Alignment of undergraduate Pharmacology learning outcomes with healthcare practitioner workplace competencies

by

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Executive summary

South Africa's healthcare sector is hindered by numerous challenges exacerbated by debilitating infrastructure, a quadruple burden of disease, staff shortages and inequality of healthcare coverage regarding public and private healthcare institutions. Educational deficiencies and misaligned curricula for healthcare practitioners further complicate the provision of sufficient healthcare, and thus contribute to the disparities in healthcare in the country. Considerable support and recommendations have been directed towards ensuring that healthcare practitioners are thoroughly equipped during their education; however, shortcomings still exist. The three healthcare practitioners relevant to my study – the dietitian, professional nurse, and physiotherapist – all contribute to the healthcare sector and form an important cog within the complex regimens that diseases require for prevention, treatment or management. Based on their roles within the healthcare sector, all three groups require pharmacology as part of their education. However, concern has been raised about how this discipline is presented, and whether competencies are adequately developed.

Pharmacology, as a discipline is important in a variety of healthcare professions due to its nature as a basic and clinical science. Depending on the scope of practice of the healthcare practitioner, the role and value of pharmacology is subject to change that inherently alters the way the curriculum for it should be presented. Unfortunately, pharmacology is often approached from a generalised basic sciences vantage that fails to cover the scope of practice of the healthcare practitioner adequately, and assuch becomes subject to a myriad of challenges, including content overload, misalignment and theory-practice gaps. Consequently the potential exists for healthcare practitioners not to develop the necessary core competencies for their world-of-work, and thus fail to contribute effectively to the healthcare sector. Each healthcare practitioner relevant to this study has a different valuation of pharmacology within their profession. The dietitian provides medical nutrition that may affect or be affected by pharmacotherapy, thus necessitating understanding of the complex interactions between nutrients and medicines. Nurses, as medication managers, serve an important role within pharmacotherapy's administration, monitoring and evaluation, to mention a few and thus require high level understanding of how these are integrated with the nursing process. Physiotherapists, although being the furthest removed from pharmacotherapy engage with physical treatment modalities that may benefit from or be affected by pharmacotherapy, necessitating understanding of how it may alter the treatment regimen. At the University of Pretoria, all three these healthcare practitioners are currently enrolled for a generalised basic sciences pharmacology curriculum that is shared with Bachelor of Science students, thus creating a myriad of complex challenges for me the course coordinator to deal with, apart from the lack of alignment with graduate competencies. However, no competency frameworks are available to guide curriculum changes to resolve the problem. The current study aimed to engage in a research-guided approach to facilitate curriculum development and address the following research question and research sub-questions:

Research question:

Which pharmacological competencies required by Bachelor of Dietetics, Bachelor of Nursing Science, and Bachelor of Physiotherapy students at the University of Pretoria should be aligned with their workplace needs?

Research sub-questions:

1. What are the pharmacological competencies that the prospective dietitian, professional nurse and physiotherapist in South Africa need to function as a healthcare practitioner?

2. What are the targeted needs of the prospective dietitian, the professional nurse and the prospective physiotherapist at the University of Pretoria regarding their pharmacology education when assessing their current programme structure?

3. What are the proposed learning outcomes and assessment criteria of an undergraduate pharmacology curriculum presented to these students at the University of Pretoria?

A mixed-methods approach was used for the study following Kern's six-step medical curriculum model. A general needs assessment was performed by conducting a scoping review for each of the healthcare practitioners to describe the pharmacological competencies relevant to their profession and to compile a list of proposed competencies. The proposed competency list was distributed to experts within each profession as a modified, reactive Delphi study to determine the nationally relevant pharmacological competencies for each healthcare practitioner. Thereafter, a targeted needs assessment was conducted by mapping the current and proposed pharmacology curriculum for each group's bachelor programme at the University of Pretoria using available module guides and year books. Linkages were defined between learning outcomes and assessment criteria of the respective modules to guide a focus group interview with the department of each healthcare practitioner to refine the proposed pharmacology curriculum for focused education in the future.

Results from the scoping review for each healthcare practitioner grouping highlighted relevant competencies for their professional practice. Although there was a paucity of information for dietetics and physiotherapy, nursing had a wealth of information that helped propose a comprehensive list of competencies that needed to be developed. While the proposed competencies for dietitians and physiotherapists were almost exclusively within the cognitive domain, nursing had a proportion of their competencies in the psychomotor and affective domain. The Delphi study further refined these lists to create a proposed national competency framework for each healthcare practitioner group to allow for focused, relevant and expected pharmacological competencies necessary for their education. Importantly, each competency framework could be justified based on the professional scope of practice of the respective healthcare practitioner, including the common diseases that they would engage with.

Targeted needs analysis showed that the current Pharmacology modules had poor alignment with the core disciplines for each healthcare practitioner's bachelor programme. However, a larger linkage was present with prerequisite modules, such as Physiology, Molecular and Cell Biology, and Chemistry. Although linkage was present with such basic sciences modules, invariably superficial description of the learning outcomes and assessment criteria was present, suggesting potential theoretical gaps during their scaffolded education that may hinder development of pharmacological competencies. The proposed pharmacology curricula had a higher level of linkage to the core disciplines; however, several gaps were identified that lacked sufficient prerequisite education. The focus group interviews further highlighted the concerns identified in the curriculum mapping exercise. Although decontextualised theoretical knowledge of pharmacology was developed, a clear deficiency in the ability to apply the knowledge within the clinical environment was present. Furthermore, a concerning misalignment with the scope of practice of the healthcare practitioners was present, creating cognitive overload, missed expectations of education, fear of pharmacology, and theory-practice gaps. Participants highlighted the fact that the proposed pharmacology curricula had a greater relevance to their scope of practice, and thus enthusiasm was displayed for its inclusion. Recommendations were to ensure horizontal and vertical integration were present, as well as the inclusion of as much of an authentic environment during learning so that contextualisation could be achieved. Given the potential inadequate understanding of prerequisite physiology for the Pharmacology module and for the core disciplines, recommendations included engaging with a programme level review to accommodate broader changes for constructive alignment.

The study allowed for three individual, focused and nationally relevant pharmacological competency frameworks to be developed for dietitians, professional nurses and physiotherapists in South Africa. As such, a potential exists for greater benchmarking of pharmacology education among institutions. Furthermore, using the targeted needs analysis, preliminary proposals for how to focus the pharmacology education at the University of Pretoria's current healthcare practitioner bachelor programmes could be developed. Given the curriculum mapping done, a broader understanding of the complexity of such curriculum design could be showcased by using Harden's ten windows of the curriculum. As such, a stronger, research-guided curriculum development approach was engaged with, providing evidence for curriculum reform to benefit students at the University of Pretoria.

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Proof of language editing

I HATE MISTEAKS

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TO WHOM IT MAY CONCERN

I, the undersigned, hereby declare that the doctoral thesis titled **Alignment of undergraduate Pharmacology learning outcomes with healthcare practitioner workplace competencies** by **Werner Cordier** has been edited.

It remains the responsibility of the candidate to effect the recommended changes.

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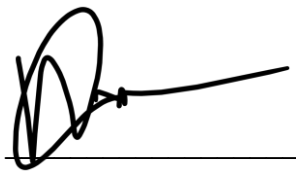

Signature

23 January 2025

Date

List of acronyms and abbreviations

COVID-19	Coronavirus Disease 2019
FAIMER	Foundation for the Advancement of International Medical Education and Research
HIV/AIDS	Human immunodeficiency virus/Acquired immunodeficiency syndrome
HPCSA	Health Professions Council of South Africa
INN	International Nonproprietary Names
NQF	National Qualifications Framework
OECD	Organisation for Economic Co-operation and Development
PGCHE	Postgraduate Certificate in Higher Education
SAFRI	Sub-Saharan Africa FAIMER Regional Institute
SAQA	South African Qualifications Authority

List of degree codes

BChD	Bachelor of Dentistry
BDietetics	Bachelor of Dietetics
BNurs	Bachelor of Nursing Science
BOH	Bachelor of Oral Hygiene
BPhysT	Bachelor of Physiotherapy
BSc	Bachelor of Science
MBChB	Bachelor of Medicine and Surgery

List of module codes

FAR 172	Pharmacology
FAR 370	Clinical Pharmacology
FAR 381	Pharmacology

FAR 382	Pharmacology
GNK 128	Introduction to Clinical Pharmacotherapy
GNK 585	Clinical Pharmacotherapy

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Chapter 1
Introduction

A simple but universal truth is that there can be no health without a workforce.

Marie-Paule Kieny (Assistant Director-General, World Health Organization, 2013 [Campbell et al., 2013, p. iv])

1. Introduction

The Coronavirus Disease 2019 (COVID-19) pandemic has emphasised the importance of a functional healthcare system that can meet the needs of the country, notwithstanding the increased pressure on healthcare practitioners, healthcare sectors, and higher morbidity and mortality (Chersich et al., 2020; Dramowski et al., 2020; Mbunge, 2020; McKinney et al., 2020; Naidu, 2020; Robertson et al., 2020; Siedner et al., 2020; Wadvalla, 2020). This includes ensuring that there are enough healthcare practitioners available to complete their duties within their world-of-work. Unfortunately, South Africa has a well-described shortage of healthcare practitioners (Mahlathi & Dlamini, 2015; Maphumulo & Bhengu, 2019; Mbunge, 2020; Neely & Ponshunmugam, 2019), with concerns surrounding the alignment of health profession education and the development of necessary competencies (Couper et al., 2018). Frenk et al. (2010) and the 2013 *World Health Organization Guidelines* report (World Health Organization, 2013) express similar concerns of static curricula that do not adapt to healthcare needs and thus fail to develop competencies required by healthcare practitioners. Additionally, the stressors faced by higher education institutions during the pandemic have created strain on the learning environment (Mbunge, 2020), further impacting the achievement learning outcomes and becoming fit-for-purpose graduates (Gaur et al., 2020).

Poignantly, the statement made by Marie-Paule Kieny in 2013 rings true: "A simple but universal truth is that there can be no health without a workforce" (Campbell et al., 2013, p. iv). To add my educational caveat to this remark: Health would not be possible without a *competent* workforce.

2. Healthcare in South Africa

South Africa faces a quadruple burden of disease (Ataguba et al., 2020; Coovadia et al., 2009; Mayosi et al., 2009), comprising a mixture of poverty-related, non-communicable, communicable, and social detriments that account for most of the premature morbidity and mortality reported in the country (Coovadia et al., 2009; Valiani, 2019). The quadruple burden is characterised by communicable diseases (such as human immunodeficiency virus/acquired immunodeficiency syndrome [HIV/AIDS] and tuberculosis); maternal and child mortality; non-communicable diseases (including diabetes and cardiovascular disorders) and injury, violence and trauma (Ataguba et al., 2020). According to the Institute for Health Metrics and Evaluation, in 2019, South Africa had an estimated Universal Health Coverage Index of 59.7%, with mortality causes in decreasing order of death echoing the quadruple disease burden: HIV/AIDS; ischaemic heart disease; stroke; lower respiratory tract infections; diabetes;

tuberculosis; road injuries; interpersonal violence; neonatal disorders; and diarrhoeal diseases (Institute for Health Metrics and Evaluation, n.d.). The Universal Health Coverage Index comprises a series of health service indicators to represent healthcare across life on a scale from 0 to 100, thus suggesting specific deficiencies in coverage in South Africa, such as antenatal care and diabetes treatment (Lozano et al., 2020). Compounding our health concerns, it is not yet clear what impact the COVID-19 pandemic has had on our burden of disease (Ataguba et al., 2020), especially as health services may have shifted focus to the current threat (Ongole et al., 2020). The Organisation for Economic Co-operation and Development (OECD) *Health at a Glance 2023* report highlights grim statistics, where life expectancy is among the lowest of the partner countries (65.3 years) in 2021, with high levels of preventable (335) and treatable (257) mortality measured as the age standardised rate per 100 000 population (based on 2016 to 2019 data) (OECD, 2023).

In South Africa, access to healthcare is categorised as public or private (Meyer et al., 2017a; Neely & Ponshunmugam, 2019). The public healthcare sector, developed to be an integrated, comprehensive service to the nation (Coovadia et al., 2009), includes primary care facilities (such as clinics and community health centres), and district hospitals, regional and tertiary hospitals (i.e., provincial or central hospitals) (Coovadia et al., 2009; World Health Organization, 2018). Although patients are free to choose their healthcare provider in the public sector (Neely & Ponshunmugam, 2019; World Health Organization, 2018), the most easily accessible site will generally be visited, often resulting in an infrastructure burden to these areas (World Health Organization, 2018). The public healthcare system is funded by the government (Mahlathi & Dlamini, 2015; Meyer et al., 2017a), thus providing healthcare for all (Mahlathi & Dlamini, 2015). However, the private healthcare sector is not accessible to all individuals, but rather those who can afford to make use of it (Mahlathi & Dlamini, 2015), as it is funded by individuals or medical aids (Meyer et al., 2017a). As such, the economically-advantaged populace will access private healthcare more often (Neely & Ponshunmugam, 2019; World Health Organization, 2018), and thus it also serves a lower proportion of the South African population (Meyer et al., 2017a). The private healthcare sector has a disproportionately greater access to facilities than the public sector (Meyer et al., 2017a). Given the dependency of the public healthcare sector on government funding, there is a persistent socio-economic inequality between the public and private healthcare sectors, with a low expenditure relative to the burden of disease within the country (Valiani, 2019). Previous reports show that although only 17.5% of the population (~8.2 million) is serviced by private healthcare, its total health expenditure (US$ 31,320) still exceeds that of the public healthcare sector (~42 million individuals; US$ 28,000) (Meyer et al., 2017a). The implementation of a national health insurance scheme in South Africa is envisaged for the future to achieve universal healthcare coverage and a bolstered primary care system (Christmals & Aidam, 2020; Mukwena & Manyisa, 2022; Pauw, 2022), though is met with much concern surrounding factors such as limited or unmaintained infrastructure, healthcare worker shortages and training (Mukwena & Manyisa, 2022; Pauw, 2022), public perception of healthcare quality reduction, and governance (Christmals & Aidam, 2020).

A myriad of reasons complicate healthcare provision in South Africa; these include infrastructure concerns and healthcare practitioner shortages (Maphumulo & Bhengu, 2019; Mbunge, 2020; Mukwena & Manyisa, 2022; Neely & Ponshunmugam, 2019), especially since there is clear maldistribution between public and private healthcare sectors, and rural and urban areas (Rispel, 2015a; Academy of Science of South Africa, 2018; Rispel et al., 2018;

Pauw, 2022). The availability of nurses, for example, is routinely remarked as being insufficient to meet the country's healthcare needs (Academy of Science of South Africa, 2018; Daviaud & Chopra, 2008; Lala et al., 2017; Neely & Ponshunmugam, 2019; OECD, 2024; Valiani, 2019). As a comparison, the 2020 OEDC statistics for nurses per 1 000 patients are 1.0 for South Africa, which is far below those of developed countries such as Australia (12.3), Canada (10.1), Norway (18.0) and the United States of America (11.8) (OECD, 2024). There is also an apparent lack of retention of healthcare professions graduates, including physiotherapists and dietitians in the public sector, although it cannot be ascertained whether these positions are being absorbed in the private sector (Rispel et al., 2018). Shortages of healthcare practitioners can further reduce the efficiency of others in the healthcare system due to imbalanced workload or inability to address certain concerns (Daviaud & Chopra, 2008; Mukwena & Manyisa, 2022; Neely & Ponshunmugam, 2019).

A fully functional healthcare system requires interprofessional teamwork, thus necessitating the interplay between different healthcare practitioners. The COVID-19 pandemic has reaffirmed such collaboration, highlighting the need for competent healthcare practitioners, each with their own strengths and foci, to ensure proper management of diseases via interprofessional teamwork (Vantini & Marson, 2020). Although the responsibilities of healthcare practitioners may overlap at times, each profession is conferred its own scope of practice to form an important part of the healthcare system. In legal frameworks, the scope of practice outlines the authority provided to healthcare practitioners to provide certain medical services, and invariably will differ depending on the specific healthcare practitioner (Markowitz et al., 2017). Scope of practice thus helps define the role of a healthcare practitioner within their unique setting (Dower et al., 2013; Weber, 2006) and provide a framework for their expected education, competence and authorisations (South African Nursing Council, n.d.). Limitations are imposed upon the scopes of practice based on the educational qualifications that each healthcare practitioner has trained towards (Lubbe & Roets, 2014; South African Nursing Council, n.d.). Although there may be several overlapping responsibilities or skillsets and generic competencies, there will also be distinct competencies or core competencies (Academy of Science of South Africa, 2018) needed for them to function as said practitioner (Weber, 2006). The scope of practice thus serves as a tool within curriculum development to ensure that education aligns with the expected graduate competencies (South African Nursing Council, n.d.). Unfortunately, given, for example, the shortage of healthcare practitioners (Littlejohn et al., 2012) or their rural distribution (Konkin et al., 2020), some healthcare practitioners may often be at risk of exceeding tasks delineated by their scope of practice or that they have received education for (French et al., 2011; Konkin et al., 2020; Lubbe & Roets, 2014). Exceeding the bounds of one's training, and thus invariably the scope of practice, may incur detriments to patient health and repercussions for the practitioners involved. Although not the only solution to the healthcare crisis, one area that should be bolstered is the capacity building and training platforms of healthcare practitioners, thus increasing the available workforce and their ability to meet their responsibilities upon graduation (Academy of Science of South Africa, 2018; Oleribe et al., 2019). The importance of education is further echoed by the 2018 South African Health Review and 2018 Academy of Science of South Africa reports, where deficiencies in the governance of health professions and sciences education have resulted in concerns about whether competencies are truly attained (Rispel et al., 2018). The 2013 World Health Organization Guidelines report also emphasises the need for transformation of the learning environment to ensure and increase the quantity, quality and relevance of health professions education to alleviate poor health outcomes (World Health

Organization, 2013). A specific area of concern within clinical education has always been the basic sciences (Bhosale et al., 2013; Fincher et al., 2009; Gaur et al., 2020; Rangachari, 1997; Sani et al., 2020), where improperly scaffolded learning of the fundamental disciplines of the body, such as anatomy, microbiology, physiology and pharmacology may have detrimental consequences for achieving appropriate clinical competencies (Fincher et al., 2009). Such educational deficiencies have once more been emphasised in recent years with the structural changes forced onto training platforms due to the COVID-19 pandemic (Gaur et al., 2020; Sani et al., 2020). Pharmacology is one such discipline that affects the clinical competence of healthcare practitioners in various sectors (Ahsan & Mallick, 2016; Brinkman et al., 2018; Mestres & Duran, 2009; Rangachari, 1997; Unger & Lochner, 2006).

3. Healthcare practitioners and their pharmacology education

Pharmacology remains one of the core treatment modalities within healthcare, though invariably is dependent on several factors that delineate its purpose and appropriateness; for example, the type of disease and which healthcare practitioner is leading the therapy.

3.1. Pharmacology as discipline

Pharmacology, a core biomedical science in various healthcare professions, including dentistry, dietetics, medicine, nursing and physiotherapy, is both a basic and clinical science (Ahsan & Mallick, 2016). As a basic science, it provides a fundamental understanding of natural phenomena to help develop theories (Uppsala Universiteit, n.d.); in the case of pharmacology, this includes the complex interactions that bioactive molecules have with biological systems to alter an organism's physiological response (Bhosale et al., 2013). As a clinical science, pharmacology forms the foundation of rational therapeutics (Bhosale et al., 2013) wherein the most appropriate course of pharmacotherapy is selected in relation to a patient's individual needs (Brinkman et al., 2018; Moura, 2012; Ross & Maxwell, 2012).

Pharmacology forms a core discipline of health sciences and health professions education (Brinkman et al., 2018), though its learning outcomes will depend on the unique scope of practice of the different health professions or sciences, and invariably need to align with the exit level outcomes of the programmes they are registered within. For example, foundational concepts in Pharmacology, such as pharmacokinetics (the movement of a drug throughout the body and its concentration at biological sites) and pharmacodynamics (the biological effects a drug exerts in the body) (Boston University, 2004; Rangachari, 1997) may be considered a need for all programmes due to their nature as core concepts (White et al., 2021). Other topics, such as individual classes of drugs or their clinical guidelines, may be more programme-specific and inferred by the exit level outcomes of the profession. Due to the needs of the profession, as will be described hereafter, pharmacology education must be aligned with their graduate competencies to ensure exit level outcomes are not under- or over-reached, which may impact their successful completion.

3.2. Pharmacology education in healthcare

Various healthcare practitioners may encounter patients that are currently using or will require pharmacotherapy to prevent, treat or cure a disease state. Invariably, not all healthcare practitioners will have the same roles related to pharmacotherapy, with responsibilities ranging

from prescribing medication (Brinkman et al., 2018), serving as non-prescribing medication managers (Dubovi et al., 2018) or conducting their own specific treatment modality alongside pharmacotherapy that may already be in the patient's current treatment plan (Mestres & Duran, 2009; Professional Board for Dietetics and Nutrition, 2016; Unger & Lochner, 2006). To be competent in approaching the clinically relevant competencies of pharmacology, students will require thorough education in several biomedical sciences, including physiology, pathophysiology, and pharmacology (Burman et al., 2009; Lim et al., 2007) but ultimately require them to be linked to their exit level outcome lest learning approaches become overly generalised.

Research regarding pharmacology education is primarily focused on the fields of medicine, dentistry and nursing. However, given the similarity in findings, extrapolation can be made to other healthcare professions. Pharmacology is typically described as interesting and essential to the success of the healthcare system (Bhosale et al., 2013; Rani et al., 2016). However, its curriculum is met with much criticism in literature. pharmacology curricula are frequently opined as content-heavy with a deluge of information presented from an overt biosciences' perspective via didactic modalities (Banning, 2003; Craft et al., 2017; Davis, 2010; Foster et al., 2017; Manias & Bullock, 2002). As such, contextualisation into clinical education may not occur that promotes misalignment with the needs of the graduates in their world-of-work (Craft et al., 2017; Engels, 2018; Karpa & Vrana, 2013) and rote learning (Ahsan & Mallick, 2016) that impacts their clinical competence (Craft et al., 2017; Engels, 2018; Karpa & Vrana, 2013). Pharmacology is frequently described as difficult (Ahsan & Mallick, 2016; Bhosale et al., 2013; Jalgaonkar et al., 2012; Lymn & Mostyn, 2010; Manias & Bullock, 2002), and graduates have been described as possessing poor knowledge (Ahsan & Mallick, 2016; Andersen & Moralejo, 2015; Banning, 2003; Davis, 2010; Harding et al., 2010; Karpa & Vrana, 2013; Kemp et al., 2014; King, 2004; Lymn & Mostyn, 2010; Manias & Bullock, 2002; Sulosaari et al., 2015), little confidence (Craft et al., 2017; Davis, 2010) and motivation (Ahsan & Mallick, 2016) and limited satisfaction with their learning or learning environment (Andersen & Moralejo, 2015; Banning, 2003; Davis, 2010; Lymn & Mostyn, 2010; Manias & Bullock, 2002). Such factors pose detriments to patient care due to improper education (Davis, 2010). Pharmacology has traditionally been taught using standard didactic modalities to facilitate knowledge transfer (Achike & Ogle, 2000; Bhosale et al., 2013; Engels, 2018; Lymn & Mostyn, 2010; Vora & Shah, 2015) given its overt focus on it as a basic science. Lecturer-centred approaches are generally used for large groups with defined learning outcomes and assessments, though may lack high levels of interactivity (Ahsan & Mallick, 2016; Vora & Shah, 2015). Such methods are argued to be less suitable for the development of lifelong learners due to limited active engagement of the student (Ahsan & Mallick, 2016), which further potentiates the possibility of poor learning. Given the factual nature of pharmacology, students are susceptible to cognitive overload, where a deluge of facts are presented, often exceeding the depth that is required for the specific exit level outcomes students need to achieve (Achike & Ogle, 2000; Foster et al., 2017; Manias & Bullock, 2002; McKimm, 2010; Michel et al., 2002). As such, the analogy of drinking from a fire hose is often used to describe learning pharmacology in health professions degrees (Achike & Ogle, 2000). Even within a field such as medicine, recommendations suggest that apart from selected emergency medicines, it is not necessary for graduates to remember exact dosing regimens, but rather know where to source information effectively and rationalise the underlying principles thereof (Ross & Maxwell, 2012). Pharmacokinetic and pharmacodynamic principles, information interpretation, responsible drug treatment and administration in special populations have been posited as

important for medicine (Midlov et al., 2015). However, these can possibly be extrapolated to other healthcare professions to various depths. Without thorough guidelines to advise on such decisions, curriculum design becomes complex and runs the risk of misalignment with graduate needs.

Often the focus of students' education (Andersen & Moralejo, 2015; Davis, 2010; Manias & Bullock, 2002) and textbooks is scientific in nature (Foster et al., 2017), emphasising the biosciences, but not providing a platform to contextualise information to their clinical skills (Achike & Ogle, 2000; Desai, 2009; Foster et al., 2017; Manias & Bullock, 2002). Nursing students have opined that their pharmacological knowledge is negatively impacted by the content-heavy nature of pharmacology and placement in their degree schedule (Foster et al., 2017; Manias & Bullock, 2002). With limited time (Craft et al., 2017) and a burden of facts (Achike & Ogle, 2000), rote learning is often undertaken by students to pass assessments, leading to lower order cognitive processes, such as recall and superficial understanding of concepts (Manias & Bullock, 2002). As only lower order cognitive processes are engaged, students do not achieve the higher order learning outcomes required for their health professions (such as critical thinking and evaluation skills), and thus lack knowledge at the appropriate depth and scope for application in their practice (Ahsan & Mallick, 2016; Lymn & Mostyn, 2010; Manias & Bullock, 2002). Such poor knowledge leads to an inability to adapt within the world-of-work in different clinical situations (Andersen & Moralejo, 2015; Banning, 2003; Davis, 2010; Lymn & Mostyn, 2010; Manias & Bullock, 2002). If the bridge between pharmacological concepts and clinical practice is tenuous, relevance for the need to study it weakens (Craft et al., 2017; Davis, 2010).

Pharmacology is not an isolated discipline receiving such critique, as graduates of various health profession degrees highlight inadequacies of knowledge in different biomedical sciences, such as anatomy and physiology (Bhosale et al., 2013; Jalgaonkar et al., 2012; Lymn & Mostyn, 2010; Manias & Bullock, 2002). The quality of the bioscience knowledge of clinical graduates is often described as poor (Andersen & Moralejo, 2015; Banning, 2004; Davis, 2010; Lymn & Mostyn, 2010; Manias & Bullock, 2002) due to inadequate comprehension of underlying principles, content-heavy curricula and the more scientific slant taken during andragogy rather than the clinical relevance thereof (Ahsan & Mallick, 2016; Andersen & Moralejo, 2015; Davis, 2010; Manias & Bullock, 2002). The misalignment of curricula with expected competencies has been well-described (Banning, 2003; Craft et al., 2017; Davis, 2010; Foster et al., 2017; Manias & Bullock, 2002) and potentiates concerns of not being able to apply said knowledge. For example, foundational principles of a disease, such as pathophysiology, are instrumental to understand how pharmacotherapy allows for treatment. Should this foundation not be facilitated appropriately, as it has often been described, scaffolded and integrated learning will not be possible due to deficits in basic principles (Michel et al., 2002). Without ensuring appropriate horizontal integration, where parallel-running basic sciences interleave with one another to allow for a comprehensive view of the concepts being taught (McKimm, 2010), scaffolding may not allow for understanding of the concepts and impact its contextualisation within the clinical environment (Craft et al., 2017). Recent concerns about changes to teaching practice incurred by the COVID-19 pandemic have emphasised the need for proper consolidation of knowledge of the basic sciences to allow for clinical integration (Gaur et al., 2020; Sani et al., 2020).

Students within clinical degrees are often at a disadvantage in comparison with those from the biosciences, as they require the ability to apply pharmacological knowledge contextually within their scope of practice to highlight rational therapeutics and consider individual patient characteristics. The transition from basic to clinical sciences often presents with a professional disconnect (De Queirós Costa et al., 2013), inability to apply knowledge (Brenner et al., 2017; Kerecsen et al., 2002; Lazić et al., 2006; Pazdernik & Walaszek, 1983) or a theory-practice gap (De Queirós Costa et al., 2013; King, 2004). As such, students lack sufficient background of the discipline to develop adequately or execute associated clinical competencies (Pazdernik & Walaszek, 1983; Kerecsen et al., 2002; King, 2004; Lazić et al., 2006; de Queirós Costa et al., 2013; Brenner et al., 2017). The issue remains multifactorial, including lack of contextualisation (Brenner et al., 2017), poor integration between disciplines (De Queirós Costa et al., 2013), inadequate depth of clinical educational resources, a high workload of clinical years, or perceptions of students of basic sciences (Lazić et al., 2006). If a poor platform exists for the development of competencies related to rational therapeutics, for example, medication management, contextualisation within their practice is not achieved (Davis, 2010; Green-Thompson et al., 2012), and rote learning persists (Manias & Bullock, 2002).

Depending on the programme organisation, pharmacology may be stand-alone or assimilated into other modules (Karpa & Vrana, 2013). Opinions differ in terms of how the basic sciences should be taught in relation to clinical sciences. Assimilation into other disciplines may allow for a greater horizontal and vertical integration of basic and clinical sciences, reduction in redundancy (Alrefaie et al., 2017; Islam et al., 2016), increased self-directed learning (Kidane et al., 2020), contextualisation and increased relevance of the basic sciences in the clinical domain (Alrefaie et al., 2017; Yograj et al., 2019). Concerns are raised, though, that creating integrated modules may reduce the basic sciences' breadth of knowledge and understanding, and complicate the scaffolded nature in which the discipline's education is presented (Bandiera et al., 2013; Karpa & Vrana, 2013; Norris et al., 2020), complicate assessment of basic sciences due to ill-representation in integrated questions (Karpa & Vrana, 2013), and limit collaborative environments across departments (Islam et al., 2016). As such, how pharmacology is presented in a programme may impact the successful achievement of the outcomes of the individual modules, and ultimately, the exit level outcomes of the programme itself. Pharmacology is also generally presented by discipline-specific experts rather than clinical professionals of the said programme (Manias & Bullock, 2002), which may direct focus away from the clinical context of pharmacology. Clinical educators may help bridge this decontextualisation; however, they may also have insufficient knowledge of the discipline to approach it correctly (Manias & Bullock, 2002).

It is not inconceivable to imagine that the culmination of an overloaded, decontextualised curriculum with an overt biomedical sciences focus will result in graduates not fully competent in terms of pharmacology. The focus of this study is on the Pharmacology[1] modules that I coordinate that service a broad admixture of healthcare practitioners and scientists. These two modules comprise students of the Bachelor of Dietetics, Bachelor of Nursing Science, Bachelor of Physiotherapy, and Bachelor of Science (majoring in a mixture of, among others,

[1] When referring to the discipline or profession as the module, the discipline or profession will be written in uppercase to reflect its titular form (e.g., pharmacology, chemistry or physiotherapy as a discipline versus Pharmacology, Chemistry or Physiotherapy as modules).

anatomy, biochemistry, genetics, microbiology, physiology, and pharmacology). As such, students may exit their studies as either clinical healthcare practitioners, or those with a more scientific slant not requiring clinical expertise. Each healthcare practitioner invariably also has a different scope of practice, and thus the clinical context is dependent on the programme in which they are enrolled. From a curricular perspective, this naturally poses a problem as an undeniable misalignment occurs in terms of the focus and depth of learning opportunities, their associated content and learning outcomes, and the expected time required to master competencies. The respective scopes of practice of the three healthcare practitioners are discussed in more detail to highlight their specific needs and expectations.

3.3. Pharmacology as discipline within dietetic, nursing and physiotherapy practice

The three healthcare practitioners that the study focuses on are briefly described here, with further discussion of their scope of practice, regulatory bodies, and core responsibilities provided in Chapters 3 to 5.

The healthcare goal of the dietitian is to evaluate and improve the nutritional status and choices of their patients or clients via food and nutrition (International Confederation of Dietetic Associations, 2016) as a mechanism to improve their quality of life and reduce the disease burden (Professional Board for Dietetics and Nutrition, 2016). Although they are not prescribing authorities based on their scope of practice (Republic of South Africa, 1991), their medical nutrition will invariably run alongside pharmacotherapy in several disease states (Mestres & Duran, 2012). Not only may there be concomitant treatment with potential better therapeutic outcomes (Mestres & Duran, 2009), but medicine may also impact the nutritional state of patients adversely (Mestres & Duran, 2009; Professional Board for Dietetics and Nutrition, 2016), necessitating nutritional countermeasures to reduce morbidity.

Professional nurses form a predominant base for healthcare provision (Academy of Science of South Africa, 2018) and afford individuals with care to assess and promote health strategies, facilitate treatment, and prevent diseases (International Council of Nurses, n.d.). Although professional nurses are not prescribers – a possibility for them with additional qualifications – they are seen as medication managers (Dubovi et al., 2018) who administer and control medicines, including the clinical evaluation of a patient's response to treatment, whether therapeutic or adverse (Dubovi et al., 2018; Moura, 2012) as part of the nursing process (Lubbe & Roets, 2014). Contextually relevant pharmacological knowledge is thus needed to address the management of medicines safely and effectively within patient care (Smith, 2014).

Physiotherapists treat patients' physical dysfunction via mechanical treatment, rehabilitation or preventative measures (Continuing Consolidation of the Statutes of Manitoba, 1991). Although physiotherapists generally treat with physical means, various strategies may incorporate pharmacotherapy for the ailment (Stenner et al., 2018) or will need to be consider such medications in patients that may already be prescribed such treatment (Narain & Mathye, 2019). As such, pharmacology knowledge will be needed to approach comprehensive treatment (Eksteen & Slabbert, 2001; Unger & Lochner, 2006) that would consider more than just the disciplinary focus of treatment, but rather all factors associated with the patient, such as their medication use.

3.4. Impact of improper training on pharmacotherapy

Unfortunately, a lack of competence has been linked to adverse outcomes in healthcare, as described below. The context below briefly relates to that of the three groups of healthcare practitioners of the study, and thus prescription errors are not discussed as these are not within the scope of practice of dietitians, professional nurses or physiotherapists.

Nurses, who serve as medication managers, have been implicated in errors relating to pharmacotherapy administration. Globally, medication administration errors have been reported, with South Africa being no exception (Du Preez, 2016; Blignaut et al., 2017; Matiso, 2017). Naturally, such lack of relevant competencies leads to poor health outcomes (Jones, 2009; Blignaut et al., 2017; Wondmieneh et al., 2020; Wang et al., 2023). Factors that have been implicated include a lack of knowledge of medicines and their adverse effects (Jones, 2009; Du Preez, 2016; Blignaut et al., 2017; Matiso, 2017), and incorrect medicine calculations (Jones, 2009; Matiso, 2017). These competencies relate to the processes required by nurses in providing appropriate patient care (Lubbe & Roets, 2014) that overlaps with concepts in pharmacology. Even reporting on pharmacotherapy's adverse effects as a function of pharmacovigilance has been remarked as being poor at times (Dirik et al., 2019).

Similarly, food-drug interactions remain a broad field of study requiring multidisciplinary action (McCabe-Sellers et al., 2006; Citty et al., 2021; Osuala et al., 2021), but by and large falls into the scope of practice of dietitians' medical nutrition. Given the potential medication failures and/or adverse effects that may arise when a drug and dietary item interact, the importance of dietitian's pharmacotherapeutic knowledge is evident (McCabe-Sellers et al., 2006; Citty et al., 2021; Osuala et al., 2021). Unfortunately, research has suggested gaps in dietitians' knowledge of food-drug interactions (Osuala et al., 2021), albeit little has been published on the matter. Pharmacotherapy also affects the success of physical therapy, and thus knowledge thereof is needed to ensure that comprehensive treatment can occur within safe bounds (Fennelly et al., 2020; Stenner et al., 2018; Unger & Lochner, 2006).

4. Undergraduate Pharmacology at the University of Pretoria

At the University of Pretoria, undergraduate Pharmacology is presented by the Department of Pharmacology (Faculty of Health Sciences) to several degrees (Table 1.1) of the Faculty of Health Sciences (Bachelor of Dentistry, Bachelor of Dietetics, Bachelor of Medicine, Bachelor of Nursing Sciences, Bachelor of Oral Hygiene, and Bachelor of Physiotherapy) and Faculty of Natural and Agricultural Sciences (Bachelor of Science comprising variable majors depending on which disciplines are selected by students). Of the undergraduate Pharmacology modules presented, I coordinate the FAR 381 and FAR 382 modules that are the focus of the current study.

TABLE 1.1: UNDERGRADUATE PHARMACOLOGY MODULES PRESENTED BY THE DEPARTMENT OF PHARMACOLOGY AT THE UNIVERSITY OF PRETORIA AS OF 2024

Module code[a] (name)	**Placement in degree**	**Module type**	**Degree (Bachelor of …)**	**Average group size between 2018 and 2022**
FAR 172 (Pharmacology)	1st year, 2nd semester	Compulsory	Oral Hygiene (BOH)	11 ± 1.5
FAR 370 (Clinical Pharmacotherapy)	3rd year, full year	Compulsory	Dentistry (BChD)	55 ± 8.5
FAR 381 (Pharmacology)	3rd year, 1st semester	Elective[b] Compulsory	Science(BSc) Human Nutrition (BDietetics) Nursing Science (BNurs) Physiotherapy (BPhysT)	194 ± 24.0 23 ± 6.2 51 ± 5.8 56 ± 6.7
FAR 382 (Pharmacology)	3rd year, 2nd semester	Elective* Compulsory	Science (BSc) Nursing Science (BNurs) Physiotherapy (BPhysT)	132 ± 77.8 51 ± 5.8 56 ± 6.7
GNK 128 (Introduction to Clinical Pharmacotherapy)	1st year, 2nd semester	Compulsory	Medicine (MBChB)	284 ± 14.2
GNK 585[c] (Pharmacotherapy)	2nd, 4th and 5th year	Compulsory	Medicine (MBChB)	284 ± 14.2

[a]The module code generally follows the following rules for delineation: a three-letter abbreviation of the module name (given the historical context, often presented in the Afrikaans language; i.e., FAR as Farmakologie [Pharmacology] and GNK as Geneeskunde [Medicine]); three numbers of which the first number suggests the year level (e.g., 1 equates to a first year module), and the subsequent two's bearing does not follow any convention anymore (e.g., the 1 and 2 at the end of 38 suggest first and second semester; however, it is not the norm with many other module codes).
[b]The FAR 381 and FAR 382 modules are electives for students enrolled for the Bachelor of Science degree.
[c]Since the module is presented longitudinally across the medical programme, the module code has been designated as fifth year given its exit-examination status.

The FAR 381 and FAR 382 modules are presented in the third year in the first- and second-semester respectively, to an admixture of students from different degrees. Each module carries an 18-credit weighting that relates to 180 notional study hours. As per the South African Qualifications Authority (SAQA), a credit is defined as "a measure of the volume of learning required for a qualification or part-qualification, quantified as the number of notional study hours required for achieving the learning outcomes specified for the qualification or part-qualification", where one credit relates to ten notional hours (South African Qualifications Authority, 2022, pp. 4-5). Notional hours are defined as "the agreed estimate of the learning time that it would take an average learner to meet the defined outcomes, it includes consideration of contact time, research, completion of assignments, time spent in structured learning in the workplace, individual learning" (South African Qualifications Authority, 2022, p. 5). However, as described further in Chapter 2, Section 3.1 credits and notional hours are a complex field that is often seen from a reductionist view as merely temporal and quantitative (Nkomo, 2000).

Students of at least four different degrees are enrolled in the FAR 381 module, three of which are clinical professions (Bachelor of Dietetics, Bachelor of Nursing Science, and Bachelor of Physiotherapy, registered within the School of Healthcare Sciences of the Faculty of Health Sciences). The fourth (Bachelor of Science, registered within the Faculty of Natural and Agricultural Sciences) can be diversified even further depending on the major disciplines

selected by students during registration, and thus prior and parallel-running modules will differ, depending on combinations of major disciplines of study, for example, anatomy, biochemistry, microbiology, or physiology. The FAR 382 module comprises the same groups apart from the Bachelor of Dietetics for reasons described in Chapter 3, Section 2.2. The modules aim to develop students' knowledge of pharmacological concepts, as well as the pharmacotherapy associated with common diseases, in twenty-one and twenty lectures, respectively; no practical component is included, and the modules are presented solely by non-clinically-educated pharmacologists. For healthcare practitioner students, this invariably forms the basis of developing additional clinical skills specific to their profession. From a curricular perspective, the admixture of students with diverse scopes of practice creates a challenge to ensuring that module learning outcomes are aligned with their specific graduate needs as exemplified by their programmes' exit level outcomes. As each profession requires a different focus on pharmacology to meet the needs of their scope of practice, one must ask whether the content discussed, the cognitive and practical expectations of such content, the andragogical modalities used, and environment of learning would not need to be different for each degree.

Several challenges have plagued the FAR 381 and FAR 382 modules; some general concerns are related to these as biosciences modules, while others are more specific to the institutional setting. As the Faculties of Health Sciences and Natural and Agricultural Sciences are located on two different campuses, and students are enrolled for different programmes, classes are taught on both campuses at different times of the week as duplicate sessions. Although this allows for the total group of students to be split between campus sessions, classes are still presented by a single lecturer to between 70 and 200 students, depending on the campus. The Department of Pharmacology has a small staff complement, and thus it is difficult to guarantee that more than one lecturer can be present for a session, even if a teaching assistant or tutor is available. This reduces the possibility of moderated small group discussions, and thus tends to shift lecturers to more traditional didactic teaching modalities. As there is limited contact time, and many of the lecturers are discipline-experts rather than having a background in educational practice, it further complicates the potential to experiment with more active forms of andragogy. The admixture of students also complicates meeting the profession-specific needs of all; thus not unexpectedly, all students are taught the same content, in the same way, with the same general context, while invariably, this should not be the case. Such a general curricular approach across degrees creates a decontextualised setting where prospective healthcare practitioners do not engage with the material of their unique contextual settings, with specific learning outcomes relevant to their profession. The risk of teaching too little, too much, or inappropriate content remains a problem. Although problematic, the initial decision to incorporate the various degrees into these modules is historically not clear to me at present, as this has been the norm for more than a decade. Reasons may include, among others, the small complement of staff within the Department and logistical constraints associated with this. Although this does not justify inappropriate design, it highlights the challenges that previous course coordinators may have faced during their terms.

The Bachelor of Dietetics, Bachelor of Nursing Sciences, and Bachelor of Physiotherapy are registered as advanced career-focused bachelor's degrees (National Qualifications Framework [NQF] level 8), which necessitate 480 credits (Council on Higher Education, 2002). The NQF level describes the appropriate expectations of learning outcomes and assessment criteria of a qualification at set benchmarks elaborated on in Chapter 2, Section 3.1 (South

African Qualifications Authority, 2012). Although FAR 381 and FAR 382 (NQF level 7), would necessitate, for example, detailed knowledge of a field and its relation to other disciplines, the bachelor programmes under investigation would elaborate further in the application that is needed using such knowledge (South African Qualifications Authority, 2012). Between 18 (Bachelor of Dietetics) and 36 credits (Bachelor of Nursing Science and Bachelor of Physiotherapy) are linked to the total credit weighting of their programmes; this has been opined as being excessive for the training of at least the dietetics and physiotherapy professions during accreditation visits by the Health Professions Council of South Africa (HPCSA). Given the limitations of the current presentation of pharmacology, it is difficult to ascertain how many notional hours would be needed within the healthcare practitioner's development, particularly as overlap within the core professional modules would need to be considered. Additionally, the assumption of the time needed for the average learner becomes contentious due to the underlying diversity in the foundational years of training and admission requirements of the programmes, which creates a relative view of what average might mean among the different healthcare practitioners. As such, notional hours may quickly be seen as a reductionist, arbitrary allotment of time to a discipline, that may either inflate or minimise the time needed to ensure that competency development is achieved.

5. Research problem

Ultimately, the learning outcomes associated with a curriculum should speak to the unique workplace competencies of a profession. As discussed in Section 4, the admixture of students does not allow for a focused curriculum that can address their unique professional needs, which promotes misalignment. Peer and student feedback have indicated such concerns in the past, though no immediate solution was available. In recent years, the need for the redesign of the curriculum of each healthcare profession's pharmacology has become more evident due to feedback from programme evaluators, the changing healthcare landscape, and discussions of extensions of scope of practice. Curriculum design is not a simplistic task, and requires a large investment to ensure that it is guided by sound worthy processes and evidence supporting change. Although pharmacological competency guidelines or proposals are available for certain professions, such as medicine (Midlov et al., 2015; Near et al., 2002; O'Shaughnessy et al., 2010; Ross & Maxwell, 2012; Shankar, 2011), these are typically lacking for others, and even more so in the South African context.

At present, a clearly aligned pharmacology curriculum that speaks to each profession individually is needed to ensure that education can be planned accordingly. It would be illogical to attempt such a design process without investigating empirically the exact competencies expected of these healthcare professionals, especially within the context of the programmes of the University of Pretoria for which they are enrolled.

6. Research questions

Given the urgency of promoting the quality of learning of my students, and the need for them to obtain profession-specific competencies for their professions, a research-guided approach is justified to facilitate curriculum development, leading to an overarching question to be answered:

Which pharmacological competencies required by Bachelor of Dietetics, Bachelor of Nursing Science, and Bachelor of Physiotherapy students at the University of Pretoria should be aligned with their workplace needs?Several sub-questions stem from this:

1. What are the general needs of each profession in South Africa with regard to pharmacological competencies to function as healthcare practitioners?

2. What are the targeted needs of each profession at the University of Pretoria with regards to their pharmacology education when assessing their current programme structure?

3. What are the proposed learning outcomes and assessment criteria of an undergraduate pharmacology curriculum presented to these students at the University of Pretoria?

The chapters that follow speak to each sub-question organised according to the respective healthcare practitioner groups to mediate a systematic flow of discussion. However, given the intertwining of my academic position, job responsibility, passion and training in the research question, my positionality should be declared.

7. Declaring my positionality

At the time of writing, I am an Associate Professor in the Department of Pharmacology of the University of Pretoria. As an academic, a prominent focus of my responsibilities has always been establishing myself as a researcher. As a biological scientist with a focus on basic sciences, my pharmacological research has in general been directed towards drug discovery and development in herbal remedies, but in recent years has become more focused on cancer modelling in advanced cellular culturing systems. In 2022 I received a Y2 Rating from the National Research Foundation for research in cancer modelling, which acknowledges my development as a basic sciences researcher. In such a way it does provide pressure to bolster such biological research that necessitates a large focus on my time to student supervision, publishing in the field, and furthering my skillsets. Although I have a distinct passion for biological sciences, and my research focus area continues to excite me, I have in recent years become more aware of where my actual strength lies: as an educator.

I have had the opportunity to coordinate undergraduate modules offered by our Department since 2016, though I have been lecturing since 2011. Much of my educational practice prior to 2016 was rooted in modelling educators in my past, and as such was predominantly didactic and lecturer-centred, with little explicit educational scholarship applied to it. My reserved personality, stereotypically, has fit well within the domain as a biological researcher, but has often made me uncomfortable as an educator. It was only until certain events in 2015 when my view of myself as educator, my strengths, growth opportunities and passion were altered. Looking back to my earlier years as a lecturer, I often shudder at what I assumed was being a good lecturer from my ignorant vantage.

I formally considered myself a health professions educationalist only after 2016 when my passion for education was ignited in full and subsequently changed my teaching practice, philosophy and view of teaching, learning and students. An expectation of my new permanent

employment in 2015 was the completion of an Academic Induction Programme offered by the University of Pretoria's Department for Education Innovation (a centralised unit tasked with providing educational support to academics). The aim of the programme was to help orientate me as a new academic to the institutional policies, regulations and expectations, as well as delve more into my role as educator. During this programme I realised that the role of educator was more complex than I had initially assumed. Prior to the programme, I had fallen victim to the typical cycle of emulating lecturers from my past degrees, without understanding the scholarship that underlies education itself. As a scientist, I found solace in seeing the scientific underpinnings of learning during this time, which helped strengthen my resolve that following scholarship would allow for a better educational outcome to be achieved. As a person, I realised the ethical weight of my serving as an educator without truly understanding what I was doing, or at the time, on what I was actively not improving. For several years I had been teaching, but arguably, not creating an environment conducive to learning. I found that during this time I also started to become an advocate for student rights in their learning. Hearing students openly discuss that the assessment was often more important than the competencies that were aimed for, that the relevant facts could not be recalled let alone applied in simulations of the workplace, or that motivation was not always present, was a concern to me. However, attending peer discussions where academics would redirect blame of inadequacies to their students was just as frustrating. Over time I have developed a more objective, or hopefully so, view of the matter: both parties in the learning relationship carry strength and fault, though ultimately, we need to ensure we do our best as educators to stimulate an environment conducive to authentic learning. Inherently, I thus approach the learning environment from a devil's advocate perspective, questioning whether the learner and educator, including myself are facilitating the process to the best of their capabilities.

It was during the Academic Induction Programme that I experienced an awakening of sorts – a transition of what I believed was necessary to act as an educator, and what I would eventually need to be able to do. Although I was well-liked as a lecturer and received good scores during module evaluation by peers and students, I realised I was not offering my students anything more than a likeable and approachable sage on the stage. Only after completing the Academic Induction Programme did I come to terms with my inadequacies and ignorance as an educator that had downstream consequences on my ontology. As a biological scientist focused on the basic sciences, I revelled in the objective nature of pharmacological theories, rooted in scientific fact with little potential to deviate from what was understood. I knew much about pharmacology, but very little about the educational principles that would allow for an authentic learning environment that promoted learning. I came to understand that as an educator I was an important role-player in the development of each of my students to become the professional that they were working towards, regardless of to which direction that might eventually lead. I had a responsibility to them to ensure that I was doing everything in my power to create an environment in which they could learn and become competent graduates. The jumble of emotions that was stirred by this realisation came as a bit of a shock, as suddenly a new path in my life had become visible. This created a dissonance of my identity as it altered the way in which I would present myself in my career, my research, and ultimately, how I would be viewed by others. An expectation of discipline-specific research and focus loomed over me, though the direction I wanted to take in my career as educator was more apparent. Ultimately, it took several years for me to reconcile my identity as a pharmacology educator that continues to drive my decision-making, passion, and view of the educational sector. With such a newfound view, the image of didactic teaching, particularly in the basic

sciences where facts reign supreme, was disheartening to see. Seeing this in my modules was deeply unsettling to me, and I actively worked towards changing as much as possible to alter my practice. This redirected focus is not something I regret, but invariably it did place several more responsibilities on my plate as academic.

Initially, I viewed the world with a positivist mindset, where facts are facts, enshrined in its objective, decontextualised and value-free position (Maton, 2014). Since becoming more entrenched in education, the importance of acknowledging external social impact has allowed me to be more aware of the isolated discipline-specific trap of not seeing the value of other role-players in the construction of meaning of those facts. While developing my proposal for this study, keeping in mind how important the clinical stakeholders' perceptions would be of what they were working towards, I discovered literature that sparked curiosity and an eventual paradigmatic shift. Although facts are facts, these facts are also subject to the social environment and role-players that guide the importance and meaning of such facts. As such, an eventual movement towards social realism (Maton, 2014) occurred, where the impact of the individuals involved in the construction of meaning became just as important as the knowledge itself. This change has been evident in my practice as an academic, where I have come to realise that knowledge, in all its forms, is subject to who is leading its discussion, including me. I thus need to ensure that when addressing pharmacology in my classroom, the meaning may be filtered through my specific understanding thereof as a basic scientist, while a healthcare practitioner may do so with the greater view of what they require from the information. Inclusion of healthcare practitioners into the design of my curriculum thus allows for their voice to come through as well. In doing so, a synergy can be achieved where their clinical expertise guides what is important within the curriculum, while my discipline-specific knowledge helps create a rich base for that knowledge to be developed.

Having realised that I lacked the background to develop as an educator, I decided to seek professional development platforms that would not only help me bridge my lack of knowledge in the field, but also help formalise my career plan. I completed a Postgraduate Certificate in Higher Education (PGCHE; University of Pretoria) and a fellowship with the Sub-Saharan Africa Foundation for Advancement of International Medical Education and Research (FAIMER) Regional Institute (SAFRI) in 2016 and 2018 respectively. Both these platforms did more than just offer educational theory, but also placed me in a position of becoming a health professions education researcher, broadening my community of practice, and solidifying my resolve as a budding leader in educational reform in the future. One of the first steps taken to becoming such a leader, was offered me by the Department of Humanities Education, Faculty of Education, at the University of Pretoria. The Department acknowledged my contribution to developing myself as a specialist in higher education, and the contribution of colleagues at the University of Pretoria by inviting me to act as a guest lecturer for a number of years on the very same PGCHE I had obtained a few years prior. The trust the Department of Humanities Education placed in me helped build my growing confidence and identity as an educator. The thought of pursuing a doctoral degree in education was multifactorial; it would serve as a motivating force for prompting a research-based curriculum development model, thus providing evidence to the decisions made, and afford me additional career opportunities in the academic world. It was important for me that should my path take me to senior management roles in education, I would have the educational background to support decision-making.

Given my background in the basic pharmacological sciences, it is no surprise that I find solace in the quantitative research design environment, as many basic scientists would. Having worked with cells for most of my career who talked to me only through the rows of numerical data generated during biological experimentation, I was not used to an environment where the subjective element was as critical. Undertaking a project within health professions education research would require much more than just quantitative data. Having dipped my toes into qualitative research, this was an exciting and nerve-wracking realisation, but one I was glad to have reached.

As a discipline-specific expert in the basic pharmacological sciences, and not being a clinical health professional, I approach the curriculum with a greater understanding of the basic sciences. As opined by Rangachari (1997) the basic sciences are often seen as antagonists in the larger clinical programme, presenting an overload of decontextualised information that may seem irrelevant to the broader context of their practice, though each believing they may be the most important discipline. This thought resonates with me, as I often find myself delving into bits of information that, ultimately, will not affect the attainment of relevant competencies in the clinical spectrum (or, I assume as much). My discipline is my passion, so it is easy for me to inflate the importance of a section without consciously realising that I am doing so. As described by Frenk et al., curricular difficulties are generally managed in silos rather than as an interprofessional team (Frenk et al., 2010). This is a reality for my curriculum, where I also run the risk of narrowly seeing the discipline-specific, basic sciences-heavy outcomes as important within my sphere, but not necessarily addressing this from a professional needs base. I also acknowledge that I may easily assume the relevance of a concept within a professional domain without truly understanding whether that may or may not be the case. Given an introverted nature and a general tendency to work in smaller groups, I require a shift in thinking to draw expertise from my community of practice, particularly those colleagues in health professions that can offer a more critical view of what my curriculum should encompass within their unique environments. Luckily, I have been successful in establishing a secondary research area for myself: pharmacology-relevant competency development in healthcare practitioners. As such, I have developed a community of practice with clinical experts, health professions educators, and students under my supervision that enriches my goals in my educational reform and research. The projects conducted by my students feed into the aim of my doctoral study, and contribute to planning beyond the curriculum.

I acknowledge all these attributes of my being and position to bring inherent biases to the forefront so that I could be aware of them. These biases have invariably been there from conceptualisation of the study, and would persist through analysis, interpretation and conclusion of this project. I am a basic pharmacologist by training, with a passion for the complex pharmacological principles that encapsulate each drug and influence their ability to modulate physiological mechanisms in different populations. As such, I thrive in the odd bits-and-bobs of my discipline that may be unnecessary for my students' professions, but would generally bleed into my teaching because of my interests and assumptions of what is important. I have formed preconceived notions of what each professional should know and can do given ignorance in my younger years as lecturer and module coordinator, communications with other discipline-specific experts, and cursory readings; ultimately this may have created a specific lens through which I interpret my data. Based on the context, depth, and quality of information, I may distort their meaning based on my views. I am a discipline-specific expert, but not part of the healthcare professions that I teach, and thus also

require experts in dietetics, nursing and physiotherapy to help guide my decisions of the data, rather than imposing mine onto them. My belief of what pharmacological competencies should be obtained by certain healthcare practitioners is not necessarily what must be obtained. The building of a community of practice that I am involved in was thus inherently important to the success of this project, as well as my growth as an educator. Within this, I also need to acknowledge that professional development in education is not characteristic of most professions, and thus those with whom I work may not intuitively understand or have the same passion for my ideals that I do, which subsequently may affect their contribution in the discussions.

Chapter 2
Competencies, curriculum design and the study methods

Knowledge is great. Competence is great. But the combination of both encourages people to trust you and increases your powers of enchantment. And in this world, the combination is a breath of fresh air.

Guy Kawasaki (Kawasaki, 2011, p. 53)

1. Introduction

Chapter 2 discusses the literature relating to generic and core competencies, and curriculum mapping and design. Furthermore, it details the experimental design and methods used for the research study as a subsequent discussion of the literature.

2. Competence in healthcare professions

As with any professional service, the ability to perform the necessary duties of the profession within the scope of practice appropriately, effectively and with quality is imperative. The section describes the broad categories of competencies, and the scaffolding thereof.

2.1 Competence and competencies

Educational programmes ultimately aim to develop the students enrolled in them into professionals of their respective practices; these practices require of professionals to possess specific skillsets. Within the ever-changing world it is vital that these programmes are aligned with the graduates' professional needs so that they can be competent in their practice.

Competence is a dynamic concept that comprises the judicious use (Academy of Science of South Africa, 2018) of cognitive (knowledge, understanding, problem-solving), affective (interpersonal) and psychomotor (technical, practical and clinical) attributes (Thomas et al., 2016; Verma et al., 2006) to complete tasks associated with their profession (López-Entrambasaguas et al., 2019; Pittenger & Olson-Kellogg, 2012; Verma et al., 2006) successfully for social benefit (Fernandez et al., 2012). As this description emphasises, competence is not a unidimensional construct that necessitates a candidate just to have knowledge of a topic, but rather encapsulates the skills, attitudes and unknown factors that allow for a task to be completed properly (Fernandez et al., 2012). There is contention, though, of what constitutes competence (Batt et al., 2020; Fernandez et al., 2012; Gibbons et al., 1994; Le Deist & Winterton, 2005; Winberg et al., 2018), how these interrelating domains contribute to one another, and whether they carry the same weight in the success of a task (Fernandez et al., 2012). Ultimately, to be competent in a discipline or profession, a candidate would need to make full use of the multi-dimensional competencies (often referred to as attributes) relevant to their field (International Confederation of Dietetic Associations, 2016). These attributes would invariably link to the education a graduate would receive in their educational programme

(International Confederation of Dietetic Associations, 2016), but also comprises intangible competencies that are not explicitly taught, but rather built from experience, time in practice, and role models (Benner, 1982; Fernandez et al., 2012). It is posited that to be competent in a discipline or profession, competence would allow one to integrate all these attributes in a holistic fashion based on what would be dictated by a specific circumstance (Fernandez et al., 2012), such as a unique pathological case in the healthcare sector or need for interprofessional teamwork. It is thus argued that isolating different competencies during decontextualised education may yield a minimalistic view of it and reduce success in achieving competence (Fernandez et al., 2012). Thus, while having knowledge of which competencies a profession may require may facilitate the planning of curricula (Talbot, 2004) and allow for a scaffolded learning approach (Fernandez et al., 2012), achieving competence is not a mere process of exposing students to such concepts, but a complex, multifactorial process that develops over time and experience (Talbot, 2004).

Numerous synonymous terms exist for competencies, including graduate attributes, core competencies or capabilities. However, definitions often differ and are contextually-bound (Jones, 2002; Wong, 2020). Furthermore, these are generally grouped according to their overarching connections; for exa discipline-specific knowledge or value systems (Jones, 2002). Higher education institutions aim to instil various competencies into their graduates, though, often contentiously, there is no guarantee that a graduate will have successfully internalised these (Jones, 2002). As the focus of teaching, learning and assessment is typically placed on the discipline- or profession-specific competencies that characterise graduates' mastering of exit level outcomes, other attributes may not be explicitly taught or assessed, but rather presumed to develop alongside experience (Fernandez et al., 2012). Although professions are held accountable for their responsibilities within their scope of practice, the development and mastery of a competency is a complex process of transitions from novice to expert levels, as popularised by Stuart and Dreyfus (Benner, 1982), and requires contextual learning, for example, within a relevant professional environment (Wong, 2020). As such, although higher education institutions develop the various cognitive, psychomotor and attitudinal skills of their students, the impact of experiences within the work setting cannot be discounted to develop true intuitive competence (Benner, 1982; Talbot, 2004).

Given the complexity and controversy in defining competencies, the Academy of Science of South Africa's definition of competencies is used for the study. Core competencies are those deemed essential for entering a profession, and thus differ for each healthcare practitioner depending on their unique role within the healthcare system (Academy of Science of South Africa, 2018). As opined by Frenk et al., curricula should be geared towards the competencies required by health professionals in a dynamically changing setting, and should be aligned with the national context in which they are going to function (Frenk et al., 2010). However, apart from core competencies, generic competencies exist that are not dictated by discipline or profession-specific needs, such as communication and problem-solving (Academy of Science of South Africa, 2018). While core competencies are necessary for a profession, generic competencies are needed regardless of field of study to allow a graduate to survive in the world-of-work (Academy of Science of South Africa, 2018), adapt to modernisation (Chu et al., 2017; Kai et al., 2017; Konttila et al., 2019; Van Heerden, 2013), and facilitate continued learning (Mylopoulos et al., 2016).

2.2. Generic competencies

As opined by Socrates, “Education is the kindling of a flame, not the filling of a vessel” (Chu et al., 2017, p. 4). Unfortunately, in modern day teaching practice, education tends to focus predominantly on capacitating students for a specific purpose, and not necessarily to adapt throughout their careers. Students are often bombarded by curricula that fail to develop them as lifelong learners and professionals within the workplace, rather opting for discipline-specific content-heavy modules over opportunities that are more conducive to adaptive learning (Chu et al., 2017). Such generic competencies are not specific to a discipline or profession, and thus are generalised as needed for any individual to develop and survive in their workplace setting (Academy of Science of South Africa, 2018).

In South Africa, generic competencies are referred to as critical cross-field outcomes and are defined by the SAQA (South African Qualifications Authority, 1998). Critical cross-field outcomes are needed to become lifelong learners (South African Qualifications Authority, 1998, 2000a) and contribute to the socio-economic profile of the country (Box 2.1) (Academy of Science of South Africa, 2018). Competencies that span further than discipline-specific are said to be imperative to solving today’s problems (Winberg, 2006), and thus feed off many concepts featured in the critical cross-field outcomes, including problem-solving and cultural sensitivity.

BOX 2.1: CRITICAL CROSS-FIELD OUTCOMES (SOUTH AFRICAN QUALIFICATIONS AUTHORITY, 1998). REPRODUCED VERBATIM AS PER THE SOUTH AFRICAN QUALIFICATIONS AUTHORITY

Critical cross-field outcomes are to:

1. Identify and solve problems in which responses demonstrate that responsible decisions using critical and creative thinking have been made.
2. Work effectively with others as a member of a team, group, organisation, community.
3. Organise and manage oneself and one's activities responsibly and effectively.
4. Collect, analyse, organise and critically evaluate information.
5. Communicate effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation.
6. Use science and technology effectively and critically, showing responsibility towards the environment and health of others.
7. Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

Although there are recommendations for how such generic competencies can be achieved, there are no prescriptions on how they should be achieved. Ultimately, all programmes should include the critical cross-field outcomes, but their coordinators oversee how the development and achievement of said competencies are facilitated (South African Qualifications Authority, 2000). There is much contention relating to generic competencies as arguments arise on comparability, contextualisation and expectations among programmes. As these competencies are generic and lack context, debates arise as to whether they can be decontextualised without losing their sense of expectation as well. For example, one would assume that although there may be similarity in problem-solving between two professions, ultimately the complexity thereof will be dependent on the context, disciplines and professions

tied to them (South African Qualifications Authority, 2000). In practical terms, generic competencies will thus typically be taught in conjunction with discipline-specific competencies to facilitate contextual relevance (South African Qualifications Authority, 2000), although, whether they are explicitly assessed or achieved is often unclear (Jones, 2002).

Generic competencies have been posited as necessary to overcome real-world challenges that transcend the disciplinary space (Academy of Science of South Africa, 2018; Jones, 2002; Winberg, 2006), leading to the so-called mode-2 knowledge that curricula should encapsulate (Winberg, 2006). Mode-2 knowledge, discussed by Gibbons in 1994, speaks more of knowledge constructed within application rather than a discipline alone (referred to as mode-1 knowledge) (Gibbons et al., 1994), which is supported by the constructionist framework of learning (Biggs, 1999). Although mode-2 knowledge creation may still be related to professional circumstances and their associated competencies, their multidisciplinary nature (Gibbons et al., 1994) will require a greater use of skills that help integrate complex processes, such as those related to problem-solving and communication (Academy of Science of South Africa, 2018; Jones, 2002; Winberg, 2006). As such, interleaving generic competencies within the context of core competencies can facilitate the application in their development and bolster professional competence.

The changing world has introduced modern-day skills, such as digitisation and advanced technologies (Dower et al., 2013), which invariably lead to an evolution of, or addition to, healthcare practitioners' functions (Weber, 2006). Given the technological advancements made within the past few decades, several competencies have been emphasised as necessities for the 21st century graduate (often called 21st century skills). The 21st century skills afford graduates the ability to navigate the modern-day world, which includes the use of information in whichever form it may arise and achieve a higher order of thinking (Binkley et al., 2014). Such competencies refer to the knowledge and skills of core subjects (such as the three Rs: reading, writing and arithmetic), mediations and resolutions of complex problems, ethical and appropriate navigation of digital information terrains, and skills that bolster life and career growth to allow for adaptability and survival (Chu et al., 2017). The ability to bolster one's development post-qualification is a valuable skill to ensure modern-day adaptability is achieved within the personal and professional domain (Mylopoulos et al., 2016). Although there are many frameworks in which these competencies are described, it is interesting to note that they are not new concepts but rather contextualised within the modern-day setting (Tan et al., 2017). Two frameworks are presented here: the Partnership for Twenty-first Century Skills (P21) and Assessment and Teaching of 21st Century Skills (ATC21S) (Box 2.2). Within these frameworks, overarching themes can be observed, speaking to broad concepts of digital literacy, intra- and interpersonal values, and higher cognitive thinking (Binkley et al., 2014; Chu et al., 2017), which speak to the critical cross-field and developmental outcomes (South African Qualifications Authority, 2000).

BOX 2.2: THE PARTNERSHIP FOR 21ST CENTURY SKILLS (CHU ET AL., 2017) AND ASSESSMENT AND TEACHING OF 21ST CENTURY SKILLS FRAMEWORKS (BINKLEY ET AL., 2014)

Partnership for 21st Century Skills	**Assessment and Teaching of 21st Century Skills**
1. Learning and innovation: a. Core subjects b. Critical thinking and problem-solving c. Communication and collaboration d. Creativity and innovation 2. Digital literacies: a. Information literacy b. Media literacy c. Information and communication technology literacy 3. Life and career skills: a. Flexibility and adaptability b. Initiative and self-direction c. Social and cross-cultural interaction d. Productivity and accountability e. Leadership and responsibility	1. Ways of thinking: a. Creativity and innovation b. Critical thinking, problem-solving and decision-making c. Learning to learn and meta-cognition 2. Ways of working: a. Communication b. Collaboration (teamwork) 3. Tools for working: a. Information literacy b. Information and communication technology literacy 4. Living in the world: a. Citizenship (local and global) b. Life and career c. Personal and social responsibility (including cultural awareness and competence)

As the nature of work changes, individuals will need to address their variable milieus dynamically to ensure that relevance is maintained and survival in the profession occurs (Flores et al., 2020). Healthcare is not exempt from this (Konttila et al., 2019). Careers are set to change dramatically as technology reduces the need for human involvement in certain ways, while creating opportunities in other facets (Hirschi, 2018). Future graduates will require digital literacy competencies to interact with new infrastructure, engage with informatics, and execute new functions of their portfolios (Dino & Ong, 2019). For example, healthcare professionals will need to be competent in digital record keeping, health informatics, ethical decision-making of such information, and technological upgrades of equipment (Konttila et al., 2019). With the recent advancement of artificial intelligence, its inclusion in the professional space is a reality (Meskó & Görög, 2020; Thibault, 2020). Healthcare practitioners will need to navigate the use of artificial intelligence within their world-of-work from a technical (Meskó & Görög, 2020; Thibault, 2020) and ethical point-of-view, so that the appropriateness of such systems can be considered within their scope of practice (Meskó & Görög, 2020). Such new competencies align prominently with the 21st century skills that are emphasised as being important to all graduates. Not only will a greater skill of digital literacy be needed given technological advancements, but so will socio-cultural and emotional intelligence competencies be required to navigate the personal attributes of the workforce (Flores et al., 2020). Globalisation is allowing for a much more diverse platform of discussion among different populations. A key recommendation made by the World Health Organization is not only the adjustment of curricula to modern healthcare needs, but also, and even more importantly, ensuring healthcare practitioners can adapt to the changing world, inclusive of cultural sensitivity and value systems (World Health Organization, 2013). Gaining experience in understanding the diversity of populations helps to overcome the biases that form, and ultimately, impact healthcare provision (Sukhera et al., 2020).

