
		Informs the patient of other rehabilitative / social services and refers if necessary.
	3.4 Referral.	Demonstrates the ability to make a judgment regarding referral and an understanding of referral pathways.
		Recognises and discusses with the patient the need for referral to other professionals for assessment and/or treatment.
		Ability to write an appropriate referral letter. [a]
4.Community:	4.1 Demonstrates the ability to apply population health approaches.	Promotes information on matters of visual health, and welfare (including the need for regular eye examinations).
		Provides advice on eye protection in the home, at work and in recreational pursuits.

	4.1.1 Demonstrates the ability to promote issues of eye and vision care to the community	Identifies various eye health promotion activities, prioritises, plans, implements and evaluates them in the community.
	4.1.2 Demonstrates the ability to understand factors affecting the community's needs for refraction services.	Demonstrates understanding of the demography and epidemiology of health conditions affecting the community and the population. (Assess eye health needs taking into account the cultural and social setting of the patient).
		Identifies and solves problems specific to the community/area in which service is offered.
		Advises on how to prevent harmful local practices and beliefs.
		Demonstrates understanding of, and tries to overcome barriers to access to eye care.
		Demonstrates initiative to and ability to collaborate with other health workers and communities to identify potential eye health problems and work out strategies to alleviate them.
		Demonstrates ability to work in a low resource environment.
	4.1.3 The ability to conduct regular monitoring and evaluation (internal and external) of refraction services for all stakeholders.	Ability to conduct static and outreach refraction screening services.
		Demonstrates ability to interpret information from monitoring and evaluation of blindness prevention programmes.
5. Technical	5.1 The responsibility to correctly use and maintain instruments and equipment.	Demonstrates competency in the use of refraction equipment including focimeters and retinoscopes.
		Demonstrates knowledge of maintenance, calibration and repair procedures of refraction equipment.
		Demonstrates responsibility for the ordering of equipment and replacement of malfunctioning equipment.
6. Research and	6.1 The ability to apply research	Initiates and conducts operational research relevant to the local eye

Training	concepts to eye health problems and suggest solutions to identified problems.	programme/interventions.
		Manages and utilises hospital information systems to improve the eye services and programmes.
		Demonstrates the ability to conduct local data collection and evaluation exercises.
	6.2 The ability to teach and participate in training of other eye health workers.	Demonstrates the ability to supervise and train other health workers in eye health care activities.
		Demonstrates the ability to plan for his/ her own continuing education.
		Demonstrates the ability to train primary level health personnel in the community.
		Demonstrates the ability to conduct training for, supervising of, and supporting student optometrists and ophthalmic technicians.

Abbreviations OT: Ophthalmic technician SD: Standard deviation

Table 2: Results from the Delphi competency framework for OTs

Unit of Competence	Element	Performance criteria
1.Communication	1.1 The ability to communicate effectively with a diverse group of patients with a range of optometric conditions and needs.	Ability to obtain and accurately records the reasons for the patients visit.
		Ability to obtain a clinical history from a patient prior to examination and treatment.
		Elicits and accurately records the relevant information required for diagnosis and management.
	1.2 The ability to impart information in a manner which is appropriate to the recipient.	Employs modes and methods of communication which take into account the physical, emotional, intellectual and cultural background of the patient.
		Understand the patient's expectations and aspirations.
		Discusses with patients the importance of systemic disease and its ocular impact.
		Ability to impart to patients an explanation of their physiological or pathological eye condition.
2: Patient evaluation	Formulates an exam plan 2.1 Performs distant and near visual acuity tests	Selects appropriate visual acuity test according to patient's age, cooperation, ability, mobility and any cultural and special needs.
		Positions and aligns patient at the correct distance from the test chart.
		Changes distance from test chart if appropriate.
		Ensures the chart is correctly illuminated for test purpose.

		Instructs patient clearly, including wearing of current optical correction appropriate to the test distance.
		Understands the use of specialist charts for distance and near vision, and the effect of lighting, contrast and glare.
		Ensures correct use of occluder.
		Ensures correct use of pinhole.
		Accurately records results and patient responses.
		Knows the expected norms for vision for different ages.
	2.2 Assesses refractive status.	Demonstrates the knowledge, understanding and skills required of an individual to measure the refractive error.
		Ability to implement an examination plan by knowing all the procedural steps, instructing the patient, and accurately recording the results.
		Ability to accurately perform retinoscopy on spherical and astigmatic eyes.
		Ability to accurately determine the subjective refraction using the best vision sphere, cross-cylindrical refraction, binocular balancing and +1.00 blur test.
		Ability to accurately determine near refraction.
		Ability to accurately record final prescription.
		Ability to utilise appropriate pharmacological agents for refraction within scope of practice.
	2.3 Ability to assess the eye and ocular adnexae.	Ability to assess the health of the eyes with an external exam.
		Ability to assess central and peripheral fundus.