The COVID-19 pandemic has highlighted the need for adaptability, particularly for healthcare practitioners. For example, science and health literacy should be present to allow individuals to make informed decisions about healthcare (Lopes & McKay, 2020; Reiss, 2020) and prevent misinformation (Sharon & Baram-Tsabari, 2020). Health literacy requires individuals to engage as lifelong learners throughout various circumstances and scrutinise information to help benefit their and others' health (Lopes & McKay, 2020; Nutbeam & Lloyd, 2021). Even more so with healthcare practitioners, health literacy is pivotal to ensure that quality work can be performed, especially in a dynamic circumstance such as a pandemic (Lopes & McKay, 2020; Sharon & Baram-Tsabari, 2020). Enabling students to be more scientifically literate, expands the possibility of intellectual discourse and open-mindedness that have potential impact on misinformation (Sukhera et al., 2020).

At the University of Pretoria, generic competencies have been identified as allowing for, among others, sound specialised knowledge, technological proficiency, leadership, the ability to work under pressure, and the promotion of professional standards (University of Pretoria, 2022). The University of Pretoria promulgates four overarching categories, namely i) basic values, skills, and orientation to the world; ii) social skills; iii) cognitive skills, and iv) career-related skills (Figure 2.1) (University of Pretoria, 2022) that inherently tie into the critical cross-field outcomes (South African Qualifications Authority, 1998). It is a noble venture to suggest that all types of competencies, especially those within the generic categorisation, can be developed or achieved within each discipline or module. However, such a task would be unrealistic given the logistical constraints within higher education institutions, or the appropriateness of the module itself to emphasise these attributes. This does not dissuade one from bolstering contextually relevant competencies with teaching practices that stimulate generic competency development, such as andragogy that enforces problem-solving or critical thinking, but necessitates investigation of what can be developed. As such, although instructional design could integrate these competencies within the pharmacology curriculum, it is prudent first to focus on the core competencies necessarily for developing a professionally-relevant understanding of pharmacology.

2.3. Core competencies

Many unique competencies are required to function appropriately within a specific profession, defined as cognitive, psychomotor and attitudinal that form part of the characteristics of such professionals (Benner, 1982; Le Deist & Winterton, 2005). The exit level outcomes of a qualification relate to the combined knowledge, skills and attitudes that should have been obtained or mastered after completion of the programme, which invariably relate to the core competencies that would be assessed (South African Qualifications Authority, 2022). Such core competencies (Academy of Science of South Africa, 2018; South African Qualifications Authority, 2022) are often compiled as competency frameworks that delineate the actual expectations of a professional within their unique setting, and what they will need to achieve educationally to facilitate those functions (Batt et al., 2020). Competency frameworks are supported by the professional's scope of practice and are informed by contextually relevant circumstances, such as national needs (Batt et al., 2020).

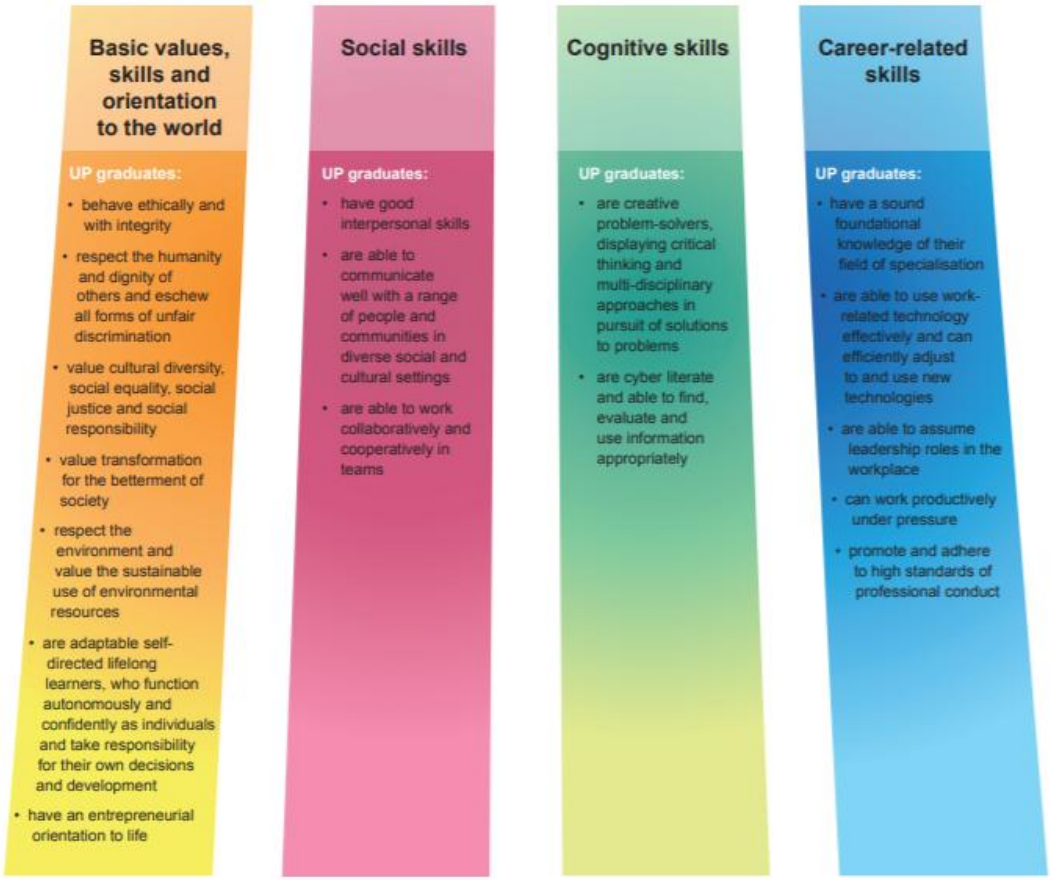

FIGURE 2.1: THE GRADUATE ATTRIBUTES ESPOUSED BY THE UNIVERSITY OF PRETORIA (UNIVERSITY OF PRETORIA, 2022)

Although such frameworks provide the minimum competencies needed, it is not the sum of all that is expected (Academy of Science of South Africa, 2018) due to the inherent nature of skills development that necessitates experience (Winberg, 2006). Competency frameworks can be developed in several ways, though in general, require the input of experts in the field to achieve a specific goal (Batt et al., 2020). Depending on the resources and time available, one can approach the sourcing of relevant information from literature or curricular documents, relevant stakeholders or experts and practice analysis (Batt et al., 2020). In doing so, frameworks can be developed that centre around core competencies required by a profession to achieve set outcomes (Batt et al., 2020). However, competency frameworks often fail to address various contextual needs, such as national considerations of the profession (Batt et al., 2020).

One of the best-known competency frameworks in healthcare is the Canadian Medical Education Directives for Specialists Framework (otherwise known as the CanMEDs Physician Competency Framework) that highlights a physician's competencies necessary to meet the healthcare needs of their patients (Frank et al., 2015). Seven unique roles are described (Figure 2.2A): medical expert; communicator; collaborator; leader; health advocate; scholar, and professional (Frank et al., 2015). Each role is further characterised by the key (essential ability) and enabling competencies (the components that culminate in performing the essential ability) (Frank et al., 2015). The Undergraduate Education and Training Subcommittee of the Medical and Dental Professions Board of the HPCSA, in collaboration with training institutions

and the South African Committee of Medical and Dental Deans, modified the CanMEDs framework, where the overarching roles remained the same (Figure 2.2B). However, enabling competencies were altered for the broader medical and dental community and the South African context (Health Professions Council of South Africa, 2014). For example, in the context of their medical expertise, they would need to resolve healthcare concerns using their body of knowledge (Frank et al., 2015) that would, among others, require core competencies related to the integration, application and evaluation of the natural sciences (Health Professions Council of South Africa, 2014). Such frameworks help guide the development of curricula as they speak to what the healthcare practitioner must be able to do as a minimum expectation of their profession.

As with the CanMEDs Physician Competency Framework, the dietitian, professional nurse and physiotherapist have guidelines or frameworks that discuss their core functions in alignment with their scopes of practice, which are discussed in-depth in Chapters 3 to 5. Although health professionals have unique scopes of practice, shared competencies may be present (Albarqouni et al., 2018; Black et al., 2008; Frank et al., 2015; Health Professions Council of South Africa, 2014; Lewis & Nierenberg, 2007; Moaveni et al., 2011; Verma et al., 2006), though invariably differ in depth depending on the scope of practice (Albarqouni et al., 2018). Separating competencies from the context in which they were applied becomes difficult at times, further suggesting overlap between healthcare professions (Midlov et al., 2015). As opined by Verma et al., although health practitioners have unique expectations within their professions, commonalities exist due to the context in which they work (i.e., healthcare) (Verma et al., 2006). Suggesting harmonisation between such competencies, Verma et al. overlaid expectations of nurses and physiotherapists onto the CanMEDs Physician Competency Framework, and highlighted shared themes between them, such as professional characteristics and profession-specific expertise needed (Verma et al., 2006).

The discipline-specific delineation of such competencies become ambiguous, though, as overarching professional competencies are discussed rather than the specific disciplinary concepts thereof. For example, in the space of pharmacology, each healthcare practitioner will have their association with pharmacotherapy, whether it be the ability to prescribe, manage medication during patient care (Dubovi et al., 2018) or consider it alongside other modes of treatment (Mestres & Duran, 2009; Unger & Lochner, 2006; Wentzel-Viljoen, 2016). However, what disciplinary elements thereof should be known becomes less clear as discipline-specific guidelines are generally not present. Given the diversity of healthcare practitioners and their needs, a one-size-fits-all approach to pharmacological competency development would be inappropriate.

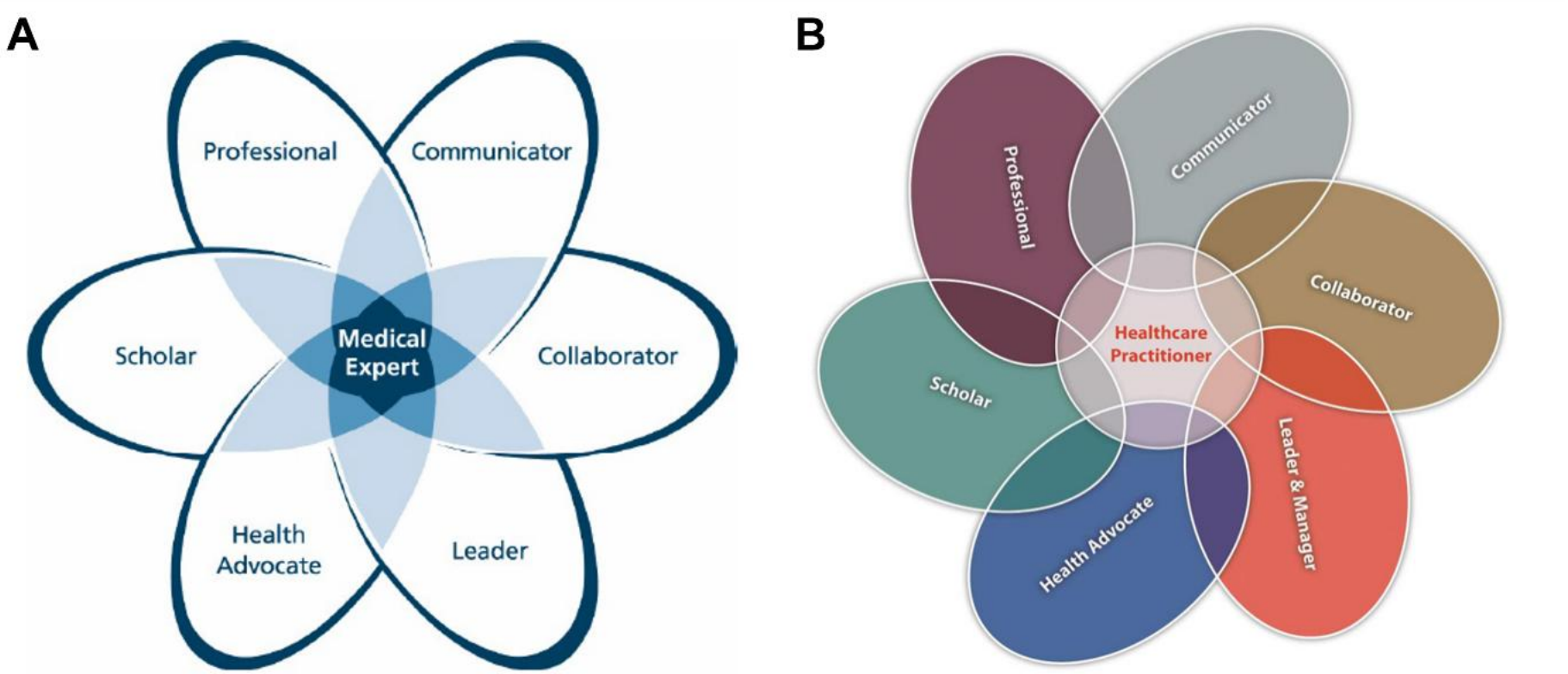

FIGURE 2.2: THE A) CANMEDS PHYSICIAN COMPETENCY FRAMEWORK (FRANK ET AL., 2015) AND B) CORE COMPETENCIES FOR UNDERGRADUATE STUDENTS IN CLINICAL ASSOCIATE, DENTISTRY AND MEDICAL TEACHING AND LEARNING PROGRAMMES IN SOUTH AFRICA FRAMEWORK (HEALTH PROFESSIONS COUNCIL OF SOUTH AFRICA, 2014). THE SIX ROLES ARE THE SAME BETWEEN BOTH FRAMEWORKS, THOUGH COMPETENCIES IN EACH ROLE ARE MODIFIED

3. The curriculum

The curriculum – a metaphorical roadmap to how academic outcomes should be met, including competencies, andragogy, assessment, and evaluation – is a complicated path of intertwining elements that should ultimately lead to a graduate attaining the skills required to function within their world-of-work (Desai, 2009; Prideaux, 2003; Thomas et al., 2016).

3.1. Requirements of the curriculum in the South African context

Two regulatory requirements of the curriculum in the South Africa context are discussed: NQF levels and credit bearing. The NQF level descriptors are used to define the expectations of learning outcomes that need to be achieved at various levels of a qualification to develop competencies. Each descriptor level is characterised by ten specific descriptors that include discipline-specific knowledge, ability to source information, solve problems, and disseminate information (South African Qualifications Authority, 2012). The descriptors showcase the cumulative expectation of the candidate as the NQF level increases (South African Qualifications Authority, 2012). The descriptors serve as a descriptive guideline for the expectations of the qualification and all its modules that contribute to competency development (South African Qualifications Authority, 2012). The level descriptors are a framework from which more discipline- or profession-specific descriptors can be defined with greater contextual relevance as the strength of the expectation will invariably differ between programmes (South African Qualifications Authority, 2012). Furthermore, they encapsulate the critical cross-field outcomes (South African Qualifications Authority, 2012) (Section 2.2). Given the present study, NQF levels 7 and 8 are presented (Table 2.1) that relate to the levels of the FAR 381 and FAR 381 modules and the healthcare practitioner degrees, respectively. The expectation at level 8 is invariably greater than that of level 7; however, there is clear relation between them. For example, although acquisition of discipline-specific knowledge is necessary (scope of knowledge) and the ability to analyse, evaluate and reflect on a problem (problem-solving) is expected during FAR 381 and FAR 382 at a professional NQF level 8 that relates to the exit level outcome of the healthcare practitioner's qualification, such specialised knowledge would be needed contextually to address problems within the professional space.

Credits have been used in the South African context to define the notional hours (as a ratio of one credit to ten notional hours) required by modules and programmes for achievement of learning outcomes and mastery of the content presented. Various elements of learning are included in the credit, such as self-study, preparation for engagement, classroom sessions and assessments (Council on Higher Education, 2002). Although time is attributed to modules via the credit system, ultimately it should not be seen in a reductionist fashion that undermines two non-temporal attributes thereof: difficulty and the value of the learning experience (Nkomo, 2000). No measurable unit is linked to these attributes, and as such cannot be associated with a time requirement as understanding a concept or mastery of a skill does not occur in a time-bound fashion (Nkomo, 2000). Notional hours thus create a relative view of the attention and focus needed between topics, instead of reductionism to the time spent to achieve the outcomes of the programme (Nkomo, 2000; Van der Horst & McDonald, 2000). The assumption of standardisation without consideration of context has been criticised, as various elements, including method of delivery or the discipline may affect the notional hours and thus the credit allotment (Van der Horst & McDonald, 2000).

TABLE 2.1: NATIONAL QUALIFICATIONS FRAMEWORK DESCRIPTORS FOR LEVELS 7 AND 8. LEVEL DESCRIPTORS ARE TAKEN VERBATIM FROM THE NATIONAL QUALIFICATIONS FRAMEWORK (SOUTH AFRICAN QUALIFICATIONS AUTHORITY, 2012)

Level 7	Level 8
Level descriptor as per NQF: Scope of knowledge	
a. Scope of knowledge, in respect of which a learner is able to demonstrate integrated knowledge of the central areas of one or more fields, disciplines or practices, including an understanding of and the ability to apply and evaluate the key terms, concepts, facts, principles, rules and theories of that field, discipline or practice; and detailed knowledge of an area or areas of specialisation and how that knowledge relates to other fields, disciplines or practices.	a. Scope of knowledge, in respect of which a learner is able to demonstrate knowledge of and engagement in an area at the forefront of a field, discipline or practice; an understanding of the theories, research methodologies, methods and techniques relevant to the field, discipline or practice; and an understanding of how to apply such knowledge in a particular context.
Level descriptor as per NQF: Knowledge literacy	
b. Knowledge literacy, in respect of which a learner is able to demonstrate an understanding of knowledge as contested and the ability to evaluate types of knowledge and explanations typical within the area of study or practice.	b. Knowledge literacy, in respect of which a learner is able to demonstrate the ability to interrogate multiple sources of knowledge in an area of specialisation and to evaluate knowledge and processes of knowledge production.
Level descriptor as per NQF: Method and procedure	
c. Method and procedure, in respect of which a learner is able to demonstrate an understanding of a range of methods of enquiry in a field, discipline or practice, and their suitability to specific investigations; and the ability to select and apply a range of methods to resolve problems or introduce change within a practice.	c. Method and procedure, in respect of which a learner is able to demonstrate an understanding of the complexities and uncertainties of selecting, applying or transferring appropriate standard procedures, processes or techniques to unfamiliar problems in a specialised field, discipline or practice.
Level descriptor as per NQF: Problem-solving	
d. Problem-solving, in respect of which a learner is able to demonstrate the ability to identify, analyse, evaluate, critically reflect on and address complex problems, applying evidence-based solutions and theory-driven arguments.	d. Problem-solving, in respect of which a learner is able to demonstrate the ability to use a range of specialised skills to identify, analyse and address complex or abstract problems drawing systematically on the body of knowledge and methods appropriate to a field, discipline or practice.
Level descriptor as per NQF: Ethics and professional practice	
e. Ethics and professional practice, in respect of which a learner is able to demonstrate the ability to take decisions and act ethically and professionally, and the ability to justify those decisions and actions drawing on appropriate ethical values and approaches within a supported environment.	e. Ethics and professional practice, in respect of which a learner is able to demonstrate the ability to identify and address ethical issues based on critical reflection on the suitability of different ethical value systems to specific contexts.
Level descriptor as per NQF: Accessing, processing and managing information	
f. Accessing, processing and managing information, in respect of which a learner is able to demonstrate the ability to develop appropriate	f. Accessing, processing and managing information, in respect of which a learner is able to demonstrate the ability to critically review information

processes of information gathering for a given context or use; and the ability to independently validate the sources of information and evaluate and manage the information.	gathering, synthesis of data, evaluation and management processes in specialised contexts in order to develop creative responses to problems and issues.
Level descriptor as per NQF: Producing and communicating information	
g. Producing and communicating information, in respect of which a learner is able to demonstrate the ability to develop and communicate his or her ideas and opinions in well-formed arguments, using appropriate academic, professional, or occupational discourse.	g. Producing and communicating information, in respect of which a learner is able to demonstrate the ability to present and communicate academic, professional or occupational ideas and texts effectively to a range of audiences, offering creative insights, rigorous interpretations and solutions to problems and issues appropriate to the context.
Level descriptor as per NQF: Context and systems	
h. Context and systems, in respect of which a learner is able to demonstrate the ability to manage processes in unfamiliar and variable contexts, recognising that problem-solving is context and system bound, and does not occur in isolation.	h. Context and systems, in respect of which a learner is able to demonstrate the ability to operate effectively within a system, or manage a system based on an understanding of the roles and relationships between elements within the system.
Level descriptor as per NQF: Management of learning	
i. Management of learning, in respect of which a learner is able to demonstrate the ability to identify, evaluate and address his or her learning needs in a self-directed manner, and to facilitate collaborative learning processes.	i. Management of learning, in respect of which a learner is able to demonstrate the ability to apply, in a self-critical manner, learning strategies which effectively address his or her professional and ongoing learning needs and the professional and ongoing learning needs of others.
Level descriptor as per NQF: Accountability	
j. Accountability, in respect of which a learner is able to demonstrate the ability to take full responsibility for his or her work, decision-making and use of resources, and limited accountability for the decisions and actions of others in varied or ill-defined contexts.	j. Accountability, in respect of which a learner is able to demonstrate the ability to take full responsibility for his or her work, decision-making and use of resources, and full accountability for the decisions and actions of others where appropriate.

3.2. The curriculum and the importance of clear development

A curriculum, as noted by Thomas et al. (2016), is a planned educational experience (Thomas et al., 2016). As such, the curriculum comprises all envisaged learning experiences (Prideaux, 2003) that influence, contribute, advise, and eventually lead to a successful educational outcome (Desai, 2009; Thomas et al., 2016). A curriculum may exist at three levels: what is intended for students to learn (the declared curriculum); what is afforded to them during learning (the taught curriculum), and what they experience during learning (the learned curriculum) (Harden, 2001; Prideaux, 2003). In such a way, implicit and explicit learning may take place depending on how the curriculum unfolds during student learning (Harden, 2001; Prideaux, 2003). Within a curriculum it should be clear what the student is set to achieve by engaging with the curriculum, and ultimately, that such engagement will have a benefit to the educational endeavour of the student (Nordquist et al., 2016). To do so, constructive alignment, as opined by Biggs (Biggs, 1999), should be held central to ensure that a golden thread runs through the curriculum.

Constructive alignment is centred on the learning outcomes that should be achieved by students, which necessitates assessment practice that can appropriately determine whether competencies have been achieved, and andragogy that can authentically develop it (Ali, 2018; Loughlin et al., 2021; Stamov Roßnagel et al., 2020; Walsh, 2007; Wang et al., 2013). By doing so, students are afforded a clear trajectory in their development of necessary competencies (Ali, 2018; Loughlin et al., 2021; Stamov Roßnagel et al., 2020; Walsh, 2007; Wang et al., 2013). Constructive alignment is underpinned by three beliefs: i) there is interdependence between andragogy, assessment and learning outcomes; ii) reflective practice is needed to modify the curriculum based on experience and feedback and iii) students' learning is dependent on their active involvement and construction of meaning (Biggs, 1999). As such, acceptance that curriculum design is an iterative process that requires continuous evaluation and reflection is necessary lest the curriculum become stagnant and unresponsive to the needs of students and society.

Various models exist for developing curricula, which include prescriptive and descriptive models (Prideaux, 2003). While a prescriptive model is directed towards the intended set of learning outcomes of the curriculum, a descriptive model is focused on addressing what a curriculum may cover within the context of the student (Prideaux, 2003). Prescriptive models thus adhere to a set objective in their design, and inform the students' learning, using behavioural objectives (Prideaux, 2003), for example, those of Bloom's taxonomy (Krathwohl, 2002). Given the set of learning outcomes, concerns arise though about whether such specificity debilitates learning beyond what is explicitly stated, and thus may not necessarily promote higher order behavioural changes (Prideaux, 2003). Descriptive models, however, assess the situation in which learning takes place to see what a curriculum can facilitate, though inherently are more context-linked and thus affected by internal and external factors (Prideaux, 2003). The way in which curriculum design is approached will be dependent on the curriculum designers' underpinning educational philosophy, and what would be achievable in their setting for design to occur. Given the framework of the University of Pretoria, a prescriptive model is used explicitly to indicate which learning outcomes are needed.

In health professions education, the curriculum should be structured in such a way that a health problem may be addressed (Bass & Chen, 2016) in a way that is responsive to the national healthcare context (Prideaux, 2003). Constituents will include diverse elements, such as the scope of practice, content, learning outcomes, andragogy and assessment practices (Steketee, 2015). The Flexner report (1910) that evaluated medical education in the United States and Canada, had a profound impact on curriculum design for healthcare practitioners (Flexner, 1910). The Flexner report highlighted several concerns of medical curricula, such as a lack of standardisation, a poor basic sciences platform for clinical skills development, and lack of integration of the clinical training platform (Flexner, 1910). The findings of the Flexner report guided the development of the standardised approach to health professions education, comprising an initial foundational training of basic sciences before approaching clinical skills (Brauer & Ferguson, 2015). However, this has been contested as inappropriate given the lack of contextual understanding and skills development of graduates (Brauer & Ferguson, 2015; Cate et al., 2015) and less workplace integration (Cate et al., 2015; Remesh, 2017).

The integrated curriculum, where integration of the basic and clinical sciences creates opportunity for contextualised learning, has thus been recommended as an alternative (Brauer & Ferguson, 2015). By integrating learning of the basic sciences within the clinical context, students develop knowledge in the circumstances that they would be applying it that reinforces connections of learning items and facilitates long-term retention (Brauer & Ferguson, 2015). Integration is achieved by organising the teaching of a topic to relate or integrate the disciplines that routinely form a part of it (Brauer & Ferguson, 2015). Within integration, three concepts have been proposed to facilitate different aspects of it: horizontal, vertical and spiral (Brauer & Ferguson, 2015). Horizontal integration aims to create interdisciplinary learning spaces, where associated basic sciences are taught within the same temporal space (Brauer & Ferguson, 2015). For example, the teaching of respiratory pathologies by integrating discussion of its anatomy and (patho)physiology. Vertical integration would create a seamless transition across time between the basic and clinical sciences of a profession (Brauer & Ferguson, 2015). For example, a systematic progression from the basic sciences of a respiratory disease to the clinical management thereof. Spiral integration that is regarded as an ideal combined form of horizontal and vertical integration, allows for basic and clinical sciences to be learnt across time and disciplines (Brauer & Ferguson, 2015). For example, interdisciplinary teaching of the systems of the body with appropriate interleaving of clinical training. The rationale for using the integrated model is to reduce siloing of disciplines, and thus reinforces a more comprehensive educational model for healthcare practitioners. A concern that has been raised with integration is the possibility of basic sciences teaching to focus heavily on application, thus potentially decreasing the understanding of the theoretical underpinnings thereof (Brauer & Ferguson, 2015). Problem-based learning curricula that also necessitate integration between basic and clinical sciences, have experienced similar deficiencies. Given the integration within the clinical space, theory deemed irrelevant at that time may form a gap later on (Karpa & Vrana, 2013; Wittert & Nelson, 2009), which has been reported based on graduates' poor basic science understanding and breadth of knowledge compared to traditional platforms in several studies (Albanese & Mitchell, 1993; Karpa & Vrana, 2013; Lohfeld et al., 2005; McKimm, 2010; Wittert & Nelson, 2009). Clinicians engaging in such programmes were also more prone to providing incorrect or irrelevant

information, engaging in backwards reasoning, and less decisive in diagnosis (Albanese & Mitchell, 1993). All curricular designs are fraught with confounding factors stemming from the curriculum, and thus choosing a model for design is a difficult process.

Various important elements are raised by the critical-cross field outcomes, which, includes sociocultural competency (South African Qualifications Authority, 2000). As posited by Green-Thompson (2014), cultural competence is called for within the modern day to reduce the effects of inequality, promote transformation within the healthcare sector, and help capacitate future healthcare practitioners to navigate their roles within society and their employment. Green-Thompson (2014) argues that understanding the complexity of social determinants of healthcare, which acknowledges the sociocultural diversity and need for transformation within our nation, increases facilitation of curriculum design and the reciprocal nurturing of relationships between stakeholders. By incorporating such thoughts into the curriculum through the acknowledgement of the diversity of our nation, it bolsters the alignment to national needs and the scope of practice of healthcare practitioners.

3.3. Curriculum mapping

Given the multitude of processes in a curriculum, understanding its implementation is difficult if a comprehensive view of it is not present. By employing curriculum mapping, all parts of the curriculum are brought together in a meaningful way to showcase it as a unified structure (Harden, 2001; Watson et al., 2020). Curriculum mapping displays the various elements of a curriculum and their linkages to one another (Prideaux, 2003). In such a way, curriculum implementation and reform can be more appropriately guided by information (Prideaux, 2003). Furthermore, it allows for transparent communication of the way in which integration between learning outcomes of the curriculum is achieved (Harden, 2001; Prideaux, 2003), and where such links exist (Harden, 2001). Watson et al. posit that various rationales exist for curriculum mapping, depending on the purpose (intended use of the map), product (type of curricular components mapped), process (actions used to map), and display (presentation of the curricular information) of the map (Watson et al., 2020). Regardless of the rationale for doing so, curriculum mapping holds immense benefit within curriculum design to ensure that a living, constructively aligned curriculum is maintained that is responsive to change (Harden, 2001). Harden suggests that during curriculum mapping, various windows should be considered (Box 2.3) (Harden, 2001). By integrating the various windows of the curriculum map, one can obtain a multi-dimensional view of all factors that affect the success of any unit in the curriculum (Harden, 2001). It furthermore unpacks the complex management that is present within any curriculum among all its stakeholders and managerial processes (Harden, 2001). Various formats are proposed on how a curriculum map can be presented, including expertise maps, nodes, hierarchical structures, and tabulations (Harden, 2001). Software is also available to support and guide curriculum mapping, such as the Learning Opportunities, Objectives and Outcome Platform (LOOOP) (Balzer et al., 2016; Treadwell et al., 2019) that allows for a simplified processing, more comprehensive and detailed overview, and management of a living curriculum. However, it does not detract from the underlying human capital and support needed to ensure a curriculum is constructed and managed appropriately (Balzer et al., 2016; Treadwell et al., 2019).

BOX 2.3: HARDEN'S TEN WINDOWS OF CURRICULUM MAPPING (PRESENTED VERBATIM) (HARDEN, 2001).

1. Expected learning outcomes
2. Curriculum content or areas of expertise covered
3. Student assessment
4. Learning opportunities
5. Learning location
6. Learning resources
7. Timetable
8. Staff
9. Curriculum management
10. Students

The expected learning outcomes speak to what the student should be able to do after engaging with the curriculum. Twelve prominent learning outcomes are identified by Harden for the medical degree, stratified according to 'What the doctor is able to do', 'How the doctor approaches his/her practice' and 'The doctor as professional' (Harden, 2001). The understanding of basic and clinical sciences, alongside all associated theories, would be classified under 'How the doctor approaches his/her practice' (Harden, 2001) given the decision-making affordance that such theoretical underpinnings would allow. Such classification supports the importance of horizontal and vertical integration (Brauer & Ferguson, 2015) and provides information for the curriculum designer to approach constructive alignment (Ali, 2018; Loughlin et al., 2021). The learning outcomes are often defined by competency frameworks linked to the professions being taught; this allows for development towards a specific set of learning outcomes that need to be achieved (Batt et al., 2020; Moaveni et al., 2011).

The curriculum content or areas of expertise covered speak to the curriculum content that can be organised as units, areas and clusters of expertise (Harden, 2001). In doing so, complex clusters of expertise (e.g., physiological systems), are broken down into areas of expertise (e.g., disease of said system), and subsequently into individual units (e.g., pharmacotherapy used in the disease of interest) (Harden, 2001). The curriculum designer is thus able to convey the relationship between content presented in a more meaningful way and helps indicate gaps that may be present (Harden, 2001). The areas of expertise are guided and encapsulated by the core competencies of the profession. By ensuring that what is taught is aligned with the competency frameworks, the declared curriculum becomes more amenable to construction and alignment (Harden, 2001; Prideaux, 2003).

The student assessment window highlights the assessment practice that occurs throughout the curriculum and all its units (Harden, 2001). The various assessment modalities, compilation thereof, individuals involved, and outcomes to which they link are thus identified and allow for longitudinal tracking of assessment (Harden, 2001). Importantly, to facilitate constructive alignment, assessments should align with learning outcomes and the andragogy used (Ali, 2018; Walsh, 2007; Wang et al., 2013), adhere to quality assurance standards (Loughlin et al., 2021), and provide feedback to learners and academic staff on student learning (Ali, 2018).

The learning opportunities window identifies the format in which learning outcomes are addressed, including their andragogical principles (Harden, 2001). Learning opportunities are inherently dependent on the learning location and learning outcomes windows due to the necessity of a space in which learning can occur, affecting the andragogy and the appropriateness for achieving said learning outcome, respectively (Harden, 2001). For example, whether didactic lectures, clinical teaching, discussion-based learning, or practical training is used is informed by the outcome required by the learning opportunity. The theory of basic sciences is often taught through didactic lectures (Banning, 2003; Craft et al., 2017; Davis, 2010; Foster et al., 2017; Manias & Bullock, 2002). Although such modalities are opined to be less effective to facilitate higher order cognitive processes (Ahsan & Mallick, 2016; Vora & Shah, 2015), didactic lectures may be opted for as the most feasible approach given the design of the curriculum. More active or innovative approaches have also been proposed, such as simulation-based training (Meyer et al., 2017b), small group sessions (Ginzburg et al., 2017), case-based learning (Vora & Shah, 2015), problem-based teaching and computer-assisted modalities (Meyer et al., 2017b).

The learning location window describes the space in which learning occurs that may be physical (Harden, 2001; Nordquist et al., 2016), virtual or a hybrid thereof (Nordquist et al., 2016). Learning locations may for the most part be existing structures that may dictate what type of learning opportunities may occur in their physical or virtual walls (Nordquist et al., 2016). As the location of where learning takes place, the environment creates the platform onto which the andragogy can be applied. For example, the traditional classroom environment may be ideal for a didactic-style presentation of a topic, but less appropriate for discussion-orientated learning among peers (Nordquist et al., 2016). A more intimate collaborative space can be amenable to peer-to-peer learning; however, it may not be able to accommodate a large group of students (Nordquist et al., 2016). Virtual spaces can be used to facilitate learning in an online setting (Aydogdu & Winder, 2022; Cordier & Lubbe, 2021; Karaksha et al., 2013; Pittenger & Olson-Kellogg, 2012), but can also allow for hybridity to facilitate both physical and online encounters (Nordquist et al., 2016). Although this may overcome physical challenges of size and scalability, it requires careful planning to accommodate the complex interconnectivity and facilitation that would occur between two modes of teaching (Nordquist et al., 2016). Similarly, virtual learning may be hampered by a lack of engagement with the educator, poor group dynamics (Aydogdu & Winder, 2022) or online tools (Karaksha et al., 2013). The learning environment spreads beyond just the classroom, but also the greater campus infrastructure and its placement in the geographical location, and thus such a context may also affect how learning can be mediated (Nordquist et al., 2016).

The learning resources window comprises all available educational material that is used to support student learning, whether physical or digital, and thus is a diverse factor depending on the appropriateness for the content presented (Harden, 2001). For example, textbooks are a common resource but may not necessarily contextualise information appropriately or could be content-heavy (Achike & Ogle, 2000; Desai, 2009; Foster et al., 2017; Manias & Bullock, 2002); thus resources amenable to resolving the problem being addressed in the learning opportunity should be used (Albanese & Mitchell, 1993).

The timetable window refers to the scheduling throughout the curriculum that can easily become a contested element in a programme (Harden, 2001). For example, due to imbalanced or perceived inequality in the time spent on various modules within it (Manias & Bullock, 2002; Craft et al., 2017; Foster et al., 2017). The lengths of sessions, placement within the programme structure, and chronological order of the curriculum would be important facets to consider (Harden, 2001). Placement of a learning opportunity and the amount of time afforded to students to engage with it may greatly impact the success of achieving the outcome (Craft et al., 2017; Foster et al., 2017; Manias & Bullock, 2002).

The staff window presents information on all academic, technical, support and administrative individuals involved in the curriculum, and may provide details of their schedule, teaching load, responsibilities and level of involvement (Harden, 2001). Depending on the circumstances of the curriculum, academic staff may comprise a single disciplinary department (Manias & Bullock, 2002), spread to interdisciplinary teamwork (Alrefaie et al., 2017; S. Smith et al., 2019), or involve clinical educators to interleave the professional context (Bandiera et al., 2013; Manias & Bullock, 2002). The broader the involvement, the more complex the organisation thereof becomes due to the structure of departments and diversity of academic roles (McKimm, 2010).

The curriculum management window relates to management staff and processes of the curriculum, and thus is informed by the staff window, but also the various committees that affect the programme (Harden, 2001). The window dictates the flow of information, approval processes, funding (Harden, 2001) and quality assurance committees (Loughlin et al., 2021).

The students window records information on the student complement, such as their demographics, academic record, attendance of learning opportunities, and so forth (Harden, 2001). Understanding the audience of the curriculum informs various decisions that can be made, such as the way in which material can be presented, at which level learning outcomes should be positioned, and which unique factors may alter the outcomes of their learning. For example, understanding the capabilities, interests and accessibility of students may inform the andragogy and resources (Stevanović et al., 2021; Tejedor et al., 2021), and how to approach online learning (Stevanović et al., 2021). South Africa has faced a myriad of socio-cultural issues; one such aspect includes transformation and the decolonisation of the curriculum (Motala et al., 2021). Having a better grasp of students' backgrounds and the socio-cultural complexity of the world helps to inform curriculum design and transformation (Motala et al., 2021). Furthermore, it also permits a better platform for culturally responsive teaching (Abacioglu et al., 2020).

3.4. Factors affecting the curricular windows of FAR 381 and FAR 382 at present

The curriculum, as a complex amalgamation of all educational experiences, is invariably susceptible to numerous factors that may influence its design, execution and success. The FAR 381 and FAR 382 modules have undergone extensive review over the past few years, with continuous development and reflection on learning outcomes to allow for constructive alignment. Review was carried out by myself as course coordinator, with input from my fellow educators in the module, as well as Education Consultants from the Department of Education Innovation of

the University. Much of the review was bolstered by soundboarding with fellow health professions educators in my community of practice, clinical members from departments that the module services, and the feedback obtained from students during module evaluation. The following factors affecting FAR 381 and FAR 382 are acknowledged and briefly described from my position as course coordinator and one of the four educators in the modules. This is included here to facilitate discussion of their possibility to affect the proposed pharmacology curricula in Chapters 3 to 5, and to help contextualise recommendations after the targeted needs analysis. Although not an extensive list, they are positioned in Harden's ten windows to facilitate reflection and organisation.

3.4.1. Expected learning outcomes

The overarching emphasis of the learning outcomes for the students is to rationalise the use of pharmacotherapy for various diseases that necessitates an understanding of their pharmacokinetic and pharmacodynamic profiles. The learning outcomes and assessment criteria adhere to Bloom's taxonomy, with a balance of lower order and higher order cognitive expectations for the third-year module. Bloom's revised taxonomy is used to guide the development of learning outcomes and assessment criteria (Krathwohl, 2002), though the expected level attributed to it is mostly guided by the educators' expectation that may be biased by their underlying belief of the importance of said taxonomical indicator to the discipline or healthcare profession, the educator's understanding of the NQF level 7 descriptors, the potential for the competencies to relate to application with the pharmacotherapeutic field, and whether they approach the taxonomy from both cognitive dimensions. Although I oversee all learning outcomes as course coordinator, invariably differences arise in the creation and review thereof when the topic is under the jurisdiction of a fellow educator. There is alignment between andragogy and assessment, though invariably, given the admixture of students, it is not unexpected that the alignment with the graduate outcome may not necessarily be achieved. All learning outcomes and assessment criteria are explicitly stated in the module guide to inform students about the expectations of the module. Although the aim would be for students to obtain set competencies, the module design, including other service delivery modules, overtly has a greater focus on exposing students to relevant topics within the discipline, and thus does not particularly follow a competency-based structure and may succumb to a more content-based approach.

Although the focus of the modules is on pharmacology, given the concerns raised about pre-requisite physiology knowledge not being retained, additional physiology-associated learning outcomes relevant to the topic are included as a preamble to learning. Learning outcomes have also been reviewed in the context of the Essential Medicines List, a formulary of necessary medicines and their use in treatment in the South African context (Perumal-Pillay & Suleman, 2017) to avoid discussion of irrelevant medicines or pharmacological concepts. Although this reduces the total content discussed, for students in the Bachelor of Science degree it does reduce the possibility of explaining trends in modern pharmacology from a global perspective.

The modules serve as a platform for basic sciences discussion, and thus capacitate the students in the principles necessary to develop competencies related to their practice, but not from a clinical

vantage. Invariably gaps have been identified through reflective practice, such as deficiencies in discussions of drug-food interactions, relation to non-pharmacological treatments that other professions may use, and aspects related to medication management. Furthermore, the decontextualised format of teaching brings forth a more disciplinary view of pharmacology that hinders the development of functional knowledge (Biggs, 1999; Winberg, 2006). Similar misalignment (Ahsan & Mallick, 2016; Andersen & Moralejo, 2015; Banning, 2003; Davis, 2010; Lymn & Mostyn, 2010; Manias & Bullock, 2002) and contextualisation issues (Achike & Ogle, 2000; Desai, 2009; Foster et al., 2017; Manias & Bullock, 2002) have been reported in literature. Ultimately, the learning outcomes of a module should speak to the workplace competencies of a profession (Brinkman et al., 2018; Steketee, 2015), and if not achieved, hinder development of competence.

One can argue that the current structure of FAR 381 and FAR 382 that places students from different professions in the same learning environment could be ideal for interprofessional competency development. As defined by the World Health Organization, interprofessional education occurs when “two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes” (World Health Organization, 2010, p. 7). Apart from the partial separation of students in FAR 381 and FAR 382 by campuses depending on their programme and their scheduling constraints, the diversity of needs within the module in relation to graduate outcomes decreases the potential of true interprofessional learning. Although some topics overlap given their status as core concepts (i.e., an underpinning of pharmacology necessary for learning to be achieved) (White et al., 2021) or the relevance of the disease between professions, the lack of context, inability to focus the opportunity, and logistical considerations do not allow for true collaborative learning at present. Opportunities may exist should larger structural alterations be made, though these are not currently feasible given the small complement of educators in the module’s team as well as the logistical constraints between facilitating sessions on two campuses. Although Thistlethwaite (2015) points out that interprofessional education in the basic sciences is often complex given the professional decontextualisation and varied requirements, opportunities do exist for such activities to take place with sufficient planning (Michel et al., 2002; Rosenbloom & Nemec, 2021). Such endeavours would be more feasible once curricula have been formalised for each separate healthcare practitioner, as currently the generalised approach perpetuates shared learning that lacks formal interaction between the professions, such as discussed by Thistlethwaite (2015). With clarity of what should be taught, overlapping possibilities may emerge more evidently and allow for a clear plan in their instruction.

3.4.2. Curriculum content or areas of expertise covered

The FAR 381 and FAR 382 modules can largely be categorised based on diseases and drug classes, and thus often follow a systems-based approach similar to that of Physiology. FAR 381 discusses foundational concepts of pharmacology (such as terminology, routes of administration, pharmacokinetics, and pharmacodynamics), treatment of diseases interacting with the autonomic nervous system, cardiovascular system, reproductive system and pharmacotherapy related to anaesthesia, diabetes, obesity, pain and inflammation. FAR 382, however, deals with diseases

(i.e., Parkinson's disease, schizophrenia, anxiety, depression, epilepsy) linked to the central nervous and gastrointestinal system, as well as pharmacotherapy related to allergies, asthma, nausea and vomiting, and microbial infections (i.e., bacterial, fungal, viral and malarial). The organisation of the content occurred prior to my involvement as course coordinator, but was based on proximity of relevant pharmacotherapy to one another. Minor reorganisation was done over the past few years to ensure scaffolding of concepts and pathways can occur, for example, discussion of anticoagulants prior to the treatment of myocardial infarction.

A review of the content occurred over the past five years to ensure that as far as possible alignment with the Essential Medicines List was present to avoid discussion of drugs that were not relevant to the national context. Furthermore, annual reviews aim to update relevant information to new guidelines or scientific findings, and minimise duplication between learning opportunities. Regarding the latter, cross-referencing is employed between learning opportunities with similar topics, such as drug classes that are employed for different diseases, to reduce duplication of efforts, mitigate ambiguity and to reinforce integration. In doing so, content is minimised and contextual differences in indications can be focused on.

The depth and breadth of the content is of general concern, and depends heavily on the educator's understanding and belief of how it should be delivered to align with the relevant learning outcome as well as their experiences with the student group over time. Given that many students struggle to apply the pharmacology concepts discussed due to an underlying deficiency in physiology knowledge, all sessions cover at least the bare basics of the relevant (patho)physiological systems so that a contextual frame is created for the pharmacology discussions thereafter. Pharmacology is discussed in relation to physiology with focus on pharmacokinetics, pharmacodynamics and toxicology. Given that the topic of pharmacokinetics can be quite intimidating to students due to the factual nature thereof and a tendency to memorise information rather than understand concepts, emphasis is placed on the parameters that have clinically significant relation to the administration, use and considerations in the disease. Pharmacodynamics is explained with a view of the drug target, cells where the drug would bind (or exert its primary mechanism of action), the physiological processes being affected, and the clinical outcome achieved; more in-depth molecular aspects are discussed only where the educator believes they are of greater relevance to the understanding of the mechanism of action or integration between other drug classes. The toxicology of the drug is generally approached in relation to the mechanism of action and off-target biological effects, and thus a basic discussion of the mechanism of toxicity is provided. The depth of the toxicology, however, tends to be dependent on the educator's belief of where emphasis on the therapeutic and toxicological principles should be, and thus at times the latter may appear more a listing of side effects than a discussion of their origin. Although discussion of the physiology does assist with relating it to the pharmacology discipline, it does add to the amount of content covered, as well as detracting focus from pharmacology. Similar concerns of content overload have been raised in literature, which impacts the experience of the student and potentially overreach their necessary training (Achike & Ogle, 2000; Banning, 2003; Craft et al., 2017; Davis, 2010; Foster et al., 2017; Manias & Bullock, 2002; McKimm, 2010; Michel et al., 2002). Regardless of emphasising the importance of physiology, students tend to prioritise pharmacology over Physiology given a silo-approach of

learning. A common occurrence during remedial sessions is the realisation that the student does not understand the physiology of the system, and thus their ability to apply pharmacology to it is debilitated.

3.4.3. Student assessment

Students are assessed formatively and summatively to showcase their pharmacological knowledge. Given the logistical constraints of the staff involved with the module, high stakes assessments are still the norm as multiple assessment points require more human involvement that is too time- and resource-intensive. Additionally, a large proportion of students fail to prepare adequately for class engagement. As such, increasing the assessment load may invariably yield stress that students may not be able to cope with. The module makes use of question banks developed over the past eight years, where questions align with the module's assessment criteria to ensure constructive alignment. Question banks are internally moderated on an annual basis via peer-review, and bolstered by item analysis for objective questions. As such, quality assurance can be applied prior to external moderation of examination papers. The internal review has increased the quality of questions, particularly in relation to their content and face validity, as well as their adherence to good assessment practice. A lateral repercussion of this has been an informal reciprocal faculty development, where I have helped capacitate my team as assessors, but due to the inherent nature of the sessions, I have also developed my leadership. Regardless of the improvements, the assessment review is generally constrained by the availability of the module's team, given the myriad of academic responsibilities.

Formative assessments comprise questions present in the learning material and learning management system's discussion board that are of similar difficulty levels and structure to the question banks used for the module. Depending on the educator, formative assessments incorporate an interactive element in learning material to allow for more automated functionality. For example, narrated presentations related to my practice make use of hyperlinks to guide students in their answer selection, with reflective feedback on their selections (Cordier & Lubbe, 2021). Questions are further moderated on the discussion board with a reflective practice in mind, and thus memoranda are not provided upfront. Students' answers are moderated by the educator with feedback on their ability to answer the question, their understanding of the topic, and areas of improvement. As such, active learning is reinforced while adhering to formative assessment principles (Ali, 2018). Students have been generally positive about this approach, appreciating the personalised feedback on their learning. However, many students use this passively, referring rather to others' posts on the discussion board than actively attempting it themselves, and often seeking a memorandum without showcasing their efforts. As the moderator, it does increase the workload to provide more personalised feedback; however, it is still manageable given that not every student will make use of it.

The bulk of the summative assessments contributing to the year mark (defined as the combined academic score prior to the examination) comprise two invigilated written module tests (35% and 45%, respectively), a research-based assignment (10%) and the combined score of several weekly online objective question-based tests (10%). Prior to 2024, students not within their final

year at the University were allowed to be exempted from the examination (contributing 40% of their final year mark) should they have achieved a minimum of 65% for all assessments; however, these provisions (known as promotion) have recently been removed by the University due to educational concerns. The promotion possibility has been a motivating force or stressor for students, though it is a contentious topic. As educator, I am not enthused about some students not writing the examination, particularly as I believe the high stakes assessments do reduce the ability continuously to assess students' knowledge of the topics, and the impact of such stress may disadvantage some students from showcasing their understanding. However, exemption did reduce the marking burden in peak times of the year. Furthermore, students have displayed concerns about the lack of exemption as it does complicate their examination schedules. The module tests and examinations comprise a range of subjective (i.e., short and long) and objective (i.e., multiple-choice, true or false, matching: no more than 35% of the assessment) questions in either a contextualised or decontextualised format on all work covered up to that stage in the module. Where possible, contextualised questions that span across learning opportunities are used to help showcase integration of pharmacology and different physiological systems. The team-based research-based assignment is typically of topical relevance, and thus over the years has included the use of herbal remedies in the treatment of metabolic syndrome or nausea and vomiting, and medicine-related controversies of COVID-19 (such as angiotensin-converting enzyme inhibitors or ivermectin) to be presented as a slideshow deck or poster. The online objective question-based tests are short, low stakes weekly assessments on the prior week's topic that allow for automated, feedback-driven learning from a question bank with randomised distributive functions. Upon completion of the test, students receive their score, as well as feedback on the answers to their questions from a generalised, reflective questioning-based approach. In such a way, students are not given the correct answer, but rather a reflective question or statement to guide their learning relating to the correct or incorrect answer. Depending on the engagement of the student, such reflective questioning was generally seen in a positive light; however, concerns have been raised by the students about not necessarily receiving access to the correct answer immediately.

The high stakes assessment used does impose pressure on students as they are placed in an environment that creates a greater level of stress than a low stakes assessment would. Feedback from students has indicated that there is a belief of fairness of the assessments, but that too much is covered during assessments, and that the lack of past papers creates difficulty for them in preparation. No past papers are distributed as part of departmental regulations; however, this is supported by providing a broad series of formative assessments. From an educator's perspective, many students do not actively engage with these opportunities based on module feedback, are mostly used from a passive perspective where other students' answers and moderation are used to guide their learning. A disconnect is thus present in how many students engage with the formative assessment practice, that decreases their ability to learn from their strengths and weaknesses during assessment.

Unfortunately, given the diversity of topics assessed, it is difficult to predict student success and outcomes on the few data points that are obtained through the modules. Although there are various data points available for the weekly online tests, their ability to predict the outcome of a

combined test is low because of their topical nature. Furthermore, due to the team-based approach used to present the module, the quality, approach and level of feedback of questions is often very educator-dependent. Although efforts are made to standardise the quality of assessments between all educators, inconsistency is present due to the level of educational experience of those involved, their time allowance to the module, and their educational philosophy.

3.4.4. Learning opportunities

There are 19 and 20 sessions presented as part of FAR 381 and FAR 382, respectively; however, they comprise 16 and 15 topics due to some being presented over two or more sessions depending on their breadth. Modules adhere to the flipped learning and blended learning educational framework of the University of Pretoria (Teach & Learn the UP Way) (University of Pretoria, n.d.-b). The framework necessitates that students prepare before, engage during, and consolidate after class; the active learning approach aims to ensure that learning outcomes are achieved using student-centredness (University of Pretoria, n.d.-b). Furthermore, the blended learning approach allows for a mixture of online and physical learning activities (University of Pretoria, n.d.-b); for example, preparation for the physical class using digital activities provided beforehand. Although each of the educators follows this format, differences do arise based on their andragogical choices, educational background, teaching philosophy and the topic. As the course coordinator, to promote intrinsic motivation and personalised growth of my team, I do place trust in them to approach their andragogy in whichever style they feel most comfortable with or excited by, as long as there is due diligence, scholarship underlying its selection, and peer-evaluation. Publications of these approaches are available as short communications (Cordier & Lubbe, 2021; Mlambo, 2021; Parkar, 2021).

During the prepare phase of learning, students have access to several resources that guide their self-regulated learning. As a standard, the resources include lecture notes and an associated narrated presentation (generally a microteaching resource rather than a full lecture). Additionally, depending on the educator, this may be supplemented by an interactive element in the narrated presentation (where formative questions are interleaved in the material), publicly available vetted videos describing the physiological or pharmacological pathways of the topic, excerpts from published literature or websites, or preparatory worksheets, such as questions relating to case reports, or activities relating to the topic. Although the module had been following a blended approach for a few years prior to the COVID-19 pandemic, the necessity of switching over to remote teaching and learning for two-and-a-half years had a beneficial repercussion of bolstering the resources that can be provided in post-pandemic years, as well as shifting the perspective of educators on how to approach blended learning more effectively.

During the engage phase of learning, students attend face-to-face sessions with the relevant educator where the approach is heavily dependent on their educational philosophy. For example, during my sessions an agile learning approach is used to focus the discussion on students' areas of need, with facilitation thereof using real-time writing via a laptop and the preparatory exercise they received for the topic. In doing so, students do not attend a repeat of their lecture notes or

narrated presentation, but rather experience a more interactive session that requires them to answer questions, describe their experiences with the medicine in their clinical or familial environments, or propose scientific reasons for why drugs work the way they do. At times mobile audience response systems are used to allow for diagnostic or formative assessment as the topic allows. Sessions have an overarching atmosphere of humour and informality, incorporating levels of pop culture, creating context within the healthcare practitioners' field, or using metaphorical description to create alternative ways of thinking about the topic.

During the consolidate phase students are required to complete a post-learning online test that contributes to their year mark, but are also given access to a discussion board forum with, as a minimum, practice questions that simulate those in summative assessments for formative purposes. Additionally, depending on the educator, additional tasks are provided, such as conceptual, case report-based, or experience-based questions to test different levels of understanding on the topic. Students are also able to revise their learning using the provided material, attend weekly tutorial sessions, and engage with the educator outside of the classroom using virtual or physical means.

The University of Pretoria's framework for teaching and learning aims to promote active learning, and is variable enough to allow for a diversity of andragogy to be applied. Support is available from instructional designers and educational consultants employed by the institution to guide development of various resources needed for successful implementation. This being said, I am concerned regarding how effectively it is applied in various programmes. Based on my reflections, anecdotal reporting, and module feedback, the three healthcare practitioners' degree schedules are quite full, with various responsibilities towards each module as well as the clinical platform; as such, whether there is sufficient time to engage with preparation and consolidation phases effectively is often unclear. Additionally, the socio-economic diversity of the group does not necessarily allow for an easy approach to engage with learning material; for example, in cases where students have long transit times between their accommodation and the campus, live in circumstances that are less amenable to learning, and have poor access to digital resources. In general, there is often a limited number of students that have prepared adequately for the sessions, which does complicate running the session as effectively as planned. This often necessitates additional discussion of concepts described in preparatory material, or an inability to provide high-level feedback on activities that were prescribed.

Each educator bases their classroom engagement on their educational philosophy, and thus the quality of sessions does depend on the topic being presented and how the educator approaches it. From a course coordination perspective, being prescriptive in how to approach the session debilitates an educator's ability to grow and develop their educational toolkit, and thus a platform for individual design is afforded to each member of the team. After each session, students are requested to provide a short summary of their experiences in the session to help guide educator's development of the design of the learning opportunity, which includes how the student interacted with their learning, what went well or did not go well in the session, and what the main points were that came across. Sessions are also routinely peer-reviewed by educational consultants to provide feedback. Two formal module evaluations are done per module by the University of

Pretoria to gauge students' experiences using a standardised feedback questionnaire. The FAR 381 and FAR 382 modules achieve a high student score during these evaluations. Feedback is taken into consideration for planning the subsequent iteration of the modules as far as possible, though any comments of acute relevance, whether positive or negative are addressed via generalised feedback.

3.4.5. The learning environment

The modules have been designed to follow a blended learning approach, in alignment with the University of Pretoria's framework for teaching and learning (University of Pretoria, n.d.-b). As such, learning occurs between the virtual space (learning management system and digital resources; preparatory and consolidation phases) and physical space (classroom; engagement phase). Although hybrid elements that allow for attendance of sessions both in person and virtually depending on the students' wishes have been approached to allow for synchronous engagement in both the physical and virtual space during classes, it has not been the norm given the logistical, infrastructure and support constraints of the session. For example, during my sessions, time is spent away from the podium to approach students for further questioning, discussion or interaction, or often to engage in some physical activity related to the learning, such as simulating a side effect. Unfortunately, the current audio-visual system makes it difficult to ensure clarity in the virtual space away from the recording device. Furthermore, online question moderation becomes difficult as there is no dedicated support for the educator in the session, and thus adds complexity to ensure that both formats are attended to in an equitable fashion.

The venues allocated for the modules are large classroom-style venues with traditional seating arrangement that allows for a focused view of the front of the podium and moderately good acoustics with the support of audio-visual equipment. As large lecture halls, the venues accommodate up to 300 students, and thus are sufficient to ensure the full group can be housed (taking into consideration the split between Hatfield and Prinshof Campuses). The audio-visual infrastructure of the venues provides a document viewer, data projector, and, in some venues, interactive smartboards. The format of the venue does allow for peer-to-peer activities to take place with individuals seated next to one another (i.e., pair-and-share activities), but larger groups have difficulty in interacting appropriately due to the stepped seating arrangements where students are on different levels from those in front and behind them. As such, the venue does limit the ability to create a collaborative space for learning with true peer-to-peer engagement, though this should not be seen as a deterrent to attempt such practices. In general, students have not shared any notable concerns of physical venues, and thus they appear to serve the function for which they are used well. Given the large number of students in the venues and limited availability of additional teaching support, I do not consider other types of lecture venues as relevant at present as it would not be feasible to mediate small group discussions (apart from short pair-and-share discussions on certain topics).

Given the admixture of students, learning opportunities are repeated on the Hatfield and Prinshof Campuses of the University of Pretoria. The campuses are approximately 6 km apart in Pretoria, Gauteng. Both campuses are security-controlled, and thus access requires a valid student or staff

card to gain entry. Hatfield Campus (campus map) houses most of the faculties of the University of Pretoria, while Prinshof Campus (campus map) is dedicated to the Faculty of Health Sciences in which the Department of Pharmacology is situated. Both campuses are amenable to learning, and the surrounding environments have access to public transport systems, including a dedicated bus service between the campuses to facilitate access. As Hatfield Campus is the site of the executive of the institution, it is generally the campus impacted by any protests or strikes; Prinshof Campus, however, is generally exempt from this or experiences only minor disruptive activity. As such, at times of disconcert, such as the #FeesMustFall protests (a student-led protest against increased tuition fees and for improved government support of higher education institutions) (University of Pretoria, 2016) or union strikes (University of Pretoria, 2024a), Hatfield Campus is more likely to require rapid transition to remote teaching and learning, or experience unamenable learning environments. Such periods create potential inequality as campuses then experience remote versus physical teaching and learning practices.

The virtual space for learning is hosted by the learning management system Blackboard Ultra (Anthology), which is referred to as clickUP in the University of Pretoria's branding (University of Pretoria, n.d.-a). The platform allows for several different functions, such as serving as a communication tool, repository for learning material, assessment and evaluation platform, collaborative discussion forum, and virtual meeting space (via Blackboard Collaborate) (University of Pretoria, n.d.-a). The modules have made use of various functions to serve as a centralised platform for module information and support, collaborative discussions, repository of all learning material including associated external open education resources, and weekly tests. Blackboard Collaborate was used as a standard meeting space during COVID-19 as an alternative to the physical classroom, and is still employed when campus disruptions occur or an ad hoc microteaching session might be called for. Blackboard Collaborate allows for recording of the session for continuous use, as well as basic functions such as polling, creation of breakout rooms, and a collaborative whiteboard. Students have expressed appreciation for the well-constructed online platform for the modules, speaking of its organisation, various resources and user friendliness, as well as the recordings available after Blackboard Collaborate sessions. However, as a collaborative learning space, as educator I have often seen a lack of engagement on both the discussion board and virtual meeting space which does decrease its efficiency. Engagement in the physical space is in general much greater, which also allows for the observation of body language as a perceived measurable of students' comfortability and understanding of the content to guide probing and clarification.

3.4.6. Learning resources

As a standard, all students are provided with the following learning resources to capitalise on the blended learning approach: a series of lecture notes compiled from recommended textbooks, research/review papers and nationally-relevant guidelines, and a narrated presentation (generally as a microteaching resource). Beyond these, each educator will supplement the material with relevant preparatory or consolidation exercises, videos, interactive elements or case reports as they see fit within their andragogy. Students are also advised to make use of recommended textbooks that are housed in the libraries of the University of Pretoria. All learning resources are

vetted by the educator for relevance to the topic, including its depth and breadth, the national context and whether it may advantage or disadvantage certain groups. Furthermore, self-created resources are updated on an annual basis to ensure their accuracy and validity in the module.

Although student handouts such as lecture notes have often been a contentious topic as necessary or beneficial to learning (Johnson & Mighten, 2005; Nouri & Shahid, 2008), it is an expectation of the students and Faculty of Health Sciences that such resources are provided. To mitigate against these become stagnating forces in learning, the engagement phase of learning is used to elaborate and contextualise handouts, thus stimulating attendance of sessions and bolstered use of any resources provided. For example, lecture notes provide the basis for understanding preparatory exercises that are used for discussion in class. Furthermore, lectures notes have reflective elements, such as posing questions to students about why they think a specific side effect may appear, how a drug class may interfere with another medicine, or which patients would not benefit from a treatment; these are general discussion points in class. Student feedback has broadly discussed the appropriateness and usefulness of lecture resources, though given the diversity of educators in the team, lack of standardisation has been raised as a concern.

As a continuous reflective practice, the module team discusses how to ensure integration and movement towards more student-centred approaches that impacts the design and sourcing of learning resources. The greatest constraint of this has been the workload of the team that hinders the incorporation of new, innovative resources.

3.4.7. Timetable

The timetable for the modules is complicated by the student admixture. Hatfield Campus receives one 2-hour learning opportunity per week in the afternoon (14h30 to 16h30; FAR 381 Mondays; FAR 382 Thursdays), while Prinshof Campus has two 1-hour sessions from 07h30 to 08h30 on Tuesdays and Wednesdays. Both slots have their own advantages and disadvantages from my perspective, a view that is bolstered by student feedback. While a late afternoon session is generally well-attended and in general students would already have been on campus for other academic matters, they are generally more fatigued by that stage in the day, with concerns of missing public transport and being locked in congested traffic. Similarly, early morning sessions might have a more refreshed individual; however, students are often late due to oversleeping or public transport issues. Unfortunately, the schedules are fixed at present, and thus organisation of other times for sessions are generally exercises in futility. The timetables of the three healthcare practitioner students are easy to source from the School of Healthcare Sciences, and are generally fixed. At times, some students may have variable schedules though due to unique considerations, such as a student repeating a module or necessitating additional clinical hours. The Bachelor of Science students have more complex schedules due to the diversity of their electives, and thus more than five permutations of schedules are possible, which does not include the myriad of unique settings created by non-degree or repeating modules that are present.

The schedules for the healthcare sciences students are typically built around morning theoretical and practical lectures, while clinical engagement occurs in the afternoon. The sessions tend to

run close to one another, and thus time for preparation and consolidation of learning for pharmacology is affected by the proximity of other sessions, students' ad hoc responsibilities, and their access to infrastructure. Bachelor of Sciences students' schedules are more variable given their electives, and thus their ability to prepare and engage is dependent on their module selections.

Each module carries a 180 notional hour weighting, which in my perspective is sufficient to cover the content and allow for sufficient self-regulated learning. However, given the lack of physiological understanding of many students, some of this time may invariably be redirected to cover prerequisite aspects rather than pharmacology. As notional hours also consider difficulty and importance as non-temporal constructs (Nkomo, 2000), it is not possible to determine whether more or less time should be spent on certain topics as the students from different programmes have different backgrounds in their training. Invariably, students with less physiology or pathophysiology training will require more time to understand the disciplinary concepts appropriately. In general, students report that their time to prepare for engagement sessions, and ultimately to consolidate their learning, is constrained due to the fullness of their programmes. Although evidence of this will be difficult to obtain and is most likely subject to the individuals' unique setting, perception, needs for learning and expectations, my impression has in general been similar. Although effective time management is a skill that is not often observed in the majority of students I teach, I do fear that programmes have over the years not adapted adequately to the flipped learning model, have become more content-heavy and been impacted by socio-demographic factors, such as excessive transit times or part-time working needs of students. As such, I do believe firmly that although I am reviewing my discipline's involvement in these programmes, an overarching collaborative approach is needed among all parties providing education in the year group to ensure sufficient time is provided effectively to train students.

3.4.8. Staff

The staff directly involved in the modules comprise four academic staff members that serve as the educators in the module (of which two are part-time contractual staff members at present), and a tutor (student appointment) who focuses on remedial support for students on a weekly basis. During 2023, a second tutor was appointed to focus specifically on physiology-associated remedial support, as well as a teaching assistant who facilitated additional administrative and monitoring-and-evaluation functions on behalf of the course coordinator. Indirectly, third-year programme coordinators of the various healthcare sciences degrees are the liaison between the course coordinator and their department, and are generally approached to access group-specific information or report on their progress. Beyond these individuals, no further support is available apart from generalised audio-visual and facilities management, and educational consultant and instructional designer services. Given the centralised nature of the educational support, members of their team service all departments in the Faculty of Health Sciences, and thus dedicated support is not possible and subject to their availability.

In my role as course coordinator I oversee the current curriculum as well as ensure that implementation and evaluation occur successfully. Depending on whether administrative support

is available in the year, I also manage all administrative functions that include general communications with students, maintenance of the learning management system, logistical arrangements, compilation of assignments and assessments (beyond individual weekly online assessments), feedback management, monitoring-and-evaluation, reporting and discussions between departments. As such, the burden on my academic schedule is quite intense, which does hinder implementing new modalities at times. As educator, I present 11 of the 19 sessions for FAR 381, and eight of the 20 learning opportunities for FAR 382. Invariably, this includes all functions that would be expected of the rest of the team of educators, such as question bank design, discussion board moderation, marking of assessments and remediation.

The other three academic members of my team contribute as educators, with one serving as acting course coordinator when I am on leave for academic or personal reasons. Historically, the three members of my team have been doctoral students in our department, and thus staff turnover occurs every few years as they complete their degrees. One of the current academic members is now permanently involved, while two are completing their degrees and serving in contractual appointments. As such, it does create a potential continuity risk depending on their degree completion dates. Although their data collection is scheduled around their academic functions, there are times when complexity arises, thus impacting their availability for student remediation or counselling, or attending to additional module-related functions. Over the years the team has developed a strong, cohesive working relationship that allows for improvements to occur. The members of my team have also grown as educators, and although lacking formal educational training, have capacitated themselves in ways that I believe are advanced relative to most lecturing staff.

Programme coordinators from the healthcare practitioner's departments are involved as liaisons with their groups, most prominently in logistical matters. Much support has been provided over the years to help streamline scheduling concerns, as well as indicate potential considerations that may arise, such as students at risk. Furthermore, they have eagerly assisted with soundboarding on pharmacology-related matters of their professions. Weekly feedback is provided to programme coordinators on the progress of their students so that they may also intervene where attendance or assessment scores become problematic.

3.4.9. Curriculum management

Matters related to my curriculum management have in part been discussed under my role as course coordinator (Section 3.4.8). Although no formal curriculum map has existed in the past, this research project reported in the thesis aims to formalise a living map to ensure curriculum management continues to improve. Over the past year, monitoring-and-evaluation processes have also greatly increased due to the support of a teaching assistant, which has allowed for continuous reminders and check-ins with students regarding their attendance and weekly assessments, more streamlined reporting to programme coordinators and bolstered statistical analysis. To collect data on the students, an entrance ticket activity is offered prior to the start of modules to determine, among other things, their degrees, preferred campus, perceived physiology aptitude (bolstered by their average marks obtained for it), areas of learning concern,

infrastructure considerations and expectations. In doing so, variables have been collected that over time, will help build rudimentary predictive models that can help streamline the support provided to students. At this stage though, they allow for module planning, where students can be stratified into specific groups for administrative and reporting purposes and to build a rapport with them.

Reports on matters related to the modules are presented to the Department of Pharmacology on a routine basis, with involvement of the Head of Department in processes requiring their approval. At present, no other departmental structure is present to inform curricular matters in the department. As the module is housed in the Department of Pharmacology, it is subject to authorisation for significant changes by the Academic Advisory Committee of the Faculty of Health Sciences, which, if it alters the structure or parameters of the module to a degree that affects its yearbook, requires further approval by the Faculty Board of the Faculty of Health Sciences and Senate of the University of Pretoria. However, the level of change necessitating involvement of any of these structures requires a large-scale adjustment to the assessment practice, structure and placement of the module, topics being presented or altered information presented in formal yearbooks of the module and programmes.

The module outcomes of the healthcare practitioner students are subject to moderation by the School of Healthcare Sciences Exam Moderation Meeting Committee. During such meetings, outcomes are discussed for each student, and overlapping concerns addressed. The committee does not have the authority to affect change; however, it can request information on the curriculum and raise concerns should student or module outcomes be less than ideal. The committee is also supportive of curriculum review and realignment. As the module has run successfully over the years, few concerns beyond student failures have been raised; however, these could be justified based on the monitoring-and-evaluation reports. The changes to remote teaching and learning in the COVID-19 pandemic, and eventual return to invigilated assessments, did create a short period of higher-than-normal failure rates, though this has been addressed and is presumed to have been markedly affected by prerequisite knowledge being underdeveloped.

3.4.10. Students

Individualised information on the student groups is provided in Chapters 3 to 5. Although an admixture, the students enrolled for the modules share many characteristics. Most students fall within a similar age bracket and generally have continued their education uninterrupted after basic education. Many are still developing as young adults, and thus face numerous new challenges and opportunities in their life, including financial pressure, work-life balance, complex social issues and learning deficits. Among the healthcare practitioner students, failing FAR 381 or FAR 382 necessitates an additional year to complete their studies, which creates an external pressure on them to pass. However, many enter the module with a poor understanding of physiology that becomes a stumbling block in their learning. Furthermore, many face financial pressure that affects their day-to-day processes, thus further complicating work-life balances. Concerns of mental health and burnout have become more evident over the years, and although support

services are available via the Faculty of Health Sciences and University of Pretoria, some do not actively seek out such assistance.

The decolonisation and transformation discussion in South Africa has raised several concerns of how curricula may precipitate inequality, for example, whether there is inaccessibility to disadvantaged students, or what and whose knowledge is brought to the forefront (Motala et al., 2021). In South Africa, several prominent social movements occurred that bolstered the debate, including the 2015 #RhodesMustFall and 2016 #FeesMustFall movements that largely discussed epistemic erasure, access to education, decolonisation of the curriculum and marginalisation (Motala et al., 2021). Within the context of the healthcare and pharmacology curriculum, more contextualised elements of transformations have occurred, such as the acknowledgement of indigenous knowledge systems, including traditional therapies, such as herbal remedies. Although students often discuss these elements during classroom engagement, few theoretical aspects are brought from the curriculum, and are rather ad hoc, based on the experience of the educators and their research. However, a larger concern of the transformation for me at present has been the acknowledgement that students enter the pharmacology modules with a varying understanding of their pre-requisite physiology due to inherent programme differences, as well as an inherent experiential difference with medicine. Students are exposed to pharmacology daily due to their medicinal needs, those of family and friends, the clinical exposure they have had up to that stage, or their socio-cultural understanding of medicine. As such, students are continuously reminded to acknowledge their knowledge of such factors in class, and bring its strength to their learning; for example, what they have experienced when taken certain medication, or what might be more general within their socio-cultural domain. In general, I have developed an excellent rapport with the students, and thus many approach me during the year for additional support and assistance. Having opened myself to listening to their concerns, hopes and fears has bolstered my advocacy of their rights within education to ensure they are not regarded as numbers in the higher education system, or merely the student who complains and wants to pass. However, I have also seen on many occasions how some students stagnate and fail to progress due to standing in their own way of development.

Reflecting on the windows of the current curriculum has illustrated a myriad of strengths and weaknesses. Some of the latter are not possible to address without larger systemic action, for example, inclusion of more staff members, but some aspects can be resolved by modifying the curriculum to accommodate a more focused approach for each group.

4. Kern's six-step curriculum development model for medical education

Given the health professions education focus of my study highlighting competency development in pharmacology, Kern's six-step curriculum development model has been selected as guiding tool and conceptual framework due to its applicability in the field (Remesh, 2017; Thomas et al., 2016).

4.1. The model of curriculum development

Thomas et al. (2016) describe the six-step process of curriculum design for medical education proposed by David E. Kern: i) problem identification and general needs assessment, ii) targeted needs assessment, iii) goals and objectives, iv) educational strategies, v) implementation, and vi) evaluation and feedback. These six points should not be seen in isolation, and in fact advise and guide one another through a dynamic, iterative process (Thomas et al., 2016). Although the model itself speaks to medical education, it can be extrapolated to the broader context of all health professions education (Just et al., 2010; Sweet & Palazzi, 2015). A focus point of Kern's model is the solution of a health problem through the efforts of the curriculum itself, and thus speaks directly to the learning outcomes and competencies that students require (Thomas et al., 2016). Although all aspects of Kern's model are discussed, focus is placed on the first three steps to ensure a competency framework is designed with clear learning outcomes that can be situated in the programmes presented at the University of Pretoria. As shown in Figure 2.3, the model allows for an integrative approach to curriculum design, where all steps support and inform one another for continuous adaptation and refinement.

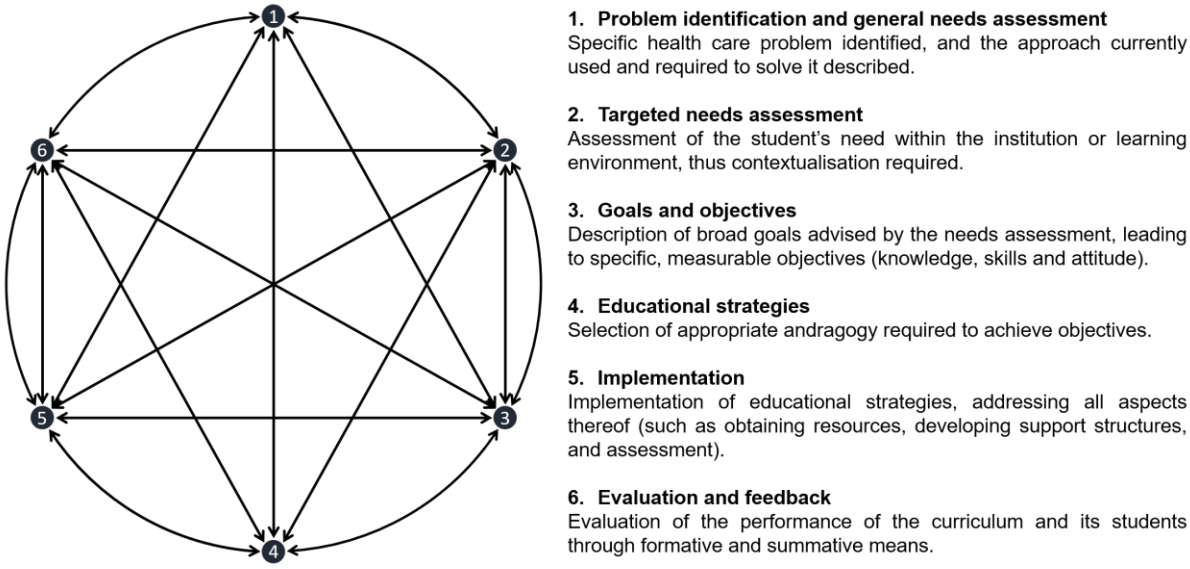

FIGURE 2.3: KERN'S SIX STEP MODEL FOR CURRICULUM DEVELOPMENT (ADAPTED FROM THOMAS ET AL. 2016). IMAGE SELF-GENERATED

4.2. Problem identification and general needs assessment

Within medical education, the curriculum should address a health-related problem, and thus ultimately offer an approach by which to resolve it (Bass & Chen, 2016). When identifying the problem, a full view is needed of the stakeholders involved (e.g., patients, healthcare practitioners, medical educators) as well as the way in which it affects them (e.g., clinical outcomes, morbidity, mortality, use of resources, societal impact) to direct the learning thereof (Bass & Chen, 2016). To assess such a problem, a general needs assessment can be performed to investigate the broad nature of the problem, asking four primary questions: i) What is currently being done by

stakeholders to address the problem? ii) Which predisposing, enabling and reinforcing personal and environmental factors affect the problem? iii) What should stakeholders ideally do to address the problem? iv) How does the ideal approach compare to the current approach? (Bass & Chen, 2016). An overview is necessary of all stakeholders and factors involved, and should not be short-sighted to just the academic sector, but also society at large. The difference between the ideal and current approach speaks to how the problem will be solved (Bass & Chen, 2016).

Various modalities are available to obtain the information required to address the problem and general needs assessment, and include a review of published literature and policies, use of consultants, or collecting new information, mostly via research-related methods (Bass & Chen, 2016). Furthermore, given the accreditation requirements of clinical professions, expected competencies as defined by regulatory bodies and clinical practice guidelines should be included (Bass & Chen, 2016).

4.3. Targeted needs assessment

Given the information obtained during the general needs assessment, the targeted needs assessment will further refine the way in which the problem will be approached (Hughes, 2016a). While the general needs assessment provides a rationale for curricular development or reform, the targeted needs assessment considers the student audience and their learning context (e.g., prior knowledge, cognitive capabilities, healthcare practice, cultural norms) (Hughes, 2016a). As such, the targeted needs assessment also takes into consideration aspects of the hidden curriculum and the influences thereof (Hughes, 2016a), allowing for a better construct of what would be most appropriate to develop, such as the 21st century skills not directly aligned with the discipline and the personal factors that could enable or constrain it. During the targeted needs assessment, content related to both the student and learning environment will be required (Hughes, 2016a). A targeted needs assessment will invariably help optimise resources by focusing them to areas that require strengthening or redirecting them from low to high priority areas in the curricula (Hughes, 2016a). By doing the targeted needs assessment, the considerations of the institution, in this case the University of Pretoria and its individual professional departments, can be considered to allow changes to be adopted into the infrastructure, planning and programme, or advise for transitions to occur to accommodate it.

The targeted audience of the curriculum – the student – will be subject to the problem identified earlier. An informed profile of the students will be needed to ascertain how the curriculum should be developed to speak optimally to them (Hughes, 2016a). Content will differ based on context; however, it can be expected that important knowledge needed to develop the curriculum would include prior experiences and professional development; socio-cultural norms; current competencies (knowledge, skills and attitudes), and learning strategies to which they are exposed (Hughes, 2016a). The learning environment, however, will depend on the context wherein the students find themselves, and will include prior or current curricula within the degree; enabling, reinforcing and barrier forces; stakeholders associated with the degree; resources and infrastructure available, and aspects related to the hidden curriculum (Hughes, 2016a).

Various modalities are available to perform a targeted needs assessment, including informal discussions, questionnaires, individual interviews, focus group interviews, direct observations, audits, tests, and strategic curriculum planning sessions (Hughes, 2016a).

4.4. Goals and objectives

Once the targeted needs of students have been identified, goals and objectives can be set to assist in fulfilling the various specific needs. Based upon the descriptions of Thomas, a goal is the broad educational objective that will be discussed within a curriculum, while the objective refers to a measurable objective that a student will achieve within the curriculum (Thomas, 2016). Within the language of the University of Pretoria, learning outcomes and assessment criteria will be used to refer to the goal and objective, respectively, as they serve the same function, but will be more easily understood within our academic context. The learning outcomes and assessment criteria serve numerous functions, such as setting the expectations of the curriculum, providing assessment structure, directing and focusing the curriculum to a specific aim, and suggesting educational strategies to achieve them (Thomas, 2016).

One of the most well-described taxonomies for guiding development of learning outcomes and assessment criteria statements is Bloom's taxonomy (1956), which was revised in 2001 (Krathwohl, 2002). Although three domains are acknowledged comprising cognitive, psychomotor and affective (Chandio et al., 2016), for the purposes of the study only the cognitive taxonomy will be discussed. The revised version of Bloom's taxonomy altered the original discussion of the cognitive domain by reorganising and renaming the categories from Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation to Remember, Understand, Apply, Analyse, Evaluate and Create (Krathwohl, 2002). Furthermore, the revised framework acknowledges that the cognitive domain comprises two dimensions: the cognitive process and knowledge (Krathwohl, 2002). While the knowledge dimension entails factual, conceptual, procedural and meta-cognitive knowledge, the cognitive process domain relates to the six categories of the taxonomy on how they are achieved (Krathwohl, 2002). The knowledge domain would speak to the noun used within a statement to determine at which level it should be, while the verb categorises the process according to the six levels of Bloom's taxonomy (Krathwohl, 2002). In doing so, a matrix is created that more explicitly provides the expectations of the statement to the students (Krathwohl, 2002). By creating a more complex hierarchical structure, it has, however, created a more relaxed differentiation between categories where there is some arguable overlap identified between categories in proximity (Krathwohl, 2002). From an educator perspective, one can understand the importance of such a revised two-part model, however, this does create an additional layer of complexity during processing of learning outcomes and assessment criteria, particularly for individuals without educational expertise. For the processes of my study, which relied on healthcare professionals without a necessarily strong education background, trying to implement such a structure would inherently complicate data collection and reduce response rates. Furthermore, although it should be acknowledged that some competencies will stretch to psychomotor or affective domains, expecting participants to evaluate in relation to two more domains will add an additional risk for reduced response rate. A contextual example of how Bloom's taxonomy is approached is provided in Figure 2.4, highlighting how assessment criteria

are stratified as lower or higher order competencies based on the cognitive expectation of said outcome.

Assessment criteria should be set appropriately, as a lack of clarity may lead to poor focus during the development and reform of a curriculum (Thomas, 2016). Assessment criteria are suggested to indicate several aspects quite clearly to ensure clarity is apparent: a specific verb indicating which criterion is to be performed, to what degree, and at what time (Thomas, 2016). During the creation of assessment criteria it is important to maintain realism that not every criterion can be included, and learning is not always as simple as a checklist of items. Assessment criteria thus need to be focused enough to provide direction, however, maintain a level of flexibility to ensure that non-prescribed learning may also take place (such as that included within the hidden curriculum) (Thomas, 2016).

Assessment criteria related to the student focus on the cognitive (knowledge), affective (attitude) and psychomotor (skill) competencies (Thomas, 2016). Although cognitive refers to knowledge attributes, it should not be reduced to mere factual knowledge, as it also comprises higher cognitive processes, such as critical thinking and problem-solving (Thomas, 2016). Those within the affective domain are typically more difficult to express; changes to attitude are less easily measured (Thomas, 2016). Psychomotor competencies entail physical activities that are performed (e.g., clinical treatment) or habitual behaviour that is necessary within practice (e.g., interpersonal skills or routines) (Thomas, 2016). Within competency-based curricula, competencies are expressed as specific goals that a student should have obtained at completion. These are typically observed to be integrations of the cognitive, affective and psychomotor domains (Thomas, 2016). Several instruments may be used to formulate such outcomes, including Blooms taxonomy and Miller's pyramid (Thomas, 2016).

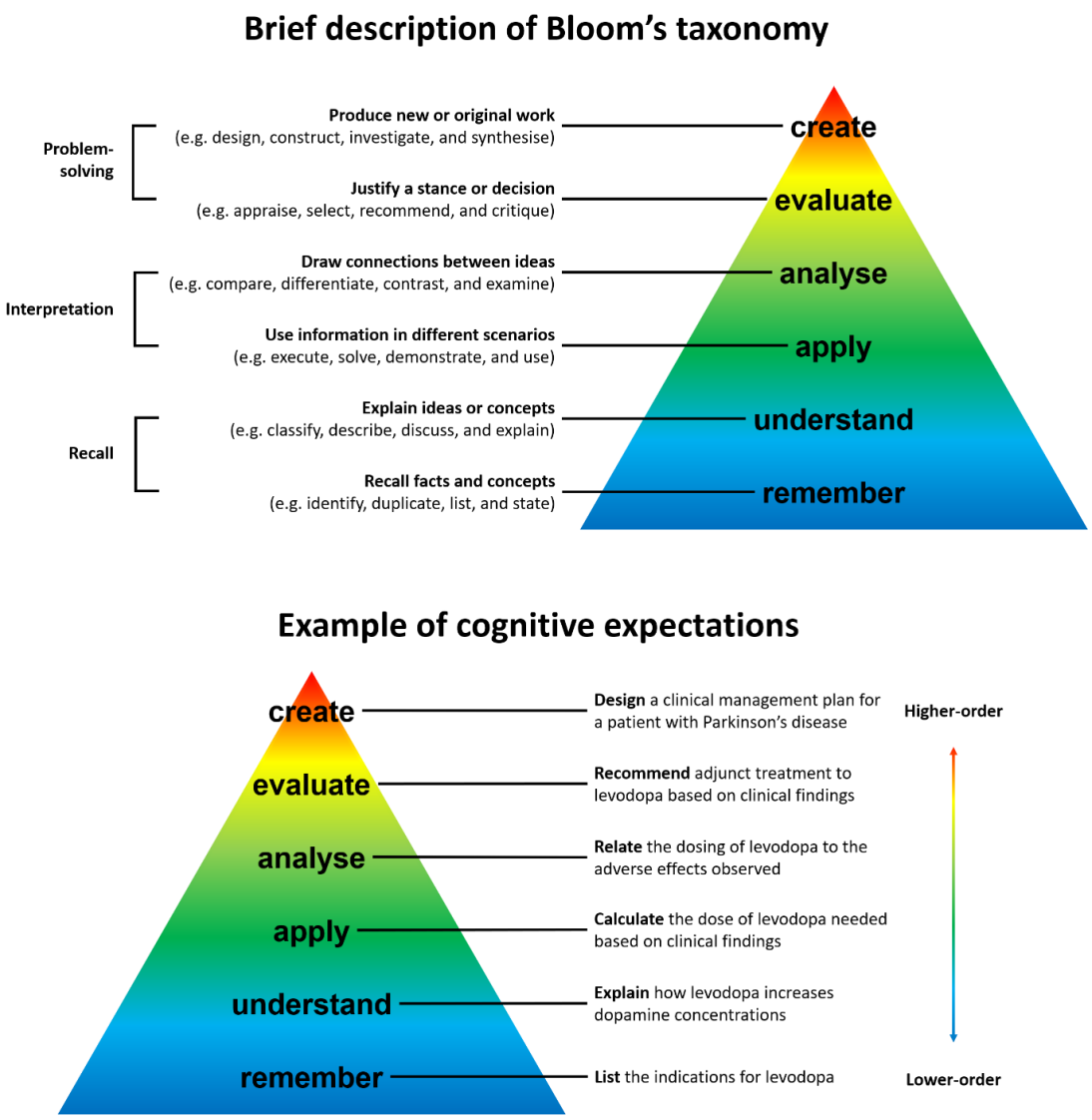

FIGURE 2.4: A BRIEF DESCRIPTION AND EXAMPLE OF EXPECTATIONS IN THE COGNITIVE DOMAIN OF BLOOM'S TAXONOMY, WHERE ONLY THE COGNITIVE PROCESS DIMENSION IS SHOWN. SELF-DEVELOPED IMAGE

4.5. Educational strategies

While the first three steps of the curriculum development highlight what needs to be achieved, educational strategies will speak to the method by which it will be done (Thomas & Abras, 2016). Within adult learning, Malcolm Knowles emphasised the differentiation of learning in adults from that of children; as such, he highlighted rather using andragogy instead of pedagogy (Knowles, 1978); however, discussions on the suitability thereof are at times controversial (Ozuah, 2005). Andragogy, based on the studies of Knowles, highlights several characteristics of adult learning: i) needing to know the relevance of learning a topic; ii) self-directness to learn; iii) prior knowledge due to past experiences; iv) eagerness to learn for development purposes; v) emphasis on problem-based rather than subject-based learning, and vi) requiring intrinsic motivation to learn (Ozuah, 2005). Such attributes can be targeted through a variety of means, and should be

investigated separately via empirical means. An important aspect that is linked to the general and targeted needs assessment is the inherent relevance of the topic to their learning: many healthcare practitioners have opined that pharmacology education often veers away from the clinical relevance (Ahsan & Mallick, 2016; Andersen & Moralejo, 2015; Davis, 2010; Manias & Bullock, 2002), which would ultimately impact the motivation to learn more about it (Ozuah, 2005).

Regardless of age, three aspects of learning are highlighted: i) cognisance of preconceived notions and prior learning; ii) developing expertise; iii) developing meta-cognition and meta-learning within students (Thomas & Abras, 2016). Within learning, no individual is a blank slate, as years of experiences and prior educational settings have etched knowledge into their memories; as such, students may enter a curriculum with certain assumptions or competencies already in place that should either be rectified, addressed or built upon (Biggs, 1999; Thomas & Abras, 2016). Students develop knowledge retrieval systems built from newly acquired knowledge assimilated or reworked from prior experiences to facilitate complex higher order thoughts; such processes build expertise (Biggs, 1999; Thomas & Abras, 2016). A quality of effective learning and development as a lifelong learner, is meta-cognition and meta-learning, typically mediated through action learning (Volz-Peacock et al., 2016) or other types of reflective practice (Thomas & Abras, 2016). Through these combined processes, ultimately a transformative learning experience should be built, where students create their own professional identities through reflection by questioning the world around them, and considering different ontologies and epistemologies (Thomas & Abras, 2016; Volz-Peacock et al., 2016).

Educational strategies would require two primary components: content and andragogical methods (Thomas & Abras, 2016) appropriately to develop required competencies. Content of the curriculum, or the underlying concepts that facilitate the development of the competency, are informed by the goals and objectives that have been identified, and should be optimally tailored to provide a basis for learning to occur for further construction and refinement of knowledge (Thomas & Abras, 2016). The methods of delivery refer to the facilitation practices that are used to help guide the learning process, and should be selected based on the goals and objectives identified for the curriculum (Thomas & Abras, 2016). Methods need to be appropriate for achieving the assessment criteria, and thus stimulate the development of the cognitive, affective or psychomotor parameter (Biggs, 1999; Krathwohl, 2002; Thomas & Abras, 2016). It is often suggested that students have preferential learning styles, and thus a variety of methods should be placed into the educator's toolkit for facilitation purposes (Thomas & Abras, 2016); this is often a contentious subject, though variety may be useful in maintaining novelty within the learning environment, provided it remains appropriate and authentic towards achieving the objective. Finally, the availability of resources should be an ever-present thought, and thus methods selected must be feasible within the means of the educational setting (Thomas & Abras, 2016). For example, it has been opined that within problem-based learning curricula, contextual learning of the basic sciences' attributes of pharmacology using case reports may be better achieved after a strong foundation of other basic sciences has been laid; however, this may hinder formation of conceptual frameworks of the discipline itself (Karpa & Vrana, 2013). Pharmacology may be inappropriate for pure problem-based learning curricula, given the diversity and breadth of information that requires assimilation (Karpa & Vrana, 2013). A structured profile of all important

concepts is thus required (Karpa & Vrana, 2013), hence emphasising the clear explanation of learning outcomes and assessment criteria (Midlov et al., 2015; Thomas, 2016).

4.6. Implementation

Implementation of a curriculum requires an in-depth knowledge of the resources available, and subsequent project management to ensure execution occurs at the highest quality possible (Hughes, 2016b). Four stages are defined during implementation: i) support generation; ii) change planning and management; iii) operationalization, and iv) ensuring viability. As such, implementation involves all aspects of stakeholder relations and resource management as well as compilation of protocols for execution and review (Hughes, 2016b).

Resources can be diverse, based on what needs to be implemented. An educational team consists of far more than just the educators themselves, but also the support staff, instructional designers, curriculum directors, curriculum faculty and other external players (e.g., simulated patients) (Hughes, 2016b). Planning such curricular changes is time-intensive, thus staff availability needs to be assessed and incorporated into any such interventions (Hughes, 2016b). Furthermore, the student schedule is not to be overlooked, as time will need to be provided for them to engage adequately with the new curriculum (Hughes, 2016b). Facilities and funding need to be included during planning to ensure that the relevant infrastructure, material and staffing that is required for the curriculum to be successful can be employed (Hughes, 2016b). As such, curriculum implementation requires not only internal support, but at times external support as well to help overcome challenges faced within the institution (Hughes, 2016b). Clearly communicated outcomes are necessary to help streamline such changes and prevent any unruly detriments to curriculum implementation (Hughes, 2016b).

Implementation should not be taken lightly, and may require a systematic rollout instead of a full release to obtain pilot data on its appropriateness (Hughes, 2016b). The selection of such a phased implementation should be based on various factors, including, among others, the urgency of the change needed, identified barriers or challenges, and resources allocated (Hughes, 2016b).

4.7. Evaluation and feedback

The sixth step of Kern's curriculum development model speaks to the assessment, evaluation and feedback systems employed within a curriculum (Lindeman & Lipsett, 2016) where assessment of the student is done, and evaluation of the programme occurs. Differential assessments and evaluation take place to provide a multitude of information that informs all stakeholders of the performance of the curriculum (Lindeman & Lipsett, 2016). In such a way, two dimensions are addressed: i) who is being assessed or evaluated (student or programme), and ii) what is the purpose of the assessment or evaluation (formative [to improve performance] or summative [to judge performance and inform decisions]) (Lindeman & Lipsett, 2016). It goes without saying that the students require feedback throughout the curriculum to reflect and adapt their learning ultimately to acquire the competencies required of them, but also to indicate whether they have done so successfully (Lindeman & Lipsett, 2016). In a similar fashion, the various stakeholders of the curriculum must be aware of its performance, whether challenges have been

encountered (and resolved), what improvements are needed, or whether it is feasible to continue (Lindeman & Lipsett, 2016).

The design of such assessments and evaluation questionnaires is a systematic process, requiring knowledge of what the pertinent questions are, and the methods most appropriate to answer them (Lindeman & Lipsett, 2016). As these questionnaires may become overly complex, it is important not to exceed the necessities thereof (Lindeman & Lipsett, 2016). Evaluation systems need to possess internal validity to ensure that they accurately relate to the setting in which they are implemented, though may also possess external validity should they be generalisable outside of their setting (Lindeman & Lipsett, 2016). To ensure that validity is achieved, it is necessary to maintain methodological rigour through the design and refinement of evaluations (Lindeman & Lipsett, 2016).

4.8. Application of Kern's curriculum development model in undergraduate Pharmacology

Although curriculum development, as shown from the integrated nature of Kern's model, cannot be regarded as isolated silos of tasks, starting points can be selected based on the need of the designer of the curriculum. Within the current context of the study, I first required knowledge of what each healthcare practitioner needed as competencies with relation to pharmacology in their world-of-work. To ensure that an unbiased view was achieved, a national-level investigation involving stakeholders from different spheres of expertise was justified. After obtaining such information, further refinement could be made to individualise curricula for each healthcare practitioner that can be integrated with the unique circumstances of the University of Pretoria.

The pharmacology curriculum for each healthcare practitioner needs to speak to a specific need within said profession, dealing with a problem related to the use of biologically-active compounds within their clinical context. Although the clinical basis of each healthcare practitioner differs due to the inherent underlying differences in treatment, the same question will be evident throughout: which considerations are important in the clinical practice when biologically-active molecules (e.g., drugs or medicine) are needed or used by the patient? As a basic and clinical science, the curricula will need to be optimised for all scopes of practice, highlighting the clinical reasoning abilities that inform rational therapeutics – something that is not pertinent for those within a bioscience's degree.

The general needs assessment will encompass determining pharmacological involvement within the context of each profession's patient management scheme, and thus institutional specifics will not be relevant. The targeted needs assessment, however, will speak to the latter, and refer specifically to the students within the undergraduate modules presented at the University of Pretoria. Thus, a more direct involvement with the respective departments will be necessary to ensure alignment with their expectations of their graduates and contextualisation within the environment. Learning outcomes and assessment criteria will relate to the core competencies that students will need to obtain to fulfil the needs determined earlier; however, it will be pertinent

to determine which generic competencies are seen as relevant and important to assess whether encapsulated training can be done alongside pharmacology.

The final three steps of Kern's curriculum development model do not form part of my study. However, a thorough andragogical review would allow for the selection of the most appropriate modalities to ensure competency development occurs. Such strategies would need to be implemented with the infrastructure available in the higher education institution, thus awareness of resources is crucial to bolstering the curriculum. Ultimately a full review of the curriculum, as well as assessment of student performance, would be needed continuously to develop the course and align it with workplace needs. All steps would need to speak to one another to ensure a cycle of development occurs.

5. Approaching the general needs assessment via the Delphi technique

The Delphi technique is a well-known research tool aimed at achieving consensus about a topic through iterative expert discussion (Hasson et al., 2000; Hsu & Sandford, 2007; Linstone & Turoff, 1975; Mckenna, 1994; Thangaratinam & Redman, 2005), thus affording decision-making (Kezar & Maxey, 2014) when variance of judgement between rounds decreases (Hussler et al., 2011). The original Delphi has several variations (Kezar & Maxey, 2014), though characteristics between them remain relatively similar: i) anonymity of participants to promote free expression of opinions; ii) systematic feedback between iterations allowing participants access to group opinion; iii) several iterations to allow participants the means to re-evaluate and clarify their opinions; iv) summation of responses to allow for further analysis and interpretation (Avella, 2016; Hsu & Sandford, 2007; Kezar & Maxey, 2014; Trevelyan & Robinson, 2015). The Delphi technique is typically employed where other scientific modalities are less appropriate as it affords the i) exploration of assumptions leading to variable judgements; ii) need for reaching consensus from respondents; iii) correlation of topic-specific judgements from multidisciplinary viewpoints, and iv) forming an educational unit on the diversity of opinions (Hasson et al., 2000).

During a Delphi study, the initial round is used to generate information or opinions (Hasson et al., 2000; Hsu & Sandford, 2007; Linstone & Turoff, 1975; Mckenna, 1994; Thangaratinam & Redman, 2005); however, a modified, reactive Delphi study may use data from document analysis or other sources as a starting point for participants to react to and elaborate (Mckenna, 1994; Albarqouni et al., 2018; Brinkman et al., 2018). The subsequent round requests rating of these topics by an expert panel (Hsu & Sandford, 2007; Linstone & Turoff, 1975; Thangaratinam & Redman, 2005) and may request explanations for their selections to enrich data (McMillan et al., 2016). Opinions that are added by participants are collated into subsequent rounds of the Delphi study (Hasson et al., 2000; Albarqouni et al., 2018). These should, as far as possible, remain untouched by the researcher to ensure the validity of participant judgements and the purpose of the modality (Hasson et al., 2000). Results of the rating are recirculated to the expert panel during further iterations, which allows for re-evaluation with the aim of reaching consensus or stability of opinions (Hsu & Sandford, 2007; Linstone & Turoff, 1975; Scheibe et al., 1975; Thangaratinam & Redman, 2005). During this reassessment participants are aware of the group aggregate score and potentially their original score, and may sometimes include relevant commentary (Hsu &

Sandford, 2007; Thangaratinam & Redman, 2005). At least three iterations of a Delphi study are needed to obtain data (Thangaratinam & Redman, 2005); however, it is also dependent on when consensus or stability of opinions is reached (Hsu & Sandford, 2007; Scheibe et al., 1975).

The Delphi technique emphasises the role of collective thought and opinion in generating consensus, though in itself also negates the extreme positions that may be taken by some participants (Linstone & Turoff, 1975). This brings to light an important consideration of agreement – although it allows for a general truth to be established on a position; it may prohibit discussion of controversial viewpoints when most important (Mitroff & Turoff, 1975). As with any tool, the Delphi technique needs careful design and execution to ensure that such discrepancies allow space for crystallisation. Use thereof may also thus be more appropriate in areas where a consensus is likely to be reached (Mitroff & Turoff, 1975). A well-planned Delphi study recognises the importance of generating comments and discussing divergences from the consensus, rather than imposing preconceived notions on a panel and avoiding disagreements (Linstone & Turoff, 1975).

It is important to note that the term expert is contentious as it is subjective in nature (Hussler et al., 2011; Mckenna, 1994; Thangaratinam & Redman, 2005; Trevelyan & Robinson, 2015), thus careful consideration and clarification of the experimental population and context is needed as it alters the basis of opinions (Hussler et al., 2011; Thangaratinam & Redman, 2005). Expertise remains as a subjective concept, based on numerous factors, including the personal biases of individuals due to their epistemological diversity and ontological view (Linstone, 1975). Selection of experts thus often proves difficult during a Delphi study, and the potential impact of bias of the researcher (Hasson et al., 2000; Thangaratinam & Redman, 2005) or the participants themselves may occur (Hasson et al., 2000; Linstone, 1975). Numerous factors may influence the decisions or willingness to change their opinions (Hussler et al., 2011; Linstone, 1975), such as the size of the institution with which they are engaged or their self-interest (Hussler et al., 2011). As such, predictions made based on responses do not necessarily infer the best or truest forecast, as has been shown numerous times in economic Delphi studies (Linstone, 1975). Selection itself will be a major determinant to the outcome of a Delphi study, leading to several recommendations. Discipline-specific knowledge is invariably an important foundation of selection (Hsu & Sandford, 2007; Hussler et al., 2011; Mckenna, 1994; McMillan et al., 2016), but may not be sufficient to yield the forecasting needed or wanted by a Delphi technique (Hsu & Sandford, 2007). Participants should preferably also have need for the results as decision-makers, form part of the professional and support staff that engage with it, and would be individuals whose knowledge is sought (Delbecq et al., 1975). Depending on the scope of the study, the expert panel may be homogenous or heterogenous to gain insight into the breadth of the topic (Kezar & Maxey, 2014). Heterogeneous populations invariably permit a greater diversity of opinion. However, they also infer less specificity in the composition of the expert panel (Kezar & Maxey, 2014). Panel diversity may potentially allow for non-expert comments that can destabilise reaching of consensus (Linstone & Turoff, 1975). However, it does not necessarily reduce the accuracy of the opinions (Hussler et al., 2011) and further provides an outside perspective that may otherwise be lost (Hussler et al., 2011; Mckenna, 1994). Although non-experts in such a panel may be more easily swayed and move towards the general opinion in subsequent rounds, experts themselves may

be more rigid due to self-interest and thus not necessarily re-evaluate their stances (Hussler et al., 2011). Participants will inherently not be experts in each-and-every aspect of the topic, and invariably each participant will be more knowledgeable in different elements thereof; the aggregate thereof may thus be more general than what it is in-depth (Hsu & Sandford, 2007). Group feedback to participants may sway re-assessment of original scores to the average, where less confident individuals may make a greater movement than more confident ones (Linstone & Turoff, 1975). Feedback should thus be approached carefully as it may sway the opinions of participants away from what they think may be true (Hsu & Sandford, 2007; Scheibe et al., 1975) as the results of a Delphi study will be inherently subjective in nature, given the ontological differences between participants (Hasson et al., 2000). Although experts or highly dogmatic individuals may be less likely to change their position than those less knowledgeable or dogmatic, psychological parameters may contribute to unexpected trends (Mulgrave & Ducanis, 1975). For example, as a dogmatic individual may seek support from an authority figure in the absence of a clear leader, the group feedback may become a surrogate and precipitate change (Mulgrave & Ducanis, 1975).

The size of the panel is wholly dependent on the composition and representation thereof (Hsu & Sandford, 2007; Kezar & Maxey, 2014), though typically will not be fewer than ten participants (Hasson et al., 2000; Hsu & Sandford, 2007). One would aim for a size large enough to represent a knowledgeable base; however, heterogeneous groups would necessitate a larger size than a homogenous group (Hsu & Sandford, 2007). Too small a panel may reduce the strength of opinions or representation thereof, while too large groups may exacerbate logistical planning and reduce the response rate (Hasson et al., 2000; Hsu & Sandford, 2007).

Different statistical models can be applied to describe group aggregates or consensus, including central tendencies (means, medians and modes) and levels of dispersion (standard deviation and inter-quartile ranges) (Hasson et al., 2000; Scheibe et al., 1975; Thangaratinam & Redman, 2005). The design of the Delphi study will determine the appropriate statistical model to be used (Hasson et al., 2000; Hsu & Sandford, 2007). For example, means would be inappropriate for ratings that lack interval scales (Hsu & Sandford, 2007), and levels of dispersion would not apply to nominal data (Hasson et al., 2000). During the design of a Delphi study, various factors influence the success thereof, including the primary human elements. Within ranking systems, simplification of scale may be more comfortable for participants, given its lower complexity and time needs, though may reduce distinguishing between scores or complicate subjectivity (Linstone & Turoff, 1975; Scheibe et al., 1975). Pair comparison scales may tax a participant should the number of options become too extensive, while ranking may discourage those who wish to apply equal ranking to more than one element (Scheibe et al., 1975). Simplification is preferred to complexification, though in itself may be a detriment during a Delphi study (Linstone, 1975). Reductionist approaches are often juxtaposed with environments where they may not be appropriate, and as such may present with an oversimplification of complex social dynamics (Linstone, 1975). The richness of a Delphi study lies in its ability to collect and present differing opinions and views, and as such cannot always be reduced to an easy answer (Linstone, 1975). Rating scales may be varied, with anything from 3-point to 9-point scales being used often (McMillan et al., 2016). For example, on a 9-point rating scale median values ≥7 may represent

appropriate, between 4 and 6 uncertain, and ≤3 inappropriate; additionally, those lacking consensus are placed under uncertain (Fitch et al., 2001). When ranking competencies, Albarqouni et al. used a 4-point ordinal scale of is not a priority so should be omitted, should just be mentioned, should be briefly explained and practised with exercises, which aligns with Miller's Pyramid of Clinical Competence (Albarqouni et al., 2018). Albarquoni et al.(2018) assessed core competencies by systemic review of literature, after which they asked participants to rank selected competencies via a 4-point ordinal scale (Albarqouni et al., 2018). Based on the rankings, five groups were created that allowed for re-evaluation of previous scores: A) ≥70% consensus for all ordinal points suggesting inclusion; B – D) <70% consensus for all ordinal points suggesting inclusion; E) any new items mentioned during the first iterations requiring a ranking (Albarqouni et al., 2018). Similarly, Midlov et al. made use of a scale consisting of not necessary, useful, desirable and necessary (Midlov et al., 2015).

No fixed value exists as measurement of consensus, with some ranging from 51% to 80% (Brinkman et al., 2018; Hasson et al., 2000; Midlov et al., 2015; Scheibe et al., 1975). Although there is a natural tendency for Delphi studies to centralise and reach some form of consensus, differential distributions and multimodal responses should be investigated as these may suggest important clefts in opinion (Scheibe et al., 1975). Assessing the stability of opinion (Linstone & Turoff, 1975) rather than convergence may thus be a better indicator (Hasson et al., 2000; Linstone, 1975; Scheibe et al., 1975) as it may preserve multimodal responses (Scheibe et al., 1975). As there is a tendency for participants to change their opinions during iterations, measurement of movement towards the mode can be done and the stability thereof assessed (Scheibe et al., 1975). Stability has been suggested to be achieved when score changes are ≤13% (Scheibe et al., 1975). Humans tend to gravitate towards certainty, and as such, during consolidation of a Delphi study, it may become uncomfortable to accept results that do not present with high levels of consensus (Linstone, 1975). Although an initial response may be to accept this as a failure of the system, such results may in fact emphasise the uncertainty regarding a given topic (Linstone, 1975). In this sense, the ontological view of a topic determines the way in which a topic is viewed, often leading to an optimism-pessimism bias (Linstone, 1975). Although invariably difficult to control for extreme viewpoints on such a spectrum, design elements in iterations may help overcome or acknowledge such issues (Linstone, 1975).

6. Methods

As it would be inappropriate to try and determine the most appropriate pharmacology curricula from a generalised perspective, it was necessary to approach each healthcare practitioner's general needs, targeted needs, learning outcomes and assessment criteria within the confines of their profession. As such, all investigations were performed for each healthcare practitioner without overlap of experts and curricular documents. The study flow is provided in Figure 2.5.

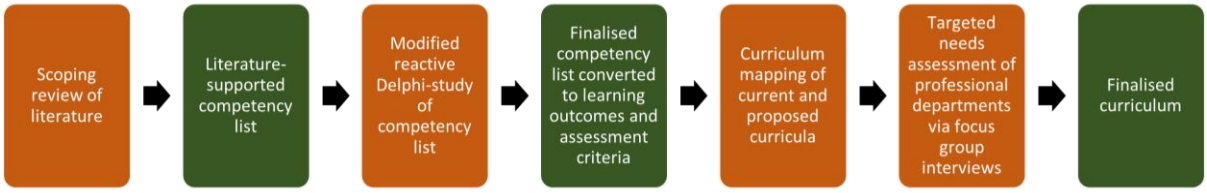

FIGURE 2.5: STUDY FLOW, WHERE ORANGE INDICATES DATA COLLECTION, AND GREEN REPRESENTS ARTEFACTS OF DATA COLLECTION

6.1. General needs assessment

The general needs assessment was conducted in two phases: a scoping review, and a Delphi study. The scoping review was used to formulate the competency list for the Delphi study.

6.1.1. Scoping review for compilation of competency lists

The scoping review framework of Mak and Thomas (2022) was used to source relevant literature. Seven databases were selected to extract information of pharmacological competencies for the relevant healthcare practitioners, which includes those that would index journals focusing on education, professional practice and discipline-specific research: EBSCOhost Academic Search Complete, EBSCOhost Education Resources Information Center, EBSCOhost Health Source – Consumer Edition, EBSCOhost Health Source – Nursing/Academic Edition, EBSCOhost Medline, Scopus, and Web of Science. Where possible, institutional resources were included when available as publicly available resources. Three primary concepts and their synonyms were used to refine search results in combination with the AND and OR Boolean operators: competencies, pharmacology and (the respective healthcare practitioner) (Table 2.2). Search results from databases were extracted as Research Information Systems (RIS) file formats and imported into Mendeley Reference Manager (Mendeley Ltd.). A systematic process was followed where i) citations were combined, ii) duplicates were removed, iii) citations' titles and abstracts were screened for relevance, iv) relevant full-text articles were screened based on inclusion criteria, and v) information was extracted. A second reviewer was used to reduce the risk of bias during the scoping review process. Eligibility criteria were defined as per Table 2.3.

TABLE 2.2: CONCEPTS USED TO SEARCH FOR RELEVANT LITERATURE ON JOURNAL DATABASES

Words related to …	Concept(s) used for search
Competencies required by the profession to perform their duties, AND	Competency, competence, competencies, skills, abilities, graduate attributes, OR attributes
The pharmacology discipline, AND	Pharmacology
The dietetics*, nursing and physiotherapy profession	Dietician, dietetics, dietitian, nutritionist, OR nutrition sciences
	Nurse, nursing, OR nursing sciences
	Physiotherapy, physiotherapist, physical therapist, OR physical therapy

*PRELIMINARY SEARCHES PRIOR TO THE SCOPING REVIEW SUGGESTED SOME OVERLAP IN CERTAIN PUBLICATIONS REGARDING THE DIETITIAN AND NUTRITIONIST; HOWEVER, THEY WERE CONSIDERED TWO SEPARATE PROFESSIONS. THIS WAS TAKEN INTO CONSIDERATION CONTEXTUALLY WHEN PERUSING THE LITERATURE.

TABLE 2.3: INCLUSION AND EXCLUSION CRITERIA FOR ELIGIBILITY SCREENING

Inclusion	Exclusion
English articles or published curricula only	Articles other than English
Full-text articles only (if publication)	No full-text available
Indication of pharmacological competency needed for the profession	Competencies unrelated to pharmacology or not explicitly inferred
Professions speak to dietetics, nursing or physiotherapy	Unrelated to dietetics, nursing or physiotherapy, or at an advanced practitioner qualification level

Data from literature was extracted with the following in mind: author(s); article title; the reason for eligibility/exclusion; competencies mentioned and/or the context, and depth or expectation of it (where possible). Items were transferred into a preliminary list and combined where they referred to the same competency and/or context thereof. Generic competencies were included as a final element of the competency list.

6.1.2. Delphi study for discussion of competency lists

The results of the scoping review were discussed with expert panels using a modified reactive Delphi study (Avella, 2016; Brinkman et al., 2018; Thangaratinam & Redman, 2005) facilitated by Qualtrics XM (Qualtrics) as the online survey platform.

6.1.2.1. The Delphi panel

Within the confines of this study, an expert was defined as an individual with a qualification in the field (i.e., accredited degree in the healthcare profession), registered with a regulatory authority (i.e., Health Professions Council of South Africa [dietitians and physiotherapists] or South African Nursing Council [nurses], or a non-South African equivalent where relevant) and was in industry, clinical practice, academia or professional societies/regulatory bodies. An initial marketing drive was performed to contact the Head of Department/director of i) various academic institutions across South Africa that were involved with the undergraduate training of dietitians, nurses and physiotherapists; ii) boards of the regulatory bodies overseeing their accreditation; iii) professional societies linked to the professions, and iv) the SAFRI health professions education fellowship. The Heads of Department or directors were requested, with a full description of the study, its purpose and the processes to be conducted, to indicate any individuals that would be relevant to the study. The rationale for doing so was to facilitate an initial vetting of experts and avoid inclusion of participants outside of the sphere of expertise. The SAFRI health professions education fellowship was included for the explicit purpose of incorporating individuals with an additional background in education from a scientific perspective, rather than just those with profession-specific knowledge and experience. Given the group, representation from academic, societal, professional and educational points of view could be included to facilitate discussion and avoid a biased perspective. However, the possibility does exist for an individual to be represented on more than one platform. The Delphi panels for each profession consisted of 16 dietitians, 50

nurses and 28 physiotherapists. Participants were allowed two to four weeks to provide feedback on the Delphi questionnaires, with three reminders sent.

6.1.2.2. The Delphi questionnaire

Three rounds were conducted to achieve consensus, with each iteration requesting consent from participants prior to starting the questionnaire. The questionnaire comprised a demographics and competency section. Demographics were collected to describe participants, though lacked any identifying characteristics to ensure anonymity. The competency section contained the competency list that was bracketed into four subsections: I) pharmacological competencies, II) competencies related to pharmacotherapy/diseases, III) cognitive level of ranked competencies, and IV) generic competencies. The competency list was distributed to two academics for content validity and pre-Delphi review to assist with face validation, readability and formulation of the questions. Feedback was incorporated where possible to streamline the questionnaire prior to its release to the Delphi panel. Validation feedback was directed towards editorial styling and composition of competencies (such as language), clarification of pharmacologyical concepts that may be nuanced to the reader (mitigated through addition of definitions), and elaboration of instructions regarding Bloom's taxonomy (altered through the addition of examples of the various levels in context).

6.1.2.3. Phases of the Delphi study

Participants were asked to rank competencies on a 4-point Likert scale; a rating of 3 and 4 was considered important for inclusion. Piping logic was used to display participants' selected important competencies to be ranked in terms of cognitive level based on Bloom's simplified taxonomy for cognition (remember to create). As such, competencies considered unimportant by the participant were not displayed and thus cognitive level rating was negated. Generic competencies were not ranked by cognitive level. A single domain for Bloom's taxonomy (i.e., cognitive) was used to mitigate loss of participants as the risk of limited knowledge of the taxonomy could impact their willingness to complete it. Participants were provided with a short visual indication of the expectations at each level of Bloom's taxonomy within the cognitive domain. Participants could enter additional competencies or pharmacotherapy that they believed may not have been included using open-ended questions for review during Phase II. An interquartile range (IQR) ≤ 1 was considered for an item to have reached consensus.

Any items that did not reach consensus or were newly included in a prior phase were included in Phase II and Phase III for re-testing. Participants were made aware of the median score of each item to facilitate their review. Any items that did not reach consensus after Phase III were bracketed into the median's classification of their importance or cognitive level, noting that consensus was not reached. The cognitive level for items that did not reach consensus was not bracketed into a specific level of Bloom's taxonomy, but rather as lower or higher order, depending on where it was ranked.

6.2. Targeted needs assessment

The targeted needs assessment was conducted in two phases: as a curriculum mapping exercise, and secondly as a focus group interview with the respective departments involved in the study. The curriculum mapping was used to inform the focus group interview.

6.2.1. Curriculum mapping of the current pharmacology curriculum

To assess the current broad alignment of the pharmacology curriculum within each healthcare profession, curriculum mapping was performed. The curriculum mapping was taken from a broad level to assess how many and whether any learning outcomes tie into pharmacological competencies currently being taught in the curriculum. The rationale for collecting this data was to highlight current strengths and weaknesses within the pharmacology curriculum's alignment, which in itself helps for the basis of targeted needs analysis for focus group discussion.

Study guides – formal guides providing information on the module, including the learning outcomes and assessment criteria – were sourced from the Departments of Human Nutrition, Nursing and Physiotherapy at the University of Pretoria. For each healthcare profession, a separate Microsoft Excel v2308 (Microsoft) workbook was created. Learning outcomes and assessment criteria were plotted into each respective healthcare profession's workbook in individual rows and individual sheets, with each sheet being linked to the module code of the study guide. Within each module's sheet, columns were created for FAR 381 and FAR 382 to indicate whether an assessment criterion linked to Pharmacology, regardless of being prior to, running parallel, or being after the Pharmacology module.

Within each workbook, sheets were created for FAR 381 and FAR 382 with all learning outcomes and assessment criteria plotted into them; however, subsequent columns were created in the sheets for each module within the healthcare profession. In each module's column the respective learning outcome that tied to Pharmacology assessment criteria was plotted. Where relevant, learning outcomes of FAR 381 that created pre-requisite knowledge for FAR 382 were also plotted.

The number of links defined as the number of modules that has one or more learning outcomes relevant to pharmacology was calculated using the COUNTIF function, and their order within the programme – prior to, parallel-running, or after pharmacology, or any combination thereof – calculated using the SWITCH function. Emphasis was placed to determine links between modules of interest, including Physiology and the healthcare practitioner-specific disciplinary modules.

To support the depth of the study guides, yearbooks (formal summarised descriptions of the module purpose, requirements and timeframe) were used to enrich information from the study guides; however, these were purely used for descriptive purposes in the discussion as no learning outcomes or assessment criteria were provided in them.

6.2.2. Curriculum mapping of the proposed pharmacology curriculum

Using the documents prepared in Section 6.2.1, the proposed pharmacology curriculum was plotted into a sheet; however, it lacked distinction as FAR 381 or FAR 382 and was considered rather as one full module. All assessment criteria were remapped according to the associated modules in the programme, and the number of links and order calculated. The number of physiology-related, pharmacology-related and new assessment criteria was also calculated and compared to the current pharmacology curriculum.

6.2.3. Focus group interviews

The Heads of Department of the three healthcare practitioners were contacted to request access to relevant staff for their input into the pharmacology curricula. Academic staff that were involved with the training of each healthcare practitioner were provided with an informed consent document as well as the proposed pharmacology curriculum. A semi-structured interview document was drafted based on the findings of the curriculum mapping (Section 6.2.2) that focused on the following three aspects: i) whether students developed pharmacological competencies; ii) whether their physiological knowledge was sufficient to develop pharmacological competencies; and iii) alignment of the new proposed curriculum with their graduate needs. One hour focus group sessions were held and audio-recorded. Audio-recordings were transcribed through Dragon Professional Speech Recognition v16 software (Nuance Communications) and confirmed for accuracy. To aid the focus group interview, participants were requested to make direct commentary on the proposed pharmacology document provided in support of their statements in the focus group interview, or to elaborate should there be unique considerations that required more specific mention.

6.3. Data analysis

As a mixed-methods study, data analysis was conducted both quantitatively and qualitatively.

6.3.1. Quantitative data analysis

Responses from Qualtrics XM were exported as a Statistical Package for the Social Sciences (SPSS) file format for frequency analysis in SPSS. Data was expressed as the median and IQR, where an IQR ≤1 was considered as reaching consensus in the Delphi study. All other collected data was expressed as the mean ± standard deviation.

6.3.2. Qualitative data analysis

Data charted from the scoping review was compiled and assessed in context of the literature in which it was presented. Cross-referencing of concepts and rationale was made within the context of the healthcare practitioners' scope of practice or commonly used treatment modalities to ensure alignment.

A three-step inductive analysis approach was used for transcribed focus groups: i) initial coding, ii) organisation of codes into descriptive items, and iii) grouping of descriptive items into themes. For qualitative analysis, scientific rigour was maintained as per recommendations by Creswell (2007). Validity was confirmed by triangulating the results of the focus group interview with the data collected from the curriculum mapping, cross-referencing to feedback provided from the proposed pharmacology curriculum via the provided document, acknowledging biases via positionality declaration, and sourcing information from clinical experts. To aid transferability, quotations were provided in full to ensure thick, rich description, though the limited sample size was acknowledged to indicate potential areas of ambiguity or deficit.

6.4. Ethics considerations

Ethics approval was granted by the Research Ethics Committees of the Faculties of Education (HU 19/06/01) and Health Sciences (EDU 056/19). Additional ethics and gatekeeper clearance was obtained from each participant institution for the Delphi study. Participants were requested to provide consent for communication in alignment with the Protection of Personal Information Act, 2013. Participants consented to be involved in the Delphi study via a consent page before starting the Delphi study. Anonymity was maintained throughout all investigations. All participants of the focus group interview were provided with an informed consent detailing the project, with anonymity maintained.

Chapter 3
A dietetics-relevant pharmacology curriculum

Let food be thy medicine and medicine be thy food.

'Hippocrates' (Cardenas, 2013, p. 1)[2]

1. Introduction

Chapter 3 reports on the development of a pharmacology curriculum for the dietitian, with a particular focus on creating learning outcomes and assessment criteria within the context of the University of Pretoria's current Dietetics programme.

2. The dietitian

The role of the dietitian within the healthcare sector as one of the healthcare practitioners of interest within my undergraduate module, including their pharmacological education, is discussed.

2.1. The scope of practice of the dietitian, and its relation to pharmacology

Nutrition has been acknowledged as an underlying factor in various diseases' development and progression, reinforcing healthy lifestyle choices with food to prevent illness (Bednarczuk & Czekajło-Kozłowska, 2019; Lee et al., 2022; Meloncelli et al., 2020; Wansink & American Dietetic Association, 2006). A healthy nutritional balance may prevent, delay or treat various lifestyle conditions, for example, non-communicable diseases (e.g., cardiovascular conditions, metabolic syndrome) potentially underpinned by nutritional choices (Bednarczuk & Czekajło-Kozłowska, 2019; Eglseer & Bauer, 2020). In doing so, nutrition may thus delay the need for pharmacotherapeutic intervention. Dietitians are ideally placed to approach the nutritional aspects of healthcare that do place them in an environment where pharmacotherapy is used.

Dietitians are tasked with the evaluation and improvement of their patients' or clients' nutritional status and choices to prevent, treat or manage nutrition-related disorders (Ahmad, 2021; Kose et al., 2021; Professional Board for Dietetics and Nutrition, 2016) by using the science of food and nutrition (International Confederation of Dietetic Associations, 2016). The American Dietetic Association speaks particularly of the importance of dietitians to advocate for and promote nutrition information that is situated in science and evidence, rather than so-called food quackery that feeds off and promotes misinformation (Wansink & American Dietetic Association, 2006). This is particularly important given the changes in nutritional trends over years, such as vegetarianism, veganism and sports nutrition (Arenas-Jal et al., 2020). In doing so, dietitians aim

[2] Although a widely used quotation, it is contested to be an accurate quotation from Hippokrates. It does not infer that food is considered medicine in the Hippokratic philosophy of medicine.

to improve the quality of life of patients via medical nutrition, patient education and evidence-based nutritional practice (Wansink & American Dietetic Association, 2006).

Patients that approach dietitians may be prescribed pharmacotherapy for different reasons, including acute and chronic diseases (Bednarczuk & Czekajło-Kozłowska, 2019; Kose et al., 2021; Meloncelli et al., 2020; Mestres & Duran, 2012), surgical procedures (Mestres & Duran, 2009, 2012), or as supplements to their lifestyle (Arenas-Jal et al., 2020; Wansink & American Dietetic Association, 2006), or require their services due to the nutritional impact of medication (D'Alessandro et al., 2022; Eglseer & Bauer, 2020). Although not authorised to prescribe medicine (D'Alessandro et al., 2022), they do require a broad understanding of pharmacology to navigate the comprehensive treatment plan with which a patient may be engaging that includes medication or biologically active substances (D'Alessandro et al., 2022; Kose et al., 2021). Medical nutrition, the practice of using nutrients to facilitate health outcomes, may beneficially or negatively influence pharmacotherapy that necessitates comprehension of the overlapping biological properties of nutrients and pharmacology (Mestres & Duran, 2009) to be cognisant of the drug-food interactions or medicine-based alterations to nutritional status (e.g., mineral loss or accumulation) (Mestres & Duran, 2009; Professional Board for Dietetics and Nutrition, 2016). In such a way, dietitians would need to establish a patient record of all pathologies and medication being taken so that a panel of potential drug-food interactions can be drawn up, including relevant adverse effects, nutritional alterations, and potential ways to overcome these through diet (Ahmad, 2021; D'Alessandro et al., 2022; Mestres & Duran, 2009, 2012).

Apart from the potential co-administration considerations during treatment, various medicines may aggravate metabolic diseases or alter nutritional status (including minerals, vitamins, fluid and macronutrients) as adverse effects, leading to deterioration in patients' quality of life (D'Alessandro et al., 2022; Mestres & Duran, 2012). For example, antiretroviral therapy for HIV/AIDS is well-known to alter fat distribution and increase the chances of metabolic syndrome (Koethe et al., 2020), while steroidal anti-inflammatory drugs alter glucose metabolism, thus impacting diabetic outcomes (D'Alessandro et al., 2022). The pharmacokinetic profiles of drugs (how drugs are absorbed, distributed, metabolised and excreted by the body) may be altered by changes in the nutritional status (Mestres & Duran, 2012; Wiernikowski & Bernhardt, 2020). For example, malnutrition during chemotherapy impacts the deposition of antineoplastic drugs in the body, and ultimately alters their therapeutic efficacy and severity of adverse effects (Wiernikowski & Bernhardt, 2020). Furthermore, altered diet may impact the clinical success of treatments due to drug-food interactions, such as the increased intake of foods containing vitamin K or vitamin C that may debilitate or enhance the anticoagulant effects of warfarin respectively (Couris et al., 2000). Concerningly, knowledge deficiencies for food-drug interactions have not been studied extensively, but have been remarked by some healthcare practitioners (Couris et al., 2000; Osuala et al., 2021). For example, various healthcare practitioners, including dietitians, have displayed poor knowledge of vitamin K-based interactions with warfarin (Couris et al., 2000), generalised food-drug interactions and timing of administration considerations (Osuala et al., 2021), and general nutrient-drug interactions (Couris et al., 2000; Osuala et al., 2021).

As per the Health Professions Act 56 of 1974 (Republic of South Africa, 1991), dietitians in South Africa are legally allowed to guide patients' health using nutrition and dietary principles (Box 3.1), often in relation to a medical doctor's treatment (Professional Board for Dietetics and Nutrition, 2016). Dietitians are registered with the HPCSA as healthcare practitioners under the domain of the Professional Board for Dietetics and Nutrition (Professional Board for Dietetics and Nutrition, 2016). According to the 2016 HPCSA's Professional Board for Dietetics and Nutrition report, core competencies of the dietitian include understanding basic sciences in relation to human nutrition, as well as the interactions between food and drugs (Professional Board for Dietetics and Nutrition, 2016). Although the HPCSA report provides some guidance, the broad description fails to unpack the complex relationship and depth of knowledge that will be needed for the basic sciences. The International Confederation of Dietetic Associations' international competency standards echo these requirements, stating that dietitian graduates need to integrate basic sciences, including pharmacology, into their services to ensure safe practice (International Confederation of Dietetic Associations, 2016). Furthermore, given the increased popularity of various herbal, sports and dietary supplements, the importance of understanding the biological mechanisms underpinning their clinical effects, whether therapeutic or adverse, is clear (Wansink & American Dietetic Association, 2006). Although there has been a proposal for a pharmacology curriculum for dietitians (Mestres & Duran, 2012), it lacks national relevance, is dated, and may not encompass the full spread of core competencies needed. Although accreditation documents and literature may speak to the exit level outcomes of the profession, they do not adequately guide the basic sciences' educator on how to approach their education effectively.

BOX 3.1: SCOPE OF PRACTICE OF THE DIETITIAN IN SOUTH AFRICA AS PER THE HEALTH PROFESSIONS ACT 56 OF 1974 (REPUBLIC OF SOUTH AFRICA, 1991). REPRODUCED VERBATIM AS PER THE ACT. TEXT IN RED INDICATES WHERE THERE IS A CLEAR RELATION TO PHARMACOLOGY

The following acts are acts which shall for the purposes of the application of the Act be deemed to be acts pertaining to the profession of dietetics:

a The application of knowledge and skills by:

(i) the establishing and applying of guidelines for the maintenance of healthy nutritional practices for individuals;

(ii) the applying of dietary principles as part of the treatment of an individual, relative to a specific disease and following a prescription by a medical doctor;

(iii) the establishing and applying of guidelines for adequate food and nutrition in the community in institutions for healthy and for ill persons;

(iv) participation in research on aspects of dietetics;

(v) participation in formal and informal education in the field of dietetics.

b The promotion of community nutrition by:

(i) the accurate interpretation of the science of normal and therapeutic nutrition;

(ii) the professional communication of scientifically-based nutrition knowledge, according to need, to individuals and groups within the community in order to motivate them to maintain or change nutritional behaviour in order to improve quality of life and to prevent nutrition-related diseases.

c	Contributing to therapeutic nutrition by the compilation and application of scientifically-justifiable dietary measures as part of the treatment of a patient or client following referral by, or consultation with, a medical doctor.
d	The promotion of food service administration by the planning, development, control, implementation and evaluation of and guidance in respect of suitable food service systems for the provision of balanced nutrition to groups in the community and in institutions for healthy and for ill persons.

Dietetic programmes invariably differ among institutions, and thus an overarching discussion of how the University of Pretoria approaches it has been provided.

2.2. The Bachelor of Dietetics degree at the University of Pretoria

The Bachelor of Dietetics degree presented by the Department of Human Nutrition at the University of Pretoria is a four-year programme, where students are enrolled for a broad range of fundamental (regarded as important for the scaffolding of learning) and core modules (regarded as unique to the qualification and professional scope of the degree) (Table 3.1).

Pharmacology is studied in the first semester of the third year (FAR 381) alongside students of the bachelor programmes for Nursing Science, Physiotherapy and Science. According to the programme's South African Qualifications Authority (SAQA) accreditation, it requires registered dietitians to plan medical nutrition accordingly in different patient groups with variable diseases (South African Qualifications Authority, 2018a). During their 2018 accreditation review by the HPCSA, the previous coordinator of the Bachelor of Dietetics programme had to reduce the overall credit load by removing certain modules from its structure. The programme coordinator, in their capacity as the organiser of the degree, included FAR 382 among the removed modules, from 2020 onwards. The decision to remove FAR 382 and other modules was taken based on an internal review of the full programme by the Department of Human Nutrition alongside stakeholder discussions with course coordinators of their service modules (such as Biochemistry, Physiology and Pharmacology). The decision to eliminate modules from its programme was not taken lightly and was necessary for programme continuation and reduction of the content-heaviness thereof, and thus guiding principles for decision-making included the relevance of the broader purpose of the modules, learning that could be relegated to other core modules, and exit level outcomes of the programme (Box 3.2) (South African Qualifications Authority, 2018a).

TABLE 3.1: STRUCTURE OF THE BACHELOR OF DIETETICS PROGRAMME AT THE UNIVERSITY OF PRETORIA (UNIVERSITY OF PRETORIA, 2024B)

Module type	Year I	Year II	Year III	Year IV
Fundamental	• Academic Information Management • Chemistry (inorganic) • Chemistry (organic) • Academic English • Molecular And Cell Biology • Academic Orientation	• Biochemistry (proteins and enzymes) • Biochemistry (carbohydrates) • Biochemistry (introductory concepts) • Physiology (respiratory, renal and skin physiology, acid-base balance) • Physiology (nutrition, digestion, metabolism, hormonal control, reproduction)	• Pharmacology	• None
Core	• Dietetic Profession • Cultural Eating Patterns • Physiology (introductory, neurological, and muscle physiology) • Physiology (body fluids, haematology, cardiovascular and lymphatic physiology, body defence mechanisms) • Integrated Healthcare Leadership	• Nutrition Education • Human Nutrition (scientific principles) • Human Nutrition (nutrition in life cycle) • Integrated Healthcare Leadership • Basic Food Preparation and Techniques • Food Commodities and Preparation	• Community Nutrition • Dietetic Counselling • Clinic And Discussion Class • Integrated Healthcare Leadership • Medical Nutrition Therapy (communicable diseases) • Medical Nutrition Therapy (non-communicable diseases) • Nutritional Assessment • Research Methodology • Food Service Management • Large-Scale Food Production	• Community Nutrition • Internship Training in Community Nutrition • Dietetic Profession • Integration In Dietetics • Internship Training in Food Service Management • Advanced Human Nutrition • Medical Nutrition Therapy • Internship Training in Medical Nutrition Therapy • Research In Healthcare Science

BOX 3.2: EXIT LEVEL OUTCOMES OF THE BACHELOR OF DIETETICS AT THE UNIVERSITY OF PRETORIA TAKEN VERBATIM FROM THE ACCREDITATION DOCUMENTATION (SOUTH AFRICAN QUALIFICATIONS AUTHORITY, 2018A). NO EXIT LEVEL OUTCOMES EXPLICITLY REFER TO PHARMACOLOGY

Learning outcomes:
Screening/Needs assessment/Situation analysis

- A demonstrable ability to screen and assess nutritional status and the concomitant health risk of clients/patients and groups in communities/institutions by applying socio-economic evaluation, anthropometrics evaluation, dietary evaluation, clinical evaluation and biochemical evaluation.
- A demonstrable ability to analyse and interpret demographic, socio-economic, anthropometrics, dietary, clinical and biochemical data to identify nutrition and related health risks and problems.
- A demonstrable ability based on the appropriate methods of nutrition assessment to predict, types and severity of nutrition and related health problems, which may occur in group(s) in communities/or public.
- A demonstrable ability to diagnose based on the appropriate methods of nutrition assessment, the type and severity of nutrition problems or special nutritional needs of individual patients/clients.
- A demonstrable ability for in-depth cause analysis of nutrition problems based on appropriate conceptual frameworks and scientific and contextual information.
- A demonstrable ability to assess patient/client/group food preferences.
- A demonstrable ability to determine needs for nutrition services, including nutrition health promotion.
- A demonstrable ability to assess the training needs of individuals and/or groups in communities/institutions involved in nutrition service delivery to ensure capacity building in this regard.

Planning, implementation, evaluation and documentation of nutrition service delivery

- A demonstrable ability to collaborate with all stakeholders in the selection, planning, implementation and evaluation of appropriate intervention strategies to address nutrition and related health problems of groups in communities and/or the public.
- A demonstrable ability to facilitate and monitor community or public participation in the selection, planning, implementation and evaluation of appropriate intervention strategies.
- A demonstrable ability to select, plan, implement, monitor, evaluate and document appropriate nutrition care and education (i.e., nutrition care plan) for individual patients/clients with specific disease conditions or special nutritional needs in different settings.
- A demonstrable ability to collaborate with the different members of the healthcare team to select, plan, implement and evaluate the nutrition care and education of individual patients/clients with specific disease conditions or special nutritional needs.
- A demonstrable ability to ensure and monitor patient/client compliance with the nutrition care plan.
- A demonstrable ability to compile appropriate menus to comply with patient/client and/or group nutritional needs and food preferences.
- A demonstrable ability to plan and control food procurement (i.e., food storage and issuing), production and distribution of the final product.
- A demonstrable ability to develop and standardize recipes for specific needs of patients/clients and /or groups in communities.
- A demonstrable ability to establish food quality standards as well as procedures to monitor these standards with reference to nutritional, sensory and microbiological aspects.
- A demonstrable ability to compile specifications for areas, space and equipment needed for optimal work flow and production based on the menu and purchasing and production policies.

- A demonstrable ability to compile food and nutritional product specifications.
- A demonstrable ability to integrate the food service system as part of the business and healthcare focus.
- A demonstrable ability to monitor patient/client/group satisfaction with service delivery.
- A demonstrable ability to adapt the intervention strategy/nutrition care plan/food service based on feedback from continuous monitoring of service delivery.

Communication

- A demonstrable ability to communicate effectively with individuals and groups at different levels with various cultural, social, educational, political and economic contexts using the oral, written and electronic media.
- A demonstrable ability to advocate for nutrition-related issues for various purposes.
- A demonstrable ability to conduct appropriate training according to the identified needs of groups in communities and/or the public.

Management

- A demonstrable ability to apply appropriate approaches and techniques to effectively manage human resources, finances and operational procedures.
- A demonstrable ability to compile, implement, monitor and evaluate a business plan/project.
- A demonstrable ability to comprehend and implement internal and external policy in management.
- A demonstrable ability to evaluate and recommend adjustments to nutrition service delivery regarding food procurement, production and distribution.
- A demonstrable ability to review, evaluate and recommend adjustments to nutrition service delivery regarding intervention strategies to address nutrition and related health problems of groups in communities and/or the public.
- A demonstrable ability to review, evaluate and recommend adjustments to nutrition service delivery regarding the nutrition care of individual patients/clients with specific disease conditions or special nutritional needs.

Research

- A demonstrable ability to assess, critically review and apply relevant scientific information.
- A demonstrable ability to participate in the formulation of a research problem, the design of an appropriate research project, the collection, analysis and interpretation of the data, the presentation of results, the writing of a research report and the identification and formulation of practical applications of the research results.

Intra-professional focus

- A demonstrable ability to apply standards of practice and professional ethics.
- A demonstrable ability to function constructively in a team or a group.