	2.4 Ability to assess central and peripheral sensory visual function and the integrity of the visual pathways.	Ability to assess pupil function.
		Ability to assess the visual field, analyse and interpret the result.
		Ability to perform tonometry.
		Ability to assess colour vision.
3: Patient management	3.1 Management of refractive error	Interprets and analyses findings to establish and record an accurate diagnosis and explain diagnosis to patient.
	3.1.1 Prescribes spectacles.	Confirms patient's existing use of optical correction and identifies the type of spectacle prescription by inspection and neutralisation of lenses.
		Measures optical prescription of spectacles, including distance, intermediate, near and prismatic corrections using a focimeter.
		Assesses the suitability of spectacles as a form of correction for the patient and explains the financial implications.
		Applies the patient's refraction, visual requirements and other findings to determine the spectacle prescription.
		Identifies the presence of myopia, hypermetropia or astigmatism from the prescription.
	3.1.2 Dispenses optical prescriptions accurately.	Measures the patient's inter-pupillary distance and demonstrates an understanding of the significance.
		Dispenses the appropriate ophthalmic lens and ensures frame design and material is appropriate, in accordance with the patient's prescription for vocational and

		recreational needs.
		Adjusts the appliance and instructs the patient in the proper use and maintenance of the appliance and of any adaptation effects which may be expected.
		Demonstrates the ability to measure for bifocals or varifocals. ,
		Demonstrate the ability to set the correct optical centre distance for generating prism by decentration. ,
	3.2 Referral.	Demonstrates the ability to make a judgment regarding referral and an understanding of referral pathways.
		Recognises and discusses with the patient the need for referral to other professionals for assessment and/or treatment.
		Ability to write an appropriate referral letter. [a]
4.Community:	4.1 Demonstrates the ability to apply population health approaches.	Promotes information on matters of visual health, and welfare (including the need for regular eye examinations).
		Provides advice on eye protection in the home, at work and in recreational pursuits.
	4.1.1 Demonstrates the ability to promote issues of eye and vision care to the community	Identifies various eye health promotion activities, prioritises, plans, implements and evaluates them in the community.
	4.1.2 Demonstrates the ability to understand factors affecting the community's needs for refraction services.	Demonstrates understanding of the demography and epidemiology of health conditions affecting the community and the population. (Assess eye health needs taking into account the cultural and social setting of the patient).
		Identifies and solves problems specific to the community/area in which service is offered.
		Advises on how to prevent harmful local practices and beliefs.

		Demonstrates understanding of, and tries to overcome barriers to access to eye care.
		Demonstrates initiative to and ability to collaborate with other health workers and communities to identify potential eye health problems and work out strategies to alleviate them.
		Demonstrates ability to work in a low resource environment.
	4.1.3 The ability to conduct regular monitoring and evaluation (internal and external) of refraction services for all stakeholders.	Ability to conduct static and outreach refraction screening services.
		Demonstrates ability to interpret information from monitoring and evaluation of blindness prevention programmes.
5. Technical	5.1 The responsibility to correctly use and maintain instruments and equipment.	Demonstrates competency in the use of refraction equipment including focimeters and retinoscopes.
		Demonstrates knowledge of maintenance, calibration and repair procedures of refraction equipment.
		Demonstrates responsibility for the ordering of equipment and replacement of malfunctioning equipment.
6. Research and Training	6.1 The ability to apply research concepts to eye health problems and suggest solutions to identified problems.	Initiates and conducts operational research relevant to the local eye programme/interventions.
		Manages and utilises hospital information systems to improve the eye services and programmes.
		Demonstrates the ability to conduct local data collection and evaluation exercises.
	6.2 The ability to teach and participate in training of other eye health workers.	Demonstrates the ability to supervise and train other health workers in eye health care activities.
		Demonstrates the ability to plan for his/ her own continuing education.
		Demonstrates the ability to train primary level health personnel in the community.
		Demonstrates the ability to conduct training for, supervising of, and supporting

		student optometrists and ophthalmic technicians.

Abbreviations OT: Ophthalmic technician SD: Standard deviation