Critical cross-field outcomes:

- Within the scope of practice (therapeutic nutrition, community nutrition and food service management) and in the contexts of institutions, private practice and communities the following critical cross-field outcomes are indicated:
- Identifying and solving problems in which responses display that responsible decisions using critical and creative thinking have been made;
- Working effectively with others as the member of a team, group, organisation, community;
- Organising and managing oneself and one's activities responsively and effectively;
- Collecting, analysing, organising and critically evaluating information;
- Communicating effectively using visual, mathematical and/or language skills in the modes or oral and/or written persuasion;
- Using science and technology effectively and critically, showing responsibility towards the environment and health of others;
- Demonstrating and understanding of the world as a set of related systems by recognising that problem-solving context do not exist in isolation;
- Computer literacy;

- Contributing to the full personal development of each leaner and the social and economic development of the society at large, by making it the underlying intention of any programme of learning to make an individual aware of the importance of:
    - Reflecting on and exploring a variety of strategies to learn more effectively;
    - Participating as responsible citizens in the life of local, national and global communities;
    - Being culturally and aesthetically sensitive across a range of social contexts;
    - Exploring education and career opportunities
    - Developing entrepreneurial opportunities.

2.3. My perspective on the current challenge

Given the admixture of students, certain challenges are observed for the whole group of students, while others become more problematic to certain student populations. To facilitate discussion and reduce duplication, these are presented separately below for further referencing in later chapters.

2.3.1. Perceptions of challenges affecting the whole group

At present, challenges have been observed within the FAR 381 module presented to dietetic students. Importantly, these challenges are spoken of in a generalised capacity and do not infer incompetence or poor quality of the graduates of the programme, or speak to the general student. Apart from the commonly observed concerns that have also been reported in literature (Chapter 1, Section 3.2), such as poor knowledge of the basic sciences, application deficiencies and amotivation, other elements have also come to light.

In terms of education, I acknowledge that the learning outcomes of the module are broad, with many treatments most likely not being within the scope of what the healthcare practitioners would engage with frequently. As such, queries on the relevance of certain sections have been raised by students, which admittedly, are not unjustified. The admixture of students creates a reality that learning outcomes may veer outside the scopes of practice of the various healthcare practitioners. Although the depth of education on pharmacological concepts, in my opinion, does not necessarily exceed what would be needed for vertical integration for clinical skills development, there have been observations of inadequate scaffolding or horizontal integration with physiological concepts. For example, at present, a general portion of each session is spent revising physiological pathways relevant to the disease and treatment mechanisms; although this is not unexpected, it is often concerning that their understanding of the pathways is not good enough logically to deduce the integration with pharmacological concepts. As such, conversations during class often deviate away from the pharmacological to the physiological. The reason for this knowledge deficiency is not assumed at present to be linked to prerequisite education alone, as a myriad of factors, including student motivation, secondary school education, socio-dynamic considerations, assessment practice and the programme schedule could impact their ability to delve into the content sufficiently. A recent attempt at resolving this has been the employment of a tutor specifically to address physiological misunderstandings and deficiencies in their understanding, which is supplementary to a pharmacological tutor who focuses only on the concepts related to the disease treatment. Unfortunately, the physiology-focused tutor could only be employed for one year, and thus it is not a sustainable venture.

Clinical indications and considerations are presented during the module. However, it invariably does not delve into the full clinical context due to the diversity of healthcare students' future scopes of practice, and is constrained by the basic sciences' focus of the module. As such, decontextualisation occurs and creates the opportunity for not addressing the most pertinent medicines used within their clinical environment. To accommodate this, South African clinical guidelines (where possible) and the Essential Medicines List (EML) are used to guide nationally relevant content development, and to avoid discussion of medicines that are not used within the public healthcare sector. This does mean that medicines that may be seen in the private sector or future treatments are not discussed fully and detracts from Bachelor of Science students seeing developments within the pharmacological discipline

According to regulations of the School of Healthcare Sciences, healthcare practitioners students are not allowed to take any third-year modules within their final year of study due to the scheduling difficulties that are faced within their clinical training platform and the focus that is needed on their practical components. As such, students are faced with what I have coined the pharmacological guillotine: an excessively stressful reality that should they not pass the Pharmacology module(s), they will need to repeat their third year of study to pass these modules. Based on discussions with students, this becomes an external regulator of motivation to study harder, but also eventually a demotivating factor when progress in the module suggests passing is no longer possible. As many students have a myriad of pressures applied to them, such as non-curricular responsibilities, financial strain and the need not to delay their careers, this eventually becomes a mental health challenge for some. Additionally, it does create stressful discussions between me and the programme coordinators at times about why some students may not be performing adequately, where both parties understand the constraints of the module, programme and student groups, though invariably reiterate the same frustrations year-in, year-out.

2.3.2. Perceptions of challenges affecting the Dietetic group

An overarching consideration of education here that is not touched on sufficiently in the current module in my opinion, is the linking of nutrition and the specific pharmacotherapy that is discussed. For example, although the core concepts related to understanding processes that result in drug-food interactions are focused on, only a few pivotal interactions are discussed while admittedly leaving several others of concern undisclosed due to content-heaviness. There is no specific session dedicated to discussing the impact of nutrition on pharmacotherapy, or vice versa, and thus these are left for discussion outside of the Pharmacology module. As such, the relation to medical nutrition is generally not emphasised and thus could easily be lost without contextualising it to the dietetic practice. The Department of Human Nutrition does provide students with a resource highlighting the effects that nutrition and pharmacotherapy have on one another, but these are not pertinently discussed or moderated within my module.

One can also surmise that core pharmacological concepts that would have been dealt with in FAR 382 may be lacking, such as the treatment of neurological conditions, microbial infections, respiratory disorders, allergies and gastrointestinal complaints. There is an overlap between nutrition and these conditions, particularly in the gastrointestinal system, and thus it may

complicate students' ability to develop the necessary clinical skillset to achieve such competencies.

The time to implement a new pharmacology curriculum is ideal at present as the Department of Human Nutrition is currently altering its Bachelor of Dietetics. A change within the professional standards for dietitians is underway, though has not yet implemented at the University of Pretoria at the time of writing. In 2012, the Professional Board for Dietetics and Nutrition investigated the education of both dietitians and nutritionists in the context of South Africa's healthcare sector (Council on Higher Education, 2023). Given the findings that scope of practice overlap and unclear role delineations impact professional services and health-related service delivery, the decision was reached to alter education to a single general nutrition profession (Council on Higher Education, 2023). In 2022, the role of the dietitian-nutritionist practitioner - who like dietitians, applies science-based food and nutrition practice to promote health, prevent disease and treat illnesses - was delineated (Council on Higher Education, 2023). Foundational knowledge of the basic sciences is still needed to develop their clinical competencies (Council on Higher Education, 2023). Prior to the completion of this study, the Department of Human Nutrition already restructured the programme to remove Pharmacology as a stand-alone module, but rather integrate it appropriately within their Medical Nutrition Therapy modules. As such, a framework for implementation has positioned the changes to the curriculum to a certain degree, which does help structure recommendations based on the findings of the study.

3. Results of the study

The results of the study are presented in two separate parts as the general needs assessment (comprising the scoping review and Delphi study) and targeted needs analysis (comprising the curriculum mapping and focus group interviews).

3.1. General needs assessment

The results of the general needs assessment are first presented as the scoping review, which guided the construction of the Delphi study.

3.1.1. Scoping review

A total of 853 records were captured during the scoping review. However, only 29 were screened as full-text sources as shown in Figure 3.1. A fair agreement between reviewers was noted (Cohen-κ = 0.366), owing to predominantly difficulty in differentiating between inference versus direct statements of competencies, and the large number of off-target hits. Five sources were used to compile the list of competencies as summarised in Table 3.2: two institutional general Pharmacology module guides, and three publications. Other sources were excluded based on their lack of relation to pharmacology or dietetics (nutritionists were not included); a focus on the pharmacology of nutrients; unclear relevance to competency; or full-text versions not being available. The module guides' descriptions of competencies varied in-depth and explicitness towards concepts, and were overtly generalised to health sciences, however, did allow for broadening of the initial list for review.

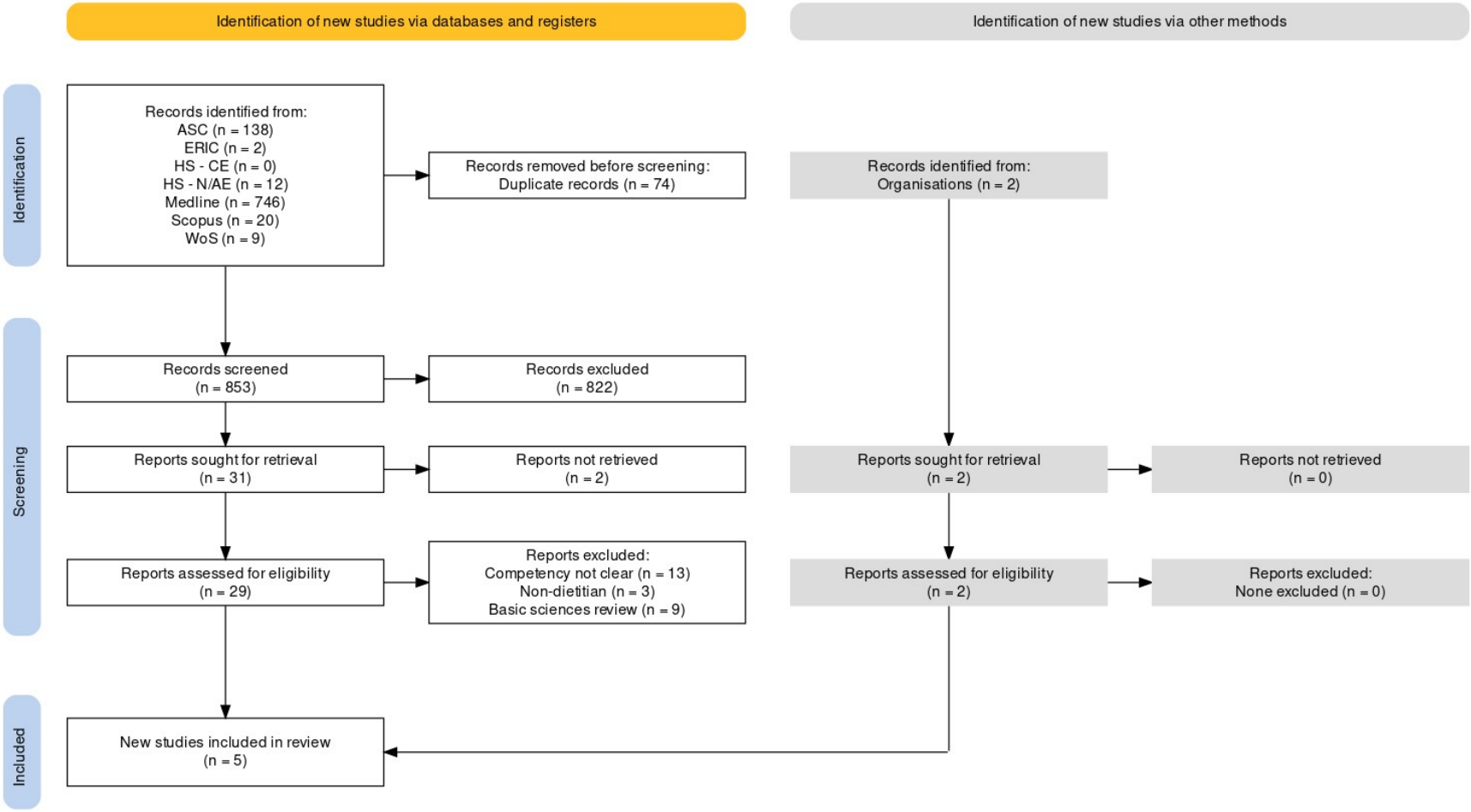

FIGURE 3.1: PRISMA DIAGRAM OF PHARMACOLOGICAL COMPETENCIES RELATING TO DIETETICS

ABBREVIATIONS: ASC – EBSCOHOST ACADEMIC SEARCH COMPLETE; ERIC – EBSCOHOST EDUCATION RESOURCES INFORMATION CENTER; HS–CE – EBSCOHOST HEALTH SOURCE – CONSUMER EDITION; HS–N/AE – EBSCOHOST HEALTH SOURCE – NURSING/ACADEMIC EDITION; WOS – WEB OF SCIENCE. GENERATED BY PRISMA2020 (HADDAWAY ET AL., 2022)

TABLE 3.2: FULL-TEXT PUBLICATIONS ELIGIBLE FOR THE DELPHI STUDY FOR THE DIETETICS GROUP

Author	Article title	Format of publication	Study population	Study findings	Justification of competencies	Contextual description of what is needed from the competency
Wix et al. (1992)	Drug-food interaction counselling programs in teaching hospitals	Research paper Questionnaire-based study of drug-food counselling programmes in America	425 participants *Dietitians (48.8%)* *Pharmacists (51.2%)*	Although the topic of food-drug and drug-drug interactions were important, the counselling programmes' impact was not high	Importance of food-drug interaction knowledge in clinical practice	Important for practice, but depth of the knowledge not alluded to
Mestres and Duran (2009)	Importance of pharmacology knowledge by dieticians	Narrative review and opinion piece	Dietitians	Importance of pharmacology within dietetics programmes to allow for clinical competency development	Broad discussion of competencies related to pharmacology in dietetics, including a suggested curricular content list	Important for practice, but the depth of what needs to understood or done with the competency not explained
Callier et al. (2014)	Engaging the next generation of healthcare professionals in genomics: planning for the future	Narrative review and opinion piece	Medical practitioners Nurses Physician assistants Genetic councillors Pharmacists Allied health practitioners (which include dietitians)	Knowledge and practical skills of genomics (which includes pharmacogenomics) is important for all healthcare practitioners, but dependent on their scope of practice	Importance of pharmacogenomics in management of diseases and treatment regimens	Basic understanding of pharmacogenomics with discussion of expectations related to clinical practice

The characteristics of the eligible publications (Table 3.3) show that most were not research-based (n = 2), but rather narrative reviews and opinions, predominantly from the United States of America (n = 2). Although not irrelevant due to their context, given the differences in healthcare settings, it should be seen in light of contextually altered healthcare needs, infrastructure support and healthcare practitioner scopes of practice. The lack of research on pharmacological competencies in Dietetics is concerning, suggesting limited focus on it within health professions education. Literature was dated though, with only one article in the past decade.

A total of 108 competencies (45 pharmacological constructs; 49 pharmacotherapies; 14 generic competencies) were captured from the publications and institutional guides. Given the variable nature of writing of the competencies (for example, as a pure topic or contextualised as an instruction), they were further refined based on content and face validation as summarised inTable 3.4. Competencies were categorised as either predominantly cognitive, psychomotor or affective, based on their context or descriptions within the source. Some competencies were allocated two domains where appropriate when more than one was considered equally valid. A total of 98.94% of the competencies were considered cognitive, 3.19% were categorised as affective and 1.75% as psychomotor. Cognitive domain competencies were focused on the various basic sciences-associated aspects of pharmacology, including the core concepts, pharmacotherapeutic areas, and the interaction of medicines with nutrition. The affective domain competencies related to patient or healthcare practitioner communication, or self-management, while the sole psychomotor competency included communication abilities. All 108 competencies were included for the Delphi study.

Only one of the publications was research-based, while others were broadly opinion pieces driven by narrative reviews and expertise of the authors. Although one publication provided a suggested curriculum (Mestres & Duran, 2012), it was not focused on South Africa and lacked expectations of the cognitive depth that would be needed for such education. Similarly, recommendations relating to drug-food interactions were positioned, though lacked clear relation to what would need to be performed by the dietitian (Wix et al., 1992). Genetic-associated competencies were provided by Callier et al. (2014), and provided some indication of the depth needed (Callier et al., 2014).

TABLE 3.3: CHARACTERISTICS OF FULL-TEXT PUBLICATIONS ELIGIBLE FOR THE DELPHI STUDY FOR THE DIETETICS GROUP

Author	Article title	Country of origin	Research design (if applicable)
Wix et al. (1992)	Drug-food interaction counselling programs in teaching hospitals	United States of America	Quantitative
Mestres and Duran (2009)	Importance of pharmacology knowledge by dieticians	Spain	Non-research
Callier et al. (2014)	Engaging the next generation of healthcare professionals in genomics: planning for the future	United States of America	Non-research

TABLE 3.4: DIETETICS COMPETENCY LIST COMPILED FROM LITERATURE AND INSTITUTIONAL RESOURCES AFTER PRELIMINARY REVIEW OF CONTENT AND FACE VALIDATORS, INCLUDING SUGGESTED DOMAINS (APART FROM GENERIC COMPETENCIES)

Theme	Competency	Domain
General pharmacological principles	Drug research and development	Cognitive
	The role of pharmacology in disease treatment and science	Cognitive
	Biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)	Cognitive
	Common pharmacological concepts	Cognitive
	Medicine compliance in pharmacology	Cognitive
	Common routes of administration used in clinical settings	Cognitive
	Stability of drugs	Cognitive
	Common formulations used in clinical settings	Cognitive
	Principles of pharmacokinetics (the movement of drug into, through, and out of the body)	Cognitive
	Pharmacokinetics: Absorption	Cognitive
	Pharmacokinetics: Distribution	Cognitive
	Pharmacokinetics: Metabolism	Cognitive
	Pharmacokinetics: Excretion	Cognitive
	Principles of pharmacodynamics (the response of the body to the drug)	Cognitive
	The modulation of drug targets to alter (patho)physiological responses	Cognitive
	Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)	Cognitive
	Factors that alter the response to pharmacotherapy	Cognitive
	Essential medicines list	Cognitive
	Medication errors	Cognitive
	The role of different healthcare workers	Cognitive Affective
	The legalities associated with pharmacotherapy	Cognitive
	Acknowledgement of herbal remedies use in pharmacotherapy	Cognitive
Special populations	The need for pharmacogenetics testing (where pharmacogenetics is the effect genetic factors has on drug reactions)	Cognitive
	Interpretation of pharmacogenetics information on drug labels	Cognitive
	Response to treatment in patients with or without pharmacogenetic markers	Cognitive
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	Cognitive
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	Cognitive Affective
Aspects particular to dietetics	Classifications of drug-drug interactions	Cognitive
	Pharmaceutical food-drug interactions	Cognitive
	Pharmacokinetic food-drug interactions	Cognitive
	Pharmacodynamic food-drug interactions	Cognitive
	Short- and long-term consequences of food-drug interactions	Cognitive
	The need for medical consultation to adjust doses or pharmacotherapy as a result of food-drug interactions	Cognitive
	Prevention of food-drug interactions	Cognitive
	Drug interactions with alcohol and tobacco	Cognitive
	Integration of dietetic and pharmacotherapy treatment modalities as an interdisciplinary therapy	Cognitive
	The influence of drugs on the nutritional status	Cognitive
	The influence of nutrition on pharmacotherapy of cancer	Cognitive
	The influence of nutrition on pharmacotherapy of HIV	Cognitive
	The influence of nutrition on pharmacotherapy of organ transplantation	Cognitive
	The influence of nutrition on pharmacotherapy of tuberculosis	Cognitive
	Prescribing of pharmacotherapy	Cognitive
	Interpreting pre-clinical and clinical pharmacological data	Cognitive
	Discussing misconceptions of pharmacotherapy with patients	Psychomotor Affective

Theme	Competency	Domain
	Interpretation of pharmacological research in relation to clinical outcomes	Cognitive
Pharmacotherapy of diseases	Allergies	Cognitive
	Anaemia	Cognitive
	Anaesthesia	Cognitive
	Anorexia and appetite stimulants	Cognitive
	Anxiety	Cognitive
	Asthma and other respiratory diseases	Cognitive
	Bacterial infections	Cognitive
	Cardiovascular diseases	Cognitive
	Constipation	Cognitive
	Contraception	Cognitive
	COVID-19	Cognitive
	Depression	Cognitive
	Diabetes	Cognitive
	Diarrhoea	Cognitive
	Digestive enzymes	Cognitive
	Epilepsy	Cognitive
	Food poisoning	Cognitive
	Fungal infections	Cognitive
	Gall stones	Cognitive
	Gastro-oesophageal disorder	Cognitive
	Gout	Cognitive
	Hepatic encephalopathy	Cognitive
	Hormone replacement therapy	Cognitive
	Hyperlipidaemia	Cognitive
	Infertility	Cognitive
	Inflammation	Cognitive
	Inflammatory bowel disease	Cognitive
	Liver disease	Cognitive
	Malaria	Cognitive
	Muscle relaxation	Cognitive
	Nausea and vomiting	Cognitive
	Nephrotoxicity and dialysates	Cognitive
	Obesity	Cognitive
	Osteoporosis	Cognitive
	Pain	Cognitive
	Parasympathetic nervous system disorders	Cognitive
	Parkinson's disease	Cognitive
	Peptic ulcers	Cognitive
	Prebiotics and probiotics	Cognitive
	Schizophrenia	Cognitive
	Sedation and hypnosis	Cognitive
	Sports performance-enhancing drugs	Cognitive
	Sympathetic nervous system disorders	Cognitive
	Thyroid diseases	Cognitive
	Tuberculosis	Cognitive
	Viral infections	Cognitive
	Vitamin deficiencies	Cognitive
	Vitamins and minerals for wound healing and burns	Cognitive
	Worm infestations	Cognitive
Generic competencies	Critical thinking	
	Problem-solving	
	Communication	
	Collaboration	
	Creativity	
	Innovation	
	Information literacy	
	Media literacy	

Theme	Competency	Domain
	Information and communication technology literacy	
	Adaptability	
	Self-directedness	
	Social and cultural interaction	
	Productivity and accountability	
	Leadership and responsibility	

3.1.2. Delphi study

The Delphi study has been stratified according to the pharmacological, pharmacotherapeutic and generic competencies within the competency list.

3.1.2.1. Participants

The response rate for the Delphi study systematically decreased from Phase I to Phase III (50%, 31.25% and 25%) based on the original number of invitees (n = 16) (Table 3.5). The Delphi panel comprised graduates from South African institutions who conducted their professional practice in South Africa. Most participants held a postgraduate qualification with at least 11 or more years of experience within the dietetic profession. The majority of participants worked both in South African academia and private practices; at least one participant per phase was associated with an accreditation or professional dietetic body.

3.1.2.2. Pharmacological competencies

After Phase I (Table 3.6), participants agreed that 32 of the 45 competencies were important, with three competencies requiring re-testing in Phase II due to a lack of consensus. Only 20 competencies reached consensus in terms of the expected cognitive level. Participants generally agreed about the importance of the competencies. However, there was lower consensus in terms of the expected cognitive level of the relevant competencies. One additional pharmacological competency was recommended in Phase I (i.e., Correct and safe administration of drugs via enteral feeding tubes). Two pharmacological competencies were agreed upon in Phase II as important (Table 3.7), with one requiring re-testing. The expected cognitive level of eighteen items was agreed upon. During Phase III, three items did not reach consensus in terms of cognitive level (Table 3.8). For items that did not reach consensus for cognitive level, their median choice was selected to bracket the competency as either lower cognitive or higher cognitive domain during reporting.

Upon completion of the Delphi study, 35 of the 46 pharmacological competencies were considered important, 10 were unimportant, and one was considered unimportant but lacked consensus (Table 3.9). Consensus was reached for 33 competencies in terms of their cognitive level. Three competencies did not reach consensus on their cognitive level, though were bracketed as lower order (two competencies) and higher order (one competency) based on their median score. From the total list of competencies, a larger proportion of lower order competencies was observed (20 competencies; 55.56%) than higher order (16 competencies; 44.44%). Unexpectedly, consensus was the most difficult to obtain for competencies referring specifically

to the dietetic practice, such as clinical aspects, food-drug interactions, and nutritional alterations that tended to fluctuate between various levels of higher order cognition.

TABLE 3.5: DEMOGRAPHICS OF DELPHI PARTICIPANTS THROUGH ALL THREE PHASES

		Phase I	Phase II	Phase III
Participants		8	5	4
Highest qualification	**Bachelors**	0	1	0
	Honours	1	0	0
	Masters	4	3	3
	Doctoral	3	1	1
Years of experience	**5 to 10**	1	0	0
	11 to 15	2	3	1
	16 to 20	2	1	1
	21 to 25	2	0	1
	26 to 30	0	0	0
	>30	1	1	1
Working in academia*	**South Africa**	5	4	4
	Outside South Africa	1	0	0
Affiliated with professional society*	**South Africa**	1	2	1
	Outside South Africa	0	0	0
Affiliated with accreditation board*	**South Africa**	1	1	1
	Outside South Africa	0	0	0
Working in private practice*	**South Africa**	5	2	1
	Outside South Africa	0	0	0
Working in public hospital*	**South Africa**	1	1	1
	Outside South Africa	0	0	0

*PARTICIPANTS WERE PROVIDED THE OPPORTUNITY TO INDICATE THEIR ASSOCIATION WITH ALL, AND THUS SOME MAY BE PART OF MORE THAN ONE AFFILIATION

3.1.2.3. Pharmacotherapeutic competencies

For pharmacotherapeutic competencies, 48 of the 63 competencies were considered important after Phase I, with eight requiring re-testing (Table 3.6). Seven competencies reached consensus in terms of the expected cognitive level. Four additional competencies were included: cancer therapy; nutrition in cancer, antihypertensives; and HIV therapy. After Phase II (Table 3.7), six pharmacotherapeutic competencies were agreed upon as important, with five requiring re-testing in Phase III. Agreement on the cognitive level was obtained for 32 items. During Phase III (Table 3.8), one competency did not reach consensus on importance, while the cognitive level of five competencies could not be agreed upon.

Of 53 pharmacotherapeutic areas, 44 were considered important, eight unimportant, and one not important (but lacking consensus) (Table 3.9). Thirty-nine competencies were agreed upon in terms of cognitive level, while three were listed as lower order and higher order cognitive levels each due to a lack of consensus. Of the 44 competencies, 14 were categorised as lower order cognitive level (31.11%), and 31 were considered among higher order cognitive levels (68.89%).

Based on the competencies identified as important in the Delphi study, a suggested national curriculum framework for pharmacology education in Dietetics is proposed in Table 3.10, categorising the main learning outcomes based on the core concepts of pharmacology, clinical

practice related to Dietetics, and pharmacotherapeutic areas of relevance to dietitians. Furthermore, it is presented as a summarised visual framework in Figure 3.2.

3.1.2.4. Generic competencies

All generic competencies were considered important to the dietetic profession during Phase I.

TABLE 3.6: COMPETENCY RANKING AFTER PHASE I OF THE DIETETICS DELPHI STUDY (N = 8 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**Drug research and development**	2.00	0.75	Not important	Not included	1	2.00	0.00	Yes	Understand	Not included
	The role of pharmacology in disease treatment and science	3.50	1.00	Important	Included	7	2.00	2.00	No	Understand	Phase II
	Biopharmaceutics	3.00	0.00	Important	Included	7	2.00	0.00	Yes	Understand	Included
	Common pharmacological concepts	3.00	1.00	Important	Included	7	2.00	0.00	Yes	Understand	Included
	Medicine compliance in pharmacology	2.00	1.00	Not important	Not included	2	2.00	0.00	Yes	Understand	Not included
	Common routes of administration used in clinical settings	3.00	1.75	No consensus	Phase II	4	2.50	4.00	No	Understand	Phase II
	Stability of drugs	2.50	1.00	Not important	Not included	3	2.00	0.00	Yes	Understand	Not included
	Common formulations used in clinical settings	3.00	1.50	No consensus	Phase II	5	2.00	4.00	No	Understand	Phase II
	Principles of pharmacokinetics	3.00	1.00	Important	Included	7	3.00	1.00	Yes	Apply	Included
	Pharmacokinetics: Absorption	3.00	1.00	Important	Included	7	3.00	0.00	Yes	Apply	Included
	Pharmacokinetics: Distribution	3.00	0.00	Important	Included	7	3.00	0.00	Yes	Apply	Included
	Pharmacokinetics: Metabolism	3.50	1.00	Important	Included	7	3.00	0.00	Yes	Apply	Included
	Pharmacokinetics: Excretion	3.00	0.00	Important	Included	7	3.00	1.00	Yes	Apply	Included
	Principles of pharmacodynamics	3.00	1.00	Important	Included	7	2.00	1.00	Yes	Understand	Included
	The modulation of drug targets to alter (patho)physiological responses	3.00	0.75	Important	Included	5	2.00	1.00	Yes	Understand	Included
	Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)	2.00	0.00	Not important	Not included	0	N/A.	N/A.	N/A.	N/A.	Not included
	Factors that alter the response to pharmacotherapy	3.00	0.00	Important	Included	7	2.00	2.00	No	Understand	Phase II
	Essential medicines list	3.00	1.00	Important	Included	7	1.00	3.00	No	Remember	Phase II
	Medication errors	2.50	1.00	Not important	Not included	3	2.00	0.00	Yes	Understand	Not included
	The role of different healthcare workers	3.00	0.75	Important	Included	6	3.00	1.50	No	Apply	Phase II
	The legalities associated with pharmacotherapy	2.50	1.75	No consensus	Phase II	3	2.00	0.00	Yes	Understand	Phase II
	Acknowledgement of herbal remedies use in pharmacotherapy	3.00	0.00	Important	Included	6	4.00	1.75	No	Analyse	Phase II
	The need for pharmacogenetics testing	2.00	1.00	Not important	Not included	2	3.00	0.00	Yes	Apply	Not included
	Interpretation of pharmacogenetics information on drug labels	3.00	0.75	Important	Included	5	4.00	2.00	No	Analyse	Phase II
	Response to treatment in patients with or without pharmacogenetic markers	2.50	1.00	Yes	Not included	3	2.00	0.00	Yes	Understand	Not included
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	2.00	0.75	Yes	Not included	1	2.00	0.00	Yes	Understand	Not included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	2.50	1.00	Yes	Not included	3	3.00	0.00	Yes	Apply	Not included
	Classifications of drug-drug interactions	2.50	1.00	Yes	Not included	3	2.00	0.00	Yes	Understand	Not included
	Pharmaceutical food-drug interactions	4.00	0.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	Pharmacokinetic food-drug interactions	4.00	0.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	Pharmacodynamic food-drug interactions	4.00	0.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	Short- and long-term consequences of food-drug interactions	4.00	0.00	Yes	Included	7	4.00	2.00	No	Analyse	Phase II
	The need for medical consultation to adjust doses or pharmacotherapy as a result of food-drug interactions	4.00	1.00	Yes	Included	6	3.50	3.25	No	Apply	Phase II
	Prevention of food-drug interactions	4.00	0.75	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	Drug interactions with alcohol and tobacco	3.00	1.00	Yes	Included	7	4.00	2.00	No	Analyse	Phase II
	Integration of dietetic and pharmacotherapy treatment modalities as an interdisciplinary therapy	4.00	0.00	Yes	Included	7	3.00	3.00	No	Apply	Phase II
	The influence of drugs on the nutritional status	4.00	0.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	The influence of nutrition on pharmacotherapy of cancer	4.00	0.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	The influence of nutrition on pharmacotherapy of HIV	4.00	0.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	The influence of nutrition on pharmacotherapy of organ transplantation	3.50	1.00	Yes	Included	6	2.50	2.50	No	Understand	Phase II
	The influence of nutrition on pharmacotherapy of tuberculosis	4.00	0.00	Yes	Included	7	4.00	4.00	No	Analyse	Phase II
	Prescribing of pharmacotherapy	3.00	0.00	Yes	Included	6	2.00	2.75	No	Understand	Phase II
	Interpreting pre-clinical and clinical pharmacological data	3.00	1.00	Yes	Included	4	2.00	3.00	No	Understand	Phase II
	Discussing misconceptions of pharmacotherapy with patients	3.00	0.75	Yes	Included	5	4.00	3.00	No	Analyse	Phase II
	Interpretation of pharmacological research in relation to clinical outcomes	3.00	0.75	Yes	Included	5	2.00	2.00	No	Understand	Phase II
Pharmacotherapy against diseases competencies	Allergies	4.00	1.00	Yes	Included	6	4.00	1.50	No	Analyse	Phase II
	Anaemia	4.00	0.75	Yes	Included	7	5.00	2.00	No	Evaluate	Phase II
	Anaesthesia	2.00	0.75	Yes	Not included	2	2.50	0.00	Yes	Understand	Not included
	Anorexia and appetite stimulants	4.00	0.75	Yes	Included	4	4.00	2.75	No	Analyse	Phase II
	Anxiety	3.00	0.00	Yes	Included	7	3.00	2.00	No	Apply	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Asthma and other respiratory diseases	3.00	1.75	No	Phase II	4	3.50	3.25	No	Apply	Phase II
	Bacterial infections	3.00	1.50	No	Phase II	5	3.00	2.50	No	Apply	Phase II
	Cardiovascular diseases	4.00	0.00	Yes	Included	7	4.00	2.00	No	Analyse	Phase II
	Constipation	4.00	0.75	Yes	Included	7	5.00	3.00	No	Evaluate	Phase II
	Contraception	2.00	1.00	Yes	Not included	2	3.00	0.00	Yes	Apply	Not included
	COVID-19	3.00	0.75	Yes	Included	5	4.00	2.00	No	Analyse	Phase II
	Depression	3.00	0.75	Yes	Included	6	3.00	2.00	No	Apply	Phase II
	Diabetes	4.00	0.00	Yes	Included	7	5.00	2.00	No	Evaluate	Phase II
	Diarrhoea	4.00	0.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	Digestive enzymes	4.00	0.75	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	Epilepsy	2.50	1.00	Yes	Not included	4	4.00	2.25	No	Analyse	Not included
	Food poisoning	2.50	1.75	No	Phase II	4	4.00	2.25	No	Analyse	Phase II
	Fungal infections	2.00	1.00	Yes	Not included	3	4.00	0.00	Yes	Analyse	Not included
	Gall stones	3.50	1.00	Yes	Included	6	4.50	3.00	No	Analyse	Phase II
	Gastro-oesophageal disorder	4.00	0.75	Yes	Included	7	4.00	2.00	No	Analyse	Phase II
	Gout	4.00	0.75	Yes	Included	7	5.00	3.00	No	Evaluate	Phase II
	Hepatic encephalopathy	3.00	1.00	Yes	Included	6	4.00	1.50	No	Analyse	Phase II
	Hormone replacement therapy	3.00	1.75	No	Phase II	4	2.00	1.50	No	Understand	Phase II
	Hyperlipidaemia	4.00	0.00	Yes	Included	7	4.00	2.00	No	Analyse	Phase II
	Infertility	3.00	1.00	Yes	Included	4	3.50	1.75	No	Apply	Phase II
	Inflammation	3.00	1.00	Yes	Included	6	4.00	1.75	No	Analyse	Phase II
	Inflammatory bowel disease	4.00	0.75	Yes	Included	7	5.00	3.00	No	Evaluate	Phase II
	Liver disease	4.00	0.75	Yes	Included	7	4.00	1.00	Yes	Analyse	Included
	Malaria	2.00	1.00	Yes	Not included	3	3.00	0.00	Yes	Apply	Not included
	Muscle relaxation	3.00	0.75	Yes	Included	5	3.00	1.00	Yes	Apply	Included
	Nausea and vomiting	4.00	1.00	Yes	Included	7	5.00	2.00	No	Evaluate	Phase II
	Nephrotoxicity and dialysates	3.00	1.00	Yes	Included	7	3.00	2.00	No	Apply	Phase II
	Obesity	4.00	0.00	Yes	Included	7	5.00	2.00	No	Evaluate	Phase II
	Osteoporosis	4.00	1.00	Yes	Included	7	4.00	3.00	No	Analyse	Phase II
	Pain	3.00	0.75	Yes	Included	6	3.00	2.00	No	Apply	Phase II
	Parasympathetic nervous system disorders	3.00	0.75	Yes	Included	5	3.00	1.50	No	Apply	Phase II
	Parkinson's disease	3.00	1.75	No	Phase II	5	4.00	2.00	No	Analyse	Phase II
	Peptic ulcers	4.00	0.75	Yes	Included	7	5.00	2.00	No	Evaluate	Phase II
	Prebiotics and probiotics	4.00	0.00	Yes	Included	7	5.00	2.00	No	Evaluate	Phase II
	Schizophrenia	2.50	1.00	Yes	Not included	4	3.00	1.50	No	Apply	Not included
	Sedation and hypnosis	2.50	1.00	Yes	Not included	3	3.00	0.00	Yes	Apply	Not included
	Sports performance-enhancing drugs	3.00	1.00	Yes	Included	6	4.00	1.50	No	Analyse	Phase II
	Sympathetic nervous system disorders	3.00	1.00	Yes	Included	5	3.00	1.50	No	Apply	Phase II
	Thyroid diseases	3.50	1.00	Yes	Included	6	4.50	3.00	No	Analyse	Phase II
	Tuberculosis	3.00	1.75	No	Phase II	5	4.00	2.50	No	Analyse	Phase II
	Viral infections	3.00	2.00	No	Phase II	4	3.50	2.50	No	Apply	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Vitamin deficiencies	4.00	0.00	Yes	Included	7	5.00	2.00	No	Evaluate	Phase II
	Vitamins and minerals for wound healing and burns	4.00	0.00	Yes	Included	7	4.00	2.00	No	Analyse	Phase II
	Worm infestations	3.00	1.50	No	Phase II	6	4.00	4.00	No	Analyse	Phase II
Generic competencies	**Critical thinking**	4.00	0.00	Yes	Included						
	Problem-solving	4.00	0.00	Yes	Included						
	Communication	4.00	0.75	Yes	Included						
	Collaboration	4.00	1.00	Yes	Included						
	Creativity	3.00	0.00	Yes	Included						
	Innovation	3.00	0.75	Yes	Included						
	Information literacy	4.00	0.75	Yes	Included						
	Media literacy	3.50	1.00	Yes	Included						
	Information and communication technology literacy	3.00	1.00	Yes	Included						
	Adaptability	4.00	1.00	Yes	Included						
	Self-directedness	4.00	0.00	Yes	Included						
	Social and cultural interaction	4.00	0.75	Yes	Included						
	Productivity and accountability	4.00	0.75	Yes	Included						
	Leadership and responsibility	4.00	0.75	Yes	Included						

ABBREVIATIONS: IQR = INTERQUARTILE RANGE; N/A – NOT APPLICABLE DUE TO INDICATION OF LACK OF IMPORTANCE

TABLE 3.7: COMPETENCY RANKING AFTER PHASE II OF THE DIETETICS DELPHI STUDY (N = 5 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**The role of pharmacology in disease treatment and science**	Consensus already reached (not tested)				5	2.00	0.00	Yes	Understand	Included
	Common routes of administration used in clinical settings	3.00	0.50	Yes	Included	5	3.00	0.00	Yes	Apply	Included
	Common formulations used in clinical settings	3.00	0.50	Yes	Included	5	3.00	1.00	Yes	Apply	Included
	Factors that alter the response to pharmacotherapy	Consensus already reached (not tested)				5	3.00	1.50	No	Apply	Phase III
	Essential medicines list	Consensus already reached (not tested)				5	1.00	2.50	No	Remember	Phase III
	The role of different healthcare workers	Consensus already reached (not tested)				5	3.00	0.50	Yes	Apply	Included
	The legalities associated with pharmacotherapy	2.00	1.00	Yes	Not included	5	2.00	0.50	Yes	Understand	Not included
	Acknowledgement of herbal remedies use in pharmacotherapy	Consensus already reached (not tested)				5	4.00	0.00	Yes	Analyse	Included
	Interpretation of pharmacogenetics information on drug labels	Consensus already reached (not tested)				5	4.00	0.50	Yes	Analyse	Included
	Pharmaceutical food-drug interactions	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included
	Pharmacokinetic food-drug interactions	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Pharmacodynamic food-drug interactions	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included
	Short- and long-term consequences of food-drug interactions	Consensus already reached (not tested)				5	5.00	1.50	No	Evaluate	Phase III
	The need for medical consultation to adjust doses or pharmacotherapy as a result of food-drug interactions	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	Prevention of food-drug interactions	Consensus already reached (not tested)				5	5.00	1.50	No	Evaluate	Phase III
	Drug interactions with alcohol and tobacco	Consensus already reached (not tested)				5	4.00	1.50	No	Analyse	Phase III
	Integration of dietetic and pharmacotherapy treatment modalities as an interdisciplinary therapy	Consensus already reached (not tested)				5	4.00	1.50	No	Analyse	Phase III
	The influence of drugs on the nutritional status	Consensus already reached (not tested)				5	5.00	1.50	No	Evaluate	Phase III
	The influence of nutrition on pharmacotherapy of cancer	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	The influence of nutrition on pharmacotherapy of HIV	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	The influence of nutrition on pharmacotherapy of organ transplantation	Consensus already reached (not tested)				5	2.00	3.00	No	Understand	Phase III
	The influence of nutrition on pharmacotherapy of tuberculosis	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	Prescribing of pharmacotherapy	Consensus already reached (not tested)				5	2.00	1.50	No	Understand	Phase III
	Interpreting pre-clinical and clinical pharmacological data	Consensus already reached (not tested)				5	2.00	0.50	Yes	Understand	Included
	Discussing misconceptions of pharmacotherapy with patients	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	Interpretation of pharmacological research in relation to clinical outcomes	Consensus already reached (not tested)				5	2.00	1.00	Yes	Understand	Included
	Correct and safe administration of drugs via enteral feeding tubes	3.00	2.50	No	Phase III	3	11.00	1.00	Yes	Create	Phase III
Pharmacotherapy against diseases competencies	**Allergies**	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included
	Anaemia	Consensus already reached (not tested)				5	5.00	0.50	Yes	Evaluate	Included
	Anorexia and appetite stimulants	Consensus already reached (not tested)				5	4.00	0.00	Yes	Analyse	Included
	Anxiety	Consensus already reached (not tested)				5	3.00	0.50	Yes	Apply	Included
	Asthma and other respiratory diseases	2.00	1.50	No	Phase III	5	3.00	1.00	Yes	Apply	Phase III
	Bacterial infections	3.00	0.50	Yes	Included	5	3.00	0.00	Yes	Apply	Included
	Cardiovascular diseases	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included
	Constipation	Consensus already reached (not tested)				5	5.00	0.50	Yes	Evaluate	Included
	COVID-19	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	Depression	Consensus already reached (not tested)				5	3.00	0.50	Yes	Apply	Included
	Diabetes	Consensus already reached (not tested)				5	5.00	0.50	Yes	Evaluate	Included
	Diarrhoea	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	Digestive enzymes	Consensus already reached (not tested)				5	5.00	1.50	No	Evaluate	Phase III
	Food poisoning	3.00	1.50	No	Phase III	5	3.00	3.00	No	Apply	Phase III
	Gall stones	Consensus already reached (not tested)				5	4.00	0.50	Yes	Analyse	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Gastro-oesophageal disorder	Consensus already reached (not tested)				5	4.00	0.50	Yes	Analyse	Included
	Gout	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included
	Hepatic encephalopathy	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	Hormone replacement therapy	3.00	1.00	Yes	Included	5	2.00	1.00	Yes	Understand	Included
	Hyperlipidaemia	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included
	Infertility	Consensus already reached (not tested)				5	3.00	2.00	No	Apply	Phase III
	Inflammation	Consensus already reached (not tested)				5	4.00	0.50	Yes	Analyse	Included
	Inflammatory bowel disease	Consensus already reached (not tested)				5	5.00	0.50	Yes	Evaluate	Included
	Nausea and vomiting	Consensus already reached (not tested)				5	5.00	0.50	Yes	Evaluate	Included
	Nephrotoxicity and dialysates	Consensus already reached (not tested)				5	3.00	0.50	Yes	Apply	Included
	Obesity	Consensus already reached (not tested)				5	5.00	0.50	Yes	Evaluate	Included
	Osteoporosis	Consensus already reached (not tested)				5	4.00	1.00	Yes	Analyse	Included
	Pain	Consensus already reached (not tested)				5	3.00	0.50	Yes	Apply	Included
	Parasympathetic nervous system disorders	Consensus already reached (not tested)				4	3.00	0.00	Yes	Apply	Included
	Parkinson's disease	3.00	1.50	No	Phase III	5	4.00	1.50	No	Analyse	Phase III
	Peptic ulcers	Consensus already reached (not tested)				4	5.00	0.75	Yes	Evaluate	Included
	Prebiotics and probiotics	Consensus already reached (not tested)				5	5.00	0.00	Yes	Evaluate	Included
	Sports performance-enhancing drugs	Consensus already reached (not tested)				5	4.00	1.50	No	Analyse	Phase III
	Sympathetic nervous system disorders	Consensus already reached (not tested)				5	3.00	0.00	Yes	Apply	Included
	Thyroid diseases	Consensus already reached (not tested)				5	4.00	1.50	No	Analyse	Phase III
	Tuberculosis	3.00	1.00	Yes	Included	5	4.00	0.00	Yes	Analyse	Included
	Viral infections	3.00	1.50	No	Phase III	5	3.00	0.00	Yes	Apply	Phase III
	Vitamin deficiencies	Consensus already reached (not tested)				5	5.00	1.00	Yes	Evaluate	Included
	Vitamins and minerals for wound healing and burns	Consensus already reached (not tested)				5	4.00	1.50	No	Analyse	Phase III
	Worm infestations	3.00	1.50	No	Phase III	5	3.00	1.50	No	Apply	Phase III
	Cancer therapy	3.00	1.00	Yes	Included	4	4.00	2.75	No	Analyse	Phase III
	Nutrition in cancer	4.00	1.00	Yes	Included	5	6.00	1.50	No	Create	Phase III
	Antihypertensives	3.00	0.00	Yes	Included	5	4.00	2.50	No	Analyse	Phase III
	HIV therapy	3.00	0.00	Yes	Included	5	4.00	1.50	No	Analyse	Phase III

ABBREVIATIONS: IQR = INTERQUARTILE RANGE

TABLE 3.8: COMPETENCY RANKING AFTER PHASE III OF THE DIETETICS DELPHI STUDY (N = 4 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**Factors that alter the response to pharmacotherapy**	Consensus already reached (not tested)				4	3.00	1.50	No	Apply	Lower cognitive domain
	Essential medicines list	Consensus already reached (not tested)				4	2.00	3.50	No	Understand	Lower cognitive domain
	Short- and long-term consequences of food-drug interactions	Consensus already reached (not tested)				4	5.00	0.75	Yes	Evaluate	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Prevention of food-drug interactions	Consensus already reached (not tested)				4	5.00	0.75	Yes	Evaluate	Included
	Drug interactions with alcohol and tobacco	Consensus already reached (not tested)				4	4.50	1.75	No	Analyse	Higher cognitive domain
	Integration of dietetic and pharmacotherapy treatment modalities as an interdisciplinary therapy	Consensus already reached (not tested)				4	4.00	0.00	Yes	Analyse	Included
	The influence of drugs on the nutritional status	Consensus already reached (not tested)				4	5.50	1.00	Yes	Evaluate	Included
	The influence of nutrition on pharmacotherapy of organ transplantation	Consensus already reached (not tested)				4	2.50	1.00	Yes	Understand	Included
	Prescribing of pharmacotherapy	Consensus already reached (not tested)				4	2.50	1.00	Yes	Understand	Included
	Correct and safe administration of drugs via enteral feeding tubes	3.50	1.00	Yes	Included	Consensus already reached (not tested)					
Pharmacotherapy against diseases competencies	**Asthma and other respiratory diseases**	2.00	1.50	No	Not included	Consensus already reached (not tested)					
	Digestive enzymes	Consensus already reached (not tested)				4	5.00	0.75	Yes	Evaluate	Included
	Food poisoning	3.00	0.75	Yes	Included	4	3.00	2.25	No	Apply	Lower cognitive domain
	Infertility	Consensus already reached (not tested)				4	3.00	1.50	No	Apply	Lower cognitive domain
	Parkinson's disease	2.00	0.75	Yes	Included	4	4.00	0.75	Yes	Apply	Included
	Sports performance-enhancing drugs	Consensus already reached (not tested)				4	4.50	1.00	Yes	Analyse	Included
	Thyroid diseases	Consensus already reached (not tested)				4	4.00	1.50	No	Analyse	Higher cognitive domain
	Viral infections	3.00	0.75	Yes	Included	Consensus already reached (not tested)					
	Vitamins and minerals for wound healing and burns	Consensus already reached (not tested)				4	5.50	1.75	No	Evaluate	Higher cognitive domain
	Worm infestations	3.00	0.00	Yes	Included	4	3.00	0.00	Yes	Apply	Included
	Cancer therapy	Consensus already reached (not tested)				4	4.50	1.00	Yes	Analyse	Included
	Nutrition in cancer	Consensus already reached (not tested)				4	6.00	0.75	Yes	Evaluate	Included
	Antihypertensives	Consensus already reached (not tested)				4	4.50	1.75	No	Analyse	Higher cognitive domain
	HIV therapy	Consensus already reached (not tested)				4	4.50	1.00	Yes	Analyse	Included

ABBREVIATIONS: IQR = INTERQUARTILE RANGE

TABLE 3.9: FINAL LIST OF COMPETENCIES SCORED BY PARTICIPANTS OVER THREE PHASES OF THE DIETETICS DELPHI STUDY

Competency			Importance			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
Pharmacological competencies	**Biopharmaceutics**	**The role of pharmacology in disease treatment and science**	3.50	1.00	Important with consensus	2.00	0.00	Understand
		Biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)	3.00	0.00	Important with consensus	2.00	0.00	Understand
		Common pharmacological concepts	3.00	1.00	Important with consensus	2.00	0.00	Understand
		Common formulations used in clinical settings	3.00	0.50	Important with consensus	3.00	1.00	Apply
		Common routes of administration used in clinical settings	3.00	0.50	Important with consensus	3.00	0.00	Apply
		Drug research and development	2.00	0.75	Not important with consensus	N/A.	N/A.	N/A.
		Stability of drugs	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A.
	Pharmacokinetics	**Principles of pharmacokinetics (the movement of drug into, through, and out of the body)**	3.00	1.00	Important with consensus	3.00	1.00	Apply
		Pharmacokinetics: Absorption	3.00	1.00	Important with consensus	3.00	0.00	Apply
		Pharmacokinetics: Distribution	3.00	0.00	Important with consensus	3.00	0.00	Apply
		Pharmacokinetics: Metabolism	3.50	1.00	Important with consensus	3.00	0.00	Apply
		Pharmacokinetics: Excretion	3.00	0.00	Important with consensus	3.00	1.00	Apply
	Pharmacodynamics	**Principles of pharmacodynamics (the response of the body to the drug)**	3.00	1.00	Important with consensus	2.00	1.00	Understand
		The modulation of drug targets to alter (patho)physiological responses	3.00	0.75	Important with consensus	2.00	1.00	Understand
		Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)	2.00	0.00	Not important with consensus	N/A.	N/A.	N/A.
		Factors that alter the response to pharmacotherapy	3.00	0.00	Important with consensus	3.00	1.50	Lower order
	Pharmacogenetics	**The need for pharmacogenetics testing (where pharmacogenetics is the effect genetic factors has on drug reactions)**	2.00	1.00	Not important with consensus	N/A.	N/A.	N/A.
		Response to treatment in patients with or without pharmacogenetic markers	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A.
		The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	2.00	0.75	Not important with consensus	N/A.	N/A.	N/A.
		Interpretation of pharmacogenetics information on drug labels	3.00	0.75	Important with consensus	4.00	0.50	Analyse
		The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A.
	Interactions	**Classifications of drug-drug interactions**	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A.
		Pharmaceutical food-drug interactions	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Pharmacokinetic food-drug interactions	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Pharmacodynamic food-drug interactions	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Short- and long-term consequences of food-drug interactions	4.00	0.00	Important with consensus	5.00	0.75	Evaluate
		Prevention of food-drug interactions	4.00	0.75	Important with consensus	5.00	0.75	Evaluate
		The need for medical consultation to adjust doses or pharmacotherapy as a result of food-drug interactions	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Drug interactions with alcohol and tobacco	3.00	1.00	Important with consensus	4.50	1.75	Higher order
	Nutritional practice	**The influence of drugs on the nutritional status**	4.00	0.00	Important with consensus	5.50	1.00	Evaluate

		The influence of nutrition on pharmacotherapy of cancer	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		The influence of nutrition on pharmacotherapy of HIV	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		The influence of nutrition on pharmacotherapy of organ transplantation	3.50	1.00	Important with consensus	2.50	1.00	Understand
		The influence of nutrition on pharmacotherapy of tuberculosis	4.00	0.00	Important with consensus	4.00	1.00	Analyse
	Clinical practice	**Integration of dietetic and pharmacotherapy treatment modalities as an interdisciplinary therapy**	4.00	0.00	Important with consensus	4.00	0.00	Analyse
		Correct and safe administration of drugs via enteral feeding tubes	3.50	1.00	Important with consensus	6.00	1.00	Create
		Essential medicines list	3.00	1.00	Important with consensus	2.00	3.50	Lower order
		Medicine compliance in pharmacology	2.00	1.00	Not important with consensus	N/A.	N/A.	N/A.
		Medication errors	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A.
		Prescribing of pharmacotherapy	3.00	0.00	Important with consensus	2.50	1.00	Understand
		The legalities associated with pharmacotherapy	2.50	1.75	Not important, no consensus	2.00	0.50	Understand
		Acknowledgement of herbal remedies use in pharmacotherapy	3.00	0.00	Important with consensus	4.00	0.00	Analyse
		The role of different healthcare workers	3.00	0.75	Important with consensus	3.00	0.50	Apply
		Interpretation of pharmacological research in relation to clinical outcomes	3.00	0.75	Important with consensus	2.00	1.00	Understand
		Interpreting pre-clinical and clinical pharmacological data	3.00	1.00	Important with consensus	2.00	0.50	Understand
		Discussing misconceptions of pharmacotherapy with patients	3.00	0.75	Important with consensus	4.00	1.00	Analyse
Pharmacotherapy against diseases competencies	**Autonomic nervous system**	**Sympathetic nervous system disorders**	3.00	1.00	Important with consensus	3.00	0.00	Apply
		Parasympathetic nervous system disorders	3.00	0.75	Important with consensus	3.00	0.00	Apply
	Cardiovascular and haematological	**Anaemia**	4.00	0.75	Important with consensus	5.00	0.50	Evaluate
		Antihypertensives	3.00	0.00	Important with consensus	4.50	1.75	Higher order
		Cardiovascular diseases	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
	Gastrointestinal	**Constipation**	4.00	0.75	Important with consensus	5.00	0.50	Evaluate
		Diarrhoea	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Digestive enzymes	4.00	0.75	Important with consensus	5.00	0.75	Evaluate
		Food poisoning	3.00	0.75	Important with consensus	3.00	2.25	Lower order
		Gall stones	3.50	1.00	Important with consensus	4.00	0.50	Analyse
		Gastro-oesophageal disorder	4.00	0.75	Important with consensus	4.00	0.50	Analyse
		Hepatic encephalopathy	3.00	1.00	Important with consensus	4.00	1.00	Analyse
		Inflammatory bowel disease	4.00	0.75	Important with consensus	5.00	0.50	Evaluate
		Liver disease	4.00	0.75	Important with consensus	4.00	1.00	Analyse
		Nausea and vomiting	4.00	1.00	Important with consensus	5.00	0.50	Evaluate
		Peptic ulcers	4.00	0.75	Important with consensus	5.00	0.75	Evaluate
	Immunological	**Allergies**	4.00	1.00	Important with consensus	5.00	1.00	Evaluate
		Inflammation	3.00	1.00	Important with consensus	4.00	0.50	Analyse
	Metabolic	**Anorexia and appetite stimulants**	4.00	0.75	Important with consensus	4.00	0.00	Analyse
		Diabetes	4.00	0.00	Important with consensus	5.00	0.50	Evaluate
		Hyperlipidaemia	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Obesity	4.00	0.00	Important with consensus	5.00	0.50	Evaluate
	Microbiological and infectious diseases	**Bacterial infections**	3.00	0.50	Important with consensus	3.00	0.00	Apply
		COVID-19	3.00	0.75	Important with consensus	4.00	1.00	Analyse
		Fungal infections	2.00	1.00	Not important with consensus	N/A.	N/A.	N/A
		HIV therapy	3.00	0.00	Important with consensus	4.50	1.00	Analyse
		Malaria	2.00	1.00	Not important with consensus	N/A.	N/A.	N/A
		Prebiotics and probiotics	4.00	0.00	Important with consensus	5.00	0.00	Evaluate
		Tuberculosis	3.00	1.00	Important with consensus	4.00	0.00	Analyse

		Viral infections	3.00	0.75	Important with consensus	3.00	0.00	Apply
		Worm infestations	3.00	0.00	Important with consensus	3.00	0.00	Apply
	Miscellaneous	**Sports performance-enhancing drugs**	3.00	1.00	Important with consensus	4.50	1.00	Analyse
		Vitamin deficiencies	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Vitamins and minerals for wound healing and burns	4.00	0.00	Important with consensus	5.50	1.75	Higher order
	Musculoskeletal	**Anaesthesia**	2.00	0.75	Not important with consensus	N/A.	N/A.	N/A
		Gout	4.00	0.75	Important with consensus	5.00	1.00	Evaluate
		Muscle relaxation	3.00	0.75	Important with consensus	3.00	1.00	Apply
		Osteoporosis	4.00	1.00	Important with consensus	4.00	1.00	Analyse
	Neurological	**Anxiety**	3.00	0.00	Important with consensus	3.00	0.50	Apply
		Depression	3.00	0.75	Important with consensus	3.00	0.50	Apply
		Epilepsy	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A
		Parkinson's disease	2.00	0.75	Not important with consensus	N/A.	N/A.	N/A
		Schizophrenia	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A
		Sedation and hypnosis	2.50	1.00	Not important with consensus	N/A.	N/A.	N/A
	Nociception	**Pain**	3.00	0.75	Important with consensus	3.00	0.50	Apply
	Oncological	**Cancer therapy**	3.00	1.00	Important with consensus	4.50	1.00	Analyse
		Nutrition in cancer	4.00	1.00	Important with consensus	6.00	0.75	Evaluate
	Renal	**Nephrotoxicity and dialysates**	3.00	1.00	Important with consensus	3.00	0.50	Apply
	Hormonal and reproductive	**Contraception**	2.00	1.00	Not important with consensus	N/A.	N/A.	N/A.
		Hormone replacement therapy	3.00	1.00	Important with consensus	2.00	1.00	Understand
		Infertility	3.00	1.00	Important with consensus	3.00	1.50	Lower order
		Thyroid diseases	3.50	1.00	Important with consensus	4.00	1.50	Higher order
	Respiratory	**Asthma and other respiratory diseases**	2.00	1.50	Not important, no consensus	3.50	3.25	Lower order
Generic competencies	**Critical thinking**		4.00	0.00	Important with consensus			
	Problem-solving		4.00	0.00	Important with consensus			
	Communication		4.00	0.75	Important with consensus			
	Collaboration		4.00	1.00	Important with consensus			
	Creativity		3.00	0.00	Important with consensus			
	Innovation		3.00	0.75	Important with consensus			
	Information literacy		4.00	0.75	Important with consensus			
	Media literacy		3.50	1.00	Important with consensus			
	Information and communication technology literacy		3.00	1.00	Important with consensus			
	Adaptability		4.00	1.00	Important with consensus			
	Self-directedness		4.00	0.00	Important with consensus			
	Social and cultural interaction		4.00	0.75	Important with consensus			
	Productivity and accountability		4.00	0.75	Important with consensus			
	Leadership and responsibility		4.00	0.75	Important with consensus			

ABBREVIATIONS: IQR – INTERQUARTILE RANGE; N/A – NOT APPLICABLE DUE TO INDICATION OF LACK OF IMPORTANCE

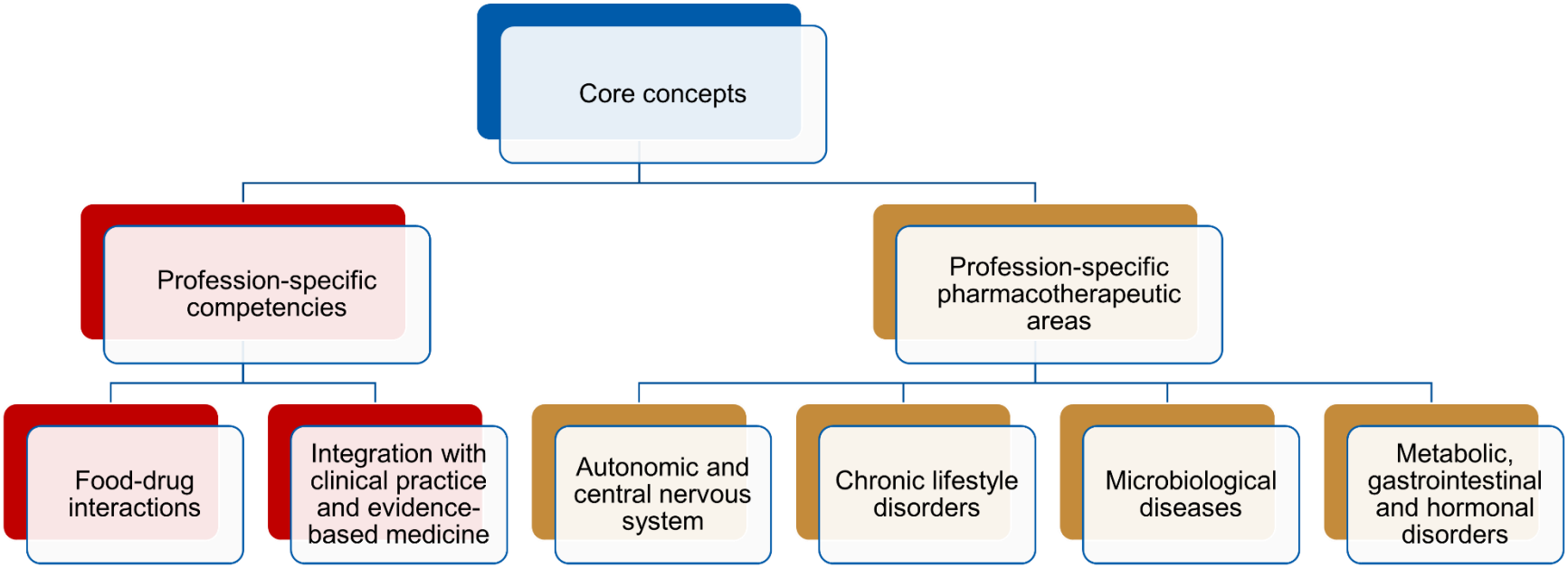

FIGURE 3.2: SUMMARISED VISUAL REPRESENTATION OF THE SUGGESTED PHARMACOLOGICAL COMPETENCY FRAMEWORK FOR DIETETICS, INDICATING THE NECESSITY OF CORE CONCEPTS, AND THEIR BASIS FOR PROFESSION-SPECIFIC PHARMACOLOGICAL AND PHARMACOTHERAPEUTIC COMPETENCY DEVELOPMENT

TABLE 3.10: SUGGESTED FRAMEWORK FOR PHARMACOLOGY CURRICULUM DESIGN OF DIETITIANS DETAILING THE LEARNING OUTCOME (END-GOAL OF THE MODULE THAT THE STUDENT SHOULD ACHIEVE) AND ASSESSMENT CRITERIA (THE WAY IN WHICH ACHIEVEMENT OF THE LEARNING OUTCOME WILL BE DETERMINED)

At the end of the curriculum, students must be able to …	Assessment criteria
… understand the core concepts of biopharmaceutics, pharmacokinetics and pharmacodynamics	Discuss the role of pharmacology in disease treatment
	Discuss biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)
	Describe common pharmacological concepts
	Discuss common routes of administration and formulations used in clinical settings
	Discuss the principles of pharmacokinetics (the movement of drug into, through, and out of the body)
	Discuss absorption, distribution, metabolism and excretion as principles of pharmacokinetics
	Discuss the principles of pharmacodynamics (the response of the body to the drug)
	*Describe the types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)
	Discuss the modulation of drug targets to alter (patho)physiological responses
	Relate factors that alter the response to pharmacotherapy to the clinical outcome
	Interpret pharmacogenetics information on drug labels
… apply pharmacological principles of pharmacology and evidence-based practice in dietetics	Evaluate pharmaceutical, pharmacokinetic and pharmacodynamic food-drug interactions
	Evaluate the short- and long-term consequences of food-drug interactions
	Evaluate strategies to prevent food-drug interactions
	Examine the need for medical consultation to adjust doses or pharmacotherapy as a result of food-drug interactions
	Evaluate drug interactions that occur with alcohol and tobacco
	Assess the influence of drugs on nutritional status
	Examine the influence of nutrition on the pharmacotherapy of cancer, HIV and tuberculosis
	Describe the influence of nutrition on the pharmacotherapy of organ transplantation
	Examine the integrated nature of dietetics and pharmacotherapy treatment modalities as an interdisciplinary therapy
	Discuss the correct and safe administration of drugs via enteral feeding tubes
	Discuss the essential medicine list
	Describe the prescribing of pharmacotherapy
	Examine the use of herbal remedies in pharmacotherapy
	Examine the role of different healthcare workers
	Discuss the interpretation of pharmacological research in relation to clinical outcomes
	Discuss the interpreting pre-clinical and clinical pharmacological data
	Simplify the discussion of misconceptions of pharmacotherapy with patients
… understand the use of pharmacotherapy against diseases relevant to the dietetic practice	*Relate the use of medicine for [pharmacotherapeutic area below] to dietetic practice*
	• Allergies
	• Anorexia and appetite stimulants
	• Anxiety
	• Bacterial infections
	• Cancer therapy and nutrition in cancer
	• Cardiovascular diseases, including hypertension and anaemia
	• Constipation and diarrhoea
	• COVID-19
	• Depression
	• Diabetes
	• Digestive enzymes
	• Gall stones
	• Gastro-oesophageal reflux disorder
	• Gout
	• Hepatic encephalopathy
	• HIV
	• Inflammation
	• Inflammatory bowel disease
	• Liver disease
	• Muscle relaxation
	• Nausea and vomiting
	• Nephrotoxicity and dialysates
	• Obesity and hyperlipidaemia
	• Osteoporosis
	• Pain
	• Peptic ulcers
	• Prebiotics and probiotics
	• Sports performance-enhancing drugs
	• Sympathetic and parasympathetic nervous system disorders
	• Thyroid diseases

At the end of the curriculum, students must be able to …	Assessment criteria
	• Tuberculosis
	• Viral infections
	• Vitamin deficiencies
	• Vitamins for wound healing and burns
	• Worm infestations
	Discuss the use of medicine for [pharmacotherapeutic area below] to dietetics practice
	• Food poisoning
	• Hormone replacement therapy
	• Infertility

3.2. Targeted needs assessment

Although a suggested framework for pharmacology education was constructed, it would be necessary to determine the needs of the dietetics programme at the University of Pretoria to ensure that alignment with the proposed curriculum is possible. To do so, curriculum mapping was performed for the current and the proposed curriculum to assess alignment strengths and deficiencies and a focus group interview with stakeholders of the Department of Human Nutrition was held.

3.2.1. Alignment with the current pharmacology curriculum

All available learning outcomes and assessment criteria from module guides for the Bachelor of Dietetics programme that could be sourced were matched to those of the FAR 381 and FAR 382 modules. Importantly, the current programme does not include FAR 382, but this was still assessed to indicate whether there were specific outcomes that were rendered unlinked due to its removal. Links were assessed before, during and/or after the presentation of the Pharmacology module in Year III to determine whether there was continuous scaffolding available, or any relation to modules of great interest. The latter included Physiology (Years I and II) and Medical Nutrition Therapy (Years III and IV) modules, due to their importance in creating an appropriate biomedical scaffold for pharmacology education and relation to the profession's clinical practice and exit level outcomes, respectively.

Where possible, quotations were taken from the publicly available module content of the programme (University of Pretoria, 2024b); however, direct statements relating to learning outcomes and assessment criteria of the individual module guides were not possible to include here, given intellectual property and its jurisdiction outside of the Department of Pharmacology. As a broad finding, module content within the programme yearbook tended to vary in explicit discussion of the focus of each module, which invariably created difficulty in ascertaining what exactly was discussed within the given timeframe. For example, Physiology modules tended to refer to broad systems-based physiology, rather than what was covered within it, which might create an assumption of what was being covered. When dealing with the individual module guides that were made available, the quality of learning outcomes and assessment criteria differed greatly. Some provided explicit statements of what was expected of the student, while others spoke more to generalised concepts without a pertinent expectation linked to, for example, Bloom's taxonomy.

The assessment of the alignment with the current curriculum did not suggest maintaining the programme as such, but rather sought to understand the current strengths and challenges within the curriculum to inform and support the focus group interview, and provide clarity on larger changes that might be needed to support the proposed pharmacology curriculum.

3.2.1.1. Mapping of FAR 381

Nineteen (8.19%) of the 232 assessment criteria for FAR 381 were considered physiologically focused, while 213 (91.81%) were pharmacology-related (Table 3.11). A total of 180 (77.59%) out of 232 assessment criteria were matched to one or more learning outcomes throughout the Bachelor of Dietetics programme, where the majority (77.59%) were linked to one or more modules in Years I and II prior to the introduction of Pharmacology in Year III. A total of 9.48% of assessment criteria had continuous scaffolding before and during Year III, while 5.17% linked only within Year III. No assessment criteria were linked to modules in Year IV only, while 1.72% were linked to modules before and after Year III. In relation to modules of great interest, linkage to Physiology in Year I (43.1%) and Year II (26.72%), and Medical Nutrition Therapy in Year III (14.66%) and Year IV (1.72%) was noted to be relatively low. Years IV is considered a predominantly clinical platform for medical nutrition, thus the low linkage implies few pharmacology assessment criteria have bearing on clinical training.

TABLE 3.11: THE NUMBER OF ASSESSMENT CRITERIA IN FAR 381, FAR 382 AND THE PROPOSED PHARMACOLOGY CURRICULUM, AND THE LINK THEY HAVE TO OTHER MODULES (WITH AVAILABLE OR RELEVANT MODULE GUIDES) LEARNING OUTCOMES, INCLUDING THOSE OF PHYSIOLOGY AND THE CORE DISCIPLINE (MEDICAL NUTRITION). NEWLY ADDED ASSESMENT CRITERIA REFER TO THOSE THAT HAVE BEEN INCLUDED BY THE DELPHI STUDY IN THE NEW CURRICULUM RELATIVE TO THE CURRENT CURRICULA

Linkage of assessment criteria	FAR 381 232 assessment criteria n (%)	FAR 382 168 assessment criteria n (%)	Proposed curriculum 66 assessment criteria n (%)
Pharmacology-related assessment criteria	213 (91.81%)	128 (45.83%)	66 (100%)
Physiology-related assessment criteria	19 (8.19%)	40 (23.81%)	0 (0.00%)
Newly added assessment criteria	N/A	N/A	23 (34.84%)
Assessment criteria linked to another module's learning outcome	180 (77.59%)	65 (38.69%)	53 (80.30%)
Assessment criteria linked to a module(s) prior to Year III	142 (61.21%)	24 (14.29%)	10 (15.15%)
Assessment criteria linked to modules prior to and during Year III	22 (9.48%)	4 (2.38%)	12 (18.18%)
Assessment criteria linked to module(s) during Year III	12 (5.17%)	16 (9.52%)	14 (21.21%)
Assessment criteria linked to module(s) after Year III	0 (0%)	12 (7.14%)	3 (4.55%)
Assessment criteria linked to modules before and after Year III	4 (1.72%)	5 (2.98%)	6 (9.09%)
Assessment criteria linked to modules during and after Year III	0 (0%)	0 (0%)	4 (6.06%)
Assessment criteria linked to modules through Years I to IV	0 (0%)	4 (2.38%)	4 (6.06%)
Assessment criteria linked to Year I Physiology	100 (43.1%)	18 (10.71%)	14 (21.21%)
Assessment criteria linked to Year II Physiology	62 (26.72%)	19 (11.31%)	17 (25.76%)
Assessment criteria linked to Year III Medical Nutrition Therapy	34 (14.66%)	7 (4.17%)	15 (22.73%)
Assessment criteria linked to Year IV Medical Nutrition Therapy	4 (1.72%)	21 (12.5%)	17 (25.76%)

For physiology education, students are presented with systems-based physiology across four modules placed quarterly across the first two years of study. The learning outcomes associated with these systems deal predominantly with the physiology of the system when healthy, and although inference can be made on how disease alters the physiological

functioning thereof, little is explicitly stated to suggest pathophysiology is contextualised. The broad ambit of physiological systems is discussed, including the central nervous, cardiovascular, haematological, immunological, muscular, renal and respiratory systems. These systems are discussed in separate modules, and thus certain physiological pathways such as those related to the central nervous, immunological, haematological and cardiovascular systems discussed are presented in Year I only, while the others are in Year II.

In terms of physiology, scaffolding of various topics of physiology required for pharmacology education were observed to be potential barriers given in absence of explicit linkage. The general aspects related to the core concepts of pharmacology, particularly biopharmaceutics, pharmacokinetics and pharmacodynamics, had variable levels of scaffolding provided, where broad discussion of molecular and cellular biology, systems physiology and biochemistry created a platform for more in-depth pharmacological principles to be integrated. For example, between Years I and II Physiology modules, Body fluids (University of Pretoria, 2024b, p. 9), Structure, gas exchange and secretory functions of the lungs; structure, excretory and non-urinary functions of the kidneys, acid-base balance (University of Pretoria, 2024b, p. 12) and metabolism (University of Pretoria, 2024b, p. 12) covered certain important factors relating to pharmacokinetics, such as distribution, metabolism and excretion. This was supported by Year I Chemistry (acid-base [(University of Pretoria, 2024b, p. 6]). Year II Biochemistry referred to enzymatic reactions (Enzyme kinetics and enzyme inhibition, allosteric enzymes, regulation of enzyme activity, active centres and mechanisms of enzyme catalysis, examples of industrial applications of enzymes and in clinical pathology as biomarkers of diseases [University of Pretoria, 2024b, p. 12]), bioenergetic pathways relevant to metabolic disorders (Blood glucose measurement in the diagnosis and treatment of diabetes. Bioenergetics and biochemical reaction types. Glycolysis, gluconeogenesis, glycogen metabolism [University of Pretoria, 2024b, p. 12]), and broad factors that affect pharmacokinetics (Ionisation of water, weak acids and weak bases. Buffering against pH changes in biological systems and energy carriers, components of enzyme cofactors and chemical messengers. [(University of Pretoria, 2024b, p. 12]).

Although aspects of the autonomic nervous system are covered, it was unclear to what degree discussion of relevant drug targets was included, and how broad the integration would be towards pharmacologically-relevant outcomes, such as the alterations to the sympathetic and nervous system leading to therapeutic efficacy or potential adverse effects. The inflammatory system, although assumed to be covered within the immune system component of physiology, did not explicitly state several aspects relevant to pharmacotherapy, such as enzymes relevant to the mechanism of action of non-steroidal anti-inflammatory drugs. Nociceptive pathways relevant to pain management could explicitly be linked though no mention was made of opioid receptor-based pathways, and thus the background may be sufficient for discussion of pharmacotherapy. physiological systems were linked to metabolic complications such as hypercholesterolaemia (an increase in cholesterol leading to adverse health outcomes) and diabetes (dysregulation of glucose leading to elevated blood sugar levels); however, no linkage to weight-related physiological systems relevant to obesity was explicitly mentioned. Cardiovascular- and muscle-related physiology were broad enough for sufficient scaffolding of pharmacologically-relevant drug targets. Integration with the core third-year Medical Nutrition Therapy module discussed more pathophysiological elements of certain disease, where Aetiology, pathophysiology and manifestation(s) of type 1 and type 2 Diabetes Mellitus,

gestational diabetes and impaired glucose tolerance and Aetiology and clinical manifestations of cardiovascular; principles and practices of medical nutrition therapy in CVD. Congenital heart disease and special problems related to children with congenital heart disease were present (University of Pretoria, 2024b, p. 18). As such, should horizontal integration be applied correctly, students should have a scaffold amenable for learning about anti-diabetic and cardiovascular pharmacology.

For medical nutrition, education is provided across three modules split between Years III and IV. Little explicit linkage was observed in the learning outcomes, which makes it difficult to assess whether there was relevance to current pharmacology education in the core discipline of dietetics. Where linkage was seen, it related to oncology (albeit a minor component of the learning outcomes of FAR 381 only relating to a sub-set of anti-oestrogenic drugs used outside of reproductive health), obesity and diabetes and cardiovascular pharmacotherapy. As discussed by the module content of the third-year Medical Nutrition Therapy module, integration was observed with these diseases: Relationships between obesity, hypertension, cardiovascular disease, insulin resistance and concomitant health risks (University of Pretoria, 2024b, p. 18). No relation to the autonomic nervous system, pain, inflammation, anaesthesia, or anticoagulant drugs was present, although the latter could be inferred alongside cardiovascular pharmacotherapy.

3.2.1.2. Mapping of FAR 382

For FAR 382, of the 168 assessment criteria, 40 (23.81%) were considered focused on physiology, while 128 (45.83%) were those of pharmacology alone (Table 3.11). A total of 65 (38.69%) assessment criteria were linked to other modules within the Bachelor of Dietetics programme. Linkage to modules prior to Year III (14.29%), prior to and during Year III (2.38%) and during Year III (9.52%) was low. Few assessment criteria (7.14%) were linked to Year IV modules. For modules of great interest, assessment criteria had relatively low linkage to Year I (10.71%) and Year II (11.31%) Physiology, and Year III (4.17%) and Year IV (12.5%) Medical Nutrition Therapy.

As discussed in Section 2.3, FAR 382 was removed during the last programme review, and thus the potential for an absence of certain pharmacological competencies is possible. Based on the curriculum mapping of the current programme, students are not exposed to pharmacotherapy related to allergies, asthma, adrenocorticosteroid-based treatment, nausea and vomiting, neurological (i.e., epilepsy, Parkinson's disease, sedation) and psychiatric conditions (i.e., anxiety, depression, schizophrenia), microbial infections (i.e., bacterial, fungal, malarial and viral) and gastrointestinal disorders (i.e., ulcers, acid reflux, constipation, and diarrhoea). Of these conditions, linkage with the Medical Nutrition Therapy is observed with adrenocorticosteroid-based treatment, asthma, viral infections (specifically HIV), and gastrointestinal disorders. As such, students lack a background in pharmacology education related to these topics of interest in their clinical modules. As described in the available Year III Medical Nutrition Therapy content description Relationship between malnutrition and AIDS; role of nutrition in immunity within the context of HIV/AIDS; clinical signs, symptoms and problems associated with HIV/AIDS and guidelines for the alleviation of these symptoms; nutritional related problems of medication used by HIV/AIDS patients (University of Pretoria, 2024b, p. 18), which in itself highlights the need for discussion of antiretroviral medication within their fundamental modules. Similarly, it also refers to Metabolic response to acute and

chronic stress (University of Pretoria, 2024b) that would tie into adrenocorticosteroid-based treatment. The Year IV Medical Nutrition Therapy module referred to diseases of neurological origin (University of Pretoria, 2024b, p. 18), which ties into the broad range of pharmacotherapy discussed during FAR 382.

In relation to physiology education, scaffolding is provided in a limited capacity for discussions of allergy (although it can be inferred as a larger aspect of immunology). Neurophysiology is presented for the central nervous system; however, explicit relation to pathways that would be dysregulated for nausea and vomiting, neurological, and psychiatric conditions was not observed. The respiratory system's physiology has explicit relation to pathways relevant to pharmacological treatment, and should allow for scaffolding to occur. Physiology related to the gastrointestinal tract covers the broad aspects related to drug targets associated with diseases covered in the gastrointestinal pharmacotherapy section: peptic ulcer disease, gastro-oesophageal reflux disorder, constipation and diarrhoea.

Although microbial infections will impact the physiological system, the discussions of relevant antimicrobial drug targets are all situated within the microbiological discipline as part of the microbe's structure and replication. No background education on microbiology is present in the Bachelor of Dietetics, thus little to no exposure is expected to allow students to understand the mechanisms of action of antimicrobial drugs.

3.2.2. Alignment with the proposed pharmacology curriculum

To facilitate a more pharmacology-focused curriculum that builds on physiology education rather than duplicates it, physiological assessment criteria were removed, and pharmacology-related assessment criteria consolidated to avoid over-specification of the curriculum.

Of the 66 assessment criteria, 22 were introduced as new via the Delphi study findings (Table 3.11). Fifty-three (80.30%) of the assessment criteria were linked to modules within the Bachelor of Dietetics programme. Although this is similar to FAR 381's linkage (which is the only module presented to the group), it is important to note that 12 (18.18%) of these assessment criteria are covered only in FAR 382. As such, linkage in the proposed pharmacology curriculum is seen to be greater than in the individual modules currently presented. The number of assessment criteria prior to Year III (15.15%) and after Year III (4.55%) decreased; however, this was associated with an increase in assessment criteria linked across the prior, during and after combinations relative to Year III, suggesting a more continuous scaffolding related to the assessment criteria. For modules of great interest, linkage to Physiology modules remained low in Year I (21.21%) and Year II (25.76%), while for Medical Nutrition Therapy modules it increased in Year III (22.73%) and Year IV (25.76%) from the individual modules.

Relating to specific areas within physiology, several of the newly suggested pharmacotherapeutic areas do not have an explicitly stated scaffolding to support discussion of pharmacotherapy, including anorexiants, oncotherapy, gall stones, gout, hepatic encephalopathy, vitamin deficiencies and anthelmintics. This is inclusive of those areas of potential deficiency for scaffolding remarked in Sections 3.2.1.1 and 3.2.1.2.

In support of the need for such integration with new pharmacotherapeutic areas, Medical Nutrition Therapy modules in Years III and IV refer to impact and influence of worm infestation (University of Pretoria, 2024b, p. 18) which would necessitate anthelmintic knowledge, and The role of diet and nutrition in the aetiology and treatment of diseases of the gastrointestinal tract and related organs, metabolic disorders and gout that would relate to gall stones and gout, respectively (University of Pretoria, 2024b, p. 23). Gastrointestinal diseases are broadly integrated within the Year IV Medical Nutrition Therapy module expectations, related to diseases of the liver, stomach, upper and lower intestines, and pancreas. Pharmacotherapy proposed for nephrotoxicity and dialysates is well positioned within the Year III Medical Nutrition Therapy module speaking to Aetiology and clinical manifestation(s) of renal disease conditions; principles and practices of medical nutrition therapy in renal conditions (nephritic syndrome, nephrotic syndrome, acute and chronic renal failure, nephrolithiasis) (University of Pretoria, 2024b, p. 18), thus providing a pathophysiological basis for discussion as well. Oncotherapy is addressed in the Medical Nutrition Therapy module based on Nutritional care of physiological trauma and cancer (University of Pretoria, 2024b, p. 23) that is also more explicitly highlighted in the learning outcomes as relating to the potential adverse effects of such treatment. Although not provided within the module content, medical nutrition relating to burn wounds is addressed in the learning outcomes of the Medical Nutrition Therapy module in Year IV, thus integrating with the proposal to include vitamin-therapies for wound healing and burns.

The addition of drug-food interactions and the impact of pharmacotherapy on nutritional status within the proposed curriculum aligns with expectations raised both in Years III and IV of the Medical Nutrition Therapy module (Nutrient-drug interactions) (University of Pretoria, 2024b, p. 18), where the context of the interaction would be within the confines of the module's specific content. Furthermore, the interdisciplinary nature of dietetics and pharmacology is highlighted with the Medical Nutrition Therapy modules based on the contextual discussion of integrating the basic and clinical sciences.

3.2.3. Focus group interview

Based on the curriculum mapping exercise, three core questions were asked to determine i) whether students developed pharmacological competencies, ii) whether their physiological knowledge was sufficient to develop pharmacological competencies, and iii) alignment of the new proposed curriculum with their graduate needs. Quotations were taken verbatim with limited cleanup via the use of brackets to reinforce readability; however, care was taken not to alter the meaning. Furthermore, quotations are prefaced with the following abbreviations in Table 3.12 to indicate the participant role alluded to within their feedback.

TABLE 3.12: ABBREVIATIONS USED TO DELINEATE PARTICIPANT ROLES. ROLES ARE DELINEATED BY PARTICIPANT FEEDBACK, AND THUS MAY NOT BE INCLUSIVE OF ALL THEIR ROLES WITHIN THE BACHELOR OF DIETETICS

Theme	Description
P #	Participant number
L	Lecturer

The focus group was attended by three members of the Department of Human Nutrition who were indicated as being appropriate to the study. Their experience included exposure to all

four years of the programme, with predominantly lecturing responsibilities in the theoretical and clinical platforms.

Four themes were evident from the focus groups: development of competencies; inadequate application of competencies; perceived barriers to competency development, and perceived facilitators of competency development (Table 3.13). The themes are discussed from a perspective of the development of pharmacological competencies; scaffolded learning from physiology, and alignment of the proposed pharmacology curriculum.

TABLE 3.13: THEMES THAT DEVELOPED DURING THE DIETETICS FOCUS GROUP INTERVIEW

Theme	Sub-themes
Development of competencies	Remarks made towards development of theoretical knowledge of pharmacology
Insufficient competency development	Deficient application of knowledge
	Poor dietetic-relevant knowledge
Perceived barriers to competency development	Inadequate basic sciences understanding
	Lack of integration and contextualisation
Perceived facilitators of competency development	Earlier exposure to pharmacology
	Integration and clinical contextualisation

3.2.3.1. Development of pharmacological competencies

Participants highlighted the fact that the students developed theoretical knowledge of pharmacology; however, they could not apply it appropriately within the clinical or dietetic context. Concerns were raised that the students were overwhelmed by information, which led to their lacking the ability to apply the knowledge appropriately within the clinical setting. A prominent barrier was the lack of alignment with the dietetic practice that invariably also led to decontextualisation of information as well as the large amount of work they needed to study. Participants opined that basic information was needed, particularly in relation to the indications, adverse effects and effect on nutrition and potential drug-food interactions. Examples were made of the inability to contextualise drug-food interactions, routes of administration or specific drug classes that they struggled with due to the lack of integration.

[3][P1; L] "So, I think theoretically they do have a lot of knowledge, but when we are only in the hospital, only in the hospitals do we see that they are not able to translate it to what they what they need to extract from the files. So the very, very simple things like the medication the patient is on the [*repeating words*] class that it is, how to read the dosage, and things like that. And in the nutrient-drug interactions. So, it's [*repeating words*] more on the practical side, but I think you know the theory that your supply is great, but it just seems to be at that at that point reading the file, they just are not able to [*repeating words*] take what is important from there."

[P1; L] "Yeah, it's a lot of information. And then the simplest things [...], they just don't [*referring to understanding the work*]."

[P2; L] "I think for me what I am seeing is that they [*repeating words*] understand pharmacology, but I think they struggle to really understand pharmacology, maybe in the concept of a dietetics professional. […] I think we only really want them to understand what is the indication of the medication, and then really looking at maybe drug-nutrients interactions and side effects and then the management of the side effects. But I think maybe the theory of the pharmacology or the medicine gets lost a little and […]

[3] Responses are provided verbatim and have not been edited.

it's overwhelming I think for them, and they don't really grasp that. You know I only need to know ABCD and you know that's all we expect of them. I think this may be a misalignment between that."

[P3; L] "I think the big things that I do see that they possibly struggle with is definitely when they look at any type of pharmacology, they're looking at it from a medical perspective rather from a nutritional perspective. So, I think nutrition gets [repeating words] lost there, and they also struggle a lot with administrative routes. An example would be, for instance, if you're looking at clotting factor, like let's say Clexane for instance, if it is given intramuscularly, it's not really going to have such an effect on dietary things compared to if [repeating words] it was another type of route. So those how administrative route maybe changes things dosages. You know dose dependences and then also like for instance when it comes to inotropic support and how that actually influences all the systems you know that they also struggle with. […] They struggle integrating it."

Participants remarked that basic information within the dietetic context was needed; however, there was value in their understanding the mechanism of action of pharmacotherapy and how it would alter the physiology of a patient, and invariably, their disease outcome.

[P2; L] "Yeah, we don't expect them to know like the full, you know, physiological mechanism of action. We really want them to understand that, you know, [an] ionotrope is given in this patient. This is why it's given and the nutritional impact it has. I think that gets lost on them."

[P2; L] "I think it is really important that they do understand it [*referring to the underling physiological changes*], but I think like or, I don't know if it's just me when we do hospital practice; when you do feedback with the students, you don't really ask them to explain it to you in that regard. We tend to focus on you know, why is the patient getting the medication and then nutritional side effects. How would you manage what education strategies which you provide to the patient? So I do think […] it would be beneficial, but maybe we are going too in in-depth with it. Maybe a bit more of a broader, more [*Afrikaans word for superficial - oppervlakkig*]."

As alluded to in the aforementioned quotations, participants had a concern that there was a clear deficiency in students' understanding of the nutritional consequences of pharmacotherapy, and thus competencies related to drug-food interactions and nutritional alterations were lacking. A concern was that the amount of pharmacology presented to them made it difficult to apply such knowledge.

[P1; L] "That they [*repeating words*] seem to have no knowledge of that. Well, they don't know where to extract it from. From the vast amount of notes that they have."

[P2; L] "There's a clear deficiency [*referring to drug-food interaction and nutritional alteration knowledge*]. No, there is a clear deficiency there. If you ask a student, the only drug nutrient interaction they can list and name is alcohol. And they would tell you a baby that is three months old then drug-nutrient interaction is alcohol. That is all they know."

3.2.3.2. Scaffolded learning from physiology

Participants believed that the physiology knowledge of students was lacking, which complicated their achieving their pharmacological or dietetic competencies. Concerns were raised that the scaffolding of physiology was inappropriate, leading to a potential loss of retention of knowledge, inappropriate understanding of physiological pathways, or irrelevance to the dietetic practice.

[P1; L] "Their physiology knowledge is [*repeating words*] not where it should be."

[P1; L] "So they don't understand the basics. And if there's a disease now that we're focusing on now to understand the complications and how it affects the physiology, then they're stuck."

[P2; L] "I don't think so. I think physiology is something that they really struggle with. I also think maybe the alignment of the curriculum, now the spacing of it, I think they maybe do physiology in second year and then once we get to third, fourth year, it feels almost like they've forgotten everything that they've learned or it's maybe not really applicable to medical nutrition therapy or what they really need to know. But for me, I think they lack in that regard and understanding of basic physiology.

[P2; L] "It is across the board and that there is just a lack of insight and understanding to you know: this is the pancreas. The pancreas is responsible for ABCD. This is how it integrates. If it goes wrong, these are your complications. […] it's pretty much the entire system, but across the board. […] I think [the] physiology that they are currently receiving, there is just, they're not understanding it. And how nutrition then plays a role into the, you know, management of the disease and how can it affect the organ function. Yeah, there's a very much a lack of that.

3.2.3.3. Alignment of the proposed pharmacology curriculum

Participants welcomed the change to the pharmacology curriculum, and believed that the focus on dietetic-relevant topics would allow for a stronger educational platform. As the pharmacology and pathophysiology curricula would already be integrated within the Medical Nutrition Therapy modules, participants believed it would allow for a clearer developmental platform to be created. This included an earlier introduction to pharmacology, not only to decrease the workload of the students, but also spread out the concepts more clearly in a scaffolded fashion. This pharmacological integration included both theoretical and practical education to allow for more contextualisation, particularly in relation to nutritional effects.

[P1; L] "Yes. So, the idea is to have the modules integrate into the therapeutic nutrition. So to maybe start off with the pathophysiology and then discuss the disease conditions and include the pharmacology into that so that it all links up for them."

[P2; L] "When we looked at our new curriculum […] our Medical Nutrition Therapy module started only in third year and then in fourth year, and the [*repeating words*] volume of work that needed to be covered was just it was overwhelming for the students. So, the idea is also that we move the medical nutrition therapy into a second-year state so that we can start introducing students to the concepts a lot earlier and with the pharmacology aspect."

[P2; L] "I think it would be really beneficial if you can be involved in both aspects [*referring to theoretical and practical platforms*]. I think […] we will create space for the theoretical aspect of it, and then we're also trying to integrate […] case studies with the students where we can trial run through, and yeah, talk about the application aspects of it as well."

[P2; L] "Yeah, I know it's they really have to understand what medication the patient is on, why and how would it impact the nutritional status of the patient. You know, is there something they need to educate the patient on because there's an interaction between maybe vitamin K and warfarin, or is it that this medication is prone to induce diarrhoea that they might have to manage it from a nutritional point of view? So it's really very much integrated."

As several new pharmacological and pharmacotherapeutic areas were included in the proposed pharmacology curriculum, participants were asked about how integration and assessment would be approached. Participants believed that should integration be approached appropriately in the design, it would allow for the contextual discussion of

pharmacotherapy in alignment with the dietetic practice. Assessment would need to be scrutinised, however, if approached from a case report-style format, as it would necessitate students to evaluate the case comprehensively.

[P1; L] "I think actually might cement it more because when they have this vast information about them about drugs [*referring to hindering their understanding*]. […] So they cannot make it very disease-specific, which is what we want, disease-specific and then nutrition-specific for that disease."

[P2; L] "But the idea is because we're moving the medical nutrition therapy to the second year, is that we try and cover all of these disease conditions in second, third and fourth year. So that we make sure our students know a bit about everything. And then to have the pharmacology integrate into that. So, […] yeah, first semester, […] for instance, cancer […]. then to have pharmacology have a lecture slot as part of that, so that those medications and pharmacology management [*repeating words*] can be covered."

[P2; L] "[…] spread it out so that it also scaffolds and builds for the student, but that the disease condition covered that includes the physiology, pathophysiology, pharmacology; all of it relating to that disease condition to make it understandable for the student."

[P2; L] "So we expect students to do […] nutrition care records where they do data collection of the patient and as part of that data collection, there is a pharmacological element to it. So we can maybe look at the weighting of that then to make sure that it is adequate."

Participants also believed it important that focus be placed on what students would encounter within their clinical practice only to ensure alignment with the EML. In such a way it would also reduce the burden of content that the students needed to study.

[P1; L] "So that [*repeating words*] they know that very well because from the clinical part of it, do they have this vast knowledge of medication but they just need to know a handful because those you routinely see in the hospitals? So if there was a way to focus a lot on that or to make sure they know that very well, then if you want to go into depth for certain medication, those are the ones I [*repeating words*] would suggest that you can go a bit deeper […]."

Participants were asked whether other areas that were not highlighted in the Delphi study that alluded to epilepsy treatment would be important for inclusion into the curriculum. Furthermore, when asked whether lactation was an area of importance, participants agreed that it could be contextually discussed. Furthermore, the importance of considering feeding in critical care patients was raised, highlighting the potential for drug-food interactions and nutritional alterations. Complementary and alternative medicines, although addressed to a small degree in the programme, were also an area of interest where pharmacology could benefit from a broad perspective.

[P1; L] "Not everything [*referring to complementary and alternative medicines*]. […] And specifically […] for nutritional-related disorders. So it wouldn't be for the anxiety or something. […] for weight loss and PCOS [*referring to polycystic ovary syndrome*] and diabetes, those sort of things, and hypertension."

[P2; L] "So currently we covered as part […] a module in the fourth year where we include topics that hasn't really been covered very well up until that point. So it's covered as part of that. But I don't think necessarily very well maybe. So I do think there is a

benefit of including pharmacology in addressing that because I think it is also becoming a lot more prevalent that we are seeing patients taking CAM [*referring to complementary and alternative medicine*]."

[P3; L] "It would be beneficial as well because they [*repeating words*] do a lot of premature babies and that's maybe where it [*referring to pharmacotherapy and lactation*] can come in."

[P3; L] "[…] is there a section maybe where they can look specifically […] medications that are given during critical illness? I'm just thinking because dietitians, it's very much related with ionotropic support and things like that, where they can decide can they feed the patient? Is the patient's stable […]."

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4. Discussion

To facilitate a structured discussion, the general needs analysis has been approached separately; however, it contributes sequentially to the targeted needs analysis.

4.1. General needs assessment

The general needs analysis is discussed first as the scoping review, which helped create a preamble for the discussion of the Delphi study results.

4.1.1. Scoping review

There is a paucity of literature on pharmacological competencies in the dietetics profession as is evident in the inclusion of only three publications. Additionally, within the available eligible literature, very few articles discussed what cognitive expectation was needed from the competencies, creating a wide berth of unknown territory in how to approach the competencies. For example, although certain diseases or pharmacotherapies were identified as necessary within a Dietetics programme, for example, metabolic disorders, there was little discussion of the depth that would be needed for such a competency – for example, the underlying mechanisms of action, or purely clinical outcomes. This poses a design problem as misalignment may occur should sufficient stakeholder engagement not take place, and thus it may revert to a more generalised, superficial or overly complex curriculum. As opined by Rangachari, the basic sciences are important in healthcare sciences; however, what depth they are applied within such fields is often contentious as one could easily focus too heavily on the foundational concepts rather than scaffold them appropriately for clinical integration (Rangachari, 1997). Curriculum alignment is exceptionally important, as it is not realistic nor required that healthcare practitioners become discipline-specific experts in all aspects related to their fields (Callier et al., 2014). This is underpinned in the relevance of concepts to the functional competency of the healthcare professions, and thus should be aligned in such a way to ensure fit-for-purpose education (Callier et al., 2014). As such, it is easy to surmise that the positionality of the curriculum designer may guide the decision of the competencies' depth and scope that may be included in such educational endeavours if not clearly delineated by a framework, which may under- or over-complicate the curriculum. The obtained institutional curricula further highlight how generalised the material is when being taught for some undergraduate programmes, thus creating potential misalignment with graduate outcomes.

Only one suggested curriculum was obtained, albeit not a recent publication (2009) and thus may not translate to modern-day needs. Mestres and Duran (2009) provided a broad outline for a structured applied pharmacology course within the context of Dietetics, highlighting general and clinical pharmacology of specific pharmacotherapeutic areas, and particularly emphasising drug-food interactions and the alteration of nutritional status (Mestres & Duran, 2009); however, it is unclear what informed such a programme in its entirety. Additionally, Mestres and Duran recommended knowledge of the impact of complex pharmacological treatments on nutrition, specifically HIV, tuberculosis, cancer and organ transplantation (Mestres & Duran, 2009), though the rationale for these as emphatic points is unclear. The communicable and non-communicable diseases of South Africa do incorporate HIV, tuberculosis and cancer (Ataguba et al., 2020; Mayosi et al., 2009); however, there are numerous others that may be contextually of equal or greater relevance. For disease treatment, recommendations speak heavily of integrating medical nutrition with pharmacotherapy for attainment of therapeutic outcomes, and highlight areas of relevance to the dietitian, such as metabolic syndromes (including diabetes and obesity) (Mestres & Duran, 2009). In terms of drug-food interactions, dietitians are recommended to identify consequences thereof, advise on preventative methods, and understand when to involve medical practitioners for pharmacotherapeutic adjustments (Mestres & Duran, 2009). Similarly, Wix et al. (1992) support the need for developing knowledge of drug-food interactions as well as how it overlaps with interprofessional competencies of pharmacists (Wix et al., 1992).

Given the importance of inter-individual variability, it has become increasingly relevant for healthcare practitioners to be well-versed in the underlying genomic differences that affect the health or treatment of their patients or clients (Callier et al., 2014). Callier et al. (2014) recommended that different types of healthcare practitioners need to develop defined genomics-associated competencies to navigate their working environment, determine when genetic underpinnings affect their diagnosis and/or treatment, and how to interpret the changes required (Callier et al., 2014). Dietitians are recommended to understand pharmacogenomics (i.e., how genetics will alter the outcome of pharmacotherapy) at a basic level (Callier et al., 2014).

The overt basic sciences' focus of the curricula (Ahsan & Mallick, 2016; Engels, 2018) may infer factual understanding rather than a psychomotor or affective domain competency. Given the scope of practice of dietitians, a high proportion of competencies identified in the cognitive domain aligns with the need to integrate the basic sciences within their clinical practice (International Confederation of Dietetic Associations, 2016; Professional Board for Dietetics and Nutrition, 2016). The broad requirement for development of an understanding of fundamental sciences aligns with their clinical scope of practice that necessitates that they apply their knowledge contextually for their medical nutrition alongside potential pharmacotherapy (Professional Board for Dietetics and Nutrition, 2016). The lack of psychomotor skills is not unexpected, as at present dietitians do not prescribe medication (apart from nutritional supplements, vitamins, minerals and the like) in South Africa (Association for Dietetics in South Africa, 2020).

4.1.2. Delphi study

The Delphi study, as with the results presentation, is discussed according to pharmacological, pharmacotherapeutic and generic competencies.

4.1.2.1. Pharmacological competencies

The Delphi panel had a good overall spread of individuals between experience levels, academic and professional or accreditation body association, and areas of practice. Importantly, the majority were working within the South African context, providing contextual credence to their guidance in the study. Although the response from the Delphi decreased after Phase I, it is important to consider that during the first round, where most consensus was obtained, a good spread of individuals between academic and practice was obtained. Although hampered by a small sample size, opinions from both the academic setting as well as the authentic environment of clinical practice were thus obtained. Although representation from accreditation and professional bodies was available that could advise competencies' alignment with regulatory requirements, the low number does create a potential for bias of opinion.

Participants ranked most of the underlying concepts of biopharmaceutics, pharmacokinetics and pharmacodynamics as important, though all with an expectation of a lower cognitive level (Bloom's taxonomy Remember to Apply). These competencies have been proposed as core concepts in pharmacology (Brinkman et al., 2018; White et al., 2021) as they deal with fundamental aspects of how drugs are created, are processed by the body through absorption to excretion, and incur physiological changes via their mechanisms of action (White et al., 2021). The importance of such core concepts is underpinned by their ability to be applied in various contexts, their predictive qualities for clinical outcomes, and their complexity throughout various applications (White et al., 2021). For example, all drug classes will present with their own unique pharmacokinetic and -dynamic properties; however, with a thorough understanding of the core principles overlayed onto the physiological framework, students will be able to develop a greater understanding of their biological effects and clinical outcomes. Given the views of participants that concepts should be understood or applied, a more general overview is needed instead of in-depth knowledge. From my perspective, a concern may be that if not dealt with sufficiently to create a foundation for understanding the scientific principles, proper scaffolding of subsequent competencies may be impacted. It is important to acknowledge, though, that each profession will, as supported by the rationale to split the three healthcare practitioner groups, have its own unique need for the core concepts, and thus care should be taken from my position as curriculum designer to force complexity into a framework.

Pharmacogenetics has become an increasingly prominent field in healthcare practice, where a patient's genetic profile is used to determine the most appropriate pharmacotherapy (Stäuble et al., 2021). Given the complexity of inter-individual variation and involvement of genetic underpinnings in numerous pharmacotherapies (Gahr et al., 2013), developing the relevant competencies may advise disease management, their therapeutic outcomes, and expectations of adverse effects. For example, in patients with a reduced metabolic potential of hepatic enzymes due to genetic factors, adverse effects may become more apparent with certain pharmacotherapy (Stäuble et al., 2021). Although the importance of pharmacogenetics has been stressed in recent years, the Delphi panel did not consider it important to dietetic

practice, apart from the ability to interpret pharmacogenetic information on medicine. Although Callier et al. (2014) made mention of the importance of pharmacogenetics for allied health practitioners such as dietitians, they did acknowledge that not all healthcare practitioners need the same level of competence (Callier et al., 2014). In support, a recent systematic review suggested that genetics testing in nutrition, although gaining traction, was not yet considered imperative to the dietitian's practice (Braakhuis et al., 2021). However, as interpretation of pharmacogenetic information was considered important, it is necessary to acknowledge that it would be reliant on understanding pharmacogenetic concepts and prominent pathways underlying such reactions, for example, individual variability and response to treatment (White et al., 2021). Given the participants' recommendation for analysis of pharmacogenetic information, it may require elaboration of concepts not prominently addressed in the suggested framework, and integration with other basic sciences, such as human genetics. At present, the current Bachelor of Dietetics programme does not have a prominent focus on genetics, although it will invariably be discussed contextually in the Molecular and Cell Biology, and Physiology modules.

Most concepts related to drug-food interactions (whether broad or with specific examples) were considered important and requiring higher cognitive skillsets as outcome. This is supported by Mestres and Duran (2009; 2012) who highlighted the clinical skills relating to drug-food interactions that would be required: preventative strategies and understanding consequences of interactions (Mestres & Duran, 2009); the possibility of interactions occurring within enteral feeding, and the impact thereof in an intensive care unit (Mestres & Duran, 2012). Food-drug interactions, especially in combination with population-specific responses to drugs, would be important for the dietitian (Adigun & Mudasiru, 2002; Noland & Raj, 2019). Elderly individuals are particularly susceptible to different types of interactions, such as drug-food and drug-drug interactions, due to age-related pharmacokinetic and pharmacodynamic changes that impact a drug's pharmacokinetic profile and the interaction with drug targets (Thiers, 2008). Should the underpinnings of drug-food and drug-drug interactions not be understood, rote learning and memorisation of prominent interactions may occur. As drug-food interactions may occur at pharmaceutical, pharmacokinetic or pharma-codynamic level (Mestres & Duran, 2009), understanding the core concepts relating to the aforementioned concepts will help develop the necessary skills to evaluate them (as proposed by the participants) rather than knowing specific examples (Noland & Raj, 2019). The development of such competencies would allow for effective clinical practice, which links to the scope of nutritional planning, implementation, monitoring, and evaluation needed by dietitians (Noland & Raj, 2019; Professional Board for Dietetics and Nutrition, 2016). The Academy of Nutrition and Dietetics, although more in alignment with a dietitian-nutritionist, recommends development of a broad knowledge of drug-food interactions so that it can be considered during therapeutic modalities (Noland & Raj, 2019). In addition to drug-food interactions, participants also ranked competencies relating to the effect of drugs on nutritional status at a higher cognitive level. Since many drugs can alter nutritional status (Mestres & Duran, 2009), patient outcomes may be negatively affected via drug-food interactions (Fagerman et al., 1986; Kose et al., 2021; Koziolek et al., 2019). In the proposed curriculum framework, four areas of importance for such interaction were highlighted as HIV, tuberculosis, cancer and organ transplantation (sourced from Mestres and Duran (Mestres & Duran, 2009)). However, the relevance of these may be contextually bound to the burden of disease of the country. It may thus be of greater relevance to develop a broader core competency related to drug-food interactions that can be extrapolated to various diseases and drug classes so that application

can be done in context-specific scenarios. This will afford the dietitian a greater ability to determine the potential for such an interaction to occur rather than a specific context, disease or medicine. Although little has been published on the topic, knowledge of drug-food interactions has been shown to be deficient in various healthcare practitioners, including dietitians. Couris et al. (2000) reported that although dietitians' knowledge of food interactions with warfarin (an anticoagulant) was good (73.0%), especially relative to other healthcare practitioners, there were deficiencies in general drug-nutrient interactions (63.2%) that could have clinical implications (Couris et al., 2000). Knowledge of the interactions between concomitant use of enteral feeding solutions (containing calcium among other nutrients) and oral tetracycline could prevent ineffective microbial treatment (Fagerman et al., 1986). Kose et al. (2021) reported that 2.1% of patients hospitalised in Istanbul were at risk of food-drug interactions due to potential incongruence between medication and dietician-prescribed meals that included foods such as grapefruit juice, fatty or fibre-rich meals, sucrose or dairy (Kose et al., 2021). My research team and I assessed the knowledge of South African dietitians on seminal examples of drug-food interactions and the associated timing and at-risk considerations thereof (Megaw et al., 2025), where the pilot study indicated knowledge deficiencies that may inform the need for curricular reform. Such results highlight the need to strengthen the underlying understanding of drug-food interactions and the effect on nutritional status.

Participants agreed that acknowledgement of herbal remedies use in pharmacotherapy was important to the dietetic practice, though only at a lower cognitive level, suggesting a broad overview would be needed, but not in-depth understanding thereof. Traditional medicine, which includes herbal remedies, remains a prominent healthcare practice in South Africa (Marais et al., 2015; McGaw et al., 2022; Mthembu, 2021; Mutale, 2020; Mutola et al., 2021). Although there is acknowledgement of the importance of traditional healers, various challenges have been posited that undermine or hinder the inclusion of traditional medicine into the formal healthcare system (Mthembu, 2021; Mutale, 2020; Mutola et al., 2021). For example, little regulation is in place at present to allow for registration of traditional medicine practices and the specific herbal remedies that may be used, leading to deficient standardisation of healthcare procedures (such as dosing) and scientific testing (Mutola et al., 2021). Additionally, although a large ethnomedicinal base is available to suggest its use for diseases (Lawrence et al., 2021; Marais et al., 2015; McGaw et al., 2022), perceptions of traditional healers are often negative (Lawrence et al., 2021; Mutale, 2020). Although there is contention on the inclusion of traditional knowledge systems into healthcare curricula, healthcare practitioners do acknowledge understanding of such practices in the community and healthcare sector as they will invariably deal with patients making use of such therapeutic modalities (Kwak et al., 2021; Lawrance, 2002; Lawrence et al., 2021; Shaik-Peremanov, 2024; Trinos & Mudaly, 2020). Lawrance (2002), Mestres and Duran (2012), and Kwak et al. (2021) also acknowledge the importance of having knowledge of traditional medicine to dietitians' practice due to inevitable use thereof alongside other therapeutic methods. Lawrance (2002) and Kwak et al. (2021) recommend that regardless of whether there is support for the use of traditional medicine, dietitians should understand the complexity thereof in a sufficient capacity still to advise their patients accordingly. The American Dietetic Association supports knowledge of such herbal remedies, although it is not within the direct scope of dietitians (McCabe-Sellers et al., 2010). At present, apart from mention of herbal remedies within the orientation session for my module, an inquiry-based assignment that generally focuses on plant-based medicines, and sporadic mention of some plants of interest

in certain learning opportunities, the current pharmacology curriculum does not discuss much on the topic of traditional medicine. Based on my own experiences, students tend to be interested in the discussion and approach it from various stances, though it does often appear as if there is lack of probing more deeply into the discussion within an open classroom forum in relation to other topics; students rather approach me individually on such topics. Although it would be rash to draw conclusions from isolated experiences, I do get the sense that the topic remains contentious when addressing it in class, and thus formal acknowledgement of what is known, unknown and needed on the matter of traditional medicine may help dispel misconceptions and allow for greater scholarly discourse on it.

Various general concepts of clinical practice were considered important, including the integration of dietetic and pharmacotherapeutic treatments, role of healthcare workers, and essential medicine list. Working as an interdisciplinary team, and integrating different treatment modalities speak to the scope of practice of dietitians for effective management of patients (Professional Board for Dietetics and Nutrition, 2016). This is supported by the American Dietetic Association's recommendations which acknowledge that the complexity of comprehensive treatment cannot be achieved by one healthcare practitioner alone, and thus interprofessional teams with those knowledgeable in medication (such as pharmacists) are needed (McCabe-Sellers et al., 2010). The EML, a formulary of medicines that are suited for primary healthcare needs of the population in reference (South African Department of Health, 2020), was listed at a lower cognitive level, suggesting that only knowledge thereof is important, and supports the need of dietitians to understand the priority treatments their patients may be taking. Given the diversity of medicine available, being aware of the most frequently used and/or important medications in the public healthcare sector, allows for a reduction in cognitive overload in the curriculum. Prescribing was also remarked as less important, which is suited to the current lack of prescribing regulations for dietitians (Association for Dietetics in South Africa, 2020).

Appropriate interpretative and communicative abilities of pharmacology research were regarded as important. Allied healthcare practitioners, including dietitians, are well-placed for patient education (Moyoh et al., 2022; Wansink & American Dietetic Association, 2006); however, the appropriateness of such endeavours would need to align with their scope of practice not to overreach their scope of practice, education and/or experience. Given their scope of practice, dietitians would speak to medical nutrition (Wansink & American Dietetic Association, 2006), though it can be assumed that any healthcare practitioner would be approached with queries outside of their direct professional experience. This would be needed in modern day contexts, for example, to mitigate the spread of misinformation (Chou et al., 2018), such as was seen with COVID-19 (Blake et al., 2022). To support evidence-based practice, dietitians would need a proper understanding and adherence to their scope of practice (Professional Board for Dietetics and Nutrition, 2016), an understanding of basic sciences, and the ability to appraise literature critically for evidence-based practice (Weng et al., 2013). Although they may be approached with non-dietetic healthcare queries, understanding where to redirect queries to more appropriate healthcare professions would be important (Noland & Raj, 2019). Additionally, understanding pharmacological research will help bolster their own knowledge on factors that may influence their practice and biases.

Importantly, participants indicated that some competencies were not important for inclusion in dietetic education, such as drug research and development, medicine compliance in

pharmacology and medication errors. However, these concepts are important in the foundational development of knowledge for subsequent competencies, such as counselling of patients. Although this opinion should be respected and invariably would be informed by the scope of practice, the scaffolded development of competencies should be considered, which may require a compromise in curriculum design to be reached to provide enough clarity and background on information for subsequent, more important competencies to develop appropriately.

4.1.2.2. Pharmacotherapeutic competencies

Pharmacotherapy directed at asthma and other respiratory diseases, anaesthesia, contraception, fungal infections, malaria, and certain neurological conditions (i.e., epilepsy, Parkinson's disease, schizophrenia, sedation, and hypnosis), were not considered important to the dietetics profession. Nutrition arguably influences all pathological states, and thus the importance to dietetic practice may be inferred by their potential to be seen during therapeutic counselling. For example, contraceptive treatment has a profound impact on nutritional status, where oral contraceptives interfere with folic acid, vitamins (B2, B6, B12, C and E) and minerals (magnesium, selenium, and zinc) (Palmery et al., 2013). Additionally, the ketogenic diet has shown potential in the treatment of epilepsy but has also been reported to alter the pharmacokinetics of anti-epileptic medication that may affect treatment success and adverse effects profiles (Asadi-Pooya et al., 2024; Tayutivutikul et al., 2022). It was noted by participants, though, that vitamin deficiencies were an important competency, and thus approaching the education thereof may be achieved from the adverse effect perspective rather than a specific drug class or disease. In doing so, students may develop a broader understanding of why drugs would interfere with vitamins within the body, and thus allow for more adaptability within different clinical scenarios. It is unclear why such a competency would not be listed as important by the participants, but may be advised by their experiences and likelihood of clinical repercussions. Given the importance of national context, pharmacology education should be responsive to what is occurring within the country itself (Chevan & Heath, 2019).

The majority of pharmacotherapeutic competencies were indicated as requiring higher order alignment, particularly those involved in cardiovascular, gastrointestinal, immunological and metabolic diseases. Given the importance of such diseases within the nutritional domain, it is not unexpected that a greater focus would be placed on chronic lifestyle disorders (Mestres & Duran, 2012; Eglseer & Bauer, 2020; Lee et al., 2022) and those linking to nutritional status, such as obesity and malnutrition (Eglseer & Bauer, 2020). Additionally, notable drug-food interactions may occur that compromise treatment and/or promote adverse effects, such as those between enteral feeding solutions and oral antibiotics (Fagerman et al., 1986), protein-enriched feedback solutions (Shahbazi et al., 2017), and grapefruit juice and nifedipine (Adigun & Mudasiru, 2002). Cardiovascular medication is known to interact with various food items (D'Alessandro et al., 2022) that impacts their ability to achieve therapeutic success or mitigate adverse effects. For example, grapefruit juice has been reported to increase nifedipine's bioavailability, which precipitated weight gain and oedema; however, it improved blood pressure control in a patient (Adigun & Mudasiru, 2002). Loop and thiazide diuretics may reduce serum calcium and sodium levels respectively, which impacts many bodily functions (D'Alessandro et al., 2022). While both loop and thiazide diuretics may precipitate reduced potassium levels, renin angiotensin system inhibitors may result in increased

potassium levels; both alterations will negatively impact the cardiovascular system (D'Alessandro et al., 2022). Vitamin K use during warfarin therapy has a significant effect on achieving anticoagulation, and thus dietary monitoring is generally needed (Couris et al., 2000), while digoxin's inotropic effect is altered by fluctuations in potassium levels (McCabe-Sellers et al., 2010).

New areas that were recommended for inclusion relevant to the gastrointestinal system comprised anorexiants and appetite stimulants, digestive enzymes, gall stones, hepatic encephalopathy, inflammatory bowel disease, prebiotics and probiotics, and food poisoning. Pharmacotherapy is routinely featured in gastrointestinal disorders, such as inflammatory bowel syndrome, small bowel syndrome (Fornals et al., 2024), pancreatic exocrine deficiency (Delaney et al., 2021), functional diarrhoea (Ford, 2023) and irritable bowel syndrome (Duff et al., 2018; Ford, 2023) that, depending on the disease, may include proton pump inhibitors, anti-secretory agents, antimicrobial agents, probiotics (Fornals et al., 2024), digestive enzymes (Delaney et al., 2021; Fornals et al., 2024), prokinetics, and bile acid sequestrants (Fornals et al., 2024). Knowledge of the effect of medication on the disease, nutritional status and medical nutrition modality is thus necessary for comprehensive patient care. For example, Australian dietitians were reported to have confidence in prescribing pancreatic enzyme replacement therapy and titrating doses given their understanding of the effect thereof on the nutritional status of patients (Delaney et al., 2021).

Within neurological conditions such as depression, the use of monoamine oxidase inhibitors (e.g., tranylcypromine) may be hazardous alongside tyramine-containing foods (e.g., avocados, cheese) due to the cheese-reaction (one of the earliest-described drug-food interactions) (Generali et al., 1981). Other neuropsychiatric drugs for depression and anxiety have been reported to increase body weight, or may interact with foods and drinks such as grapefruit juice and caffeine to alter their biological effect (D'Alessandro et al., 2022).

Sports performance-enhancing drugs were also identified as being important, which is supported by the recent emphasis on sports nutrition and trends in healthier lifestyles (Arenas-Jal et al., 2020). Dietitians would be well positioned to encounter sports performance-enhancing drugs that may impact a client's nutritional status (Arenas-Jal et al., 2020), particularly if working within a sports nutrition area. Dietitians are also remarked as being important within wound care, as many wounds may alter or be affected by nutrition that may necessitate dietary changes and inclusion of vitamins (e.g., in burn wounds) (Hurd, 2004).

Nutrition is invariably important in many infectious diseases given the role it plays within its progression and treatment of associated nutritional deficiencies. For example, HIV is associated with wasting, malnutrition and vitamin and mineral deficiencies (Willig et al., 2018; Young, 1997). However, metabolic syndrome and lipodystrophy may also occur, often because of antiretroviral therapy (Willig et al., 2018). Nutrition has also been shown to affect antimicrobial resistance (Oliver et al., 2022), further suggesting knowledge of the intricacies between nutritional status and infections be solidified.

Oncotherapy used for cancer management is notorious for affecting the nutritional status of individuals, which can, among other adverse effects, precipitate malnutrition (Guest et al., 2023; Ringwald-Smith et al., 2022) or altered mineral and vitamin levels (D'Alessandro et al., 2022). As such, dietitians are frequently approached to support nutritional changes and

betterment during treatment, particularly in more severe cases (Guest et al., 2023; Ringwald-Smith et al., 2022). Choi et al. (2015) recommended job standards for clinical dietitians working within the oncotherapeutic area, which among others, included assessment of direct and indirect medication use for cancer, the effect of the medication on nutritional status and adverse effects, and mitigation strategies for nutritional deficiencies (Choi et al., 2015). For example, Ringwald-Smith et al. (2022) reported that dietitians working within paediatric oncology provided approximately the same education on pharmacological appetite stimulants as medical and nurse practitioners. Given the importance of improving nutrition within the oncology setting, inclusion of discussions of cancer therapy and nutrition in cancer thus aligns well with their scope of practice.

4.1.2.3. Generic competencies

All generic competencies were considered important to the dietetic profession during Phase I. Although the generic competencies are not pharmacology-specific and go beyond disciplinary bounds, modalities should be considered where appropriate to reinforce their development and attainment where possible. By devising such learning opportunities, more generalised competencies can be developed in tandem with core competencies. For example, the current inquiry-based team assignments for FAR 381 and FAR 382 already provide a platform amenable to the development of collaboration, communication, critical thinking and information literacy, but could be bolstered to more formally approach its education.

As the world changes due to, among others, digitisation and the introduction of new technologies (Dower et al., 2013), healthcare practitioners' roles will evolve to accommodate new functions (Weber, 2006; Van Heerden, 2013). It cannot be expected that healthcare practitioners will be able to accommodate the needs of the country if they are not adaptable with newer competencies necessitated by their professions (Van Heerden, 2013). Given the technological advancements made within the past few decades, several 21st century skills have been emphasised as necessities for the 21st century graduate. These skills afford graduates the ability to navigate the modern-day world, which includes the use of information in whichever form it may arise and achieving a higher order of thinking (Binkley et al., 2014). Many of these competencies overlap with the critical cross-field and developmental outcomes (South African Qualifications Authority, 2000), and core subject knowledge relating to reading, writing and arithmetic (Chu et al., 2017). Additionally, they are an expectation of the graduate attributes of the University of Pretoria (University of Pretoria, 2022).

As stated by the American Dietetic Association (McCabe-Sellers et al., 2010), Academy of Nutrition and Dietetics (Andersen et al., 2018; Noland & Raj, 2019) and Professional Board for Dietetics and Nutrition (Professional Board for Dietetics and Nutrition, 2016), interdisciplinary teams are needed to approach comprehensive treatment, particularly given the complexity and integrated nature of disease treatment, scopes of practice of different healthcare practitioners, and their underlying education. Competence in collaboration and communication would be necessary to achieve such interdisciplinary and interprofessional practice (Andersen et al., 2018). Communication stretches further as a generic competency (Markowitz et al., 2017; Academy of Science of South Africa, 2018) to matters of patient counselling, for example, of drug-food interactions (McCabe-Sellers et al., 2010; Mestres & Duran, 2009; Wix et al., 1992). This would also necessitate social and cultural interaction given the diversity of patients that may be encountered to allow for person-centred care (Noland &

Raj, 2019), and approaching sensitive matters such as traditional medicine that would inherently be culturally bound (Kwak et al., 2021; Lawrance, 2002; McCabe-Sellers et al., 2010).

Recommendations are also made to incorporate mentorship and professional development within practice to ensure continuous development of others and oneself, and to promote leadership and accountability within the profession (Noland & Raj, 2019; Tweedie et al., 2021). Reflective practice is also considered an important competency, ultimately allowing for meta-cognition to promote healthcare approaches and critical thinking (Picknell et al., 2024). By developing critical thinking strategies, approaches to treatment could be bolstered, for example, by applying them within the interpretation of scientific evidence (Tweedie et al., 2021) and engaging with evidence-based practice (Albarqouni et al., 2018). This also necessitates the ability to source information and interpret information to ensure intervention plans can be properly approached (Khullar, 2022; Tweedie et al., 2021; Wansink & American Dietetic Association, 2006). In recent years, misinformation has showcased the importance of healthcare practitioners to be media and technologically literate to guide correct information sourcing for patients (Chou et al., 2018; Khullar, 2022; Wansink & American Dietetic Association, 2006), as discussed in Section 4.1.2.1.

4.2. Targeted needs

The targeted needs analysis is discussed in a stratified format according to the development of pharmacological competencies, scaffolded learning from physiology, and alignment of the proposed pharmacology curriculum. This incorporates both the curriculum mapping and focus group interviews, given their cohesive nature.

4.2.1. Development of pharmacological competencies

Curriculum mapping was done for both the current and the proposed pharmacology curricula. Although information from most modules that comprise the Bachelor of Dietetics programme could be sourced through the relevant stakeholders, there was a large variation in the quality, explicitness and description of it. For example, the content of most core modules was described in-depth in the yearbook (University of Pretoria, 2024b) that allowed for an additional level of confirmation of what is expected from the Dietetic students. This afforded me the opportunity to confirm various pharmacotherapeutic areas as either explicitly necessary or not discussed. However, the content of some fundamental modules in the yearbook, such as Physiology, spoke more broadly of the systems being addressed. Although this does provide a tangible point of departure for what is being dealt with, depending on the breadth of the learning outcomes and assessment criteria within the individual modules, some level of uncertainty was evident in whether there was explicit coverage of basic sciences concepts. To allow for the creation of a cohesive learning opportunity that is scaffolded appropriately, minimises redundancy and supports a more contextualised discussion, horizontal and vertical integration is needed (Faingold & Dunaway, 2002). By bolstering the curriculum mapping process, further clarity is obtained on how to approach such a design. Curriculum mapping of FAR 381 and FAR 382 helped showcase potential strengths and deficiencies within the current curricula that further advises on how to approach implementation of the proposed pharmacology curriculum.

Participants opined that although pharmacological knowledge was being developed, students could not apply it appropriately within their clinical context. As such, clear competency development concerns were present that were supported by several examples of the inability to determine the relevance of certain medication used in the clinical setting. Furthermore, knowledge of drug-food interactions, which forms an important part of dietetic practice was deficient. Knowledge deficiencies of drug-food interactions in healthcare practitioners have already been described in Section 2.1 (Couris et al., 2000; Kose et al., 2021), and thus support the potential of the current students correctly to interpret, analyse and mitigate such interactions, leading to clinical repercussions. Interestingly, participants highlighted illogical thinking by their students in the clinical platform, where alcohol was mentioned as one of the few (if only) true interactions they understood, regardless of whether alcohol would be a feasible clinical scenario, such as in paediatric patients. Participants remarked during several parts of the focus group on the importance of drug-food interactions, the nutritional alterations that pharmacotherapy could cause, and how a dietitian would need to educate, prevent and treat such occurrences. This aligns with the exit level outcomes of the Bachelor of Dietetics (South African Qualifications Authority, 2018a) as well as curricular recommendations on a dietitian's practice (Noland & Raj, 2019; Professional Board for Dietetics and Nutrition, 2016). Beyond such deficiencies, participants remarked that the route of administration was important to consider within the dietetic practice as it could affect drug-food interactions; however, no literature could be found to support whether knowledge deficiencies were present within dietitians. The time and way in which medication is administered may influence the pharmacokinetics of medication, for example, nutrient ingestion alongside azithromycin (an antibiotic), ibuprofren (a non-steroidal anti-inflammatory drug) (Ağagündüz et al., 2021), captopril (an antihypertensive) and levodopa (an anti-Parksinon's disease drug) (Ased et al., 2018) may alter its bioavailability and inherently its clinical effect in the individual. As such, ignorance of how to approach medical nutrition alongside pharmacotherapy may lead to clinically-significant alteration to the therapeutic and/or adverse outcomes of disease treatment.

As mentioned previously, the removal of the FAR 382 module does impact on certain competency development. To acknowledge the complexity of decision-making regarding the module's removal, content overload is considered a general concern of many accreditation processes, and thus reducing the number of credits within the programme was necessary to ensure continuation of the programme. As modules could not be altered within such a small timeframe without affecting other healthcare practitioner degrees, it is understandable although unfortunate that potential areas of deficit may have arisen. Although only a small number of assessment criteria were linked with Medical Nutrition Therapy in Years III (4.17%) and IV (12.5%), the importance of the pharmacological background for certain areas was contextually evident. Module content and learning outcomes highlighted medical nutrition practices relating to adrenocorticosteroid-based treatment, asthma, viral infections (specifically HIV), neurological diseases and gastrointestinal disorders that invariably would not be covered within the third-year since the removal. Although Medical Nutrition Therapy modules may acknowledge the relevant pharmacotherapy within their modules, the lack of a foundational discussion of the mechanisms of action may inherently complicate clinical knowledge development (Bandiera et al., 2013) and reinforce memorisation of information. The basic sciences, such as pharmacology, ultimately become encapsulated within clinical knowledge, and thus if not present, theory-practice gaps may occur (Jefferies et al., 2010; Rikers et al., 2004). Clinical decision-making can be impacted by improper scaffolding, thus

leading to difficulty in understand new information, or applying it in different contexts (Bandiera et al., 2013; Jefferies et al., 2010).

For FAR 381, several pharmacotherapeutic areas currently being addressed within the curriculum do not have explicit linkage to any Year III or Year IV Medical Nutrition Therapy modules, including the autonomic nervous system, pain, anaesthesia, reproduction and fertility concerns. As such, these topics may not have a noteworthy relevance to the profession within the national or local context, or may not be explicitly mentioned within the module content or learning outcomes. These aspects were not mentioned as being important during the focus group; however, epilepsy was considered to be included in the list.

4.2.2. Scaffolded learning from physiology

As opined by Rangachari (1997) and Jefferies et al. (2010), pharmacology is an applied physiological discipline, drawing heavily from other biomedical sciences such as physiology and biochemistry. In support of this, Islam et al. (2017) recommended teaching pharmacology alongside physiology and pathophysiology to achieve greater horizontal integration and contextualisation of how drugs may affect a biological system (Islam et al., 2017), and Bandiera et al. (2013) posit the complexity that may arise clinically if a foundational understanding of physiology and pathophysiology is absent. White et al. (2021) also speak to the core concepts of pharmacology's reliance on physiological systems for pharmacokinetic and pharmacodynamic responses (White et al., 2021). Based on the curriculum mapping, the molecular, chemical, biochemical and physiological scaffold for many aspects relating to pharmacokinetics and pharmacodynamics appears to be sufficiently addressed within the first two years to promote further discussion of concepts. For example, between Molecular and Cell Biology, Chemistry, Biochemistry and Physiology modules, aspects relating to acids and bases, ionisation properties of chemicals, cell structures, body fluids and physiological systems should give a broad enough understanding to allow for discourse relating to drug absorption, distribution, metabolism and excretion (Gaohua et al., 2021; Manallack et al., 2013). Similarly, a broad discussion of enzyme function and kinetics between Biochemistry and Physiology modules promotes an understanding of the pharmacokinetic and pharmacodynamic role of enzymes in metabolism (Testa et al., 2012). However, certain areas were found to be more lacking or not explicitly mentioned that tie into an understanding of various drug targets apart from enzymes, thus potentially complicating the discourse related to how drugs would interact with such targets to elicit changes in the body. The concern of such deficiencies aligns with the importance of ensuring that proper scaffolding of the core concepts of pharmacology is achieved (Santiago et al., 2021; White et al., 2021; Guilding et al., 2024). To illustrate the complex interconnected nature of the core concepts as an underlying framework for pharmacology education, Figure 3.3 showcases how concepts build on top of one another, support comprehension of subsequent concepts, and create a generalised approach to contextualising the information in various pharmacological circumstances. Without a thorough understanding of pharmacokinetics and pharmacodynamics (Guilding et al., 2024), developing a broader sense of how drugs affect patient outcomes is thus invariably more complex. Notably, core concepts are underpinned by other basic sciences, including physiology and biochemistry (Jefferies et al., 2010).

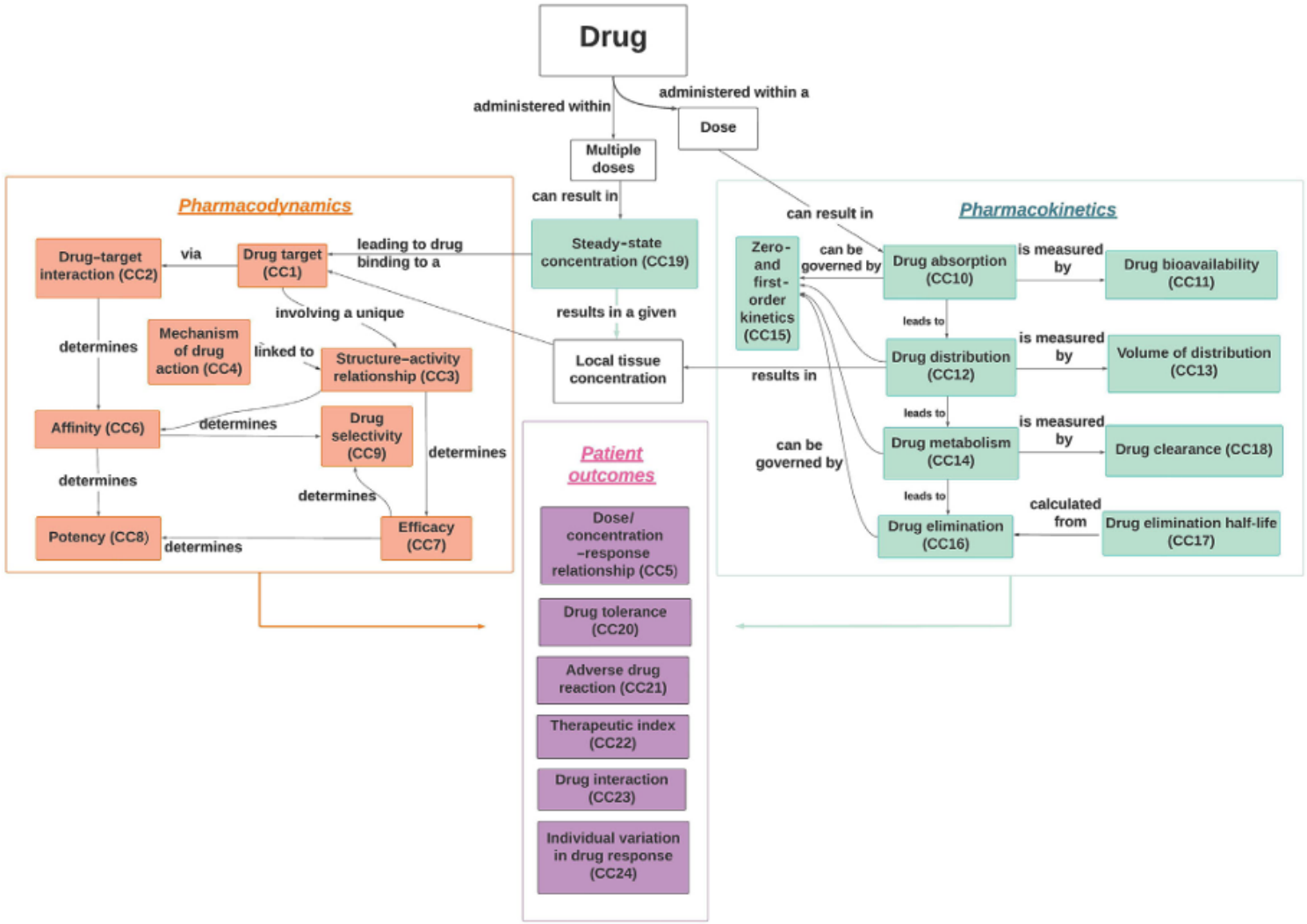

FIGURE 3.3: CONSENSUS CONCEPT MAP SHOWCASING THE RELATIONSHIP OF THE CORE CONCEPTS (CC) OF PHARMACOLOGY TO ONE ANOTHER (GUILDING ET AL., 2024). REPRODUCED UNDER THE CREATIVE COMMONS LICENCE OF JOHN WILEY AND SONS, INC

Several physiological areas are likely sufficient to allow for scaffolding; for example, gastrointestinal, respiratory, cardiovascular, renal and certain neurological systems are presented within the first two years. Additionally, biochemistry discussions of carbohydrates and proteins also support discussions of their role in certain physiological processes, such as digestion, nutrition and glucose control. Additionally, relevant pathophysiology is discussed in Year III second-semester (cardiovascular and metabolic diseases) and Year IV (gastrointestinal and neurological disorders) Medical Nutrition Therapy modules. Although such education takes place, the scaffolding of the pathophysiology is not aligned appropriately with the current structure of the Pharmacology modules. For example, cardiovascular and metabolic diseases are dealt with in the first semester; however, the pathophysiology is discussed only in the semester thereafter. Additionally, the pathophysiology relating the gastrointestinal and neurological disorders is present in Year IV, while the pharmacotherapy thereof is discussed in the Year III and was removed from the Bachelor of Dietetics programme. Improper scaffolding may inherently lead to more complexity in the development of the relevant competencies (Bandiera et al., 2013). Other physiological areas, particularly those related to allergies and neurophysiology relating to nausea and vomiting, mental health disorders and psychiatric conditions, are not explicitly mentioned in the curricular material. Participants concurred that the physiological background of students was insufficient to allow for further competency development, particularly hampering their ability to understand pharmacology, the complex interactions that diseases have with the physiological systems, and how they affect medical nutrition. The misaligned scaffolding was also remarked upon, thus emphasising the need for careful review of the programme curriculum to ensure sufficient competency development is achieved.

The Year III Medical Nutrition Therapy module discusses microbial diseases, particularly HIV and worm infestations; however, the basic science of the pharmacotherapy is discussed in the FAR 382 module that is no longer included in the Bachelor of Dietetics programme. As with physiology, without a proper scaffold for discussion of appropriate drug targets, contextualisation of pharmacodynamic properties becomes complex and requires additional time to discuss the pre-requisite information. At present, students do not have an explicit background in microbiology and thus may struggle to understand targets associated with viruses, bacteria, fungi, parasites or worms. Microbiology is included in several healthcare practitioner programmes due to its importance in contextualising infectious diseases and their treatment (Andersen et al., 2018; Davey et al., 1993; DiMaria-Ghalili et al., 2014; Steinel et al., 2019), where horizontally integrated associated disciplines allow for a more cohesive view of antimicrobial treatment (Steinel et al., 2019). The Academy of Nutrition and Dietetics recommends the inclusion of microbiology as one of its fundamental sciences (Andersen et al., 2018), which invariably strengthens the practitioner's position of being able to evaluate and review pharmacotherapeutic efficacy and adverse effects in infectious conditions such as HIV (Willig et al., 2018).

4.2.3. Alignment of the proposed pharmacology curriculum

The mapping of the proposed pharmacology curriculum not only reduced the number of assessment criteria but also showcased a greater linkage to the core Medical Nutrition Therapy modules in Year III (22.73%) and Year IV (25.76%). Removing physiological assessment criteria reinforces the importance and focus of the pharmacology curriculum on

its core mandate. Within the broader discussion of pre-requisite knowledge of physiology, there will need to be an emphasis on ensuring that students attain the background necessary to allow for scaffolded learning. Additionally, when doing so, it will be necessary to ensure that horizontal integration is achieved by presenting the physiological framework within the context of the relevant harmacology. Such integrated andragogy has shown successful outcomes (Bandiera et al., 2013; Ginzburg et al., 2017; Islam et al., 2017; Meechan et al., 2011; Obi et al., 2022; Steinel et al., 2019). Areas of physiological concern, apart from those presented earlier, include newly recommended areas such as anorexiants, oncotherapy, gall stones, gout, hepatic encephalopathy, vitamin deficiencies and anthelmintics. These pharmacotherapeutic areas are highlighted already in Medical Nutrition Therapy modules as important, with clinical treatment of worm infestations, various gastrointestinal diseases (including the liver and biliary system), renal insufficiencies, cancer and wounds. An important competency acknowledged within these modules is also the contextual management of drug-food interactions and the implication on nutritional status.

As described in Section 2.3, the Council on Higher Education delineated a dietitian-nutritionist practitioner in 2022 (Council on Higher Education, 2023), which necessitated that higher education institutions review their current dietetic programmes. The Department of Human Nutrition has already compiled a macro-structure for its new Bachelor of Sciences with specialisation in Dietetics and Nutrition programme, where certain fundamental modules have been incorporated into relevant core modules, such as Biochemistry and Pharmacology, and Physiology has been shortened to a single module in the first year. Pharmacology will be incorporated within the Medical Nutrition Therapy modules to allow for a greater integration within therapeutic and pathophysiological discussions. Such integration, as noted before, allows for a comprehensive and contextualised view of the clinical domain (Bandiera et al., 2013; Islam et al., 2017; McCabe-Sellers et al., 2010), which may lead to a greater attainment of horizontal and vertical integration. Participants did explain that the integration would be approached in a manner to package all relevant aspects of the pathophysiological and pharmacological system together to ensure alignment with the medical nutrition; however, planning was still to be undertaken. The premise, though, relies on stakeholders creating an integrated package that allows for contextualisation of the topic within the field of dietetics. In such a manner, a more clinically-relevant learning opportunity is created. Although my concern was noted about the breadth of physiology decreasing from four modules to a single semester module, this would be accommodated within the earlier introduction of Medical Nutrition Therapy as a Year II module, thus spreading the workload throughout the final three years and allowing for a greater level of scaffolding to be approached. In doing so, pharmacology could also be included at an earlier year-level to showcase its relevance to the field.

Participants highlighted that to reduce the number of drugs to be discussed, and particularly elevate those that were relevant, students should be made aware of the EML (South African Department of Health, 2020) with tutelage of only its relevant pharmacotherapy. The EML, comprising necessary treatment for the national context that is accommodated with the healthcare budget and available infrastructure (Perumal-Pillay & Suleman, 2017), features more standardised guidelines as well, thus assisting with how dietitians may encounter such pharmacotherapy. Although there is current focus on the EML, students are not educated on what the document is, why it is necessary within the primary healthcare setting, and how drugs are selected. In doing so, students will have a better grasp of why they see certain drugs more frequently, and thus also be more prepared for encountering those specific

pharmacotherapies. However, it should be noted that this may leave a deficiency when moving to more private healthcare sectors where such drugs are not featured in the EML, and thus careful consideration of how to approach this should be taken.

Participants remarked that complementary and alternative medicines, which include herbal remedies, were touched on in the curriculum but could benefit from discipline-specific guidance. Similar to what was shown in the Delphi study, it is important for dietitians to understand the role of such therapies in their practice, especially in a country such as South Africa where herbal remedy use is quite common (Marais et al., 2015; McGaw et al., 2022; Mthembu, 2021; Mutale, 2020; Mutola et al., 2021). As discussed in Section 4.1.2.1, the various researchers within the dietetics profession have acknowledged the importance of understanding their patients' alternative remedies (Augustine et al., 2016; Kwak et al., 2021; Lawrance, 2002; McCabe-Sellers et al., 2010; Mestres & Duran, 2012; Swift, 2012) to allow for education, integration and mitigation of detrimental clinical outcomes. This, in itself, also affords the dietitian a greater socio-cultural understanding, which forms part of the generic competencies ranked as important, and is also considered part of the University of Pretoria graduate outcomes (University of Pretoria, 2022) and South African critical cross-field outcomes (South African Qualifications Authority, 1998).

Although not initially addressed in the Delphi study, when participants were asked about their opinion of the effect of pharmacology on lactation and breastfeeding, it was considered relevant to include. Many drugs distribute into breastmilk, which inherently affects the baby during breastfeeding (Dytrych, 2012; Lebedevs & Kendrick, 2019; Mitchell et al., 2020; Nallani et al., 2023; Pennell et al., 2007) that may include a sedative effect while feeding (Mitchell et al., 2020; Pennell et al., 2007). Furthermore, many pharmacotherapies are used off-label as galactogogues (medication that stimulates breastmilk production), and thus should be considered during patient assessment (Lebedevs & Kendrick, 2019). The Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition posit that as a standard of clinical practice, dietitians should have competency in breastfeeding practice (Corrigan et al., 2021). Although participants mentioned that there was not a large representation of breastfeeding in the curriculum, it is addressed in their community nutrition platform, and thus would be beneficial for students to have sufficient understanding of the nuances of lactational pharmacology that may affect their patients or their children.

5. Recommendations

Several recommendations have been made for the revised Bachelor of Science with specialisation in Dietetics and Nutrition programme.

5.1. Programme level curriculum mapping

Curriculum mapping has currently shown areas of alignment, strength and potential deficiency in the current Bachelor of Dietetics programme in relation to pharmacology. The current mapping suggested that Molecular Biology, Chemistry, Biochemistry and certain aspects of Physiology would be sufficient to allow for scaffolding of specific areas of pharmacology education, which includes elements related to the core concepts of pharmacology and some pharmacotherapeutic modalities. The physiological knowledge that was not explicitly

mentioned in curricular information for some core pathologies and treatments in medical nutrition might not adequately be addressed with the current reduction in time for physiology.

To circumvent any areas of concern, it is recommended that the new Bachelor of Science with specialisation in Dietetics and Nutrition be mapped using the available curriculum mapping platform of the University of Pretoria (LOOOP) to investigate links between modules. Through the LOOOP platform, among others, transparency to all stakeholders and clarity of links between modules can be gained (Balzer et al., 2016; Treadwell et al., 2019), thus providing a clear auditable trail of areas of strength and deficiency. Additionally, LOOOP addresses Harden's ten windows of curriculum mapping (Balzer et al., 2016), thus affording the curriculum designer a myriad of information necessary for successful management of the curriculum. Although such a process requires a large initial investment of time and resources (Balzer et al., 2016; Treadwell et al., 2019), the downstream dynamicity thereof will benefit the programme to maintain a living curriculum that is adaptable over time, based on student evaluation and alterations in the national context of the profession and disease burden.

Mapping will necessitate that all stakeholders involved in the programme ensure that constructive alignment is present between their assessments and andragogy to develop competencies required for the profession (Ali, 2018; Loughlin et al., 2021; Walsh, 2007). As noted during data collection, the variability in quality of learning outcomes and assessment criteria creates complexity for mapping purposes and may precipitate misalignment. By engaging with faculty development platforms, for example, training sessions presented by the Department of Education Innovation of the University, a benchmarked standard can be achieved. This is not to say that current faculty members are not capable of doing so, or have already systematically increased the quality of their curricular information, but merely to acknowledge that education itself is not an area of focus for all academic members, nor necessarily their strength or interest. Similar concerns have been noted in literature that often ties into the diversity of academic members' strengths, interests and, in many cases, lack of formal health professions education training (Balzer et al., 2016; Treadwell et al., 2019). Furthermore, given the stage of planning that the Department of Human Nutrition is at, it is an ideal time for such collaborative working to occur to allow for a well-placed curriculum map.

5.2. Integrated Medical Nutrition Therapy and Pharmacology

The results of the study support the integration of pharmacology into the Medical Nutrition Therapy modules of the Bachelor of Science with specialisation in Dietetics and Nutrition. By integrating pharmacology within the core clinical context dealing with the Pathology and Medical Nutrition practice, it not only reinforces horizontal and vertical integration, but also highlights the relevance and value of pharmacology to the profession. Integration will also allow for a new envisagement of andragogy and assessment due to the smaller class sizes, and focus, given the removal of non-dietetic healthcare practitioner students.

As Medical Nutrition Therapy will be presented on a semester-basis from the second year, second semester to the full fourth year, placement of Pharmacology within it will be dependent on what specifically will be addressed during each semester. As opined by participants, packages will be created to address the pathophysiological aspects alongside pharmacotherapy and Medical Nutrition, and in such a way our curriculum design would be guided by and large by the Department of Human Nutrition to set the platform of their relevant

diseases. Core concepts of pharmacology (White et al., 2021) would be appropriate to include in the second year so that disease-specific treatment could be approached as early as possible in tandem with Medical Nutrition concepts. The conceptual framework designed by Guilding et al. (2024) may serve as a formalised way in which to approach teaching the subject matter, with appropriate interleaving of relevant nutrients that will inherently share biological processes with medication. Various nutrients undergo similar pharmacokinetic and pharmacodynamic processes, coined nutrikinetics (Gonzalez et al., 2023) and nutridynamics (Gonzalez et al., 2023; Mohajeri et al., 2015). By contextualising pharmacokinetic and pharmacodynamic principles within the context of nutrients, students are introduced to relevant terminology, concepts and principles that can be further unpacked from the pharmacological vantage when drug classes are introduced. Alongside the discussion of nutrikinetics and nutridynamics, it may thus create a greater valuation of the material due to the overlapping nature with their core discipline. For example, tyramine, a trace amine found in various foodstuffs (VanDenBerg et al., 2003), such as cheese, can be discussed from a pharmacokinetic and pharmacodynamics perspective that also becomes contextually important for the discussion of drug-food interactions at a later stage with monoamine oxidase inhibitors (McCabe-Sellers et al., 2006). By building on the concepts of pharmacokinetics and pharmacodynamics, it thus also facilitates a mechanistic framework for understanding various ways in which drug-food interactions may occur (Koziolek et al., 2019; Mestres & Duran, 2009).

The pharmacology of various drug classes can be introduced based on a systems- or treatment-approach, dependent on the structure of the Medical Nutrition Therapy modules. By facilitating an integrated curriculum, broader discussions within the context of Medical Nutrition can take place and allow for horizontal and vertical integration. Various strategies have been proposed to do so, including problem-based learning (Islam et al., 2017; Liu et al., 2019; Rosenbloom & Nemec, 2021; Umar & Haque, 2022), flipped classroom environments (Umar & Haque, 2022; Zhang et al., 2024), team-based learning (Umar & Haque, 2022) or case-based learning (Hark & Morrison, 2000; Umar & Haque, 2022; Vashe et al., 2019). In doing so, it allows for an integrated view of topics, decreased content-heaviness and contextual relation of the basic sciences with clinical relevance (Umar & Haque, 2022; Vashe et al., 2019; Woodman et al., 2004). Several challenges need to be acknowledged with many integrated practices, such as the potential for disciplinary depth to be lost (i.e., important core aspects of pharmacology may become diluted within the broader context), important molecular and/or physiological pathways are not delved into fully (Umar & Haque, 2022; Woodman et al., 2004), the inappropriate placement of more generalised concepts that are not bound within a specific context (Woodman et al., 2004), increased logistical needs, and potential change management concerns (McKimm, 2010; Umar & Haque, 2022). Incorporating dietetic educators with clinical experience further allows the bridge between basic and clinical sciences to be crossed during a lesson, highlighting authentic experiences but supported with appropriate fundamental sciences. Such team-based teaching can have varied responses though, depending on how well it is implemented, as clinical teaching could elevate the contextual relevance, but also allow for misconceptions between basic and clinical educators (Manias & Bullock, 2002; Umar & Haque, 2022). The smaller class sizes also allow for small-group discussions that allow for more interaction and engagement with peers (Aydogdu & Winder, 2022; Ginzburg et al., 2017; Jalgaonkar et al., 2012). Regardless of the approach taken, proper stakeholder engagement would be needed during lesson planning to ensure there is constructive alignment of the learning outcomes, andragogy and assessment practice.

Integrating the disciplines affords the opportunity also to assess in an integrated fashion that further promotes an interdisciplinary and encapsulated view of the basic sciences within the clinical context (Fielding & Regehr, 2017). Integrated assessments have been shown to have benefit in creating a more cohesive opportunity for learning (Dukhi et al., 2014; Fielding & Regehr, 2017; Hudson & Tonkin, 2004) but may invariably be more cost- and time-intensive (Dukhi et al., 2014; Fielding & Regehr, 2017), require change management (Fielding & Regehr, 2017), and require continuous review to ensure an appropriate weighting of disciplines (Dukhi et al., 2014; Hudson & Tonkin, 2004). Invariably, to ensure a valid and authentic integrated assessment is created, stakeholder engagements would be required with a clear aim and outcomes, quality assurance, and regulations on how to approach feedback (Fielding & Regehr, 2017). Such a clinically relevant integrated assessment, potentially as an inquiry-based format, would be to include a clinical vignette with a complex patient profile requiring both medical nutrition and pharmacotherapy. In doing so, students will need to be proficient in their core therapeutic approach, but also integrate understanding of pharmacological principles that may impact drug-food interactions or nutritional alterations. Variations of this can be made to fit a myriad of clinical contexts, or present the case from a nutritional deficiency precipitated by adverse effects from pharmacotherapy. Participants posited that this approach would be the best way to mitigate any other discipline from becoming under-assessed within their modules.

5.3. Development of generic competencies

Generic competencies need to be assessed at programme level to ensure they are approached appropriately, with formal investigation of whether they are achieved. For example, incorporating a team-based inquiry-based assessment would allow for a variety of competencies to be stimulated in an authentic matter, which allows for, among others, incorporation of research skills, problem-solving, critical thinking, communication, collaboration and technical literacy. These competencies are also reflected in the exit level outcomes of the Bachelor of Dietetics that prominently speak to collaborative problem-solving and communicate abilities (South African Qualifications Authority, 2018a). Andragogy that reinforces the University of Pretoria's Prepare, Engage and Consolidate framework also inherently reinforces many of these generic competencies given their student-centred nature (University of Pretoria, n.d.-b).

6. Considerations of the curriculum windows

Using the recommendations made in Section 5, the following considerations will need to be kept in mind when addressing the proposed curriculum. It is important to acknowledge that these will require iterative stakeholder discussions, and thus should not be seen as a finalised proposal, but rather a platform for the creation of an initial proposal document.

6.1 Expected learning outcomes

Learning outcomes, based on the proposed pharmacology curriculum and refined via the targeted needs analysis, have allowed for a more succinct and focused list of pharmacological competencies necessary for the Bachelor of Science with specialisation in Dietetics and Nutrition. By mapping these learning outcomes and assessment criteria on the LOOOP platform, a more auditable trail of information will be available to help guide curriculum

development, management and evaluation over time. Given the integrated nature, it will also necessitate close collaboration with the module coordinator and lecturing staff of the Medical Nutrition Therapy modules to ensure that appropriate horizontal and vertical integration is achieved, rather than purely sharing the space. However, this will necessitate a larger programme review to ensure the full map is available to be linked from the first to fourth year, which will also allow for deficiencies within the scaffolding to be indicated.

6.2. Curriculum content or areas of expertise covered

Based on the learning outcomes and the expected depth highlighted by the Delphi panel, a greater focus on the core principles of the various pharmacotherapeutic areas can be achieved. This will reduce the content-heaviness of Pharmacology. For the most part, given the current breadth of pharmacology education within the Faculty of Health Sciences, expertise is available for the majority of current and new assessment criteria, thus intellectual capacity should not be a concern. However, refinement to contextualise the information in a dietetic space will require close collaboration with clinical dietetic educators to ensure that focus is maintained. This is particularly true for any drug-food interaction and nutritional effects that may arise that has clinical relevance within the national context, including the potential lactational relation for select pharmacotherapy. The EML will continue to guide this process, and additionally, given the removal of the admixture of students, will inherently decrease the formulary required for discussion with the students. What can be considered, though, is having an overt focus on the EML pharmacotherapy, but still alluding to those not present in the list that are frequently encountered in the private healthcare sector. Although the latter may thus be less of an assessable aspect, it can then remain as a continuous educational resource for them should they transition to other healthcare settings. The positioning of curriculum content will need to be investigated carefully in association with course coordinators of Medical Nutrition Therapy modules to ensure they are dealt with in the most appropriate timing for the new programme.

6.3. Student assessment

The smaller size of the class (approximately 23 ± 6.2 based on a five-year average) will allow for a reimagining of the teaching, learning and assessment approach for the group of students. As discussed more in-depth in Section 5.2, integrated assessments may ultimately yield a much more cohesive, authentic and relevant opportunity for students to showcase their understanding of the interdisciplinary nature of Medical Nutrition and Pharmacology. However, such assessments would also require collaborative effort from the various stakeholders to ensure it is appropriately designed and valid. Formative assessments can be designed to provide more individualised feedback for individual growth, rather than the more generalised approach that is currently used given the large class nature of FAR 381 and FAR 382.

6.4. Learning opportunities

The current pharmacology curricula have already shown how the lecturers involved have approached andragogy within a large classroom setting, supported by scholarship (Cordier & Lubbe, 2021; Mlambo, 2021; Parkar, 2021), and thus a myriad of exciting opportunities is available to investigate new modalities, particularly focused on small group settings. Although described in-depth in Section 5.2, integrated teaching between basic and clinical educators

may provide clinical relevance and a greater emphasis on understanding of the fundamental science. The integrated nature of the module may, however, require careful planning of andragogy to ensure the approaches used complement one another, and do not create complications within a team-based approach.

6.5. The learning environment

Given the small group nature, ideally and dependent on the andragogy used, venues amenable to round-table or world café discussions can be used. This, however, is in the domain of the course coordinators of the Medical Nutrition Therapy modules and it would be inappropriate to dictate the setting for learning as a service department that carries a smaller weight within the integrated module. Given the focused curriculum, it is expected that all classes will take place on a single campus, thus also streamlining the logistical arrangements for it.

6.6. Learning resources

Resources for the curriculum would most likely not be altered to a large degree from what is currently being used (bar annual updates and refinement) when dealing with core concepts given their more general nature. These resources, however, can be contextualised more where nutrients can be used as exemplars for pharmacokinetics and pharmacodynamics. When dealing with specific pharmacotherapeutic areas, larger changes might be expected depending on the integrated nature of the course. For example, whether pharmacological elements are interspersed within the core learning material, or be provided as stand-alone resources will need to be discussed with stakeholders. Given logistical complexity of integration of the material itself, it may be relevant to create microteaching resources, whether built from lecture notes, narrated presentations, case reports or other interactive formats, to allow for a reduction of the content-heaviness of the material and potential overlap between resources. This would require careful planning to ensure pathophysiological, medical nutrition and pharmacology resources complement one another appropriately.

6.7. Timetable

The logistical benefits of integrating and removing the admixture of the students is particularly noted in the timetable for the programme. The challenge may remain between departments to find ideal placement for the discipline within the module, as well as delineating sufficient time to pharmacology to cover the breadth of work needed within their earmarked sessions.

6.8. Staff

Internal staffing considerations will necessitate that academic members be designated to the programme. At present it is not uncommon for two or more staff members from the Department of Pharmacology to be involved within a module, and thus the expectation might be still to maintain a diversity of members within the integrated module to cover the various areas of expertise. This also helps to reduce the risk of losing sustainability of teaching should a team member fall ill, resign or be incapable of proceeding with the session. Capacity investigations will need to be done to ensure that the additional learning opportunities gained by a team member do not complicate their academic schedules and associated responsibilities. How

large the academic team of the full module becomes does depend, though, on what support is available from the Department of Human Nutrition, but one would expect administrative, teaching and remedial support systems.

Course coordination will invariably be taken over by the Department of Human Nutrition; however, it will still require an internal coordinator from the Department of Pharmacology to maintain accountability for the discipline's role within the Medical Nutrition Therapy modules. The expectation would be that support be provided from professional staff of the Department of Human Nutrition for any administrative matters that may arise.

6.9. Curriculum management

Curriculum management will by and large be done by the Department of Human Nutrition; however, input will be needed from an internal discipline coordinator. This would be needed to ensure that alignment and integration with the core discipline is maintained, and regular evaluation be done on teaching, learning and assessment practices of the Pharmacology team contributing to the Medical Nutrition Therapy modules.

As approval has already been obtained from the Faculty of Health Sciences to continue with the new Bachelor of Science with specialisation in Dietetics and Nutrition, University of Pretoria Senate approval will now be needed to ensure that the programme be implemented in 2026. A large-scale consideration for this is the transitionary plan that would ultimately allow for pharmacology only to be introduced into the curriculum in an integrated fashion from 2027 onwards (assuming initial placement in the second year of the programme). Until 2027 (the current FAR 381 module) or 2028 (depending on students repeating FAR 381), the current Pharmacology module will still need to run as planned with an admixture of students.

6.10. Students

The students have already been described as part of Section 2.3, thus invariably the largest change here would be a focused group with a singular professional outlook. A consideration that may need to be addressed is the change in the professional identity of the new group of students as a combined dietitian-nutritionist practitioner rather than a dietitian. Professional overlap has often created tension within healthcare practitioners, and thus the transition to a new practitioner may yield uncertainties of their expectations or capabilities.

7. Conclusion

Thirty-five pharmacological and 44 pharmacotherapeutic competencies relevant to the dietetic practice in South Africa were compiled based on a modified, reactive Delphi study using qualified and registered dietitians across the academic, professional society, accreditation and healthcare landscape. Alongside these, fourteen generic competencies were emphasised that could be incorporated contextually within pharmacology education where appropriate. The Delphi participants recommended that most pharmacological competencies were aimed at a lower cognitive expectation. Higher cognitive level expectations were set for drug-food interactions, nutritional alterations precipitated by pharmacotherapy, and the interdisciplinary aspects of medical nutrition practice. The majority of pharmacotherapeutic competencies were

recommended to be addressed at a higher cognitive level, particularly those linked to primary dietetic scopes of practice (such as chronic lifestyle disorders).

Targeted needs analysis via curriculum mapping and focus group interviews highlighted potential physiological scaffolding concerns that would hinder the development of pharmacological competencies in the current curriculum. Although the proposed pharmacology curriculum increases the alignment with the medical nutrition discipline, it would still be constrained by underlying areas of deficit in physiology education. The proposed pharmacology curriculum is supported by literature as core areas of need within dietetic practice, and thus by focusing the curriculum, areas of alignment concern are potentially more easily addressed through focused curriculum review. Participants agreed that pharmacological competencies were not being developed appropriately within their clinical context, but did believe that the training received was of good quality. The most prominent concern was found to be drug-food interactions and alterations to nutritional status that participants believed students were clearly deficient in. Discussions yielded insights into the way in which the Department of Human Nutrition would approach the integration of different disciplines into their Medical Nutrition Therapy modules, where clinical cases and small group discussions would be used to navigate their education. An overarching consideration for the targeted curriculum would be which diseases are discussed during their Medical Nutrition Therapy modules, thus ultimately creating a guided context for which the Department of Pharmacology should plan.

Overall, this sub-section of the study provided valuable insights into the most important pharmacological competencies for dietitians in South Africa. By creating a proposed pharmacology curriculum that aligns pharmacology education with what is expected from a dietitian, a more standardised educational approach can be used in South Africa to reinforce a benchmarked pharmacology curriculum among institutions. By focusing on these competencies, dietitians can enhance their ability to provide effective and evidence-based care to their patients, and reduce the potential misalignment that may occur in undergraduate programmes. Although the context of the study was within South Africa, given the paucity of global information on pharmacology education in dietetic practice, it may serve as a valuable resource to help further adjust curricula within an international space.

This sub-section of the study does present some limitations, particularly the low response rate of participants that may skew the consensus of some items. Additionally, a compromise was met with how specific or broad competencies could be for certain items. For example, although nutritional alterations in pharmacotherapy during HIV, cancer, tuberculosis and organ transplantation were remarked upon, it can be argued that these competencies would spread beyond just isolated disease treatment and more towards the general concept of nutritional alterations caused by pharmacotherapy. Targeted needs analysis helped clarify the breadth of what should be focused on, indicating its importance within curriculum design and implementation at an institution. Additionally, the use of only the cognitive domain of Bloom's taxonomy, rather than including the psychomotor and the affective domains as well, does not fit ideally within the specification of non-cognitive related competencies. However, this was done to reduce potential confusion and/or drop-off during the Delphi study. Although only three participants were available for the focus group, this is considered adequate in terms of the small size of the Department of Human Nutrition.

Chapter 4
A professional nursing-relevant pharmacology curriculum

The very first requirement in a hospital is that it should do the sick no harm.

Florence Nightingale, (Nightingale, 1863, p. iii)

1. Introduction

Chapter 4 reports on the development of a pharmacology curriculum for the professional nurse, with a particular focus on creating learning outcomes and assessment criteria within the context of the University of Pretoria's current nursing science programme.

2. The professional nurse

The role of the professional nurse within the healthcare sector, as one of the healthcare practitioners of interest within my undergraduate module, including their pharmacological education, is discussed.

2.1. The scope of practice of the nurse, and its relation to pharmacology

Nurses, the largest category of healthcare practitioners in South Africa (Academy of Science of South Africa, 2018), care for individuals to improve their health outcomes through assessment and health promotion strategies, ultimately facilitating treatment and preventing diseases (International Council of Nurses, n.d.; Rispel & Bruce, 2014; Singh & Mathuray, 2018). Several categories of nursing exist, each with their own delineated scope of practice (Lubbe & Roets, 2014; Rispel, 2015b), with many serving as midwives as well (Rispel, 2015b). These various categories are characterised by different scopes of practice and depth of nursing education, where professional nurses undergo a four-year programme at a higher education institution (Lubbe & Roets, 2014; Rispel, 2015b). The focus of the study was the professional nurse category, specifically the Bachelor of Nursing Science programme offered by the University of Pretoria (South African Qualifications Authority, 2018b).

South Africa has been plagued by a nursing crisis (Rispel & Bruce, 2014; Rispel, 2015b; Rispel, 2016), speaking to a shortage of nurses (Rispel, 2015b; Singh & Mathuray, 2018; OECD, 2024), reduced interest in the profession and misalignment of professional and public expectations (Rispel, 2015b). The shortage of nurses impacts the ability to provide quality healthcare service delivery, thus placing additional strain on healthcare practitioners (OECD, 2023; Singh & Mathuray, 2018). Nursing education in South Africa has also been a matter of discussion, with suggestions of educational reform to ensure quality education is met in the profession (Rispel & Bruce, 2014; Rispel, 2015b; Singh & Mathuray, 2018; Crowley & Daniels, 2023). The South African nursing profession has changed over the years to accommodate the evolving healthcare and professional landscape, as well as global trends, to afford more accountability and independence in patient care over time (Rispel & Bruce, 2014; Rispel,

2015b; Rispel, 2016; Singh & Mathuray, 2018; Crowley & Daniels, 2023). As such, a national mandate directed to ensuring nurses were competent to drive progress in primary and universal healthcare was envisaged (Crowley & Daniels, 2023). In doing so, post-1994, a large effort was made to ensure nursing education institutions were aligned with exit level outcomes, accredited as higher education institutions, and promoted quality education (Crowley & Daniels, 2023).

In South Africa, professional nurses are permitted, according to their scope of practice, the right to perform the full nursing process to bolster patient care (Lubbe & Roets, 2014; Mutshatshi et al., 2020). The nursing process is a systematic approach followed by professional nurses via a guiding framework (Mutshatshi et al., 2020) to allow engagement in clinical decision-making based on theoretical underpinnings of nursing education and practice (Mutshatshi et al., 2020; Tadzong-Awasum & Dufashwenayesu, 2021). During each phase of the nursing process, nurses approach a part of the five-step framework (assessment, diagnosis, planning, implementation and evaluation) to determine the best action to follow (Mutshatshi et al., 2020; Younas, 2017). During assessment, objective and subjective information is identified through patient consultation (Younas, 2017) that invariably will include their pharmacotherapy (Comerford & Durkin, 2024; Lilley et al., 2022). Assessment allows the nurse the formulation of a diagnosis of the problem, and collaboratively the patient and nurse can plan for a course of treatment (Younas, 2017). Such action can then be implemented, either dependent on or independent of the nurse, and monitored over time for success (Younas, 2017). Pharmacotherapy is thus inherent to the nursing process that necessitates formal education and understanding thereof not only in terms of the framework, but also the basic science of pharmacology (Comerford & Durkin, 2024; Lilley et al., 2022; Preston et al., 2019).

Nurses serve as primary medication managers (Bengtsson et al., 2021; Bucknall et al., 2019; Choo et al., 2010; Dubovi et al., 2018) involved in the administration and control of medicines, as well as evaluation of a patients' response to treatment, whether therapeutic or adverse (Dubovi et al., 2018; Moura, 2012). Nurses should be competent in the five rights of medication administration: the right medication, dose, route, time and patient (Alrabadi et al., 2021; Choo et al., 2010; Hanson & Haddad, 2024). The framework provides a systematic checking that the intended patient receives the correct dose of the medication via the appropriate route of administration within an allowable timeframe at which it should be given (Hanson & Haddad, 2024). Alongside this, various elements of patient education, interprofessional communication and posology (i.e., dosing of medication) occurs (Choo et al., 2010; Hanson & Haddad, 2024). Although a useful checklist to follow, these rights are more complex and multifactorial than perceived as they rely on amenable working conditions, legibility of prescriptions and interprofessional teamwork (Alrabadi et al., 2021; Choo et al., 2010; Hanson & Haddad, 2024). Given their positioning within the administration of medication, nurses are also well-placed to prevent and report on medication-related errors (Bengtsson et al., 2021; Bucknall et al., 2019; De Baetselier et al., 2022). Ultimately, nurses thus serve as a final barrier to such errors as well (De Baetselier et al., 2022), which in itself is a challenging position to hold due to the multifactorial nature of medication errors (Alrabadi et al., 2021; Choo et al., 2010; De Baetselier et al., 2022) and that they can be perceived as the last individual in the chain of administration. By engaging in pharmaceutical care, a process during which pharmacists work together with the patient and other healthcare practitioners for therapeutic benefit from pharmacotherapy, nurses thus align themselves in several core areas of benefit with patient

care when medicine is involved (De Baetselier et al., 2021, 2022). Given the large emphasis on medication, contextually-relevant knowledge is needed for safe medicine administration and patient care (Smith, 2014) that necessitates integration of underpinning basic sciences with the clinical context to facilitate therapeutic procedures (Moura, 2012; Smith, 2014).

The self-perceived and observed inadequacies relating to pharmacological competencies of some nursing graduates have been well-described (Andersen & Moralejo, 2015; Banning, 2004; Bullock & Manias, 2002; Davis, 2010; Lymn & Mostyn, 2010; Manias & Bullock, 2002). Such educational deficiencies not only complicate patient care, but also prevent further professional growth, thus debilitating the career opportunities and upskilling of the individual (Andersen & Moralejo, 2015; Davis, 2010; Manias & Bullock, 2002). Consequently, confidence is broken and anxiety in nursing practice occurs (Davis, 2010; King, 2004). Nursing students have indicated that the content-heavy nature of pharmacology, including the placement thereof in their degree, textbooks not directed towards their scope of practice (Foster et al., 2017) and inadequate time scheduled towards learning (Craft et al., 2017) debilitates their achievement of learning outcomes. Although multifactorial, one area of nursing practice that has prominent pharmacotherapeutic repercussions is the well-published field of medication errors (Bond et al., 2001; Jones, 2009; Petrova, 2010; Ehsani et al., 2013; Dirik et al., 2019; Alrabadi et al., 2021; Jones et al., 2022), which, among other precipitating factors, emphasise the need for appropriate and relevant pharmacology education.

As per the Nursing Act 33 of 2005 (Republic of South Africa, 2020), nurses in South Africa are legally allowed to guide patients' health via all permissible actions within their scope of practice that includes the execution of treatment and administration of medicines (Box 4.1). Professional nurses are registered with the South African Nursing Council as healthcare practitioners that also serves as the accreditation body for all nursing curricula (Crowley & Daniels, 2023). As noted in Box 4.1, various aspects are underpinned by pharmacological competencies; however, within the broad definitions thereof it is difficult to ascertain the depth and breadth of pharmacology education that is needed. Although recommendations of what should be taught have been made (Blaauw et al., 2014; Rispel & Bruce, 2014; Rispel, 2015b), and international curricula are available (Arizona State Department of Education, 1982; Mississippi Research and Curriculum Unit for Vocational and Technical Education State College, 1995), some do not specifically address the discipline-level competencies needs for pharmacology as well as lack national and modern context. Little is thus available to ensure a basic sciences' educator can approach curriculum design sufficiently within their discipline to align with the exit level outcomes of nursing qualifications within the modern-day, South African context.

BOX 4.1: SCOPE OF PRACTICE OF THE NURSE IN SOUTH AFRICA AS PER THE NURSING ACT 33 OF 2005 (REPUBLIC OF SOUTH AFRICA, 2020). REPRODUCED VERBATIM AS PER THE ACT. TEXT IN RED INDICATES WHERE THERE IS A CLEAR RELATION TO PHARMACOLOGY

1. It is within the competence of a professional nurse to assume full responsibility and accountability for:
   a. providing comprehensive nursing treatment and care of persons in all healthcare settings;
   b. managing the nursing care of individuals, groups and communities;
   c. providing emergency care;

d. ensuring the safe implementation of nursing care and the execution of treatment or the administration of medication prescribed by an authorised registered person;

e. delegating nursing care, ensuring that nursing care is only delegated to competent practitioners or persons;

f. preparing and supporting a patient throughout the operative, diagnostic and therapeutic acts; and

g. facilitating the attainment of optimum health for the individual, the family, groups and the community, inclusive of a child and geriatric person.

2. The professional and ethical practice of a professional nurse requires a practitioner to:

a. demonstrate knowledge of and insight into legislation relevant to the practice of nursing. midwifery and healthcare in the Republic;
b. practise nursing in accordance with the legislation relevant to nursing, midwifery and health care in the Republic;
c. protect the human rights of individuals, groups, and communities within the healthcare environment;
d. practise nursing in an ethically just manner;
e. create and maintain an enabling environment for ethical practice;
f. accept and assume accountability and responsibility for his or her own actions and omissions within the legal and ethical parameters of a dynamic healthcare environment;
g. advocate for the rights of healthcare users.

3. The clinical practice of a professional nurse is to provide comprehensive nursing care and management for the nursing treatment and rehabilitation for all health problems of individuals, groups and communities as an independent practitioner. which practice requires a practitioner to:

a. develop an integrated, comprehensive nursing care plan for the promotion of activities of daily living, self-care, treatment and rehabilitation of healthcare users, also taking cognisance of natural, biological and psychosocial sciences;
b. provide direction for the implementation of the nursing care plan;
c. provide supervision for nursing care and execution of treatment or the administration of medication prescribed by an authorised registered person;
d. initiate and maintain a therapeutic relationship with healthcare users;
e. facilitate the establishment and maintenance of an environment in which healthcare can be provided safely and optimally;
f. review the nursing practice continuously against professional standards and within the relevant context;
g. facilitate the continuity of care in collaboration with relevant members of the healthcare team;
h. effectively manage a health facility or service;
i. assess and plan for the healthcare information needs, and respond accordingly;
j. assess the healthcare. nursing and midwifery care needs of individuals and groups;
k. diagnose and prioritise individual healthcare and nursing care needs based on comprehensive analysis and the interpretation of data;
l. manage and coordinate nursing care within the healthcare setting;
m. refer a healthcare user timeously and appropriately to other members of the multidisciplinary team;
n. evaluate a healthcare user's progress towards expected outcomes and revise nursing care plans in accordance with evaluation of data;
o. facilitate the creation and maintenance of an environment that promotes safety, security and integrity of healthcare users;
p. create and maintain a complete and accurate nursing record for individual healthcare users;
q. promote and empower healthcare users. through health counselling and education, to participate in healthcare to achieve self-reliance;
r. demonstrate and maintain adequate knowledge and skills of safe practice; and
s. prepare and support a patient throughout the operative, diagnostic and therapeutic acts.

4. The quality of nursing practice of a professional nurse requires the practitioner to:

a. participate in the development and maintenance of a plan to improve the quality of nursing and healthcare;
b. implement and manage a quality improvement plan for his or her own context of practice:
c. participate in the auditing of the quality of nursing and healthcare;
d. incorporate appropriate and current research findings to ensure an evidence-based nursing practice;
e. commit to the development, maintenance and facilitation of quality nursing practices;
f. identify own learning needs and to maintain knowledge and skills required for competent and independent nursing practice;
g. actively engage in the development of standards, criteria and indicators for quality nursing and healthcare;
h. create an environment and learning opportunities that foster professional growth and improvement in nursing care practice;
i. actively engage in the education and training of learners, students and colleagues in the healthcare system; and
j. assist with the development of nursing standards for the improvement of care through research

Nursing programmes invariably differ between institutions, and thus an overarching discussion of how the University of Pretoria approaches it is provided.

2.2. The Bachelor of Nursing Science degree at the University of Pretoria

At the University of Pretoria, the Bachelor of Nursing Science is offered as a four-year programme, during which nursing science students take Pharmacology at the third-year level alongside the students of the bachelor programmes of Dietetics, Physiotherapy and Science. Students are enrolled for both first (FAR 381) and second (FAR 382) semester Pharmacology. Based on their programme structure, fundamental and core modules are necessitated (Table 4.1), where the primary core modules of interest are Nursing Practice, Nursing Theory and Midwifery. In this degree, students graduate as professional nurses where their education is focused on capacitating them for general nursing, community nursing, psychiatric nursing and midwifery (South African Qualifications Authority, 2018b). Additionally, they are registered with the South African Nursing Council as professional body (South African Qualifications Authority, 2018b). The qualification particularly targets the relevant social, biomedical and nursing sciences needed for competency development that includes their roles as generalist nurse clinicians, health educators, therapeutic communicators and facilitators in the healthcare sector (South African Qualifications Authority, 2018b). Furthermore, the Bachelor of Nursing Science qualification highlights the importance of pharmacology within the nursing process to achieve thorough patient assessment and treatment to ensure that health concerns are dealt with (South African Qualifications Authority, 2018b). The full extent of exit level outcomes is presented in Box 4.2, with several descriptions relating to pharmacology (South African Qualifications Authority, 2018b). The South African Nursing Council does not prescribe a particular credit weighting for pharmacology, but advises that it should be considered in relation to the complexity, duration and volume of learning (South African Nursing Council; personal e-mail communication; 22 February 2024).

TABLE 4.1: STRUCTURE OF THE BACHELOR OF NURSING SCIENCE PROGRAMME AT THE UNIVERSITY OF PRETORIA (UNIVERSITY OF PRETORIA, 2024C)

Module type	Year I	Year II	Year III	Year IV
Fundamental	• Academic information management • Anatomy (introductory) • Anatomy of the Limbs • Anatomy of the Torso • Anatomy of the Head and Neck • Physiology (introductory, neurological, and muscle physiology) • Physiology (body fluids, haematology, cardiovascular and lymphatic physiology, body defence mechanisms) • Medical Terminology • Sepedi for Beginners • isiZulu for Beginners • Academic English • Academic Orientation	• Physiology (respiratory, renal and skin physiology, acid-base balance) • Physiology (nutrition, digestion, metabolism, hormonal control, reproduction) • Medical Microbiology (infection, immunity and basic bacteriology) • Medical Microbiology (systemic bacteriology) • Medical microbiology (fungi, parasitology and virology) • Psychology (general introduction) • Psychology (biological basis of human behaviour)	• Pharmacology • Pharmacology	None

Core	• Nursing Practice Education (introduction to nursing practice) • Nursing Practice Education (application of wellness in hospitals) • Nursing Studies (introduction to nursing theory) • Nursing Studies (health promotion and nursing process) • Integrated Healthcare Leadership (introductory) • Integrated Healthcare Leadership (multidisciplinary teams and healthcare systems)	• Integrated Healthcare Leadership (project management, communication, leadership) • Integrated Healthcare Leadership (nursing profession and integrative healthcare principles) • Nursing Practice Education (medical and surgical nursing care) • Nursing Practice Education (nursing skills related to systems physiology) • Nursing Studies (homeostasis, immunology, haematology and nursing care) • Nursing Studies (communicable and non-communicable diseases)	• Integrated Healthcare Leadership (communities) • Integrated Healthcare Leadership (mentoring, regulatory frameworks, quality improvement) • Midwifery: Theory (pre-conception care, health education and genetic counselling) • Midwifery: Practical (pre-conception care, health education and genetic counselling) • Midwifery: Theory (normal and high-risk intrapartum, postpartum and neonatal care) • Midwifery: Practical (normal and high-risk intrapartum, postpartum and neonatal care) • Nursing Practice Education (nursing skills related to systems physiology • Nursing Practice Education (mental health) • Nursing Studies (communicable and non-communicable diseases) • Nursing Studies (mental health) • Research Methodology	• Integrated Healthcare Leadership (professional activities, ethics) • Integrated Healthcare Leadership (professional activities, regulations, guidelines, legalities) • Midwifery: Theory (gender-based violence, immunisation, minor ailments) • Midwifery: Practical (gender-based violence, immunisation, minor ailments) • Midwifery: Theory (community maternal and child healthcare) • Midwifery: Practical (community maternal and child healthcare) • Nursing Practice Education (emergencies, death and dying) • Nursing Practice Education (self-care for vulnerable communities, integrated management of childhood illness) • Nursing Studies (emergencies) • Nursing Studies (self-care for vulnerable communities, integrated management of childhood illness) • Research

BOX 4.2: EXIT LEVEL OUTCOMES OF THE BACHELOR OF NURSING SCIENCE AT THE UNIVERSITY OF PRETORIA TAKEN VERBATIM FROM THE ACCREDITATION DOCUMENTATION (SOUTH AFRICAN QUALIFICATIONS AUTHORITY, 2018B). TEXT IN RED INDICATES WHERE THERE IS A CLEAR RELATION TO PHARMACOLOGY

Nurses who successfully complete the qualification will be comprehensive generalist practitioners functioning as:

Beginning professional nurse practitioners, managers and leaders:

- Show respect for the dignity and uniqueness of human beings (as individual members of groups, families, organisations and their communities of concern) within their socio-cultural and religious contexts. This implies approaching human beings, as health service consumers, as physical, psychological and social beings within these contexts.
- Demonstrate an understanding of the complexity and inter-dependency between human beings and their environment and between the bio-diverse organisms sharing our world.

Demonstrate competency in:

- Effectively organising and managing own tasks, duties and responsibilities while providing nursing care to health service consumers and prioritising all activities involved with comprehensive nursing care.
- Obtaining, co-ordinating and liaising with the necessary support services to ensure optimal care of health service consumers in both community and institutional settings.
- Effectively managing and leading a team approach to nursing care as a beginning manager and leader.
- Effectively managing a nursing or comprehensive health service unit as a beginning manager and leader.
- Functioning within, and limiting own practice to, a proven scope of skills, knowledge, competency and proficiency.
- Functioning within the professional, ethical and legal framework governing the nursing profession and society as a whole.
- Acting as a role model in the promotion and maintenance of optimal health and wellbeing and within the norms and values of the nursing profession.
- Providing effective and appropriate patient advocacy when required.
- Practising the art and science of nursing, as beginning professional practitioners, in a responsible, accountable and independent manner.
- Analysing healthcare policies and the ability to make suggestions and influence the process of healthcare policy development.
- Collaborating harmoniously within nursing and multidisciplinary healthcare teams, in accordance with the principles of interdependence and co-operation in attaining common goals. Co-operation implies that human interactions, in teams, groups or organisations, should be effective in attaining such common goals.

Generalist nurse clinicians:

Demonstrate competency in:

- Rendering comprehensive, client-specific, scientifically sound and evidence-based nursing care to individuals, groups, families and communities. This includes monitoring and evaluating health service consumers to identify changes and responses that warrant immediate intervention. Through the use of the scientific approach to nursing (nursing process) health needs and responses to health threats or health problems will be assessed and diagnosed, therapeutic

actions and nursing interventions planned and implemented and the outcomes of the nursing care evaluated for the effectiveness thereof.
Comprehensive nursing care should address the needs of individuals, groups, families and communities at any point along the wellness-illness continuum and during all stages of the human lifecycle (including preconception, pregnancy, child birth and care of the dying).

- Appropriate consultation and referral of any health service consumer with health needs or health problems that will require interventions beyond the nurse's level of competence and proficiency.
- Providing culturally sensitive and appropriate nursing care, including care of the dying patient.
- Teamwork and active involvement, as a member of the multidisciplinary healthcare team. Teamwork applies to the contexts of health promotion, disease and injury prevention (as well as the preventable after effects of disease and injury), cure and rehabilitation of health service consumers in community and institutional settings within healthcare delivery systems in South Africa.
- Diagnosing and effectively managing life-threatening illness and injury, uncomplicated minor and common ailments and pathological health problems within Primary Healthcare (PHC) settings.

Health educators and clinical educators in healthcare settings:

- Providing proof of up-to-date knowledge and skills to facilitate optimal nursing care and an ongoing endeavour to explore new ideas, innovation and research in specialised areas of patient care.
- Demonstrating active participation in the health education of health service consumers and the clinical teaching of colleagues, peers and subordinates.

Therapeutic communicators and facilitators in healthcare settings:
Demonstrate competency in:

- The effective use of verbal and non-verbal communication skills during all interpersonal and professional encounters and relationships with health service consumers, colleagues, peers and sub-ordinates.
- Promoting and facilitating community involvement in attaining optimal health and wellbeing at any point along the wellness-illness continuum and during all stages of the human life cycle.
- Scientifically communicating assessment findings, nursing care, prescriptions, reports and scientific data.
- Establishing, maintaining and terminating (through appropriate referral when necessary) therapeutic encounters, related to health, illness, crisis and health-seeking behaviour, with health service consumers
- Ensuring compassionate interactions with health service consumers to facilitate empathic and caring interpersonal encounters.

Baccalaureate scholars in Nursing Science:

- Demonstrating scholarly characteristics, related to nursing science, at a baccalaureate level, with reference to scientific inquiry into phenomena related to the art and science of nursing within clinical practice settings.
- Demonstrate the ability to obtain, organise, analyse, evaluate and manage scientific data, review scientific literature and identify researchable problems in nursing practice.
- After thorough, analytical and critically evaluative reasoning and creative thinking, demonstrate the ability to effectively utilise the scientific and technological aids and resources, as well as innovation, which underlie the scientific approach to nursing care.

- This implies an inquiring approach to science and technology. Furthermore it implies a willingness to initiate and/or accept innovation and change and to show a sense of responsibility towards the environment and the health of others whilst considering such changes and innovation.
- Critically analysing the extent and importance of environmental health issues in South Africa.
- Demonstrate the ability to analyse and apply nursing theory to clinical practice settings.
- Exhibit a commitment to continuing education and professional development and to the value of lifelong learning.

2.3. My perspective on the current challenge

Challenges presented in Chapter 3, Section 2.3.1 remain relevant, and thus will not be reiterated to avoid duplication. Challenges observed for the nursing science group predominantly entail the decontextualised setting away from nursing practice, and as such, much of the discussion may veer away from the medication management inherent to their practice. For example, a larger focus is placed on the basic sciences scope of pharmacology, while elements such as dosing, routes of administration and safety monitoring of drug classes is not touched on within their context. Although one can argue that the module's purpose is more towards the molecular underpinnings of the medicines discussed, the lack of context does hinder its relevance, such as when students query the depth of the mechanism of action in relation to how the drug would be administered. Furthermore, although clinical outcomes are discussed, it remains in the field of basic sciences, thus little is done to guide clinical decision-making beyond occasional examples. Matters related to posology and pharmacovigilance are not touched on beyond a few contextual examples, and thus it is largely assumed that these concepts will be dealt with in the clinical domain.

The predominant focus of basic sciences in the module, although justified from an isolated module perspective, does raise some concern for me at times. Given the rife discussion of medication errors and lack of pharmacological knowledge of nursing students, I am generally concerned that I may inadvertently contribute to such deficits by not addressing these within the module for which I am responsible. This is particularly true when students are asked questions relating to more clinical aspects of pharmacology, where it becomes evident that there is a lack of clarity on many theoretical concepts that they should have been exposed to in fundamental modules, or gained some practical education in. In doing so, the pharmacology education provided tends to become decontextualised, overwhelming and difficult to apply within a practical context. Such assumptions have over time been a guiding reason for me to restructure the curriculum from an evidence-based perspective (hence, the current research project) rather than making lateral changes that are unjustified or not supported by data. As a basic sciences module, it is important to acknowledge that the education I provide would be overtly within the cognitive domain, while psychomotor and affective domain competencies would be more appropriate for their clinical modules led by healthcare practitioners with insight into the professional environment. As such, the hope is to bolster their understanding of pharmacology so that appropriate, contextualised application is possible within the clinical platform to enhance their authentic learning.

The perception of nurses within the healthcare system has also raised unique concerns within the modules for which I am responsible. Some nursing science students lack confidence in their

knowledge and practical abilities within their clinical setting, which at times appears to be because of the reputational structures of healthcare practitioners. The professional identity of nurses, as has been discussed in literature, appears to suffer from various assumptions of what they do, their competence, their quality of healthcare and education, and the outcomes of their engagements (Cerulli, 2017; Cheraghi et al., 2010; Mbalinda et al., 2023; Ugwu et al., 2023). Such detrimental effects of negative views on the profession precipitate demotivation within and beyond their learning environment, where students have often reflected on interactions within the clinical platform that have made them knowledge and abilities related to pharmacology.

Curriculum review of the Pharmacology module is well positioned by me in collaboration with the Department of Nursing Science due to the post-basic qualification developments of the profession. Such review should be done systematically by determining the alignment of the education provided to the exit level outcomes of the programme that inherently should be guided by the scope of practice and national needs of the country. Post-basic professional development opportunities would necessitate graduates to have a proper foundation of pharmacology to continue their growth as professionals. Such opportunities afford nurses specialised postgraduate and diploma opportunities, such as nursing education, critical care, primary healthcare, emergency nursing, and mental health (Crowley & Daniels, 2023). With each specialisation, the pharmacotherapeutic involvement is more focused, and thus quality education is needed to ensure competence. Some qualifications increase the involvement of prescribing rights. Qualified nurses who work at facilities in the public sector designated by the Nursing Act 33 of 2005 (Section 56[6]) may prescribe medication aligned with the Primary Healthcare Standard Treatment Guideline (STG) and EML (South African Pharmacy Council, 2022). This affords them the opportunity to prescribe medication under certain conditions (Republic of South Africa, 2011) from Schedules 1 to 4 (Republic of South Africa, 2011). In such a way nurses may prescribe drugs that are not classified under the scheduling categories for potential abuse properties (South African Health Products Regulatory Authority, 2022). Initiatives have been established to focus prescribing authorisation on prominent concerns in South Africa. The nurse-initiated management of antiretroviral therapy (NIMART) was introduced in response to the World Health Organization's recommendations to bolster healthcare measures against HIV/AIDS (Mboweni & Makhado, 2020; Ngcobo et al., 2024). A NIMART qualification extends the scope of the nurse to initiate antiretroviral therapy, a capability typically reserved for medical practitioners (Ngcobo et al., 2024). Importantly, this extends the clinical competence of the nurse in terms of pharmacotherapy beyond the basic education received as a professional nurse, but is dependent on having a thorough understanding of pharmacology (Crowley et al., 2021). Although further education is offered during NIMART, basic sciences knowledge, including pharmacology, would be needed for competence in clinical decision-making to develop. In recent years, the National Strategic Plan for HIV, TB and STIs (2023 to 2028) has also recommended that nurses be capacitated to prescribe and dispense medication to treat common mental health conditions to combat the mental health crisis in the country (South African Department of Health, 2023), though this is not yet in place. With such current and future qualifications, the importance of ensuring a strong pharmacological foundation for clinical competence is emphasised.

3. Results of the study

The results of the study are presented in two separate parts as the general needs assessment (comprising the scoping review and Delphi study) and targeted needs analysis (comprising the curriculum mapping and focus group interviews).

3.1 General needs assessment

The results of the general needs assessment are first presented as the scoping review that guided the construction of the Delphi study.

3.1.1. Scoping review

A total of 145 full-text resources were screened from the 1 251 records that were found among the seven databases (as displayed in Figure 4.1), with a moderate agreement (Cohen-κ = 0.498). After exclusion due primarily to a lack of focus on competencies of registered nurses, 39 full-text publications and two institutional guides were used to compile the list distributed for the Delphi study discussion as summarised in Table 4.2. Seven of the 39 resources were comprehensive curricula for pharmacology related to nursing, mostly of practical nursing, which allowed for a broad description. Most of these curricula overlapped in terms of competencies, which is not unexpected as they were predominantly from the United States of America. Publications that did not include formal curricula presented the importance of competencies in a variety of different ways, including showcasing areas of knowledge and practical deficit via research-based approaches, institutional content analysis, working group reports, or opinion pieces and reviews supported by literature. These publications supported areas of unique concern within pharmacology curricula, but rarely focused on the whole spectrum of pharmacology.

Publication characteristics (Table 4.3) indicated an overwhelming number of publications from the United States of America (n = 20) and the United Kingdom (n = 5), with only one study from South Africa. It appears that contextually little is present in terms of research from South Africa, highlighting an important field of investigation for relevance to be maintained. As such, the transferability of the findings of these studies may skew perceptions towards a Global North need. Ten curricula (none from South Africa), 16 quantitative and 4 qualitative publications were presented, providing some basis of evidence to draw from for the curriculum design.

After a pilot review, 146 competencies (97 pharmacological constructs; 49 pharmacotherapies; 14 generic competencies) were distributed for Delphi study (Table 4.4). The list comprised cognitive (88.46%), psychomotor (10.00%) and affective (3.08%) domain competencies, respectively. Cognitive competencies were predominantly linked to the basic sciences' elements of pharmacology, such as the core concepts, pharmacotherapeutic areas, and understanding of the place of pharmacology in the nursing process. Psychomotor competencies were more directed to medication management principles, including the preparation and administration of medicines, as well as the monitoring skills required to assess biological effects (whether beneficial or detrimental), such as glucose monitoring. Affective domain competencies tied into interprofessionalism, communication, and reflective attributes.

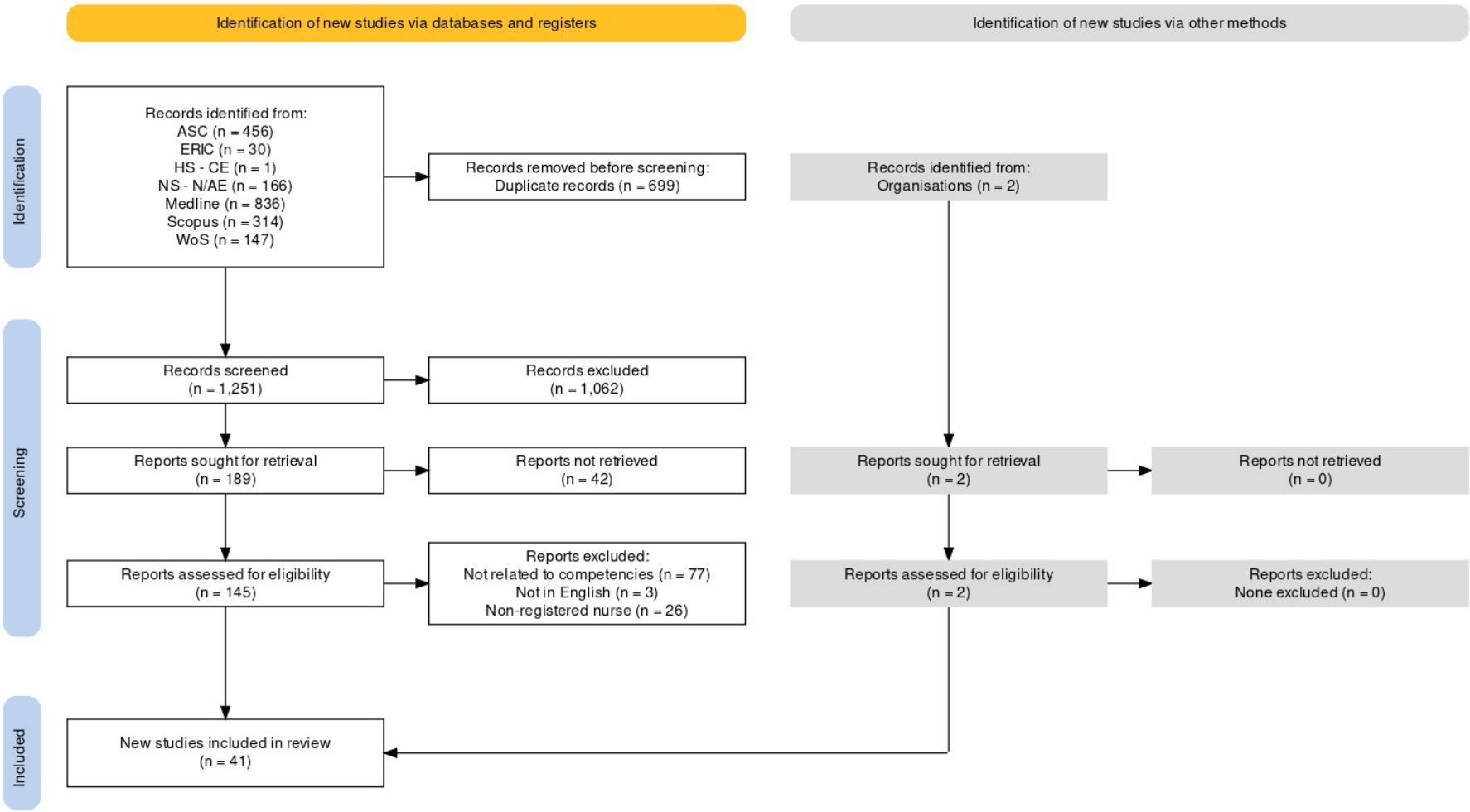

FIGURE 4.1: PRISMA DIAGRAM OF PHARMACOLOGICAL COMPETENCIES RELATING TO NURSES (HADDAWAY ET AL., 2022)

ABBREVIATIONS: ASC – EBSCOHOST ACADEMIC SEARCH COMPLETE; ERIC – EBSCOHOST EDUCATION RESOURCES INFORMATION CENTER; HS–CE – EBSCOHOST HEALTH SOURCE – CONSUMER EDITION; HS–N/AE – EBSCOHOST HEALTH SOURCE – NURSING/ACADEMIC EDITION; WOS – WEB OF SCIENCE. GENERATED BY PRISMA2020

TABLE 4.2: FULL-TEXT PUBLICATIONS ELIGIBLE FOR THE NURSING DELPHI STUDY

Author	Article title	Format of publication	Study population	Study findings	Justification of competencies	Contextual description of what is needed from the competency
Arizona State Department of Education (1982)	Health Occupations Curriculum. Skills and Theory for Practical Nurse. Units 18, 19, and 20	Curriculum	Nurses	Full, formalised curriculum from the Arizona State Department of Education	Comprehensive curriculum for nursing studies	In-depth descriptions of curricular goals involve medication calculations, administrations, and nursing considerations, including reference to general pathologies of interest
Oklahoma State Department of Vocational and Technical Education Stillwater (1990)	Pharmacology. Teacher Edition	Curriculum	Nurses	Full, formalised curriculum from the Oklahoma State Department of Vocational and Technical Education, with a focus on practical nursing	Comprehensive curriculum for nursing studies	In-depth descriptions of curricular goals involve medication calculations, administrations, and nursing considerations, including reference to general pathologies of interest
Idaho State Department of Education (1992)	Practical Nursing Curriculum Guide. Including the Expanded Functions of I.V. Therapy and LPN Management. Invest in Success	Curriculum	Nurses	Full, formalised curriculum from the Idaho State Department of Education, with a focus on practical nursing	Comprehensive curriculum related to administration of medicines	In-depth discussion of calculation, administration, education, monitoring and storage of medicines
Campinha-Bacote (1994)	Ethnic pharmacology: A neglected area of cultural competence.	Opinion piece and research invitation	Nurses	Importance of competencies related to ethnic pharmacology, and variations they may cause within therapy stressed	Competencies related to ethnic pharmacology	Understanding the impact of ethnicity or population differences on drug responses
Mississippi Research and Curriculum Unit for Vocational and Technical Education (1995)	Mississippi Curriculum Framework for Practical Nursing Programs CIP: 51.1613--Practical Nurse (L.P.N. Training). Postsecondary Programs	Curriculum	Nurses	Full, formalised curriculum from the Mississippi Research and Curriculum Unit for Vocational and Technical Education, with a focus on practical nursing	Comprehensive pharmacology curriculum for nurses	In-depth discussion of core competencies of pharmacology, administration, calculations, nursing practice, and special considerations in populations

Laborde and Texidor (1996)	Knowledge and attitudes toward chronic pain management among home healthcare nurses	Research paper Questionnaire-based study of nursing pain management	109 nurses	Poor actual and perceived knowledge of pain management, particularly for cancer-associated pain, which necessitated further education	Competencies related to pain management	Knowledge of analgesics
Heinzer et al. (1997)	A program evaluation approach to drug administration education	Opinion piece	Nurses	Curriculum map provided for drug administration competencies	Competencies related to administration-associated practice	Applying knowledge of medicines for calculations, solubilisation, administration, and values
American Association of Colleges of Nursing (2000)	Peaceful death: Recommended competencies and curricular guidelines for end-of-life nursing care	Curriculum	Nurses	Full, formalised curriculum from the American Association of Colleges of Nursing, with a focus on end-of-life nursing care	Competencies related to end-of-life care mentioned in undergraduate curricula	Using data, information, and comprehensive treatment modalities to ensure patient quality of life and symptomatic management at the end-of-life
McMillan et al. (2000)	Knowledge and attitudes of nurses in veterans hospitals about pain management in patients with cancer	Research paper Questionnaire-based study of nursing pain management	87 nurses	Poor knowledge of analgesic pharmacology, including pharmacokinetics and posology, however, tolerance knowledge was sufficient	Pharmacological competencies related to pain management	Analgesics
Ohio State Department of Education (2001)	Practical Nursing. FasTrak Specialization Integrated Technical and Academic Competency (ITAC). Revised.	Curriculum	Nurses	Full, formalised curriculum from the Ohio State Department of Education, with a focus on practical nursing	Comprehensive pharmacology curriculum for nurses	In-depth discussion of medicine administration, storage, and disposal, as well as calculations, administration, and patient education
Banning (2003)	Pharmacology education: A theoretical framework of applied pharmacology and therapeutics	Narrative review and opinion piece	Nurses	Framework for applied pharmacology and therapeutics discussed	Pharmacological competencies related to nurses	A range of competencies are described, including administration, therapeutic windows, medicine errors, polypharmacy, interprofessionalism, and nursing practice

King (2004)	Nurses' perceptions of their pharmacology educational needs	Research paper Interview-based study of nursing perceptions on pharmacology education needs	10 nurses	Poor knowledge, confidence and satisfaction with pharmacology education, with deficits identified for drug administration, patient assessment and education, and nurse prescribing	Pharmacological competencies related to administration, patient education and professional development	Knowledge needed in drug administration, as well as the education of patients The basis of prescribing should be known as a preamble for future practitioner development
Oldridge et al. (2004)	Pilot study to determine the ability of health-care professionals to undertake drug dose calculations	Research paper Questionnaire-based study of drug dose calculations	111 participants *Registrars (20)* *Pharmacists (22)* *House surgeons (19)* *Medical students (22)* *Nurses (28)*	Nursing group had highest knowledge deficiency in the majority of calculations out of the assessed groups, stressing the importance of reinforced learning	Competencies related to drug dose calculations	Drug calculations
Sherman et al. (2004)	Learning pain assessment and management: A goal of the End-of-Life Nursing Education Consortium	Curriculum	Nurses	Pain assessment and management curriculum from the End-of-Life Nursing Education Consortium	Pharmacological competencies related to pain management	Pain management relating to treatment algorithms, dosing, and appropriate pharmacotherapy
Burns et al. (2006)	Returning nurses to the workforce: Developing a Fast Track back program	Curriculum	Nurses	Return-to-work curriculum presented from the University of Pittsburgh	Competencies related to pharmacology in the context of nurses returning to practice	Applying nursing therapeutics that supports current clinical pharmacological concepts and safe practice in patient care
Davidhizar and Bartlett (2006)	Re-entry into the registered nursing work force: We did it!	Curriculum	Nurses	Return-to-work curriculum presented from the Bethel College, Indiana	Pharmacological competencies related to nurses	Core competencies of pharmacology and nursing practice, as well as pertinent drug classes used in standard patient care
Lim and Honey (2006)	Integrated undergraduate nursing curriculum for pharmacology	Curriculum	Nurses	pharmacology curriculum from the University of Auckland	Comprehensive curriculum of pharmacological competencies for nursing	No depth is mentioned, however, it relates to the core competencies of pharmacology, including special populations and specific diseases

Scarpaci et al. (2007)	Assessment of hospice nurses' technique in the use of inhalers and nebulizers	Research paper Questionnaire-based study of inhalers and nebulizers	47 nurses	Knowledge deficiencies identified for assessment, pharmacology, pharmacokinetics and administration techniques	Competencies related to the use of inhalation and nebulisation administrations	Routes of administration with inhalers and nebulisers
Voynarovska and Cohen (2008)	The role of the endoscopy nurse or assistant in endoscopic sedation	Opinion piece	Nurses	Endoscopic sedation competencies discussed	Pharmacological competencies related to nurses	Identification of medicines used for sedation and reversal thereof, including their pharmacological properties and administration guidelines
Meechan et al. (2011)	The impact of an integrated pharmacology and medicines management curriculum for undergraduate adult nursing students on the acquisition of applied drug/pharmacology knowledge	Research paper Questionnaire-based study of curricular intervention for integrated pharmacology education	120 nurses	Curriculum framework for applied pharmacology showcased an increased knowledge of pharmacokinetics and use in clinical scenarios	Pharmacological competencies related to nurses	Core competencies of pharmacology, including the application in nursing practice, patient education, and medicine calculations
Jenny et al. (2012)	Nurses opinion on the attributes of polypharmacy in patient safety	Research paper Questionnaire-based study of polypharmacy perceptions	109 nurses	Importance of polypharmacy within healthcare acknowledged, with recommendations for improved education related to it	Competencies relating to the knowledge of polypharmacy	Polypharmacy
Sulosaari et al. (2012)	Nurse students' medication competence — An integrative review of the associated factors	Integrated literature review	Nurses	Factors involved with medication competence included student circumstances, clinical learning environments, and the educational institution, suggesting competency development needed	Pharmacological competencies related to nursing	Professional basis of medication management and administration, including calculations, medication safety, and pivotal diseases

Alexander-Magalee (2013)	Addressing pharmacology challenges in older adults	Narrative review	Nurses	Pharmacokinetic and pharmacodynamic challenges in elderly patients with insights into competencies needed	Importance of pharmacokinetics and -dynamics in elderly	Understanding the pharmacokinetics and pharmacodynamics of drugs in the elderly
Guenter and Boullata (2013)	Drug administration by enteral feeding tube	Research paper Questionnaire-based study of knowledge of medication administration via enteral feeding tubes	823 nurses	Knowledge strengths and deficits identified, suggesting areas of growth required for competency development	Competencies related to enteral feeding tube administration	Medicine administration via enteral feeding tube
Lloyd et al. (2013)	An evaluation of pharmacology curricula in Australian science and health-related degree programs	Research paper Questionnaire-based study of higher education institutions in Australia and their pharmacology curriculum	22 institutions, with curricula presented to different degrees *Science (14) Pharmacy (10) Nursing (11) Medicine (10)*	Diversity of curricula identified, with integrated or stand-alone programmes for nursing, and a broad coverage of pharmacotherapeutic topics	Comprehensive comparison of pharmacology curricula in Australia	Core competencies of pharmacology, including pertinent diseases
Lo et al. (2013)	Faculties' and nurses' perspectives regarding knowledge of high-alert medications	Research paper Questionnaire-based study of high-alert medication	199 nurses	High-alert medication listed as an important competency, however, is often not taught satisfactorily	Competencies related to high-alert medications	High-alert medicine and their administration
Swart et al. (2013)	Analysis of queries from nurses to the South African National HIV & TB Healthcare Worker Hotline	Research paper Analysis of calls to the South African National HIV & TB Healthcare Worker Hotline for prevalence and knowledge deficiencies	Nurses, including NIMART-trained nurses	Knowledge deficiencies noted for use and initiation of antiretrovirals in different population groups, dosing, adverse effects, and medication stock	Discuss knowledge gaps in pharmacological competencies	Describes antiretroviral use in several population groups, and pertinent pharmacological concepts related to antiretrovirals
Callier et al. (2014)	Engaging the next generation of healthcare professionals in genomics: Planning for the future	Narrative review and opinion piece	Medical practitioners Nurses Physician assistants Genetic councillors Pharmacists	Knowledge and practical skills of genomics (which includes pharmacogenomics) is important for all healthcare practitioners, but	Importance of pharmacogenomics in management of diseases and treatment regimens	Basic understanding of pharmacogenomics with discussion of expectations

			Allied health practitioners (which include dietitians)	dependent on their scope of practice		
Johansson-Pajala et al. (2014)	Nurses' self-reported medication competence in relation to their pharmacovigilant activities in clinical practice	Research paper Questionnaire-based study of pharmacovigilance activities	168 nurses	Deficiencies in pharmacovigilance activities, although high self-perceived confidence in medication competencies	Pharmacological competencies related to general pharmacology, and its downstream implications on pharmacovigilance	Knowledge of core competencies of pharmacology Assessment of drug responses, whether therapeutic or adverse Information retrieval of pharmacologically-relevant information
Aronsson et al. (2015)	The understanding of core pharmacological concepts among healthcare students in their final semester	Research paper Interview-based study of understanding of core concepts of pharmacology	12 participants *Medical students (4)* *Nursing students (4)* *Specialist nursing (4)*	Knowledge deficiencies in explaining and applying the core concepts, however, definitions were satisfactory	Pharmacological competencies related to nurses	Appropriate management and patient education related to medicines, application of pharmacokinetic and pharmacodynamic concepts, and understanding of interactions
Lohmann et al. (2015)	Knowledge and training needs of nurses and physicians on unsuitable drugs for patients with dysphagia or feeding tubes	Research paper Questionnaire-based study of drug therapy for dysphagic or feeding tube patients	448 participants *373 nurses* *75 physicians*	Knowledge deficiencies in sustained-release suffixes and safety risks with coating destruction	Competencies related to administration in patients with dysphagia or feeding tubes	Administration of medication with emphasis on sustained-release forms and destruction of formulations
Farrar et al. (2017)	Pharmacologic interventions for pain management	Narrative review of pain management guideline	Nurses	Importance of pain management guidelines and competencies stressed	Pharmacological competencies related to pain management	Critical reasoning related to pharmacological pain management, including abuse potential
Di Simone et al. (2018)	Medication errors in the emergency department: Knowledge, attitude, behaviour, and training needs of nurses	Research paper Questionnaire-based study of medication errors	123 nurses	Self-perceived knowledge deficiencies identified concerning contributing factors to medication errors	Pharmacological competencies related to nurses	Dosing and calculation skills
Druedahl et al. (2018)	Mandatory medication content in the curricula of six	Research paper Content analysis of healthcare curricula	Healthcare curricula, including nursing	Pharmacological competencies related to pharmacotherapy	Pharmacological competencies related to nurses	Communication abilities about medicines

	healthcare personnel types with patient contact in Denmark			communication identified		
Reumerman et al. (2018)	Urgent need to modernize pharmacovigilance education in healthcare curricula: Review of the literature	Structured literature review	Healthcare practitioner students, including nurses	Poor knowledge and implementation of pharmacovigilance competencies	Discusses the importance of pharmacovigilance in practice	Pharmacovigilance
van Eekeren et al. (2018)	What future healthcare professionals need to know about pharmacovigilance: introduction of the WHO PV core curriculum for university teaching with focus on clinical aspects	Report of World Health Organization on pharmacovigilance	Healthcare practitioners, including nurses	Competencies necessitated for pharmacovigilance as reported by the World Health Organization	Pharmacovigilance-related competencies of healthcare practitioners	Understanding the importance of pharmacovigilance, and facilitating its preventative, management and reporting functions
Fleuren et al. (2019)	Clinically relevant pharmacokinetic knowledge on antibiotic dosing among intensive care professionals is insufficient: A cross-sectional study	Research paper Questionnaire-based study of antibiotic dosing	1 448 participants *Nurses (154) Residents (198) Fellows (169) Intensivists (927*)	Poorest knowledge of pharmacokinetics of antibiotics seen with the nursing group, suggesting poor competency development	Pharmacological competencies related to antibiotic pharmacokinetics	Antibiotic pharmacokinetics
Frazee et al. (2019)	Intensive care nurses' knowledge about use of neuromuscular blocking agents in patients with respiratory failure	Research paper Questionnaire-based study of neuromuscular blockers	160 nurses	Knowledge of associated analgesia and sedation was satisfactory, but that of routes of administration, duration of action and adverse effects generally poor	Pharmacological competencies related to neuromuscular blockade	Indications and adverse effects of neuromuscular blockers
Begum et al. (2020)	Antipsychotic medication side effects knowledge amongst registered mental health nurses in England: A national survey.	Research paper Questionnaire-based study of antipsychotic medication	245 nurses	Suboptimal working knowledge of antipsychotics and their adverse effects	Competencies related to neuropharmacology	Side effects of neuropharmacological agents

TABLE 4.3: CHARACTERISTICS OF FULL-TEXT PUBLICATIONS ELIGIBLE FOR THE NURSING DELPHI STUDY

Author	Article title	Country of origin	Research design (if applicable)
Arizona State Department of Education (1982)	Health Occupations Curriculum. Skills and Theory for Practical Nurse. Units 18, 19, and 20	United States of America	Non-research (curriculum)
Oklahoma State Department of Vocational and Technical Education Stillwater (1990)	Pharmacology. Teacher Edition	United States of America	Non-research (curriculum)
Idaho State Department of Education (1992)	Practical Nursing Curriculum Guide. Including the Expanded Functions of I.V. Therapy and LPN Management. Invest in Success	United States of America	Non-research (curriculum)
Campinha-Bacote (1994)	Ethnic pharmacology: A neglected area of cultural competence.	United States of America	Non-research
Mississippi Research and Curriculum Unit for Vocational and Technical Education (1995)	Mississippi Curriculum Framework for Practical Nursing Programs CIP: 51.1613--Practical Nurse (L.P.N. Training). Postsecondary Programs	United States of America	Non-research (curriculum)
Laborde and Texidor (1996)	Knowledge and attitudes toward chronic pain management among home healthcare nurses	United States of America	Quantitative
Heinzer et al. (1997)	A program evaluation approach to drug administration education	United States of America	Non-research
American Association of Colleges of Nursing (2000)	Peaceful death: Recommended competencies and curricular guidelines for end-of-life nursing care	United States of America	Non-research (curriculum)
McMillan et al. (2000)	Knowledge and attitudes of nurses in veterans hospitals about pain management in patients with cancer	United States of America	Quantitative
Ohio State Department of Education (2001)	Practical Nursing. FasTrak Specialization Integrated Technical and Academic Competency (ITAC). Revised.	United States of America	Non-research (curriculum)
Banning (2003)	Pharmacology education: A theoretical framework of applied pharmacology and therapeutics	United Kingdom	Non-research
King (2004)	Nurses' perceptions of their pharmacology educational needs	United Kingdom	Qualitative
Oldridge et al. (2004)	Pilot study to determine the ability of health-care professionals to undertake drug dose calculations	New Zealand	Qualitative

Author	Article title	Country of origin	Research design (if applicable)
Sherman et al. (2004)	Learning pain assessment and management: A goal of the End-of-Life Nursing Education Consortium	United States of America	Non-research (curriculum)
Burns et al. (2006)	Returning nurses to the workforce: Developing a Fast Track back program	United States of America	Non-research (curriculum)
Davidhizar and Bartlett (2006)	Re-entry into the registered nursing work force: We did it!	United States of America	Non-research (curriculum)
Lim and Honey (2006)	Integrated undergraduate nursing curriculum for pharmacology	New Zealand	Non-research (curriculum)
Scarpaci et al. (2007)	Assessment of hospice nurses' technique in the use of inhalers and nebulizers	United States of America	Quantitative
Voynarovska and Cohen (2008)	The role of the endoscopy nurse or assistant in endoscopic sedation	United States of America	Non-research
Meechan et al. (2011)	The impact of an integrated pharmacology and medicines management curriculum for undergraduate adult nursing students on the acquisition of applied drug/pharmacology knowledge	United Kingdom	Quantitative
Jenny et al. (2012)	Nurses opinion on the attributes of polypharmacy in patient safety	United Arab Emirates	Quantitative
Sulosaari et al. (2012)	Nurse students' medication competence — An integrative review of the associated factors	Finland	Qualitative
Alexander-Magalee (2013)	Addressing pharmacology challenges in older adults	United States of America	Non-research
Guenter and Boullata (2013)	Drug administration by enteral feeding tube	United States of America	Quantitative
Lloyd et al. (2013)	An evaluation of pharmacology curricula in Australian science and health-related degree programs	Australia	Quantitative
Lo et al. (2013)	Faculties' and nurses' perspectives regarding knowledge of high-alert medications	Taiwan	Quantitative
Swart et al. (2013)	Analysis of queries from nurses to the South African National HIV & TB Healthcare Worker Hotline	South Africa	Quantitative
Callier et al. (2014)	Engaging the next generation of healthcare professionals in genomics: Planning for the future	United States of America	Non-research
Johansson-Pajala et al. (2014)	Nurses' self-reported medication competence in relation to their pharmacovigilant activities in clinical practice	United Kingdom	Quantitative

Author	Article title	Country of origin	Research design (if applicable)
Aronsson et al. (2015)	The understanding of core pharmacological concepts among healthcare students in their final semester	Sweden	Qualitative
Lohmann et al. (2015)	Knowledge and training needs of nurses and physicians on unsuitable drugs for patients with dysphagia or feeding tubes	Germany	Quantitative
Farrar et al. (2017)	Pharmacologic interventions for pain management	United States of America	Non-research
Di Simone et al. (2018)	Medication errors in the emergency department: Knowledge, attitude, behaviour, and training needs of nurses	Italy	Quantitative
Druedahl et al. (2018)	Mandatory medication content in the curricula of six healthcare personnel types with patient contact in Denmark	Denmark	Quantitative
Reumerman et al. (2018)	Urgent need to modernize pharmacovigilance education in healthcare curricula: Review of the literature	Netherlands	Non-research
van Eekeren et al. (2018)	What future healthcare professionals need to know about pharmacovigilance: introduction of the WHO PV core curriculum for university teaching with focus on clinical aspects	Netherlands	Non-research
Fleuren et al. (2019)	Clinically relevant pharmacokinetic knowledge on antibiotic dosing among intensive care professionals is insufficient: A cross-sectional study	Netherlands	Quantitative
Frazee et al. (2019)	Intensive care nurses' knowledge about use of neuromuscular blocking agents in patients with respiratory failure	United States of America	Quantitative
Begum et al. (2020)	Antipsychotic medication side effects knowledge amongst registered mental health nurses in England: A national survey.	United Kingdom	Quantitative

TABLE 4.4: NURSING COMPETENCY LIST COMPILED FROM LITERATURE AND INSTITUTIONAL RESOURCES AFTER PRELIMINARY REVIEW OF CONTENT AND FACE VALIDATORS, INCLUDING SUGGESTED DOMAINS (APART FROM GENERIC COMPETENCIES)

Theme	Competency	Domain
General pharmacological principles	The role of pharmacology in disease treatment and science	Cognitive
	Common pharmacological concepts	Cognitive
	Legal aspects of drug control and administration	Cognitive
	Common formulations used in clinical settings	Cognitive

Theme	Competency	Domain
	Common routes of administrations used in clinical settings	Cognitive
	Principles of pharmacokinetics	Cognitive
	Pharmacokinetics: Absorption	Cognitive
	Pharmacokinetics: Distribution	Cognitive
	Pharmacokinetics: Metabolism	Cognitive
	Pharmacokinetics: Excretion	Cognitive
	The modulation of drug targets to alter (patho)physiological responses	Cognitive
	Principles of pharmacodynamics	Cognitive
	Types of ligands in pharmacotherapy	Cognitive
	Factors that alter the response to pharmacotherapy	Cognitive
	Pharmacogenetics information on drug labels	Cognitive
	Principles of polypharmacy	Cognitive
	Pharmacodynamic and pharmacokinetic drug interactions	Cognitive
Pharmacotherapy of diseases	Allergies and anaphylaxis	Cognitive
	Anaesthesia	Cognitive
	Anxiety	Cognitive
	Asthma	Cognitive
	Bacterial infections	Cognitive
	Cardiovascular diseases	Cognitive
	Constipation	Cognitive
	Contraception	Cognitive
	Depression	Cognitive
	Dermatological diseases	Cognitive
	Diabetes	Cognitive
	Diarrhoea	Cognitive
	Drugs of abuse	Cognitive
	Ear disorders	Cognitive
	Endocrine disorders	Cognitive
	Epilepsy	Cognitive
	Eye disorders	Cognitive
	Fungal infections	Cognitive
	Gastro-oesophageal disorder	Cognitive
	High-alert medicine	Cognitive
	Hormone replacement therapy	Cognitive
	Inflammation	Cognitive
	Intensive care unit procedures	Cognitive
	Malaria	Cognitive
	Muscle relaxation	Cognitive
	Musculoskeletal disorders	Cognitive
	Nausea and vomiting	Cognitive
	Neoplasia	Cognitive
	Obesity	Cognitive
	Osteoporosis	Cognitive
	Overdose and poisonings	Cognitive
	Pain	Cognitive
	Parasympathetic nervous system disorders	Cognitive
	Parkinson's disease	Cognitive
	Peptic ulcers	Cognitive
	Reproductive disorders	Cognitive
	Resuscitation medicine	Cognitive
	Respiratory diseases	Cognitive
	Schizophrenia	Cognitive
	Sedation	Cognitive
	Sedation and hypnosis	Cognitive
	Sympathetic nervous system disorders	Cognitive
	Tuberculosis	Cognitive
	Urological diseases	Cognitive
	Vaccinations	Cognitive

Theme	Competency	Domain
	Viral infections	Cognitive
Special populations	Management of medicine in different patient groups	Cognitive
	Pharmacokinetics and pharmacodynamics of drugs in the elderly	Cognitive
	Special considerations in administration of medications to paediatric and geriatric patients	Cognitive
	Special considerations in administration of medications to pregnant patients	Cognitive
	Paediatric dosing of antiretrovirals	Cognitive
	The impact of ethnicity or population differences on drug response	Cognitive
	Effects of inter-individual variability on drug response	Cognitive
	The need for pharmacogenetics testing	Cognitive
	Response to treatment in patients with or without pharmacogenetic markers	Cognitive
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	Cognitive
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	Cognitive Affective
Information finding	Finding information from major drug sources, publications or websites to obtain medicine information	Cognitive
	Appropriate drug management guidelines	Cognitive
	Computer support for medicine review	Psychomotor
Nursing practice	Verification of accuracy of medical orders	Cognitive
	Transcription of medicine orders	Cognitive
	Following the nursing process as related to pharmacotherapy	Cognitive
	Evaluation of medication orders for possible revision or discontinuation	Cognitive
	The impact of traditional, complementary, and technological therapies on patient-centred outcomes	Cognitive
	The World Health Organization three-step ladder for pain management	Cognitive
	Appropriate use of pain medication while taking consideration of abuse potential	Cognitive
	The treatment of adverse effects related to pain management	Cognitive
	Conversion of one analgesic to another (equianalgesia [dose changes between analgesics that deliver a same therapeutic response])	Cognitive
	Application of nursing therapeutics that supports current clinical pharmacological concepts and safe practice in patient care	Cognitive
	Evaluation of the need for 'as needed' medicine	Cognitive
Administration skills	Commonly used terms to describe medicines and methods of administration	Cognitive
	The five rights of medicine administration	Cognitive
	Nursing considerations relating to administration of drugs	Cognitive
	Documentation of medicine administration	Cognitive
	Calculation of relevant administration doses	Cognitive
	Preparation of medicines using arithmetic of dosages and solutions	Psychomotor
	Sustained release formulations of medicines	Cognitive
	Use of various routes of administration	Psychomotor
	Value orientation of "do no harm" in relation to drug administration	Affective
	Responsibilities and limitations of the practical nurse in the administration of medicine	Cognitive
Patient communication and education	Determination of the patient's use of home remedies and over-the-counter drugs	Cognitive
	Communication of relevant information of medication to patients, including adherence and concordance	Psychomotor
	Instructions relating to self-administration of prescribed medicine	Psychomotor
	Instructions for the patient regarding use, expected effects, side effects, and procedure for administration of prescribed medications	Psychomotor
	Documentation of patient/family teaching and verbalisation of understanding of instructions	Psychomotor
Medicine monitoring, pharmacovigilanc	Promotion of medicine safety	Affective
	Discussions with doctors about prescribed drugs	Psychomotor
	Assessment of current drug therapy, including benefits and risk	Cognitive

Theme	Competency	Domain
e and management	Medication, pharmacokinetics and pharmacodynamic principles within patients' settings	Cognitive
	Assessment of drug and dose reasonableness	Cognitive
	Monitoring of drug effects	Cognitive Psychomotor
	Reporting and recording of medication administered and patient response	Psychomotor
	Documentation of drug errors and prescription errors	Cognitive
	Drug-induced harm and hospital admissions	Cognitive
	Recognition of adverse drug reactions and their impact on individual patients	Cognitive
	Reporting of adverse events	Cognitive
	Responsibility of reporting of adverse drug reactions	Affective
	Use of data from symptom assessment to plan	Cognitive
	Intervention in symptom management using state-of-the-art traditional and complementary approaches	Cognitive Psychomotor
	Pharmacotherapeutic interventions for relatively simple cases of adverse drug reactions	Cognitive
	Detection of drug interactions	Cognitive
	Monitoring of blood levels of medicines	Psychomotor
	Detection of management problems	Cognitive
	Antimicrobial stewardship	Cognitive
	Antiretroviral use in children, patients who have defaulted, pregnant patients, patients with renal failure prior to or during treatment, patients with tuberculosis, and those who failed second-line treatment	Cognitive
	Treatment of antiretroviral-induced rashes and hepatitis	Cognitive
	Pharmacological pain management in children, elderly, individuals with a history of substance abuse, and uninsured or poor individuals	Cognitive
	Appropriate storage of medicines	Psychomotor
	Medications which are controlled substances	Cognitive
	Procedure for accounting for controlled substances following facility policy	Cognitive
	Disposing of medications in accordance with employer's policies and government regulations	Psychomotor
	Documenting medicine storage	Cognitive
Generic competencies	Accountability and responsibility	
	Adaptability	
	Collaboration and interdisciplinary teamwork	
	Communication	
	Creativity	
	Critical thinking	
	Information and communication technology literacy	
	Innovation	
	Leadership	
	Media literacy	
	Problem-solving	
	Productivity	
	Self-directedness	
	Social and cultural interaction	

3.1.2. Delphi study

The Delphi study has been stratified according to the pharmacological, pharmacotherapeutic and generic competencies within the competency list.

3.1.2.1. Participants

Response rates were 35.7%, 28.6% and 46.4% for Phases I, II and III of the Delphi study based on the 28 invitees (Table 4.5). Participants were all South Africans who had completed their nursing degrees in South Africa and had obtained a master's or doctoral degree. Many participants had more than 21-years' experience in nursing, with the majority exceeding 30-years' experience. Most participants worked in the academic environment in South Africa, but some representation from those outside of the country was also seen. An overt representation from professional nursing societies in South Africa was noted, with affiliation with accreditation boards in (South African Nursing Council) and outside of South Africa. Representation from both the public and private healthcare sector was included.

TABLE 4.5: DEMOGRAPHICS OF DELPHI PARTICIPANTS THROUGH ALL THREE PHASES

		Phase I	Phase II	Phase III
Participants		23	17	10
Country of practice	**Lesotho**	4	4	2
	Namibia	1	1	1
	South Africa	18	12	7
Highest qualification	**Bachelor's degree**	1	3	1
	Honours	1	0	0
	Masters	8	4	3
	Doctoral	13	9	6
	Other	0	1	0
Years of experience	**5 to 10**	2	0	0
	11 to 15	4	3	1
	16 to 20	5	3	2
	21 to 25	3	3	1
	26 to 30	2	2	2
	>30	7	6	4
Working in academia	**South Africa**	16	9	5
	Outside South Africa	5	5	3
Affiliated with professional society	**South Africa**	5	2	2
	Outside South Africa	0	2	0
Affiliated with accreditation board	**South Africa**	4	1	1
	Outside South Africa	2	2	2
Working in private practice	**South Africa**	2	2	1
	Outside South Africa	0	1	1
Working in public hospital	**South Africa**	6	2	1
	Outside South Africa	2	3	0

*PARTICIPANTS WERE PROVIDED THE OPPORTUNITY TO INDICATE THEIR ASSOCIATION WITH ALL, AND THUS SOME MAY BE PART OF MORE THAN ONE AFFILIATION.

3.1.2.2. Pharmacological competencies

After Phase I, 92 pharmacological competencies were identified as important to nursing practice (Table 4.6), with four requiring re-testing. Four competencies reached agreement of cognitive level, with 93 re-tested. Four competencies were added: patient assessment before medication administration; managing patients who are on multiple treatments and/or suffer from multiple conditions; sources of drugs; and management of Steven-Johnson syndrome.

After Phase II (Table 4.7), seven competencies were important, with one needing re-testing. Cognitive level was agreed upon for 72, with 24 re-tested. After Phase III (Table 4.8), the competency did not reach consensus in terms of importance; cognitive level was agreed upon for fifteen competencies. After all three phases were completed, from 102 pharmacological competencies, 101 were important (although four were not agreed upon), and one considered unimportant (Table 4.9). There was agreement of 16 (15.84%) and 76 (75.24%) competencies being listed in the lower and higher order cognitive levels, respectively. Given a lack of consensus, two (1.98%) and seven (6.93%) competencies were bracketed into the lower and higher order cognitive levels given the proximity of their medians. The core concepts of pharmacology (particularly pharmacokinetics), competencies related to clinical and nursing practice, medication management, pain management, patient education and special populations were recommended to be approached at a higher cognitive level, while those involved with inter-individual variation (including genetics and drug-drug/drug-food interactions) were positioned at a lower cognitive level.

3.1.2.3. Pharmacotherapeutic competencies

Forty-six out of forty-nine pharmacotherapeutic competencies were considered important, with two requiring re-testing after Phase I (Table 4.6). Only one competency reached agreement on cognitive level, with 48 needing re-testing. Five additional pharmacotherapeutic areas were included after Phase I: marijuana-containing therapies; hematopoietic drugs; intravenous fluids; anti-helminthic drugs; and immune reconstitution inflammatory syndrome. After Phase II (Table 4.7), five competencies were agreed upon as important, with two needing re-testing. In total, 44 competencies were settled in terms of cognitive level, with eight requiring re-testing. After Phase III (Table 4.8), only one competency lacked agreement (immune reconstitution inflammatory syndrome); however, its median suggested importance. Six competencies were agreed upon in terms of cognitive level, with two not settled.

From the 54 competencies, 53 pharmacotherapeutic competencies were considered important though three were unsettled, and one unimportant (Table 4.9). Only eight competencies were considered lower order cognitive levels, with one bracketed within it due to a lack of consensus. The majority (45; 84.91%) were considered higher order cognitive level competencies, with one lacking consensus.

Based on the competencies recommended as important for nursing, a suggested national curriculum framework for pharmacology education is proposed in Table 4.10, and summarised visually in Figure 4.2. The main learning outcomes are positioned, linking to their associated assessment criteria, for the core concepts of pharmacology, namely medication management, patient education and pharmacotherapeutic areas of relevance to nurses.

3.1.2.4. Generic competencies

All generic competencies were agreed upon as important (Table 4.6).

TABLE 4.6: COMPETENCY RANKING AFTER PHASE I OF THE NURSING DELPHI STUDY (N = 23 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**The role of pharmacology in disease treatment**	4.00	1.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Biopharmaceutics	3.00	1.00	Yes	Included	13	3.00	3.00	No	Apply	Phase II
	Common pharmacological concepts	4.00	0.00	Yes	Included	16	3.00	1.00	Yes	Apply	Included
	Common routes of administration used in clinical settings	4.00	0.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Common formulations used in clinical settings	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Legal aspects of drug control and administration	4.00	0.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Principles of pharmacokinetics	4.00	1.00	Yes	Included	17	3.00	1.50	No	Apply	Phase II
	Pharmacokinetics: Absorption	4.00	1.00	Yes	Included	16	3.00	2.00	No	Apply	Phase II
	Pharmacokinetics: Distribution	4.00	1.00	Yes	Included	16	3.00	2.00	No	Apply	Phase II
	Pharmacokinetics: Metabolism	4.00	1.00	Yes	Included	16	3.00	2.00	No	Apply	Phase II
	Pharmacokinetics: Excretion	4.00	1.00	Yes	Included	17	3.00	2.50	No	Apply	Phase II
	Principles of pharmacodynamics	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	The modulation of drug targets to alter (patho)physiological responses	3.00	2.00	No	Phase II	13	3.00	2.50	No	Apply	Phase II
	Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)	2.00	1.00	Yes	Not included	10	2.50	2.25	No	Understand	Not included
	Factors that alter the response to pharmacotherapy	4.00	1.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Principles of polypharmacy	4.00	1.00	Yes	Included	15	4.00	2.00	No	Analyse	Phase II
	Pharmacodynamic and pharmacokinetic drug interactions	4.00	1.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	The impact of ethnicity or population differences on drug response	4.00	1.00	Yes	Included	14	3.00	2.25	No	Apply	Phase II
	Effects of inter-individual variability on drug response	3.00	2.00	No	Phase II	13	4.00	2.00	No	Analyse	Phase II
	The need for pharmacogenetics testing	3.00	1.00	Yes	Included	10	2.00	2.25	No	Understand	Phase II
	Pharmacogenetics information on drug labels	3.00	1.00	Yes	Included	9	3.00	1.00	Yes	Apply	Included
	Response to treatment in patients with or without pharmacogenetic markers	3.00	2.00	No	Phase II	10	3.00	2.00	No	Apply	Phase II
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	3.00	1.00	Yes	Included	12	3.00	1.75	No	Apply	Phase II
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	3.00	2.00	No	Phase II	11	3.00	2.00	No	Apply	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Management of medicine in different patient groups	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Pharmacokinetics and pharmacodynamics of drugs in the elderly	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Special considerations in administration of medications to paediatric and geriatric patients	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Paediatric dosing	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Special considerations in administration of medications to pregnant patients	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Medication, pharmacokinetics and pharmacodynamic principles within patients' settings	4.00	1.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Appropriate drug management guidelines	4.00	0.00	Yes	Included	16	5.00	3.00	No	Evaluate	Phase II
	Verification of accuracy of medical orders	4.00	0.00	Yes	Included	17	5.00	1.50	No	Evaluate	Phase II
	Transcription of medicine orders	4.00	0.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Discussions with doctors about prescribed drugs	4.00	0.00	Yes	Included	15	4.00	2.00	No	Analyse	Phase II
	Implementing the nursing process as related to pharmacotherapy	4.00	0.00	Yes	Included	16	6.00	1.75	No	Create	Phase II
	Evaluation of medication orders for possible revision or discontinuation	4.00	0.00	Yes	Included	17	5.00	2.50	No	Evaluate	Phase II
	Assessment of current drug therapy, including benefits and risk	4.00	0.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Assessment of drug and dose reasonableness	4.00	1.00	Yes	Included	14	4.00	2.00	No	Analyse	Phase II
	Evaluation of the need for 'as needed' medicine	4.00	1.00	Yes	Included	16	4.00	1.75	No	Analyse	Phase II
	Application of nursing therapeutics that supports current clinical pharmacological concepts and safe practice in patient care	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	The five rights of medicine administration	4.00	0.00	Yes	Included	16	4.00	3.00	No	Analyse	Phase II
	Nursing considerations relating to administration of drugs	4.00	0.00	Yes	Included	17	5.00	3.00	No	Evaluate	Phase II
	Documentation of medicine administration	4.00	0.00	Yes	Included	17	5.00	3.00	No	Evaluate	Phase II
	Calculation of relevant administration doses	4.00	0.00	Yes	Included	17	4.00	3.00	No	Analyse	Phase II
	Preparation of medicines using arithmetic of dosages and solutions	4.00	0.00	Yes	Included	16	4.00	2.75	No	Analyse	Phase II
	Sustained release formulations of medicines	4.00	1.00	Yes	Included	14	3.00	2.25	No	Apply	Phase II
	Use of various routes of administration	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Value orientation of "do no harm" in relation to drug administration	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Responsibilities and limitations of the practical nurse in the administration of medicine	4.00	0.00	Yes	Included	17	5.00	2.00	No	Evaluate	Phase II
	Determination of the patient's use of home remedies and over-the-counter drugs	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Communication of relevant information of medication to patients, including adherence and concordance	4.00	0.00	Yes	Included	17	4.00	3.00	No	Analyse	Phase II
	Instructions relating to self-administration of prescribed medicine	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Instructions for the patient regarding use, expected effects, side effects, and procedure for administration of prescribed medications	4.00	0.00	Yes	Included	17	5.00	3.00	No	Evaluate	Phase II
	Documentation of patient/family teaching and verbalisation of understanding of instructions	4.00	0.00	Yes	Included	17	4.00	3.00	No	Analyse	Phase II
	Monitoring of drug effects	4.00	0.00	Yes	Included	17	5.00	1.00	Yes	Evaluate	Included
	Reporting and recording of medication administered and patient response	4.00	0.00	Yes	Included	17	5.00	2.50	No	Evaluate	Phase II
	Reporting and recording of drug errors and prescription errors that are encountered	4.00	0.00	Yes	Included	17	5.00	3.00	No	Evaluate	Phase II
	Drug-induced harm and hospital admissions	4.00	0.00	Yes	Included	17	4.00	1.50	No	Analyse	Phase II
	Recognition of adverse drug reactions and their impact on individual patients	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Promotion of medicine safety	4.00	0.00	Yes	Included	17	5.00	3.00	No	Evaluate	Phase II
	Reporting of adverse events	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Responsibility of reporting of adverse drug reactions	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Use of data from symptom assessment to plan	4.00	0.00	Yes	Included	17	5.00	2.00	No	Evaluate	Phase II
	Intervention in symptom management using state-of-the-art traditional and complementary approaches	3.00	1.00	Yes	Included	13	4.00	2.00	No	Analyse	Phase II
	Pharmacotherapeutic interventions for relatively simple cases of adverse drug reactions	4.00	1.00	Yes	Included	15	3.00	2.00	No	Apply	Phase II
	Detection of drug interactions	4.00	1.00	Yes	Included	15	5.00	2.00	No	Evaluate	Phase II
	Monitoring of blood levels of medicines	3.00	1.00	Yes	Included	12	4.00	2.00	No	Analyse	Phase II
	Detection of management problems	4.00	1.00	Yes	Included	14	4.00	2.00	No	Analyse	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Appropriate storage of medicines	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Medications which are controlled substances	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Procedure for accounting for controlled substances following facility policy	4.00	0.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Disposing of medications in accordance with employer's policies and government regulations	4.00	1.00	Yes	Included	15	3.00	1.00	Yes	Apply	Included
	Documenting medicine storage	4.00	0.00	Yes	Included	15	3.00	3.00	No	Apply	Phase II
	The World Health Organization three-step ladder for pain management	4.00	0.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Appropriate use of pain medication while taking consideration of abuse potential	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	The treatment of adverse effects related to pain management	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Conversion of one analgesic to another (equianalgesia)	4.00	1.00	Yes	Included	14	3.00	1.25	No	Apply	Phase II
	Antimicrobial stewardship	4.00	0.00	Yes	Included	15	4.00	2.00	No	Analyse	Phase II
	Antiretroviral use in children	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Antiretroviral use in patients who have defaulted	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Antiretroviral use in pregnant patients	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Antiretroviral use in patients with renal failure prior to or during treatment	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Antiretroviral use in patients with tuberculosis	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Antiretroviral use in those who failed second-line treatment	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Treatment of antiretroviral-induced rashes and hepatitis	4.00	0.00	Yes	Included	17	5.00	2.00	No	Evaluate	Phase II
	Pharmacological pain management in children	4.00	0.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Pharmacological pain management in the elderly	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Pharmacological pain management in individuals with a history of substance abuse	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Pharmacological pain management in uninsured or poor individuals	4.00	1.00	Yes	Included	15	4.00	2.00	No	Analyse	Phase II
	The impact of traditional, complementary, and technological therapies on patient-centred outcomes	4.00	1.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Finding reliable information from major drug sources, publications	4.00	0.00	Yes	Included	15	5.00	3.00	No	Evaluate	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	or websites to obtain medicine information										
	Finding reliable information from major drug sources, publication or websites to obtain evidence-based practice guidelines	4.00	1.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Computer support for medicine review	3.00	1.00	Yes	Included	14	3.50	2.00	No	Apply	Phase II
	Prescribing of pharmacotherapy	4.00	0.00	Yes	Included	15	3.00	3.00	No	Apply	Phase II
	Interpreting pre-clinical and clinical pharmacological data	3.00	1.00	Yes	Included	12	3.50	1.75	No	Apply	Phase II
	Discussing misconceptions of pharmacotherapy with patients	4.00	1.00	Yes	Included	16	3.00	2.00	No	Apply	Phase II
	Interpretation of pharmacological research in relation to clinical outcomes	3.00	1.00	Yes	Included	13	3.00	2.00	No	Apply	Phase II
Pharmacotherapy against diseases competencies	Allergies and anaphylaxis	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Anaesthesia	3.00	2.00	No	Phase II	11	4.00	2.00	No	Analyse	Phase II
	Anxiety	4.00	1.00	Yes	Included	17	4.00	1.50	No	Analyse	Phase II
	Asthma	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Bacterial infections	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Burns	4.00	1.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Cardiovascular diseases	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Constipation	4.00	0.00	Yes	Included	16	4.00	2.75	No	Analyse	Phase II
	Contraception	4.00	0.00	Yes	Included	16	4.00	2.75	No	Analyse	Phase II
	COVID-19	4.00	0.00	Yes	Included	15	4.00	2.00	No	Analyse	Phase II
	Depression	4.00	0.00	Yes	Included	17	3.00	1.50	No	Apply	Phase II
	Dermatological diseases	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Diabetes	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Diarrhoea	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Drugs of abuse	4.00	1.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Ear disorders	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Endocrine disorders	4.00	1.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Epilepsy	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Eye disorders	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Fungal infections	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Gastro-oesophageal disorder	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	High-alert medicine	4.00	1.00	Yes	Included	15	4.00	2.00	No	Analyse	Phase II
	HIV	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Hormone replacement therapy	3.00	1.00	Yes	Included	15	3.00	2.00	No	Apply	Phase II
	Hypnosis	2.00	1.00	Yes	Not included	8	3.00	2.75	No	Apply	Not included
	Inflammation	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Intensive care unit procedures	4.00	1.00	Yes	Included	16	4.00	3.00	No	Analyse	Phase II
	Malaria	4.00	1.00	Yes	Included	16	3.00	2.75	No	Apply	Phase II
	Muscle relaxation	4.00	1.00	Yes	Included	16	4.00	2.00	No	Analyse	Phase II
	Musculoskeletal disorders	4.00	0.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Nausea and vomiting	4.00	0.00	Yes	Included	17	4.00	3.00	No	Analyse	Phase II
	Neoplasia	3.00	2.00	No	Phase II	13	3.00	2.00	No	Apply	Phase II
	Obesity	4.00	1.00	Yes	Included	14	4.00	3.00	No	Analyse	Phase II
	Osteoporosis	4.00	1.00	Yes	Included	15	3.00	1.00	Yes	Apply	Included
	Overdose and poisonings	4.00	0.00	Yes	Included	16	4.00	3.00	No	Analyse	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Pain	4.00	0.00	Yes	Included	17	5.00	2.50	No	Evaluate	Phase II
	Parasympathetic nervous system disorders	4.00	1.00	Yes	Included	15	3.00	2.00	No	Apply	Phase II
	Parkinson's disease	3.00	1.00	Yes	Included	15	3.00	2.00	No	Apply	Phase II
	Peptic ulcers	4.00	1.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Reproductive disorders	4.00	1.00	Yes	Included	17	3.00	2.00	No	Apply	Phase II
	Resuscitation medicine	4.00	0.00	Yes	Included	16	5.00	2.75	No	Evaluate	Phase II
	Respiratory disorders	4.00	0.00	Yes	Included	17	4.00	3.00	No	Analyse	Phase II
	Schizophrenia	4.00	1.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Sedation	4.00	1.00	Yes	Included	16	3.50	2.00	No	Apply	Phase II
	Sympathetic nervous system disorders	4.00	1.00	Yes	Included	16	3.50	2.00	No	Apply	Phase II
	Tuberculosis	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
	Urological disorders	4.00	1.00	Yes	Included	17	4.00	2.00	No	Analyse	Phase II
	Vaccinations	4.00	0.00	Yes	Included	17	5.00	2.50	No	Evaluate	Phase II
	Viral infections	4.00	0.00	Yes	Included	17	4.00	2.50	No	Analyse	Phase II
Pervasive skills	**Critical thinking**	4.00	0.00	Yes	Included						
	Problem-solving	4.00	0.00	Yes	Included						
	Communication	4.00	0.00	Yes	Included						
	Collaboration and interdisciplinary teamwork	4.00	0.00	Yes	Included						
	Creativity	3.00	1.00	Yes	Included						
	Innovation	4.00	1.00	Yes	Included						
	Media literacy	3.00	1.00	Yes	Included						
	Information and communication technology literacy	4.00	1.00	Yes	Included						
	Adaptability	4.00	0.00	Yes	Included						
	Self-directedness	4.00	0.00	Yes	Included						
	Social and cultural interaction	4.00	0.00	Yes	Included						
	Productivity	4.00	0.00	Yes	Included						
	Accountability and responsibility	4.00	0.00	Yes	Included						
	Leadership	4.00	0.00	Yes	Included						

ABBREVIATIONS: IQR = INTERQUARTILE RANGE

TABLE 4.7: COMPETENCY RANKING AFTER PHASE II OF THE NURSING DELPHI STUDY (N = 17 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**The role of pharmacology in disease treatment**	Consensus already reached (not tested)				16	4.00	1.75	No	Analyse	Phase III
	Biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)	Consensus already reached (not tested)				16	3.00	1.75	No	Apply	Phase III
	Common routes of administration used in clinical settings	Consensus already reached (not tested)				16	4.00	1.75	No	Analyse	Phase III

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Common formulations used in clinical settings	Consensus already reached (not tested)				15	5.00	1.00	Yes	Evaluate	Included
	Legal aspects of drug control and administration	Consensus already reached (not tested)				16	4.00	2.00	No	Analyse	Phase III
	Principles of pharmacokinetics (the movement of drug into, through, and out of the body)	Consensus already reached (not tested)				15	4.00	2.00	No	Analyse	Phase III
	Pharmacokinetics: Absorption	Consensus already reached (not tested)				16	3.50	1.75	No	Apply	Phase III
	Pharmacokinetics: Distribution	Consensus already reached (not tested)				16	3.50	1.00	Yes	Apply	Included
	Pharmacokinetics: Metabolism	Consensus already reached (not tested)				16	4.00	1.00	Yes	Analyse	Included
	Pharmacokinetics: Excretion	Consensus already reached (not tested)				16	4.00	1.75	No	Analyse	Phase III
	Principles of pharmacodynamics (the response of the body to the drug)	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	The modulation of drug targets to alter (patho)physiological responses	3.00	0.50	Important	Included	16	3.00	1.00	Yes	Apply	Included
	Factors that alter the response to pharmacotherapy	Consensus already reached (not tested)				16	4.00	1.75	No	Analyse	Phase III
	Principles of polypharmacy	Consensus already reached (not tested)				16	4.50	1.00	Yes	Analyse	Included
	Pharmacodynamic and pharmacokinetic drug interactions	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	The impact of ethnicity or population differences on drug response	Consensus already reached (not tested)				16	3.50	1.00	Yes	Apply	Included
	Effects of inter-individual variability on drug response	3.00	0.00	Important	Included	16	4.00	0.75	Yes	Analyse	Included
	The need for pharmacogenetics testing (where pharmacogenetics is the effect genetic factors has on drug reactions)	Consensus already reached (not tested)				15	2.00	2.00	No	Understand	Phase III
	Response to treatment in patients with or without pharmacogenetic markers	3.00	0.00	Important	Included	16	3.00	1.00	Yes	Apply	Included
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	Consensus already reached (not tested)				16	3.00	1.00	Yes	Apply	Included
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	3.00	0.50	Important	Included	14	3.00	2.00	No	Apply	Phase III
	Management of medicine in different patient groups	Consensus already reached (not tested)				15	4.00	2.00	No	Analyse	Phase III
	Pharmacokinetics and pharmacodynamics of drugs in the elderly	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Special considerations in administration of medications to paediatric and geriatric patients	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Paediatric dosing	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Special considerations in administration of medications to pregnant patients	Consensus already reached (not tested)				14	4.50	1.00	Yes	Analyse	Included
	Medication, pharmacokinetics and pharmacodynamic principles within patients' settings	Consensus already reached (not tested)				13	4.00	0.00	Yes	Analyse	Included
	Appropriate drug management guidelines	Consensus already reached (not tested)				14	5.00	0.25	Yes	Evaluate	Included
	Verification of accuracy of medical orders	Consensus already reached (not tested)				14	5.00	0.00	Yes	Evaluate	Included
	Transcription of medicine orders	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Discussions with doctors about prescribed drugs	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Implementing the nursing process as related to pharmacotherapy	Consensus already reached (not tested)				14	6.00	1.00	Yes	Create	Included
	Evaluation of medication orders for possible revision or discontinuation	Consensus already reached (not tested)				14	5.00	0.25	Yes	Evaluate	Included
	Assessment of current drug therapy, including benefits and risk	Consensus already reached (not tested)				15	5.00	1.00	Yes	Evaluate	Included
	Assessment of drug and dose reasonableness	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Evaluation of the need for 'as needed' medicine	Consensus already reached (not tested)				13	4.00	1.00	Yes	Analyse	Included
	Application of nursing therapeutics that supports current clinical pharmacological concepts and safe practice in patient care	Consensus already reached (not tested)				14	4.50	1.00	Yes	Analyse	Included
	The five rights of medicine administration	Consensus already reached (not tested)				14	5.00	1.50	No	Evaluate	Phase III
	Nursing considerations relating to administration of drugs	Consensus already reached (not tested)				14	5.00	0.75	Yes	Evaluate	Included
	Documentation of medicine administration	Consensus already reached (not tested)				14	5.00	1.50	No	Evaluate	Phase III
	Calculation of relevant administration doses	Consensus already reached (not tested)				14	4.50	1.00	Yes	Analyse	Included
	Preparation of medicines using arithmetic of dosages and solutions	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Sustained release formulations of medicines	Consensus already reached (not tested)				14	3.00	1.00	Yes	Apply	Included
	Use of various routes of administration	Consensus already reached (not tested)				14	4.00	1.25	No	Analyse	Phase III
	Value orientation of "do no harm" in relation to drug administration	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Responsibilities and limitations of the practical nurse in the administration of medicine	Consensus already reached (not tested)				14	5.00	0.00	Yes	Evaluate	Included
	Determination of the patient's use of home remedies and over-the-counter drugs	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Communication of relevant information of medication to patients, including adherence and concordance	Consensus already reached (not tested)				15	5.00	2.00	No	Evaluate	Phase III
	Instructions relating to self-administration of prescribed medicine	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Instructions for the patient regarding use, expected effects, side effects, and procedure for administration of prescribed medications	Consensus already reached (not tested)				13	5.00	1.50	No	Evaluate	Phase III
	Documentation of patient/family teaching and verbalisation of understanding of instructions	Consensus already reached (not tested)				15	5.00	1.00	Yes	Evaluate	Included
	Reporting and recording of medication administered and patient response	Consensus already reached (not tested)				14	5.00	1.00	Yes	Evaluate	Included
	Reporting and recording of drug errors and prescription errors that are encountered	Consensus already reached (not tested)				13	5.00	1.00	Yes	Evaluate	Included
	Drug-induced harm and hospital admissions	Consensus already reached (not tested)				14	5.00	1.00	Yes	Evaluate	Included
	Recognition of adverse drug reactions and their impact on individual patients	Consensus already reached (not tested)				15	5.00	1.00	Yes	Evaluate	Included
	Promotion of medicine safety	Consensus already reached (not tested)				13	5.00	1.00	Yes	Evaluate	Included
	Reporting of adverse events	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Responsibility of reporting of adverse drug reactions	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Use of data from symptom assessment to plan	Consensus already reached (not tested)				14	5.00	0.00	Yes	Evaluate	Included
	Intervention in symptom management using state-of-the-art traditional and complementary approaches	Consensus already reached (not tested)				15	4.00	0.00	Yes	Analyse	Included
	Pharmacotherapeutic interventions for relatively simple cases of adverse drug reactions	Consensus already reached (not tested)				15	3.00	0.00	Yes	Apply	Included
	Detection of drug interactions	Consensus already reached (not tested)				14	5.00	0.25	Yes	Evaluate	Included
	Monitoring of blood levels of medicines	Consensus already reached (not tested)				15	4.00	0.00	Yes	Analyse	Included
	Detection of management problems	Consensus already reached (not tested)				15	4.00	0.00	Yes	Analyse	Included
	Appropriate storage of medicines	Consensus already reached (not tested)				14	4.00	1.25	No	Analyse	Phase III
	Medications which are controlled substances	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Procedure for accounting for controlled substances following facility policy	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Documenting medicine storage	Consensus already reached (not tested)				14	3.50	1.00	Yes	Apply	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	The World Health Organization three-step ladder for pain management	Consensus already reached (not tested)				14	4.00	1.25	No	Analyse	Phase III
	Appropriate use of pain medication while taking consideration of abuse potential	Consensus already reached (not tested)				14	4.00	0.00	Yes	Analyse	Included
	The treatment of adverse effects related to pain management	Consensus already reached (not tested)				14	4.00	0.00	Yes	Analyse	Included
	Conversion of one analgesic to another (equianalgesia)	Consensus already reached (not tested)				15	3.00	1.00	Yes	Apply	Included
	Antimicrobial stewardship	Consensus already reached (not tested)				16	4.00	1.00	Yes	Analyse	Included
	Antiretroviral use in children	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Antiretroviral use in patients who have defaulted	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Antiretroviral use in pregnant patients	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Antiretroviral use in patients with renal failure prior to or during treatment	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Antiretroviral use in patients with tuberculosis	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Antiretroviral use in those who failed second-line treatment	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Treatment of antiretroviral-induced rashes and hepatitis	Consensus already reached (not tested)				13	5.00	0.00	Yes	Evaluate	Included
	Pharmacological pain management in children	Consensus already reached (not tested)				16	4.00	2.00	No	Analyse	Phase III
	Pharmacological pain management in the elderly	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Pharmacological pain management in individuals with a history of substance abuse	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Pharmacological pain management in uninsured or poor individuals	Consensus already reached (not tested)				15	4.00	0.00	Yes	Analyse	Included
	The impact of traditional, complementary, and technological therapies on patient-centred outcomes	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Finding reliable information from major drug sources, publications or websites to obtain medicine information	Consensus already reached (not tested)				14	5.00	0.00	Yes	Evaluate	Included
	Finding reliable information from major drug sources, publication or websites to obtain evidence-based practice guidelines	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Computer support for medicine review	Consensus already reached (not tested)				14	4.00	1.25	No	Analyse	Phase III
	Prescribing of pharmacotherapy	Consensus already reached (not tested)				15	3.00	1.00	Yes	Apply	Included
	Interpreting pre-clinical and clinical pharmacological data	Consensus already reached (not tested)				14	4.00	0.00	Yes	Analyse	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Discussing misconceptions of pharmacotherapy with patients	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Interpretation of pharmacological research in relation to clinical outcomes	Consensus already reached (not tested)				13	3.00	1.00	Yes	Apply	Included
	Patient assessment before medication administration	4.00	0.50	Important	Included	16	4.50	1.75	No	Analyse	Phase III
	Managing patients who are on multiple treatments and/or suffer from multiple conditions	4.00	1.00	Important	Included	17	4.00	1.50	No	Analyse	Phase III
	Sources of drugs	3.00	1.00	Important	Included	10	3.00	2.25	No	Apply	Phase III
	Management of Steven-Johnson syndrome	3.00	2.00	No consensus	Phase III	11	3.00	2.00	No	Apply	Phase III
Pharmacotherapy against diseases competencies	**Allergies and anaphylaxis**	Consensus already reached (not tested)				14	4.00	0.50	Yes	Analyse	Included
	Anaesthesia	3.00	1.00	Important	Included	15	4.00	0.00	Yes	Analyse	Included
	Anxiety	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Asthma	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Bacterial infections	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Burns	Consensus already reached (not tested)				14	4.50	1.00	Yes	Analyse	Included
	Cardiovascular diseases	Consensus already reached (not tested)				14	4.00	1.25	No	Analyse	Phase III
	Constipation	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Contraception	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	COVID-19	Consensus already reached (not tested)				15	4.00	2.00	No	Analyse	Phase III
	Depression	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Dermatological diseases	Consensus already reached (not tested)				15	5.00	1.00	Yes	Evaluate	Included
	Diabetes	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Diarrhoea	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Drugs of abuse	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Ear disorders	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Endocrine disorders	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Epilepsy	Consensus already reached (not tested)				13	4.00	0.50	Yes	Analyse	Included
	Eye disorders	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Fungal infections	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Gastro-oesophageal disorder	Consensus already reached (not tested)				14	4.00	0.00	Yes	Analyse	Included
	High-alert medicine	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	HIV	Consensus already reached (not tested)				14	3.50	1.00	Yes	Apply	Included
	Hormone replacement therapy	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Inflammation	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Intensive care unit procedures	Consensus already reached (not tested)				15	3.00	1.00	Yes	Apply	Included
	Malaria	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Muscle relaxation	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Musculoskeletal disorders	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Nausea and vomiting	Consensus already reached (not tested)				14	3.00	1.25	No	Apply	Phase III
	Neoplasia	3.00	1.00	Important	Included	14	4.00	0.25	Yes	Analyse	Included
	Obesity	Consensus already reached (not tested)				14	4.00	1.00	Yes	Analyse	Included
	Overdose and poisonings	Consensus already reached (not tested)				14	5.00	0.00	Yes	Evaluate	Included
	Pain	Consensus already reached (not tested)				14	3.50	1.00	Yes	Apply	Included
	Parasympathetic nervous system disorders	Consensus already reached (not tested)				14	3.00	1.00	Yes	Apply	Included
	Parkinson's disease	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Peptic ulcers	Consensus already reached (not tested)				14	4.00	1.25	No	Analyse	Phase III

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Reproductive disorders	Consensus already reached (not tested)				14	5.00	0.00	Yes	Evaluate	Included
	Resuscitation medicine	Consensus already reached (not tested)				15	4.00	1.00	Yes	Analyse	Included
	Respiratory disorders	Consensus already reached (not tested)				14	4.00	0.00	Yes	Analyse	Included
	Schizophrenia	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Sedation	Consensus already reached (not tested)				14	4.00	0.50	Yes	Analyse	Included
	Sympathetic nervous system disorders	Consensus already reached (not tested)				15	4.00	0.00	Yes	Analyse	Included
	Tuberculosis	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Urological disorders	Consensus already reached (not tested)				14	5.00	0.00	Yes	Evaluate	Included
	Vaccinations	Consensus already reached (not tested)				14	4.00	0.25	Yes	Analyse	Included
	Viral infections	Consensus already reached (not tested)				16	4.50	1.75	No	Analyse	Phase III
	Marijuana-containing therapies	3.00	1.00	Important	Included	10	3.00	1.25	No	Apply	Phase III
	Hematopoietic drugs	3.00	1.50	No consensus	Phase III	12	3.00	1.00	Yes	Apply	Included
	Intravenous fluids	4.00	1.00	Important	Included	17	4.00	2.00	No	Analyse	Phase III
	Anti-helminthic drugs	3.00	1.00	Important	Included	15	3.00	1.00	Yes	Apply	Included
	Immune reconstitution inflammatory syndrome	3.00	1.50	No consensus	Phase III	13	4.00	2.50	No	Analyse	Phase III

ABBREVIATIONS: IQR = INTERQUARTILE RANGE.

TABLE 4.8: COMPETENCY RANKING AFTER PHASE III OF THE NURSING DELPHI STUDY (N = 10 PARTICIPANTS).

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**The role of pharmacology in disease treatment**	Consensus already reached (not tested)				7	5.00	2.00	No	Evaluate	Included
	Biopharmaceutics	Consensus already reached (not tested)				8	3.50	1.75	No	Apply	Included
	Common routes of administration used in clinical settings	Consensus already reached (not tested)				8	5.00	0.75	Yes	Evaluate	Included
	Legal aspects of drug control and administration	Consensus already reached (not tested)				8	5.00	1.50	No	Evaluate	Included
	Principles of pharmacokinetics	Consensus already reached (not tested)				8	4.00	1.75	No	Analyse	Included
	Pharmacokinetics: Absorption	Consensus already reached (not tested)				8	4.00	1.00	Yes	Analyse	Included
	Pharmacokinetics: Excretion	Consensus already reached (not tested)				8	4.00	1.00	Yes	Analyse	Included
	Factors that alter the response to pharmacotherapy	Consensus already reached (not tested)				7	4.00	1.00	Yes	Analyse	Included
	The need for pharmacogenetics testing	Consensus already reached (not tested)				8	2.50	1.00	Yes	Understand	Included
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	Consensus already reached (not tested)				8	3.00	1.50	No	Apply	Included
	Management of medicine in different patient groups	Consensus already reached (not tested)				9	5.00	1.00	Yes	Evaluate	Included
	The five rights of medicine administration	Consensus already reached (not tested)				9	5.00	1.00	Yes	Evaluate	Included
	Documentation of medicine administration	Consensus already reached (not tested)				9	5.00	1.00	Yes	Evaluate	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Use of various routes of administration	Consensus already reached (not tested)				9	5.00	1.00	Yes	Evaluate	Included
	Communication of relevant information of medication to patients, including adherence and concordance	Consensus already reached (not tested)				8	5.00	0.75	Yes	Evaluate	Included
	Instructions for the patient regarding use, expected effects, side effects, and procedure for administration of prescribed medications	Consensus already reached (not tested)				8	5.00	1.00	Yes	Evaluate	Included
	Appropriate storage of medicines	Consensus already reached (not tested)				8	5.00	0.75	Yes	Evaluate	Included
	The World Health Organization three-step ladder for pain management	Consensus already reached (not tested)				7	5.00	2.00	No	Evaluate	Included
	Pharmacological pain management in children	Consensus already reached (not tested)				7	5.00	1.00	Yes	Evaluate	Included
	Computer support for medicine review	Consensus already reached (not tested)				7	4.00	1.00	Yes	Analyse	Included
	Patient assessment before medication administration	Consensus already reached (not tested)				7	5.00	1.00	Yes	Evaluate	Included
	Managing patients who are on multiple treatments and/or suffer from multiple conditions	Consensus already reached (not tested)				8	5.00	1.75	No	Evaluate	Included
	Sources of drugs	Consensus already reached (not tested)				8	4.00	1.75	No	Analyse	Included
	Management of Steven-Johnson syndrome	3.50	1.25	No consensus	Included	9	4.00	2.50	No	Analyse	Included
Pharmacotherapy against diseases competencies	Cardiovascular diseases	Consensus already reached (not tested)				7	4.00	1.00	Yes	Analyse	Included
	COVID-19	Consensus already reached (not tested)				7	4.00	1.00	Yes	Analyse	Included
	Nausea and vomiting	Consensus already reached (not tested)				8	4.00	1.00	Yes	Analyse	Included
	Peptic ulcers	Consensus already reached (not tested)				6	4.00	0.50	Yes	Analyse	Included
	Viral infections	Consensus already reached (not tested)				6	5.00	1.50	No	Evaluate	Included
	Marijuana-containing therapies	Consensus already reached (not tested)				6	3.50	1.50	No	Apply	Included
	Hematopoietic drugs	3.00	1.00	Yes	Included	Consensus already reached (not tested)					
	Intravenous fluids	Consensus already reached (not tested)				6	4.00	0.50	Yes	Analyse	Included
	Immune reconstitution inflammatory syndrome	3.00	1.25	No consensus	Included	7	4.00	1.00	Yes	Analyse	Included

ABBREVIATIONS: IQR = INTERQUARTILE RANGE.

TABLE 4.9: RESULTS OF THE FULL COMPETENCY LIST SCORED BY NURSING PARTICIPANTS IN THE DELPHI STUDY. ITEMS THAT LACKED CONSENSUS FOR IMPORTANCE WERE CATEGORISED AS SUCH. ITEMS NOT REACHING CONSENSUS IN TERMS OF THEIR COGNITIVE LEVEL WERE BRACKETED AS EITHER LOWER OR HIGHER ORDER DOMAIN COMPETENCIES BASED ON THE MEDIAN SCORE

Competency			Importance			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
Pharmacological competencies	**Biopharmaceutics**	**Biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)**	3.00	1.00	Important with consensus	3.50	1.75	Lower order
		The role of pharmacology in disease treatment	4.00	1.00	Important with consensus	5.00	2.00	Higher order
		Sources of drugs	3.00	1.00	Important with consensus	4.00	1.75	Higher order
		Common pharmacological concepts	4.00	0.00	Important with consensus	2.00	1.00	Understand
		Common formulations used in clinical settings	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Sustained release formulations of medicines	4.00	1.00	Important with consensus	3.00	1.00	Apply
		Common routes of administration used in clinical settings	4.00	0.00	Important with consensus	5.00	0.75	Evaluate
		Principles of polypharmacy	4.00	1.00	Important with consensus	4.50	1.00	Analyse
	Pharmacokinetics	**Principles of pharmacokinetics (the movement of drug into, through, and out of the body)**	4.00	1.00	Important with consensus	4.00	1.75	Higher order
		Pharmacokinetics: Absorption	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Pharmacokinetics: Distribution	4.00	1.00	Important with consensus	3.50	1.00	Apply
		Pharmacokinetics: Metabolism	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Pharmacokinetics: Excretion	4.00	1.00	Important with consensus	4.00	1.00	Analyse
	Pharmacodynamics	**Principles of pharmacodynamics (the response of the body to the drug)**	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)	2.00	1.00	Not important with consensus	N/A.	N/A.	N/A.
		The modulation of drug targets to alter (patho)physiological responses	3.00	0.50	Important with consensus	3.00	1.00	Apply
		Factors that alter the response to pharmacotherapy	4.00	1.00	Important with consensus	4.00	1.00	Analyse
	Interindividual variation, pharmacogenetics and interactions	**Effects of inter-individual variability on drug response**	3.00	2.00	Important, no consensus	4.00	0.75	Analyse
		The impact of ethnicity or population differences on drug response	4.00	1.00	Important with consensus	3.50	1.00	Apply
		The need for pharmacogenetics testing (where pharmacogenetics is the effect genetic factors has on drug reactions)	3.00	1.00	Important with consensus	2.50	1.00	Understand
		Response to treatment in patients with or without pharmacogenetic markers	3.00	2.00	Important, no consensus	3.00	1.00	Apply
		The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	3.00	1.00	Important with consensus	3.00	1.00	Apply
		Pharmacogenetics information on drug labels	3.00	1.00	Important with consensus	3.00	1.00	Apply
		The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	3.00	0.50	Important with consensus	3.00	1.50	Lower order
		Detection of drug interactions	4.00	1.00	Important with consensus	5.00	0.25	Evaluate
		Pharmacodynamic and pharmacokinetic drug interactions	4.00	1.00	Important with consensus	4.00	1.00	Analyse
	Medication management	**Appropriate drug management guidelines**	4.00	0.00	Important with consensus	5.00	0.25	Evaluate
		Detection of management problems	4.00	1.00	Important with consensus	4.00	0.00	Analyse
		Appropriate storage of medicines	4.00	0.00	Important with consensus	5.00	0.75	Evaluate
		Documenting medicine storage	4.00	0.00	Important with consensus	3.50	1.00	Apply

Competency			Importance			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
		Disposing of medications in accordance with employer's policies and government regulations	4.00	1.00	Important with consensus	3.00	1.00	Apply
		Transcription of medicine orders	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Verification of accuracy of medical orders	4.00	0.00	Important with consensus	5.00	0.00	Evaluate
		Evaluation of medication orders for possible revision or discontinuation	4.00	0.00	Important with consensus	5.00	0.25	Evaluate
		Evaluation of the need for 'as needed' medicine	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Determination of the patient's use of home remedies and over-the-counter drugs	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Assessment of drug and dose reasonableness	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Calculation of relevant administration doses	4.00	0.00	Important with consensus	4.50	1.00	Analyse
		Paediatric dosing	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Preparation of medicines using arithmetic of dosages and solutions	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		The five rights of medicine administration	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Value orientation of "do no harm" in relation to drug administration	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Documentation of medicine administration	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Nursing considerations relating to administration of drugs	4.00	0.00	Important with consensus	5.00	0.75	Evaluate
		Responsibilities and limitations of the practical nurse in the administration of medicine	4.00	0.00	Important with consensus	5.00	0.00	Evaluate
		Assessment of current drug therapy, including benefits and risk	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Management of medicine in different patient groups	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Legal aspects of drug control and administration	4.00	0.00	Important with consensus	5.00	1.50	Higher order
		Medications which are controlled substances	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Procedure for accounting for controlled substances following facility policy	4.00	0.00	Important with consensus	4.00	1.00	Analyse
	Clinical practice	Prescribing of pharmacotherapy	4.00	0.00	Important with consensus	3.00	1.00	Apply
		Computer support for medicine review	3.00	1.00	Important with consensus	4.00	1.00	Analyse
		Finding reliable information from major drug sources, publications or websites to obtain medicine information	4.00	0.00	Important with consensus	5.00	0.00	Evaluate
		Finding reliable information from major drug sources, publication or websites to obtain evidence-based practice guidelines	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Interpreting pre-clinical and clinical pharmacological data	3.00	1.00	Important with consensus	4.00	0.00	Analyse
		Interpretation of pharmacological research in relation to clinical outcomes	3.00	1.00	Important with consensus	3.00	1.00	Apply
		Discussing misconceptions of pharmacotherapy with patients	4.00	1.00	Important with consensus	4.00	1.00	Analyse
	Nursing practice	Implementing the nursing process as related to pharmacotherapy	4.00	0.00	Important with consensus	6.00	1.00	Create
		Use of data from symptom assessment to plan	4.00	0.00	Important with consensus	5.00	0.00	Evaluate
		The impact of traditional, complementary, and technological therapies on patient-centred outcomes	4.00	1.00	Important with consensus	4.00	0.25	Analyse
		Intervention in symptom management using state-of-the-art traditional and complementary approaches	3.00	1.00	Important with consensus	4.00	0.00	Analyse

Competency			Importance			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
		Application of nursing therapeutics that supports current clinical pharmacological concepts and safe practice in patient care	4.00	0.00	Important with consensus	4.50	1.00	Analyse
		Managing patients who are on multiple treatments and/or suffer from multiple conditions	4.00	1.00	Important with consensus	5.00	1.75	Higher order
		Medication, pharmacokinetics and pharmacodynamic principles within patients' settings	4.00	1.00	Important with consensus	4.00	0.00	Analyse
		Patient assessment before medication administration	4.00	0.50	Important with consensus	5.00	1.00	Evaluate
		Use of various routes of administration	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Reporting and recording of medication administered and patient response	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Reporting and recording of drug errors and prescription errors that are encountered	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Monitoring of drug effects	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Monitoring of blood levels of medicines	3.00	1.00	Important with consensus	4.00	0.00	Analyse
		Drug-induced harm and hospital admissions	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Recognition of adverse drug reactions and their impact on individual patients	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Pharmacotherapeutic interventions for relatively simple cases of adverse drug reactions	4.00	1.00	Important with consensus	3.00	0.00	Apply
		Treatment of antiretroviral-induced rashes and hepatitis	4.00	0.00	Important with consensus	5.00	0.00	Evaluate
		Management of Steven-Johnson syndrome	3.00	2.00	Important, no consensus	4.00	2.50	Higher order
		Responsibility of reporting of adverse drug reactions	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Reporting of adverse events	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Antimicrobial stewardship	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Discussions with doctors about prescribed drugs	4.00	0.00	Important with consensus	4.00	1.00	Analyse
	Pain management	The World Health Organization three-step ladder for pain management	4.00	0.00	Important with consensus	5.00	2.00	Higher order
		Conversion of one analgesic to another (equianalgesia)	4.00	1.00	Important with consensus	3.00	1.00	Apply
		Pharmacological pain management in children	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Pharmacological pain management in individuals with a history of substance abuse	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Pharmacological pain management in the elderly	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Pharmacological pain management in uninsured or poor individuals	4.00	1.00	Important with consensus	4.00	0.00	Analyse
		The treatment of adverse effects related to pain management	4.00	0.00	Important with consensus	4.00	0.00	Analyse
	Patient education	Communication of relevant information of medication to patients, including adherence and concordance	4.00	0.00	Important with consensus	5.00	0.75	Evaluate
		Instructions for the patient regarding use, expected effects, side effects, and procedure for administration of prescribed medications	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Instructions relating to self-administration of prescribed medicine	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Promotion of medicine safety	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
		Documentation of patient/family teaching and verbalisation of understanding of instructions	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
	Special populations	Antiretroviral use in children	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Antiretroviral use in patients who have defaulted	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Antiretroviral use in patients with renal failure prior to or during treatment	4.00	0.00	Important with consensus	4.00	1.00	Analyse

Competency			Importance			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
		Antiretroviral use in patients with tuberculosis	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Antiretroviral use in pregnant patients	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Antiretroviral use in those who failed second-line treatment	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Appropriate use of pain medication while taking consideration of abuse potential	4.00	0.00	Important with consensus	4.00	0.00	Analyse
		Pharmacokinetics and pharmacodynamics of drugs in the elderly	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Special considerations in administration of medications to paediatric and geriatric patients	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Special considerations in administration of medications to pregnant patients	4.00	0.00	Important with consensus	4.50	1.00	Analyse
Pharmacotherapy against diseases competencies	Auditory	Ear disorders	4.00	0.00	Important with consensus	4.00	1.00	Analyse
	Autonomic nervous system	Parasympathetic nervous system disorders	4.00	1.00	Important with consensus	3.00	1.00	Apply
		Sympathetic nervous system disorders	4.00	1.00	Important with consensus	4.00	0.00	Analyse
	Cardiovascular and haematological	Cardiovascular diseases	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Hematopoietic drugs	3.00	1.00	Important with consensus	3.00	1.00	Apply
	Gastrointestinal	Constipation	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Diarrhoea	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Gastro-oesophageal disorder	4.00	0.00	Important with consensus	4.00	0.00	Analyse
		Nausea and vomiting	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Peptic ulcers	4.00	1.00	Important with consensus	4.00	0.50	Analyse
	Hormonal and reproductive	Contraception	4.00	0.00	Important with consensus	4.00	0.25	Analyse
		Endocrine disorders	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Hormone replacement therapy	3.00	1.00	Important with consensus	4.00	0.25	Analyse
		Reproductive disorders	4.00	1.00	Important with consensus	5.00	0.00	Evaluate
	Immunological	Allergies and anaphylaxis	4.00	0.00	Important with consensus	4.00	0.50	Analyse
		Immune reconstitution inflammatory syndrome	3.00	1.50	Important, no consensus	4.00	1.00	Analyse
		Inflammation	4.00	0.00	Important with consensus	4.00	1.00	Analyse
	Metabolic	Diabetes	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Obesity	4.00	1.00	Important with consensus	4.00	1.00	Analyse
	Microbiological and infectious diseases	Anti-helminthic drugs	3.00	1.00	Important with consensus	3.00	1.00	Apply
		Bacterial infections	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		COVID-19	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Fungal infections	4.00	0.00	Important with consensus	4.00	0.25	Analyse
		HIV	4.00	0.00	Important with consensus	3.50	1.00	Apply
		Malaria	4.00	1.00	Important with consensus	4.00	0.25	Analyse
		Tuberculosis	4.00	0.00	Important with consensus	4.00	0.25	Analyse
		Vaccinations	4.00	0.00	Important with consensus	4.00	0.25	Analyse
		Viral infections	4.00	0.00	Important with consensus	5.00	1.50	Higher order
	Miscellaneous	Drugs of abuse	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		High-alert medicine	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Intensive care unit procedures	4.00	1.00	Important with consensus	3.00	1.00	Apply
		Intravenous fluids	4.00	1.00	Important with consensus	4.00	0.50	Analyse
		Marijuana-containing therapies	3.00	1.00	Important with consensus	3.50	1.50	Lower order
		Overdose and poisonings	4.00	0.00	Important with consensus	5.00	0.00	Evaluate
		Resuscitation medicine	4.00	0.00	Important with consensus	4.00	1.00	Analyse
	Musculoskeletal	Anaesthesia	3.00	2.00	Important, no consensus	4.00	0.00	Analyse
		Muscle relaxation	4.00	1.00	Important with consensus	4.00	0.25	Analyse
		Musculoskeletal disorders	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Osteoporosis	4.00	1.00	Important with consensus	3.00	1.00	Apply

Competency			Importance			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
	Neurological	Anxiety	4.00	1.00	Important with consensus	4.00	1.00	Analyse
		Depression	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Epilepsy	4.00	0.00	Important with consensus	4.00	0.50	Analyse
		Hypnosis	2.00	1.00	Not important with consensus	N/A.	N/A.	N/A.
		Parkinson's disease	3.00	1.00	Important with consensus	4.00	1.00	Analyse
		Schizophrenia	4.00	1.00	Important with consensus	4.00	0.25	Analyse
		Sedation	4.00	1.00	Important with consensus	4.00	0.50	Analyse
	Pain	Pain	4.00	0.00	Important with consensus	3.50	1.00	Apply
	Oncology	Neoplasia	3.00	2.00	Important, no consensus	4.00	0.25	Analyse
	Ophthalmic	Eye disorders	4.00	0.00	Important with consensus	4.00	1.00	Analyse
	Renal	Urological disorders	4.00	1.00	Important with consensus	5.00	0.00	Evaluate
	Respiratory	Asthma	4.00	0.00	Important with consensus	4.00	1.00	Analyse
		Respiratory disorders	4.00	0.00	Important with consensus	4.00	0.00	Analyse
	Topical and wounds	Burns	4.00	1.00	Important with consensus	4.50	1.00	Analyse
		Dermatological diseases	4.00	0.00	Important with consensus	5.00	1.00	Evaluate
Generic competencies	Accountability and responsibility		4.00	0.00	Important with consensus			
	Adaptability		4.00	0.00	Important with consensus			
	Collaboration and interdisciplinary teamwork		4.00	0.00	Important with consensus			
	Communication		4.00	0.00	Important with consensus			
	Creativity		3.00	1.00	Important with consensus			
	Critical thinking		4.00	0.00	Important with consensus			
	Information and communication technology literacy		4.00	1.00	Important with consensus			
	Innovation		4.00	1.00	Important with consensus			
	Leadership		4.00	0.00	Important with consensus			
	Media literacy		3.00	1.00	Important with consensus			
	Problem-solving		4.00	0.00	Important with consensus			
	Productivity		4.00	0.00	Important with consensus			
	Self-directedness		4.00	0.00	Important with consensus			
	Social and cultural interaction		4.00	0.00	Important with consensus			

ABBREVIATIONS: IQR – INTERQUARTILE RANGE; N/A – NOT APPLICABLE DUE TO INDICATION OF LACK OF IMPORTANCE

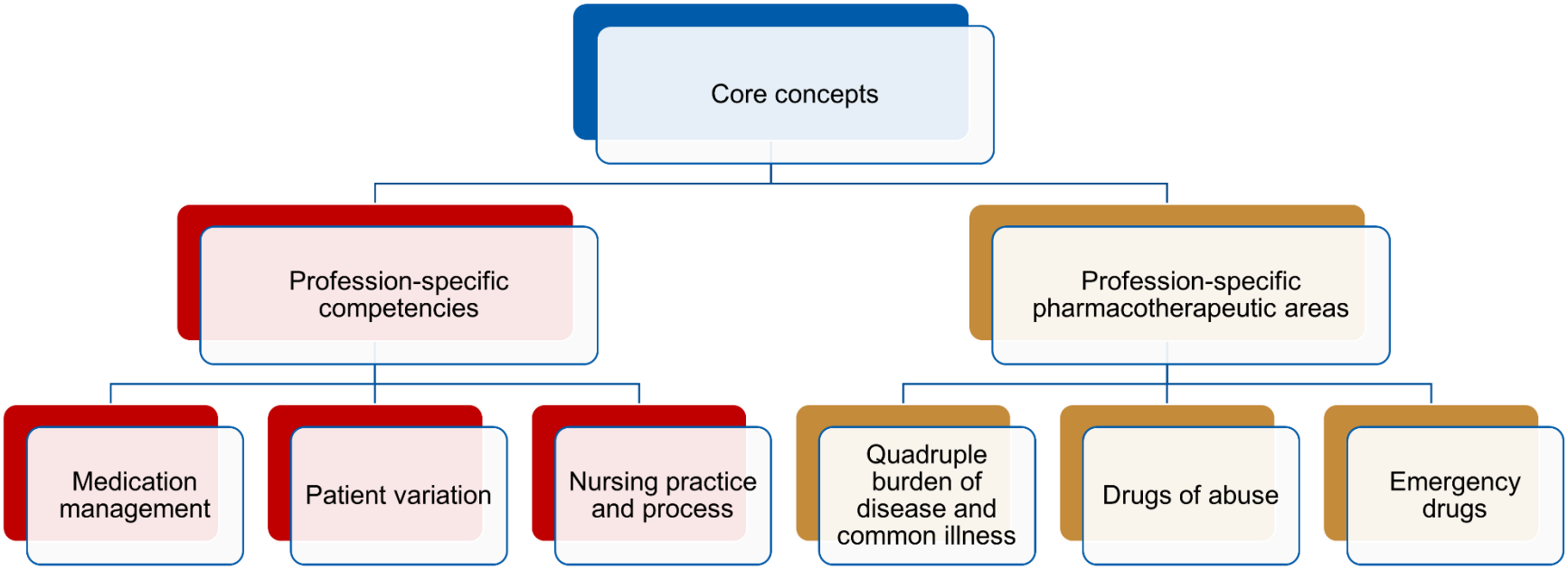

FIGURE 4.2: SUMMARISED VISUAL REPRESENTATION OF THE SUGGESTED PHARMACOLOGICAL COMPETENCY FRAMEWORK FOR NURSES, INDICATING THE NECESSITY OF CORE CONCEPTS, AND THEIR BASIS FOR PROFESSION-SPECIFIC PHARMACOLOGICAL AND PHARMACOTHERAPEUTIC COMPETENCY DEVELOPMENT

TABLE 4.10: SUGGESTED FRAMEWORK FOR PHARMACOLOGY CURRICULUM DESIGN OF NURSING PROGRAMMES DETAILING THE LEARNING OUTCOME (END-GOAL OF THE MODULE THAT THE STUDENT SHOULD ACHIEVE) AND ASSESSMENT CRITERIA (THE WAY IN WHICH ACHIEVEMENT OF THE LEARNING OUTCOME WILL BE DETERMINED)

At the end of the curriculum, students must be able to …	Assessment criteria
… understand the core concepts of biopharmaceutics, pharmacokinetics, pharmacodynamics and pharmacogenetics	Describe biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)
	Explain the role of pharmacology in disease treatment
	Discuss the sources of drugs
	Describe common pharmacological concepts
	Appraise common formulations used in clinical settings
	Discuss sustained release formulations of medicines
	Appraise common routes of administration used in clinical settings
	Explain the principles of polypharmacy
	Explain the principles of pharmacokinetics (the movement of drug into, through, and out of the body)
	Explain absorption, distribution, metabolism and excretion as principles of pharmacokinetics
	Principles of pharmacodynamics (the response of the body to the drug)
	*Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)
	The modulation of drug targets to alter (patho)physiological responses
	Relate factors that alter the response to pharmacotherapy to the clinical outcome
	Evaluate the effects of inter-individual variability on drug response
	Determine the impact of ethnicity or population differences on drug response
	Describe the need for pharmacogenetics testing (where pharmacogenetics is the effect genetic factors has on drug reactions)
	Determine the response to treatment in patients with or without pharmacogenetic markers
	Determine the impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics
	Evaluate pharmacogenetics information on drug labels
	Describe the limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training
	Evaluate the detection of drug interactions
	Determine the effect of pharmacodynamic and pharmacokinetic drug interactions
… manage medication according to the nursing process	Determine the appropriateness of drug management guidelines
	Detect medicine management problems
	Evaluate the appropriateness of storage of medicines
	Document medicine storage
	Dispose medications in accordance with employer's policies and government regulations
	Evaluate the transcription of medicine orders
	Verify the accuracy of medical orders
	Evaluate medication orders for possible revision or discontinuation
	Evaluate the need for 'as needed' medicine
	Determine the patient's use of home remedies and over-the-counter drugs
	Assess drug and dose reasonableness
	Calculate relevant administration doses
	Evaluate paediatric dosing
	Prepare medicines using arithmetic of dosages and solutions
	Defend the five rights of medicine administration
	Defend the orientation of "do no harm" in relation to drug administration
	Document medicine administration
	Evaluate nursing considerations relating to administration of drugs
	Evaluate the responsibilities and limitations of the practical nurse in the administration of medicine
	Assess current drug therapy, including benefits and risk
	Manage medicine in different patient groups
	Discuss the legal aspects of drug control and administration
	Discuss medications which are controlled substances
	Discuss the procedure for accounting for controlled substances following facility policy
	Implement the nursing process as related to pharmacotherapy
	Use of data from symptom assessment to plan
	Evaluate the impact of traditional, complementary, and technological therapies on patient-centred outcomes
	Discuss the intervention in symptom management using state-of-the-art traditional and complementary approaches
	Apply nursing therapeutics that supports current clinical pharmacological concepts and safe practice in patient care
	Manage patients who are on multiple treatments and/or suffer from multiple conditions
	Evaluate medication, pharmacokinetics and pharmacodynamic principles within patients' settings
	Assess patients before medication administration
	Use various routes of administration
	Report and record the medication administered and the patient response
	Report and record drug errors and prescription errors that are encountered
	Monitor drug effects
	Monitor blood levels of medicines
	Evaluate drug-induced harm and hospital admissions
	Recognise adverse drug reactions and their impact on individual patients

At the end of the curriculum, students must be able to …	Assessment criteria
	Apply pharmacotherapeutic interventions for relatively simple cases of adverse drug reactions
	Evaluate the treatment of antiretroviral-induced rashes and hepatitis
	Manage Steven-Johnson syndrome
	Defend the responsibility of reporting of adverse drug reactions
	Report adverse events
	Discuss antimicrobial stewardship
	Discuss prescribed drugs with doctors
	Discuss the World Health Organization three-step ladder for pain management
	Convert one analgesic to another (equianalgesia)
	Evaluate pharmacological pain management in children, individuals with a history of substance abuse, the elderly, and uninsured or poor individuals
	Evaluate the treatment of adverse effects related to pain management
	Evaluate antiretroviral use in children, patients who have defaulted, patients with renal failure prior to or during treatment, patients with tuberculosis, pregnant patients, and those who failed second-line treatment
	Defend the appropriate use of pain medication while taking consideration of abuse potential
	Interpret pharmacokinetics and pharmacodynamics of drugs in the elderly
	Consider special considerations in administration of medications to paediatric and geriatric patients, and pregnant patients
…educate patients on treatment	Communicate relevant information of medication to patients, including adherence and concordance
	Instruct the patient regarding use, expected effects, side effects, and procedure for administration or self-administration of prescribed medications
	Promote medicine safety
	Document patient/family teaching and verbalisation of understanding of instructions
… apply pharmacological principles of pharmacology and evidence-based practice in dietetics	Discuss prescribing of pharmacotherapy to nursing practice
	Evaluate computer support for medicine review
	Find reliable information from major drug sources, publications or websites to obtain medicine information evidence-based practice guidelines
	Interpret pre-clinical and clinical pharmacological data
	Relate pharmacological research to clinical outcomes
	Simplify the discussion of misconceptions of pharmacotherapy with patients
	Relate the use of medicine for [pharmacotherapeutic area below] to nursing practice
	• Allergies and anaphylaxis
	• Anaesthesia
	• Anxiety
	• Asthma and other respiratory disorders
	• Bacterial infections
	• Burns
	• Cardiovascular diseases
	• Constipation and diarrhoea
	• Contraception
	• COVID-19
	• Depression
	• Dermatological diseases
	• Diabetes
	• Drugs of abuse
	• Ear disorders
	• Endocrine disorders
	• Epilepsy
	• Eye disorders
	• Fungal infections
	• Gastro-oesophageal reflux disorder
	• High-alert medicine
	• Hormone replacement therapy
	• Immune reconstitution inflammatory syndrome
	• Inflammation
	• Intravenous fluids
	• Malaria
	• Muscle relaxation
	• Musculoskeletal disorders
	• Nausea and vomiting
	• Neoplasia
	• Obesity
	• Overdose and poisonings
	• Parasympathetic and sympathetic nervous system disorders
	• Parkinson's disease
	• Peptic ulcers
	• Reproductive disorders
	• Resuscitation medicine
	• Schizophrenia
	• Sedation
	• Tuberculosis
	• Urological disorders
	• Vaccinations

At the end of the curriculum, students must be able to …	Assessment criteria
	• Viral infections
	Discuss the use of medicine for [pharmacotherapeutic area below] to nursing practice
	(i) Anti-helminthic drugs
	• Hematopoietic drugs
	(ii) HIV
	• Intensive care unit procedures
	• Marijuana-containing therapies
	• Osteoporosis
	• Pain

3.2. Targeted needs assessment

The results of the targeted needs assessment are first presented as the curriculum mapping to both the current and proposed pharmacology curricula that helped inform the focus group interviews with the Department of Nursing Sciences.

3.2.1. Alignment with the current pharmacology curriculum

All available learning outcomes and assessment criteria from study guides from the Bachelor of Nursing Science programme that could be sourced were matched with those of the FAR 381 and FAR 382 modules. Links were assessed before, during and/or after Pharmacology in Year III to determine whether there was continuous scaffolding available, or any relation to modules of great interest. The latter included Physiology (Years I and II), Nursing Studies (Years I to IV), and Nursing Practice Education (Years II to IV) due to its importance in creating an appropriate biomedical scaffold for pharmacology education and relation to the profession's clinical practice and exit level outcomes, respectively.

Where possible, quotations were taken from the publicly available module content of the programme (University of Pretoria, 2024c); however, direct statements relating to learning outcomes and assessment criteria of the individual study guides are not possible given intellectual property and its jurisdiction outside of the Department of Pharmacology. As a broad finding, module content within the programme yearbook tended to vary in explicit discussion of what each module focuses on that tends to create ambiguity of what exactly may be covered during learning opportunities. Broad concepts related to systems physiology, nursing practice, midwifery and other disciplines were described, but without enough depth to create an explicit perspective of the breadth. The learning outcomes and assessment criteria in individual study guides varied in terms of explicit description, but did provide a broad structured view of the competencies expected. The core disciplines, particularly, provided a systematic approach to managing the patient, ranging from the disease definition, aetiology, assessment findings, medical history and nursing care plans. Some provided explicit statements of what is expected of the student, while others spoke more to generalised concepts without a pertinent expectation linked to, for example, Bloom's taxonomy. Midwifery study guides could not be obtained during the data collection phase, nor the Year II Nursing Practice Education study guides, and thus have only been associated in terms of their module content descriptions in the yearbook. The yearbook's description of the Midwifery module was not explicit in terms of where pharmacology may feature (University of Pretoria, 2024c), but it is inferred that the pharmacological care during such procedures would be necessitated.

The assessment of the alignment with the current curriculum does not suggest maintaining the programme as such, but rather sought to understand the current strengths and challenges

within the curriculum to inform and support the focus group, and provide clarity on larger changes that may be needed to support the proposed pharmacology curriculum.

4.2.1.1. Mapping of FAR 381

Of the 232 assessment criteria, 161 (69.4%) were linked to at least one learning outcome in the Bachelor of Nursing Science programme (Table 4.11). The majority of these (64.66%) had linkages to Years I and II prior to engaging with pharmacology. Only 3.45% of learning outcomes linked to modules with continuous exposure before and during Year III. Only one link (0.43%) each was made during Year III, after Year III, and before and after Year III, while no matches were present during and after Year III, or throughout the entire course. Physiology modules had 43.10% and 26.72% linkage in Years I and II, respectively. Nursing Studies modules had matches in Years I (0.86%), II (17.67%), III (3.88%) and IV (0.43%), while the Nursing Practice Education module only had a link in Year IV (0.43%).

TABLE 4.11: THE NUMBER OF ASSESSMENT CRITERIA IN FAR 381, FAR 382 AND THE PROPOSED PHARMACOLOGY CURRICULUM, AND THE LINK THEY HAVE TO OTHER MODULES (WITH AVAILABLE OR RELEVANT MODULE GUIDES) LEARNING OUTCOMES, INCLUDING THOSE OF PHYSIOLOGY AND THE AVAILABLE CORE DISCIPLINES (NURSING STUDIES AND NURSING PRACTICE EDUCATION). NEWLY ADDED ASSESMENT CRITERIA REFER TO THOSE THAT HAVE BEEN INCLUDED BY THE DELPHI STUDY IN THE NEW CURRICULUM RELATIVE TO THE CURRENT CURRICULA

Linkage of assessment criteria	FAR 381 232 assessment criteria n (%)	FAR 382 168 assessment criteria n (%)	Proposed curriculum 139 assessment criteria n (%)
Pharmacology-related assessment criteria	213 (91.81%)	128 (45.83%)	139 (100%)
Physiology-related assessment criteria	19 (8.19%)	40 (23.81%)	0 (0.00%)
Newly added assessment criteria	N/A	N/A	95 (0.68%)
Assessment criteria linked to another module's learning outcome	161 (69.40%)	89 (52.98%)	120 (86.33%)
Assessment criteria linked to a module(s) prior to Year III	150 (64.66%)	64 (38.10%)	61 (43.88%)
Assessment criteria linked to modules prior to and during Year III	8 (3.45%)	15 (8.93%)	30 (21.58%)
Assessment criteria linked to module(s) during Year III	1 (0.43%)	9 (5.36%)	23 (16.55%)
Assessment criteria linked to module(s) after Year III	1 (0.43%)	1 (0.60%)	1 (0.72%)
Assessment criteria linked to modules before and after Year III	1 (0.43%)	0 (0.00%)	1 (0.72%)
Assessment criteria linked to modules during and after Year III	0 (0.00%)	0 (0.00%)	1 (0.72%)
Assessment criteria linked to modules through Years I to IV	0 (0.00%)	1 (0.60%)	3 (2.16%)
Assessment criteria linked to Year I Physiology	100 (43.10%)	18 (10.71%)	20 (14.39%)
Assessment criteria linked to Year II Physiology	62 (26.72%)	19 (11.31%)	16 (11.51%)
Assessment criteria linked to Year I Nursing Studies	2 (0.86%)	0 (0.00%)	51 (36.69%)
Assessment criteria linked to Year II Nursing Studies	41 (17.67%)	9 (5.36%)	20 (14.39%)
Assessment criteria linked to Year III Nursing Studies	9 (3.88%)	11 (6.55%)	16 (11.51%)
Assessment criteria linked to Year IV Nursing Studies	1 (0.43%)	2 (1.19%)	6 (4.32%)

Linkage of assessment criteria	FAR 381 232 assessment criteria n (%)	FAR 382 168 assessment criteria n (%)	Proposed curriculum 139 assessment criteria n (%)
Assessment criteria linked to Year III Nursing Practice Education	0 (0.00%)	11 (6.55%)	14 (10.07%)
Assessment criteria linked to Year IV Nursing Practice Education	1 (0.43%)	0 (0.00%)	3 (2.16%)

Nursing Science students share certain modules of interest with the Dietetics students, including Physiology modules. They are also enrolled for some modules not taken by the Dietetics students, including Anatomy, Medical Terminology, Medical Microbiology, Psychology and their unique core disciplines. They do, however, lack Molecular and Cell Biology, Biochemistry and Chemistry modules that were indicated as important for various pharmacological competencies as scaffolds. This already highlights the existing knowledge differential that will be present between the groups of students, and thus creates a further inequality in the expectations of the understanding with which they enter the Pharmacology modules.

Students are enrolled for the Year I Medical Terminology module that provides them with a functional etymological background of the language used in the healthcare sector: The manner in which the meanings of medical terms can be determined by analysing the terms into their recognisable meaningful constituent parts, is taught and exercised. The functional use of medical terms in context as practical outcome of terminological application is continually attended to (University of Pretoria, 2024c, p. 10).

Anatomy is presented through Year I as four semester modules, preparing them for the broad anatomical regions (limbs, torso, head and neck), as well as osteology, embryology and histology (University of Pretoria, 2024c). Although focused on the anatomical principles, and thus lacking the physiological pathways that pharmacology would target, such a background would benefit students' understanding of the placement, structure, blood supply and innervation of systems.

For physiology, a systems-based approach is used across four quarter modules spread over the first two years of study as explained in Chapter 3, Section 3.2.1.1. These modules cover predominantly normal physiological processes of the central nervous, cardiovascular, haematological, immunological, muscular, renal and respiratory system at various stages in the two years. The core concepts of pharmacology that build from systems-based physiological processes provide a basis for learning, and thus there is a variable background provided for elements of pharmacokinetics (for example, absorption, distribution, metabolism and excretion): Body fluids (University of Pretoria, 2024c, p. 9), Structure, gas exchange and secretory functions of the lungs; structure, excretory and non-urinary functions of the kidneys, acid-base balance (University of Pretoria, 2024c, p. 14) and metabolism (University of Pretoria, 2024c, p. 14). There is a lack of topics that would be more attributed to Molecular and Cell Biology, Biochemistry and Chemistry modules, which would inherently cover important factors relating to pharmacokinetics, such as distribution, metabolism and excretion.

As with the Dietetic students, the autonomic nervous system breadth of coverage is unclear for the Year I third-quarter Physiology module covering neurophysiology (University of

Pretoria, 2024c). However, the Year I Psychology module in their second year, second semester addresses the key concepts and terminology related to the biological subsystem, the rules and principles guiding biological psychology, and identification of the interrelatedness of different biological systems and subsystems (University of Pretoria, 2024c, p. 16). Within this module, linkages with the central and peripheral nervous system, with discussion of the physiological principles of neurons, neurotransmitters, endocrine systems, functional areas of the brain and pain pathways were noted in the study guides' assessment criteria. It is interesting to note an assessment criterion for the Psychology module speaks to drug effects, mechanisms of drug action, drug-induced dependence, and the effect of drugs on health. Given the breadth of this criterion, it is unclear what is explicitly being discussed, and whether sufficient background will be available to clarify these concepts to students without a pharmacological discipline view thereof.

Many of the physiological and pathophysiological pathways are addressed between Physiology (Years I and II) and Nursing Studies modules (Years II and III), with the Nursing Studies module in Year IV providing additional clinical context for it though falling outside of the scaffolding for pharmacological competency development. For example, the Nursing Studies module in the first semester of Year II discusses Nursing skills in medical and surgical nursing care, including basic resuscitation, suctioning and medication administration, skills related to medical and palliative nursing care, and skills related to pre- and post-operative nursing care (University of Pretoria, 2024c, p. 17). Between Physiology and Nursing Studies modules, physiology and pathophysiology of the inflammatory and nociceptive pathways are discussed that would support pharmacotherapy for cellular and tissue damage, though the explicit inclusion of elements such as cyclooxygenase enzymes and opioid receptors was not made. The Nursing Studies module presents further insights into immunological disorders, post-operative nursing care, cancer, and haematological diseases according to the module's learning outcomes. It is interesting to note that within the module pharmacological interventions are discussed in reference to demonstrating adequate knowledge thereof.

The physiology of cardiovascular, haematological and metabolic systems provides a basis for understanding the healthy individual, which is bolstered by Nursing Studies modules' discussions of fluid-, cardiovascular-, reproductive- and endocrine-related diseases as per their learning outcomes. Content for the Nursing Studies module in Year II (homeostasis, immunology, haematology [University of Pretoria, 2024c, p. 18] and communicable and non-communicable conditions of the respiratory-, cardiovascular-, neurological-, musculoskeletal- and gastrointestinal systems [sic] [University of Pretoria, 2024c, p. 18]) and Year III (communicable and non-communicable conditions of the renal-, endocrine-, reproductive-, and integumentary systems and special senses (eyes and ears)) (University of Pretoria, 2024c, p. 23) support the theoretical scaffolding needed for pharmacological competency development. Practical elements for cardiovascular- and contraceptive-related nursing skills are dealt with in Nursing Practice Education module in Year II (Nursing skills related to care of patients with conditions of the respiratory-, cardiovascular-, neurological-, musculoskeletal- and gastrointestinal systems [sic] [University of Pretoria, 2024c, p. 18]) and Year III (Nursing skills related care of patients with conditions of the renal-, endocrine-, reproductive-, and integumentary systems and special senses (eyes and ears) [sic] [University of Pretoria, 2024c, p. 23]). Within Year IV, haemodynamic status is covered theoretically and practically in Nursing Studies and Nursing Practice Education modules, respectively (University of Pretoria, 2024c) that may be seen as an end-outcome for much of the cardiovascular-related

pharmacotherapy taught. Given the emergency status of many aspects related to the cardiovascular and haematological system, Nursing Studies (medical emergencies, surgical emergencies and shock [University of Pretoria, 2024c, p. 27]) and Nursing Practice Education modules (medical emergencies, management of surgical emergencies [University of Pretoria, 2024c, p. 26]) in the fourth year deal with heart attacks and bleeding.

The Year I Nursing Studies module introduces students to various routes of administration and formulations under their appraisal of safe medication management, as indicated in the applicable learning outcome, and is further supported by the module content of the inclusion of the nursing process, therapeutic environment and daily living activities and principles of medication management (University of Pretoria, 2024c).

4.2.1.2. Mapping of FAR 382

Eighty-nine assessment criteria (52.98%) were linked to FAR 382 (Table 4.11). Linkage to modules prior to Year III (38.10%), prior to and during Year III (8.93%) and during Year III (5.36%) was low. Only one assessment criterion (0.60%) was linked to Year IV modules, one assessment criterion (0.60%) throughout all four years, and no other year-combination linkage was identified. Year I and Year II Physiology had 10.71% and 11.31% linkage. Nursing Study modules had a low linkage of 5.36%, 6.55% and 0.60% in Years II, III and IV respectively. The Nursing Practice Education modules had linkage only in the third year with 6.55%.

Physiology modules provided limited scaffolding based on no explicit description for allergies, adrenocorticosteroid-based treatments, and Parkinson's disease that also appear to have no pathophysiological discussion in other modules. The Physiology module does discuss neurological, respiratory, and gastrointestinal aspects. Explicit description of the breadth of neurophysiology is lacking though, and thus clear relation to scaffolding needed for certain neurological disorders is unclear. The Nursing Studies module does discuss pathological aspects related to gastrointestinal, neurological (i.e., mania, depression and schizophrenia), and respiratory disorders, with nursing skills related to gastrointestinal disorders and mental health presented in Nursing Practice Education modules (University of Pretoria, 2024c). In support of psychiatric-related conditions, specifically anxiety, depression and schizophrenia, the Year I, second-semester Psychology module's learning outcomes speak to pathophysiological elements of the diseases and also appear to assess drug-related effects.

The Bachelor of Nursing Science group is enrolled for three second-year Medical Microbiology modules that run a quarter of the semester each, and covers Bacterial cells and the classification of disease-causing bacteria, Commonly occurring bacterial infections and the bacteria that cause them, and Fungi, parasitology and virology (University of Pretoria, 2024c, p. 15). In doing so, linkage to antimicrobial-related pharmacotherapy such as antibacterial, antifungal, antiviral and anti-malarial drugs is possible.

3.2.2. Alignment with the proposed pharmacology curriculum

To ensure no duplication of physiology education was built into the proposed pharmacology curriculum, all physiology-related assessment criteria were removed.

Of the 139 assessment criteria, 95 (68.35%) were newly introduced (Table 4.11). One hundred and twenty assessment criteria (86.33%) were linked to modules within the Bachelor of Nursing Science programme, which is increased from both FAR 381 and FAR 382 modules. The number of assessment criteria prior to Year III (43.88%) decreased, while those prior and during Year III (21.58%), and only during Year III (16.55%) increased. Assessment criteria were linked after Year III (0.72%), before and after Year III (0.72%), during and after Year III (0.72%), and throughout the full programme (2.16%). Physiology linkages were decreased in FAR 381, but remained relatively similar for FAR 382 in Years I (14.39%) and II (11.51%). Assessment criteria linkage in Years I (36.69%), II (14.39%, III (11.51%) and IV (4.32%) of Nursing Studies were observed, as well as Nursing Practice Education in Years III (10.07%) and IV (2.16%).

Newly proposed competencies related to drug-drug interactions and inter-individual variability (for example, based on genetic, population or ethnic variation) are not explicitly covered in any modules; however, some overlap of unique patient considerations is present within the first year, second-semester Nursing Studies module (health promotion in the hospital setting with inclusion of the nursing process, therapeutic environment and daily living activities and principles of medication management [University of Pretoria, 2024c, p. 13]) as part of the nursing process assessment criteria. Furthermore, the module content for Year III, first-semester Midwifery theoretical and practical module content suggests coverage of genetic counselling (University of Pretoria, 2024c, p. 21) that would allow for integration with the proposal for interpreting pharmacogenetic information of medicine's labels. The evaluation of the impact of traditional, complementary, and technological therapies on patient-centred outcomes are possibly touched on during the nursing process as well, given the evaluation of patient factors; however, no explicit mention of this in the learning outcomes or assessment criteria is present and thus may be deficient. Discussion of traditional therapies could also include the suggested pharmaco-therapeutic inclusion of marijuana, but at a lower cognitive level as recommended. Such unique patient factors invariably fit into the assessment phase of the nursing process to ensure all factors are considered in the nursing diagnosis (Comerford & Durkin, 2024).

All newly proposed competencies related to medication management and patient education are encapsulated within the nursing process. Discussion of, among others, drug management guidelines, medication storage, documentation processes, the rights of medication administration, posology, pharmacovigilance and patient education are covered during the Year I, second-semester Nursing Studies module (health promotion in the hospital setting with inclusion of the nursing process, therapeutic environment and daily living activities and principles of medication management [University of Pretoria, 2024c, p. 13]) with explicit description under their learning outcomes for the nursing process and appraisal of safe medication management learning outcomes. Additionally, the Year I, second-semester Nursing Practice Education module focuses on the Application of promotion of wellness in the hospital setting: record keeping, comprehensive assessment and basic care in the hospital setting (University of Pretoria, 2024c, p. 12) that should provide practical exposure to medication documentation and assessment principles. Legal aspects related to medication management, for example control of scheduled items and facility policies, would likely be touched on in Integrated Healthcare Leadership modules in Years I (introduction to ethical legal practice and an introduction to concepts of quality nursing, Healthcare systems and

legislation [University of Pretoria, 2024c, p. 12]) and III (ethical-legal framework governing and disciplinary hearings at SANC [University of Pretoria, 2024c, p. 20]).

Relating to specific areas within physiology, several of the newly suggested pharmacotherapeutic areas do not have an explicitly stated scaffolding to support discussion of pharmacotherapy, including burns, drugs of abuse, overdoses, poisonings, and worm infestations. This is inclusive of those areas of potential deficiency for scaffolding remarked in Sections 4.2.1.1 and 4.2.1.2.

New competencies related to the dermatological conditions, eye and ear conditions, hormone replacement therapy, intravenous fluids, inflammatory syndromes, urological disorders, osteoporosis and haematopoietic drugs are likely to have a basic physiological underpinning based on Year I (neurophysiology [University of Pretoria, 2024c, p. 9], Body fluids; haematology; cardiovascular physiology, lymphatic system, and body defence mechanisms [University of Pretoria, 2024c, p. 9]) and Year II Physiology modules (skin and body temperature control, hormonal control of body functions, and the reproductive systems University of Pretoria, 2024c, p. 14]). Furthermore, these physiological underpinnings are supported by broad description of the concepts within learning outcomes and assessment criteria. Some of the pathophysiological aspects and clinical nursing relevance of these conditions are covered to various degrees within Year II (immunology, haematology, neurological-, musculoskeletal- [University of Pretoria, 2024c, p. 18]) and Year III Nursing Studies modules (renal-, endocrine-, reproductive-, and integumentary systems and special senses (eyes and ears) [University of Pretoria, 2024c, p. 22]), with practical nursing skills introduced in Year III Nursing Practice Education module (renal-, endocrine-, reproductive-, and integumentary systems and special senses (eyes and ears) [University of Pretoria, 2024c, p. 22]). Within Year II, first-semester Nursing Studies module, cancer is discussed under medical, palliative and surgical nursing care (University of Pretoria, 2024c, p. 17), and is supported from a pathophysiological and clinical relevance point of view as indicated in their learning outcomes. As with many of the areas covered by the Nursing Studies modules, assessment criteria expect students to demonstrate adequate understanding of pharmacological therapies, but this would be scaffolded incorrectly given the placement of the module in the second year.

Medication relevant to resuscitation and intensive care unit (ICU) procedures would scaffold from the second year (basic resuscitation [University of Pretoria, 2024c, p. 17]) to the fourth year in the Nursing Practice Education modules (inclusion of resuscitation and management of haemodynamic status, management of medical emergencies, management of surgical emergencies [University of Pretoria, 2024c, p. 17]). Physiological scaffolds for this would be covered by broad discussions of, among others, the cardiovascular, haematological and neurological systems. Vaccine discussions that would be possible given the underpinning of immunology provided by physiology, would scaffold to Midwifery modules in Year IV speaking to immunisation principles (University of Pretoria, 2024c).

3.2.3. Focus group interview

Three core questions were asked to all participants to ascertain their opinions on i) whether students developed pharmacological competencies, ii) whether their physiological knowledge was sufficient to develop pharmacological competencies, and iii) the alignment of the new

proposed curriculum with their graduate needs. Direct quotations are provided verbatim with limited cleanup via the use of brackets to reinforce readability, but not in such a way to alter their meaning. Furthermore, quotations are prefaced with the following abbreviations in Table 4.12 to indicate the participant role alluded to within their feedback.

TABLE 4.12: ABBREVIATIONS USED TO DELINEATE PARTICIPANT ROLES. ROLES ARE DELINEATED BY PARTICIPANT FEEDBACK, AND THUS MAY NOT BE INCLUSIVE OF ALL THEIR ROLES WITHIN THE BACHELOR OF NURSING SCIENCE

Theme	Description
P #	Participant number
CC	Course coordination
CL	Clinical lecturer
IHL	Involvement in Integrated Healthcare Leadership
L	Lecturer
MS	Involvement in Medical Surgery
MW	Involvement in Midwifery

The focus group was attended by six members of the Department of Nursing Science who have experience throughout all four years of the nursing group, have a range of responsibilities through both the theoretical and practical portions of the course, and have historical understanding of the programme. All participants have clinical experience in different areas of practice, including general nursing, medical surgery, ward management and midwifery, and at different course levels and responsibilities (i.e., clinical educators, course coordinators, lecturing years I, II and/or IV).

Three themes were evident from their feedback: insufficient competency development, perceived barriers to competency development, and perceived facilitators of competency development (Table 4.13).

TABLE 4.13: THEMES THAT DEVELOPED DURING THE NURSING FOCUS GROUP INTERVIEW

Theme	Sub-themes
Insufficient competency development	Deficient, isolated or decontextualised competencies
	Evident theory-practice gap
Perceived barriers to competency development	Poor perception of pharmacology
	Inadequate basic sciences understanding
	Lack of integration and contextualisation
	The nursing profession's effect hindering of competency development
Perceived facilitators of competency development	Earlier exposure to pharmacology
	Integration and clinical contextualisation

3.2.3.1. Development of pharmacological competencies

Participants were asked whether they believed that the students were developing the pharmacological competencies necessary for nurses. Participants, in general, believed that students were developing their pharmacological competencies, and had the potential to do so, but deficiencies were present. Reference was made to the historical difficulties students faced in Pharmacology, where pass rates in FAR 381 and FAR 382 initially increased but tended to fluctuate between their groups.

[P1; CC; IHL; L] "I cannot say that they do or they do not […]. Because the students, there was a time [*provision of identifying information*], where our students yesterday failed [*pharmacology*] like big time. And then one last something happened. But you

know what happened? We started to talk. Pharms Department and Nursing Department starts to talk to one another. […] Because now we also took responsibility to make sure that the students attended tutorials, the students are on time, you know, but also now again you see this thing that the students are failing and failing. They do not attend tutorials. So, I think if we can, competencies is there, the skills is there, but I think it is something bigger than only competencies and skills they get […] they reach it to be in their third year here at the University of Pretoria […] these students or learner can do it, they can attain them."

[P6; L; MW] "Because I was also really concerned that how, why, why is it that failing from pharmacology"

Although competency development was seen at times, concerns were raised that these were developed in isolation. Students lacked the ability to see the context within their clinical environments, thus reinforcing a silo-approach to their learning and understanding of the pharmacotherapy. This further reiterated that some knowledge of pharmacology was not being attained, which impacted other modules' abilities to contextualise pharmacotherapy within their clinical profession, and might impact their compliance during accreditation reviews. One participant was emphatic that students were not capable of linking their knowledge to practice, highlighting the theory-practice gap in their nursing profession. This extended beyond their higher institution education, but also what was not being retained or scaffolded from basic education. Another participant highlighted potential contradictions that arose between pharmacology and their nursing-specific sessions.

[P2; CL; MS] "Another important thing that needs to be which [*repeating words*] worries me more than everything is correlation of theory to practice. Yeah, it's like when the student passed matric. That knowledge of matric is packed in a box somewhere and then it's put away. So when they come, when they come to [*repeating words*] the profession, to the university, its [*repeating words*] like they starting afresh. […] You'll find that they have chartered a temperature, but they cannot graph it on the graph. Then I'm asking them why did you do the number line at school? Its why can't you remember the number line? […] its correlation of theory to practice […] Why did you do grade R and to grade 12. You're building [*repeating words*] on top of it and then you […] you must use it. […] In the pharmacology class, you need to [*repeating words*] drop in this information from the classroom. It's you when you teach pharmacology. There are those milligrams that are talking about. There are those millimetres that are talking about […] Drop them in in pharmacology, so that they know that from school."

[P4; L] "Because I see the issue here is [*repeating words*] teaching the basics, but in pharmacology […] don't think you get time like you talk about this […] where you give a profile of a patient. You don't go with the patient […] to the clinical thing. […] they cannot link it because they're doing it in the class and […] there is no linkage. There is no integration. So they see themselves as in a class."

[P4; L] […] for instance, the role of the nurse in preparing for an emergency trolley. The role of the nurse managing the storeroom for medications. The role of the nurse in terms of relationship between a ward pharmacist who is visiting […]. So those things I think they are very crucial because when the Office of Healthcare Standard Compliance comes, they expect the nurse to understand which medications are relevant for the top shelf of the emergency trolley and those things. If they're not emphasised in their training, they are found wanting. […] let it be pitched, but let it be contextualised to the ward situation.

[P5; L; MW] "I find that it's almost like they know nothing, and I have to teach them from scratch; like they have not been in your class. Let me give you an example. They cannot differentiate between your types of insulin you get, whether it's short or long-working; the different types of antihypertensives. It's almost like they're thinking in silos; they don't think in systems."

[P6; L; MW] […] there was a time where I was taking them for HIV. You know, this is the first line regimen that we give then. They said no pharmacology said there is efavirenz. And I'm like, no, we have removed efavirenz from our first line because it has been seen to have psychotic effects, you know, on the woman."

[P6; L; MW] "Because even the same way I ask them about antihypertensives; they don't know like antihypertensives."

Various barriers were noted as to why such development could be impacted. Participants remarked that students lacked clinical contextualisation of pharmacology, which debilitated their ability to understand pharmacotherapy within the real-world environment. This reinforced an isolated view of medicine, and made them incapable of working within their clinical environment effectively. Students were not capable of addressing their direct duties within the environment as they lacked understanding of medication within an authentic context. The focus on the basic sciences' elements of pharmacology became a challenge as students lost perspective or valuation of it within their profession. One participant remarked that this was like their pharmacology education in their undergraduate programme, which may reflect the generic basis of pharmacology teaching.

[P6; L; MW] "You know, neurotransmitters for example, when they come to [*repeating words*] nursing then they are unable to [*repeating words*] link whatever they've been told in pharmacology with what is being taught in nursing. If I can also reflect as a student […] I also did pharmacology [*identifying information provided*]. Yeah, I don't think it's something that I'm also meeting, you know, [*repeating words*] in the hospitals. Like it is pitched at [*repeating words*] a very high level. But, then when I get to the hospital, you know, the [*repeating words*] medications […] that they are using, it's not what I was told in pharmacology. So I just feel like what is to be taught then gets it. It gets lost. I don't know along the way. […] we can match whatever that they are being told in pharmacology with what also they have been told also in their nursing modules […] Indeed, to see maybe if you were to get a patient, you know a scenario that is also nursing-specific to see in the wards. We even find that they can't even on the trolley, they don't even know what is the most important medication. […] So, I don't know where, where are we missing this linkage between pharmacology and also the nursing modules.

[P6; L; MW] "I just feel like if we can bring in some reality […] Important you know basic information that is required to know about in terms of medication. Not only do we need to know about, you know, neurotransmitters […]. How does it come to a patient? How does it apply to this patient that you are meeting now in the ward? All this knowledge, you know about the mechanism that the neurotransmitters, that's this and this and this. Then how do they still bring it back to the ward if they're meeting a patient with such a condition? Then how could they link it with what they have been told?

Participants also felt that students had a preconceived perception that pharmacology was a difficult discipline, which impacted their ability to stay motivated for the module, and invariably impacted their learning. Participants did, however, feel that there were ways in which this could be mitigated by exposing students to pharmacology earlier in their studies, or by introducing it alongside clinical educators whom they would already have come to know.

[P1; CC; IHL; L] "It's almost like when you do research for the first time. It is just boring, but already in your mindset it's already you speak, it's this big monster."

[P1; CC; IHL; L] "Imagine in a class […] next to you is [*identifying name of an academic colleague*], and you say: let me give over to my colleague. You know immediately this when the students see this familiar face […] attitude and their mentality will change."

[P2; CL; MS] "And I think students see pharmacology as a monster. […]. I think if they can start with it, and it has been linked to [*repeating words*] the nursing modules then they will come from first year, second, to third year, they [*repeating words*] will come up with it. And I think it will bridge this gap."

[P4; L] "They were verbalising […] the fear, you know pharmacology. That pharmacology, calling me by my name to say if it, it sounds like we're not going to make it so. […]. They were afraid of the pitching, that this is not what they were expecting."

[P6; L; MW] "like the [*repeating words*] monster. The previous monster was anatomy."

Two participants raised a professional identity concern that they believed also affected the development of competencies and the curricula that they were positioned in. Comments were raised that the nursing profession tended to be overly militaristic, which tended to create environments where the profession wanted to take ownership of all matters related to them. This was noted as a potential concern for working alongside one another for the development of competencies. However, as much as this view was positioned, the undermining of the nursing profession also created frustrations where perceptions of being overused, not respected within the learning environment, and having a too wide a scope of practice were raised. In such a way, competency development could become impacted due to their placement within the team of educators, or the diversity of what needed to be included within their curricula. For one participant, this undermining that occurred would create misrepresentation of a lack of competency (for example, interpreting prescriptions) when it was due to another professions' failure to adhere to good practice. Another participant stated that such negative reinforcement often redirected the purpose of healthcare away from the patient and their outcomes, and rather to bureaucratic elements of the healthcare system.

[P1; CC; IHL; L] "Let me be very frank to say that nurses are trained very militaristically […]. It must be there, you must be this way. You know. […]. We don't want to bring other people in. We own things. You will go to the practicals and people will say, where's my drip stand? Because you're the sister in charge, my nurses. And the same thing here. We're going to have this problem with pharmacology and all of the other things because we do not draw in the people who's out there. In practice, we do not draw in these clinical facilitators. We don't take our clinical facilitators […] to lectures and to say today I'm going to give over to [*clinical educator*] to come and give class […] we are still in that ranks. I'm here, you here. You there, you there. […]. We can't say students shouldn't learn in silos when we also operate in silos. […] the curriculum must touch on all these people, all these stakeholders that is involved in teaching and learning."

[P1; CC; IHL; L] "[…] We must become pertinent and relevant as nurses. That's why people decide for us; that's why we can't decide for ourselves. We don't have the directive because we feel like we are 'jack of all trades, master of many'. We need to come work with all the other masters, so that we can be part of the castle and reign together for better patient outcomes."

[P2; CL; MS] "I think other professions undermine the nursing profession. I'm sorry to say that I think we have been undermined. That is why other professions don't think we can get anything good from the nursing profession. It is always from them down to us, and that is a problem. One day I was at Steve Biko teaching my [*repeating words*] third years' interpretation […] the heart rate, or the ECG. And as I was teaching them, I didn't realise I found myself surrounded by the student doctors. They were part of that I didn't even realise that we only saw it after. The student doctors also joined because they also had a problem in calculating the heart rate so I'm just trying to say there's good that they [*nurses*] lecturers can offer to other professions."

[P2; CL; MS] "I think we have been forced to accept everything, […] even if its [*repeating words*] not linked to the curriculum that we are teaching. It's like things like just forced to down our throat. […] But let us be all on the same path, let us be equal, let us

be the lecturers irrespective of whose profession is right and [*repeated words*] and bring the expertise of each individual into the picture for students to benefit."

[P2; CL; MS]: "Nurses struggle in the clinical environment with the prescription. That is not. You can't read the prescription. […]. Students, irrespective whether it's a doctor or the doctor, is the one that actually prescribes, and we expect the doctor, when he receives a prescription, […] they will just prescribe and leave the prescription unidentified. So he's going to get the nurses to run around, get the information about the patient and identify that document. So this is the militant rule. It's like the [*repeating words*] nurses are [*repeating words*] cleaning after this doctor's because they are higher than them. That is what I was saying. We are being undermined. So if the clinical component is introduced into the curriculum a doctor should know that my signature should be accompanied by qualifications, my initials and surname […]. So it must not be the responsibility [*repeating words*] of the nurse to run after the doctor, because the nurse is going to be penalised. This prescription is incomplete or it's illegal. It's not the responsibility of the nurse to see to it that they prescription chart is legal."

3.2.3.2. Scaffolded learning from physiology

Participants were asked whether they believed that their students had a sufficient understanding of physiology to allow for pharmacological competencies to develop. Participants found their students lacking the necessary physiological background, not only for pharmacology, but also for learning within their nursing-specific modules. Several examples of situations were provided where students struggled to apply physiological principles in their practice, which hampered their clinical interpretative abilities. Similar concerns about pharmacology were noted, where education was overtly focused on the basic sciences, and appeared to lack the vantage needed for health professions education. The lack of clinical contextualisation yielded a decontextualised perspective of principles, which did not allow students to see their world-of-work within the classroom setting. This invariably meant that lecturers spent more time reiterating or revising previous work, detracting from the core function of their classroom activity. Participants' opinions highlighted their frustration with this reality, which created misalignment and missed opportunities for students actively to engage within their sessions.

[P2; CL; MS] "I don't think so [*in reference to understanding physiology*] because, right now, from anatomy and physiology for first year and second year, […] when you teach, for an example, interpretation of ECG in third year and fourth year, that prior knowledge of first year and second year, it's lacking. So, every time for them to understand what you want to teach, you'll have to go back to first year and second year work for them to understand what you want to tell them in third year and fourth year. So, […] your zooming and you never finish what you want to do with the students. […] the fourth years already provided a request for interpretation of blood results, ECG, and blood-gas analysis, and these are the things that I taught them in third year. They're still finding it difficult, so I must still make it point."

[P2; CL; MS] "[…] if you have a [*repeating words*] renal failure treatment, you teach about pharmacology that relates to a renal failure in class and then I go on clinical and I find a student who is nursing a patient with renal fail. Then the first thing I'm going to do, I'm going to say: OK, give me the normal functions of the kidney. […] I want to see if this student is going to be able to identify the pathophysiology thereof. What is it that is wrong with this patient? Because when it's [*repeating words*] normal, I expect the potassium to be this much […], the blood pressure of the patient should be like this, and then and that is not there. So every time you will start with the anatomy and [*repeating words*] go to the normal physiology and thereafter we say: OK, let's say this [*repeating words*] kidney does not work now you both go down to the level […]. So it's time consuming. Sometimes you'll find that you [*repeating words*] have to lead the students to refer them to study after hours because you [*repeating words*] can spend 2 hours on a student because you want to leave that environment with the student who understand something from that

area. So correlation of theory with practice; it's a problem and being a problem it means there [*repeating words*] are gaps that we need to bridge.

[P4; L] "Continuing with the linkage that is linking with pathophysiology, and maybe anatomy. You [*repeating words*] realise that the students who are doing nursing in our department, they cannot link the disease progression, say diabetes mellitus. How does the physiological part of the body, maybe what is happening to it when the person is presenting with symptoms of diabetes mellitus, hypertension. Because they don't look at the structures or the body structures that are involved. So when [*repeating words*] we are teaching them, maybe general nursing of a patient with a kidney failure, we will [*repeating words*] have teach them the basics of kidneys and then link it to what they see on the patient. […] because we are saying pharmacology should be linked. Also, this one must […] also be linked to basic.

[P6; L; MW] "[…] is also not aligned with the physiology that they are being taught. So, it remains abstract. Again, to them that they are trying to [link] physiology in a way of physiologists or you know something like that. And it come back to also nursing as well. So, I really think that they also need to be that bridge. […] you know we bridge that gap; it includes some of that physiology into our own nursing curriculum because if we depend on others you know to teach them or to [*repeating words*] prepare them in terms of the physiology then this way we are missing because […] it's remaining abstract to them. I also did this, but I can't remember […] I did in physiological class. It was mostly things like your [*repeating words*] principles and you know it [*repeating words*] was at a level that I can't come back and say, OK, he's a patient. Yeah, this is what they were talking about. You know the [*repeating words*] pathophysiology […] you can't [*repeating words*] bring it back to clinical practice and say this is what I learned and this is what I'm implementing so somewhere somehow we are missing it. I think that's because they are mixed with other with [*repeating words*] other courses, it gets taught as if it is not related to health professionals or you know something like this. I think if it we can also find that linkage or that bridge also then I have some win the battle."

The understanding of physiology was also a concern for the broader integration of healthcare sciences, and for understanding the impact of systems on one another. One participant remarked that students struggled to understand how various physiological systems interacted with one another when a patient was ill, and failed to understand that patients could have a diversity of factors that influence their disease progression. In such a way, it highlighted the inter-individual variability that would be inherent within patient care.

[P2; CL; MS] "[…] one person with all these systems [*repeating words*] are working together for good for this person, and if my kidneys are not functioning well, this very person will develop hypertension. How did it happen then they should understand that: oh this person has got a [*repeating words*] kidney problem and developed hypertension, this must have been pathophysiology of the renal system. What are the bloods that are related with this […]. They've got many people. […] then it is that the thing that makes them more [*Afrikaans word for confused* – '*deurmekaar*'] and they are not understanding anything. They should know that all the systems that are in one person and that they work together."

3.2.3.3. Alignment of the proposed pharmacology curriculum

Participants felt that the proposed curriculum, while more extensive than the current one, was achievable and relevant to the nursing profession. Nothing in particular was noted as being necessary to remove. Given my concern that the additional pharmacotherapeutic areas increase the time needed for the module, probing yielded some comments on what can be done to help minimise the time-intensive nature thereof, such as grouping drugs by conditions or ensuring focus was placed on the exit level outcomes of the Bachelor of Nursing Science. However, an alternative suggestion was that fewer common illnesses or more specialised areas of treatment should be dealt with only in postgraduate qualifications. Problematically

though, little was indicated as unnecessary within the undergraduate curriculum, thus necessitating further stakeholder discussions to elucidate the importance of such therapeutic areas, which will require a broader review of what is being dealt with in the core disciplinary modules.

[P1; CC; IHL; L] "What is our end product of this module? What is nice to have and what is there that you must know? We go to a neurosurgery work. For me it was a blue line. I know. If that […] patient can't function, I put a blue line there, but you won't find it in other wards. Stick to what is the outcome? Because you can't […], you only have this little one time. And it is not only pharmacology at all. […]. If you look at the burns and there's some primary healthcare elements there that the student can do postgrad, she can do a postgrad, but let's focus and see what is important and let us be realistic."

[P2; CL; MS] "So you group them according to like, we have normal hypertension, we have hypertension in pregnancy, and then you treat them together."

Midwifery was seen as an area where insufficient competency development was occurring. As pregnancy was seen to be a pertinent factor that alters the way in which pharmacotherapy can be used, emphasis was placed on ensuring that the curriculum contextualises these areas appropriately. This was positioned as well to reduce the potential for ambiguity or contradictions between the Pharmacology and Midwifery modules. The time constraints for this were acknowledged as difficult to overcome.

[P5; L; MW] "I always tell the students that a pregnant mum is especially at a higher response to existing conditions. But now the pregnancy complicates everything and that there is a lot of extra load on the systems and [*repeating words*] students need to understand […] pharmacology and this mom cannot just take any medication."

[P5; L; MW] "You know how did you go to the patient, and not to take medication or what supplements are good. So I think not a lot to be added […]. Not a lot, but yeah, some aspects."

[P6; L; MW] "There information is the same, our information is [*repeating words*] interconnected because I'm telling them […] in this case it's we are now using TLD [*reference to HIV treatment algorithm*]. You know this is the combination and then they said no but here this is what we were taught. So I really do think that if we can just put in some components you know of midwifery for them."

Although concerns were noted about pharmacology, participants believed that the quality and depth of teaching should not be reduced to ensure that students were challenged in the higher education sector. Furthermore, this was necessary to develop pharmacological competencies, though required clinical contextualisation.

[P2; CL; MS] "I think we still need to the high level of teaching because this is a university. It's not college; it's a university. So we still need that high level of teaching, but we need to bridge the gap of nursing modules with pharmacology."

[P6; L; MW] "But if we can really make it [*pharmacology*] to […] pitching it at a high level. But if we can really make it adaptable or make it contextual you know."

[P6; L; MW] "And we should not lose, you know, teaching them at a high level because it prepares them […]. I don't feel the standard of pharmacology, the way it's been provided to the student should be dropped."

Research was acknowledged as an important element of the Bachelor of Nursing Science programme, which was already touched on in certain teaching sessions. However, incorporating it into pharmacology was seen as a good platform for competency development, and allowed them to be more aware of what is occurring in the modern day. Research would also allow them to apply evidence in practice, which would infer a potential for gaining evidence-based practice competencies necessary for their nursing profession.

[P6; L; MW] "We also do infuse, you know we [*repeating words*] indicate to them that they go get articles, you know in a certain disease, because this really assists them to look at what is out there; the evidence they need out there. So it makes them to be well-rounded professionals to know that times are changing, it will be new. […]. So I really do think that you infusing research into pharmacology is a good way […] teaching them to look at what is out there, available evidence, and then to apply it to their current situation."

Participants had several suggestions on how alterations could be made in future to facilitate a greater holistic view of the healthcare system, not only from a basic sciences vantage, but also from a clinical context. Creating an integrating platform for teaching was remarked as being an imperative for students to develop a clearer understanding of pharmacology in relation to other basic sciences and the nursing profession. Interdisciplinary and interprofessional teaching opportunities were espoused as being ideal to help elevate the learning achieved in Pharmacology and other modules, and would inherently showcase the clinical context more appropriately.

[P2; CL; MS] "I feel the clinical students should be taught together, […] maybe nurses with [*repeating words*] physiotherapist, dieticians. I think if they are together because they are the ones that are mostly going to be mixing with patients more, more than somebody who can come maybe after a while to visit a patient for a specific person."

[P6; L; MW] "Don't search and not only us, you know. Also radiographers, there something that they can come with. And we can partake. And you know physiotherapist. Everyone can bring a case and say this is efficient. Now this is what you have been taught. Now this is how we would really save scenarios even in class. Yes, dealing with this specific scenario together relate the pharmacodynamics, kinetics that we have talked [*about*]. Is the patient presenting with this? How would you manage certain patients? So if they get such practical examples during the class session when they get to the test or the exam they remember: oh, we had a patient like this even though this one won't be the same but this is how I would tackle it […], this is how I can relate the disease process to the pathophysiology, to the pharmacodynamics and kinetics. So I do think that if we have such a clinical contextual, you know integration, then we'll make our students to, you know, to flourish […]. Then I really do think that we're going to get well-rounded professionals that remember that, you know, the neurotransmitters […] and they teach the patient, and we can do things […]. We will have very competent and well-rounded healthcare professionals."

While participants remarked that an earlier start may decrease the perception of pharmacology as being difficult or problematic to their success, they also stressed that this could allow for a more continuous integration with core nursing disciplines. In such a way, students would be exposed to Pharmacology from the first year onwards and bolster its importance within the curriculum. The integration was recommended to be done in ways that highlighted clinical context and the authenticity of the nursing profession. This would not remove Pharmacology as a stand-alone module within the third year, but rather help bolster the contextualisation of pharmacology in a more authentic, clinically applicable way. For example, discussing posology and administration within the context of medication management, or the determination of a medication's role or outcomes within the nursing process. This alluded to a

much larger programme level curriculum redesign that would be needed, which did appeal to participants.

[P1; CC; IHL; L] "This is the same thing that happened with pharmacology [*at my previous employer*]. […] OK, now we're going to come as a group and we now design a nursing guideline for pharmacology for nurses, at grassroot level […]. The departments from pharmacology was there, anatomy was there, and together we [*repeating words*] presented. We were the same. So also we learn from each other, because sometimes you think you know but you don't know."

[P2; CL; MS] "The clinical lecturers need to work together with the other lecturers that are teaching these modules and we need to introduce [pharmacology] into the nursing modules from first year. They should start it from first year; a little bit of everything until they complete in fourth year."

[P5; L] "I think I might want suggest that it can be done maybe as an introductory module, or we need to write in more pharmacology specific outcomes into our nursing curriculum."

Bolstering the clinical context was necessary to ensure students could understand the relevance of pharmacotherapy in their authentic environment. Participants believed this would help overcome much of their learning challenges, and ensure that they could become better healthcare practitioners. Integration of such clinical contexts was also proposed for assessment in pharmacology. Reference was made to possibly including a more practical element into the curriculum, such as those seen during a dispensing course one participant attended that would allow for more application of theoretical aspects of pharmacology in an authentic context. In doing so, the basic science of pharmacology would interleave more appropriately with clinical competencies, such as medication management and the nursing process. When participants were probed about these clinical competencies not being taught in nursing-specific modules, and possibly more appropriately being taught by clinical educators, participants alluded to its inclusion in their modules, but added that it might require greater support from the Department of Pharmacology.

[P2; CL; MS] "[…] the pharmacology question paper, because now we are sitting with a problem where our students are repeating pharmacology. […] the clinical component that is lacking. I think if the question paper is balanced where the student can also see the clinical component in the pharmacology paper […] that can also help our students to actually do well in pharmacology."

[P3; CC; IHL; L; MW] "Previously they had a short course [*dispensing short course*] […], that course it [*repeating words*] more practical [*repeating words*] things than I'm not sure about this one that is offered. […] It was so relevant because, you know, it was integrating the theory and the practice. I remember you will have that theory and then you will also have during the [*repeating words*] OSCE, you will have to [*repeating words*] dilute this medication. […] also the legal principles for record keeping. So all those things were packed together."

[P6; L; MW] "I am proposing, perhaps can there be a clinical component. You know, in terms of pharmacology, you know with other modules we teach theory and then we say now, you know clinical. You can, for an example, […] you bring in a prescription and then you say maybe assess the pharmacological […], so that it can bring that application or it can bring that clinical exposure. […]. You know, you were [*repeating words*] asking us about the [*repeating words*] management of medication according to the nursing process. So they say, oh, I thought that perhaps if [*repeating words*] you were talking about issues of, for example, that you meeting on the prescription or should we get the pharmacodynamics of a certain medication to also infuse clinical, practical components that can ensure that application. Because currently it is theory, like it is basic science. […] But then clinical, you

know, […] now we're going to the skills we're going to practice and we get the drugs […]. I just feel like it […] align what was important dealing with what is kind of the clinical perspective."

[P6; L; MW] "Yeah, it is [*in reference to clinical aspects of pharmacology being taught in the nursing-specific modules*], but […] maybe the example I used is something that you're already doing, but because you are the [*repeating words*] the pharmacology department, I would think that they would be clinical practice or they would be something that besides having it in theory. You can go and show them in terms of clinical […] the management [*of medicine*]. This is how you can do it."

Comparisons were made to prior experiences with integrated modules, where integration facilitated learning via an interdisciplinary and interprofessional perspective. This not only benefited the students, but also allowed for a greater collaborative teaching platform with improved relationships between all stakeholders. The interprofessionalism was also key to breaking certain stigmas within the medical hierarchy, and allowed for a better understanding of the role of different healthcare practitioners within the clinical sector.

[P1; CC; IHL; L] "You're not an island on your own, and what you're doing in the healthcare system is not for us. It's not for our career per se, but it [*repeating words*] boils down to the patient. And I think once we understand what is our core mission as a healthcare practitioner and then we work. […] this integrated health leadership grew so big. […] That now we note, even if you go into a [*repeating words*] setting where your students is going to do that project, they come and greet you. […]. And we start talking about last year's students and, you know, students even start to know each other. And like I said before, it goes beyond teaching because now it [*repeating words*] goes into sustainable relationship. It goes into teamwork. […]."

[P3; CC; IHL; L; MW] "I was exposed [*to integration*] in that module and it helps […] me to understand that working as a team always, it comes with positive results. […] when they come to my class, to her class, he doesn't know what was taught. Whereas, if you are there, you will make sure that everything that the students are taught, especially your module, the education, is linked to the [*repeating words*] subject."

4. Discussion

To facilitate a structured discussion, the general needs analysis has been approached separately, but contributes sequentially to the targeted needs analysis.

4.1. General needs assessment

The general needs analysis is discussed first as the scoping review that helps create a preamble for the discussion of the Delphi study results.

4.1.1. Scoping review

The number of publications on pharmacological competencies for nursing was not unexpected, given their function for medication managers (Dubovi et al., 2018). To illustrate the complexity of the nursing competency framework, Black et al. (2008) summarised a conceptual framework for organising competencies (Figure 4.3) that span professional responsibility and accountability, knowledge-based practice, ethical practice, service to the public and self-regulation, all of which are centred on the client, comprising individuals, families, groups, communities and populations) (Black et al., 2008). Although extensive, this framework does illustrate the reach that nurses have with the central point being that of the

client (Black et al., 2008) that arguably will be their patients and associated networks. Pharmacology would feature in all aspects of these competencies to varying degrees, supporting the scoping review's breadth of competencies that were yielded, ranging from cognitive, psychomotor and affective domains. The basic sciences' components of pharmacology would mostly fit into knowledge-based practice; however, as they become encapsulated knowledge within clinical practice (Rikers et al., 2004), one cannot localise them beyond their benefits of knowledge.

FIGURE 4.3: CONCEPTUAL FRAMEWORK FOR ORGANISING NURSING COMPETENCIES, HIGHLIGHTING THE BROAD COMPETENCIES AS A CYCLE WITH THE CLIENT AS CENTRAL POINT. IMPORTANTLY, NO COMPETENCY IS MORE IMPORTANT THAN ANOTHER (BLACK ET AL., 2008). REPRODUCED UNDER THE CREATIVE COMMONS LICENCE OF JOHN WILEY AND SONS, INC

Nurses have been reported to spend a large proportion of working time (17.2% to 26.9%) on medication-related matters (Hendrich et al., 2008; Keohane et al., 2008), although some claims of 40% are made (Armitage & Knapman, 2003). Medication preparation and administration, for example, is well-described as a fundamental task in nursing (Dossey, 2010). In pharmaceutical care, an interprofessional practice to ensure patient therapeutic outcomes are reached, seven core responsibilities are defined by De Baetselier et al. (2022) that relate to nurses' roles: medication's therapeutic and adverse effects management; medication adherence management; management of patient medication self-management; patient education and information management; prescription management; medication safety management, and care/transition of care coordination (De Baetselier et al., 2022). A variety of roles within these responsibilities has been recommended to involve a large contribution from nursing (De Baetselier et al., 2021). As such, information is not lacking to help guide curriculum design. Although a range of curricula were available through the scoping review and bolstered by publications' reporting of specific areas of nursing practice of concern, little national context

was available. Curricula tended to be more than ten years old as well, which does bring into question whether updated information is included. Cognitive competencies were predominantly linked to the basic sciences' elements of pharmacology, such as the core concepts, pharmacotherapeutic areas and understanding of the place of pharmacology in the nursing process (e.g., documentation trails, the five rights of medication administration, pharmacovigilance, and posology). Although many competencies may have a theoretical underpinning, transition or encapsulation of these within psychomotor competencies are expected in other core nursing modules, as supported by, for example, the understanding of dose calculations translating to the preparation and dilution of medication. It is thus expected that theoretical pharmacology education for nursing will invariably require contextualisation within the practical environment of their scope of practice (Lim & Honey, 2006).

Seven comprehensive nursing curricula were available to create a broad framework of what was needed for inclusion in the Delphi study (Arizona State Department of Education, 1982; Idaho State Department of Education, 1992; Lim & Honey, 2006; Lloyd et al., 2013; Mississippi Research and Curriculum Unit for Vocational and Technical Education State College, 1995; Ohio State Department of Education, 2001; Oklahoma State Department of Vocational and Technical Education Stillwater, 1990). Curricula tended to overlap, providing support for the importance of the basic sciences' aspects of pharmacology. Beyond the basic sciences, curricula also described the affective and psychomotor nursing competencies needed that allowed for practical expansion of the competency list. The majority of these competencies included, among others, dosing arithmetic, medication preparation and administration, and patient education (Idaho State Department of Education, 1992; Mississippi Research and Curriculum Unit for Vocational and Technical Education State College, 1995; Ohio State Department of Education, 2001; Oklahoma State Department of Vocational and Technical Education Stillwater, 1990). The breadth of information obtained was beneficial; however, it does bring into discussion the importance of having a focused curriculum for the scope of practice lest it become content heavy. As remarked by Andersen and Moralejo (2015), focus is needed as most curricula cannot address a multitude of items without losing scope or becoming content-heavy (Andersen & Moralejo, 2015). Acknowledgement of the scope of the practitioner would delineate the depth of discipline-specific information needed to make them fit-for-purpose (Callier et al., 2014). This relates to the current concern for the FAR 381 and FAR 382 modules where overreach and misalignment are present to the exit level outcomes related to registered programmes for the individual healthcare practitioners. Additionally, as these curricula were predominantly from the United States of America, the importance of national context and disease burden needs to be acknowledged to ensure that the pharmacology education can be responsive to what is occurring within the country (Chevan & Heath, 2019)

Non-curriculum publications presented more specific information on competencies, and thus often lacked explicit discussion of the depth at which they would need to be included for education. Much research was conducted to assess areas of knowledge deficit that generally reported on concerns of certain competencies not being achieved or precipitating poor clinical practice (Aronsson et al., 2015; Begum et al., 2020; Di Simone et al., 2018; Fleuren et al., 2019; Frazee et al., 2015; Guenter & Boullata, 2013; Johansson-Pajala et al., 2015; King, 2004; Laborde & Texidor, 1996; McMillan et al., 2000; Meechan et al., 2011; Oldridge et al., 2004; Reumerman et al., 2018; Scarpaci et al., 2007; Sulosaari et al., 2012; Swart et al., 2013). This was further bolstered by institutional content analysis highlighting the amount of time

spent on pharmacology or diversity of pharmacology topics being covered (Druedahl et al., 2019; Lloyd et al., 2013). Working group reports (Van Eekeren et al., 2018) and literature-guided opinion pieces and reviews (Alexander-Magalee, 2013; Banning, 2003; Callier et al., 2014; Campinha-Bacote, 1994; Farrar et al., 2017; Heinzer et al., 1997; Sulosaari et al., 2012; Voynarovska & Cohen, 2008) provided additional insights into areas of importance within nursing disciplines, such as ethnopharmacology and pharmacogenetics, considerations in elderly patients, and pain management.

Practical nursing competencies were most commonly presented, where medication preparation and administration (Arizona State Department of Education, 1982; Di Simone et al., 2018; Guenter & Boullata, 2013; Heinzer et al., 1997; Idaho State Department of Education, 1992; Mississippi Research and Curriculum Unit for Vocational and Technical Education State College, 1995; Oklahoma State Department of Vocational and Technical Education Stillwater, 1990; Oldridge et al., 2004; Scarpaci et al., 2007; Sulosaari et al., 2012), including dosage calculations, was a pertinent and important skillset acknowledged (Arizona State Department of Education, 1982; Di Simone et al., 2018; Heinzer et al., 1997; Idaho State Department of Education, 1992; Mississippi Research and Curriculum Unit for Vocational and Technical Education State College, 1995; Oklahoma State Department of Vocational and Technical Education Stillwater, 1990; Oldridge et al., 2004; Sulosaari et al., 2012). Return-to-work curricula were also available for nurses re-entering practice, reiterating the aforementioned pharmacological competencies needed for clinical work (Burns et al., 2006; Davidhizar & Bartlett, 2006; Ohio State Department of Education, 2001). Given the nurses' alignment with administration of medication, a lack of such competencies impacts the ability to engage in safe medication management with patients (Di Simone et al., 2018; Guenter & Boullata, 2013; Scarpaci et al., 2007) that is supported by the numerous published cases of medication errors in nursing (Di Simone et al., 2016; Ehsani et al., 2013; Gracia et al., 2019; Jones et al., 2022; Lan et al., 2014; Page & McKinney, 2007; Truter et al., 2017). Furthermore, pharmacovigilance (the practice of detecting, assessing and preventing medication-induced adverse effects) was remarked as important for nurses' education. As medication managers who follow the nursing process of evaluating patient responses to treatment (Younas, 2017), nurses are well placed to document, assess and report adverse effects as a pharmacovigilance task (Johansson-Pajala et al., 2015; Reumerman et al., 2018; van Eekeren et al., 2018).

Nurses, in their role of caring for patients, are also involved in pain management modalities that in general would necessitate analgesics. Competencies related to pain management were discussed (American Association of Colleges of Nursing, 2000; Farrar et al., 2017; Laborde & Texidor, 1996; McMillan et al., 2000; Sherman et al., 2004), often in the context of cancer (Laborde & Texidor, 1996; McMillan et al., 2000) and end-of-life care (American Association of Colleges of Nursing, 2000; Sherman et al., 2004), creating contextual relevance of the knowledge and skills needed in such environments. Pain management included understanding and managing adverse effects related to analgesic treatment that could complicate patient care (American Association of Colleges of Nursing, 2000). End-of-life care competencies include the affective domain, which is based on the sensitivity needed to deal with a dying patient and their loved ones (American Association of Colleges of Nursing, 2000).

Building on the need to respond to inter-individual variability sources also acknowledges nurses' need to understand contextual differences caused by genetic variation (Callier et al.,

2014), age-related changes (e.g., in the elderly) (Alexander-Magalee, 2013), and population differences caused by ethnicity (Campinha-Bacote, 1994). In comparison with dietitians and physiotherapists, nurses are recommended to have a greater understanding of pharmacogenomics (Callier et al., 2014), most likely given their increased contact time with patients and the nursing process' relation to the evaluation of the response to medication.

4.1.2. Delphi study

The Delphi study, as with the results presentation, is discussed according to pharmacological, pharmacotherapeutic and generic competencies.

4.1.2.1. Pharmacological competencies

As with the Dietetic group, the core concepts of pharmacology were remarked as important, though at a high order cognitive level. This is supported as the core concepts allow for scaffolded learning due to their applicability in a larger context, forming a conceptual framework by which students should approach pharmacotherapy (White et al., 2021). Nurses' role in medication management (Dubovi et al., 2018) and the nursing process (Lilley et al., 2022; Yildirim & Ozkahraman, 2011; Younas, 2017) does support that the base of learning pharmacology should be strong, which is also emphasised in nursing-specific curricula obtained (Arizona State Department of Education, 1982; Idaho State Department of Education, 1992; Mississippi Research and Curriculum Unit for Vocational and Technical Education State College, 1995; Oklahoma State Department of Vocational and Technical Education Stillwater, 1990). Participants concurred about this as the concepts related to biopharmaceutics, pharmacokinetics and pharmacodynamics were recommended to be targeted at a higher order cognitive level. Such competencies link to the relationship to clinical indications and rationale for use, administration, posology (Dubovi et al., 2018; King, 2004), pharmacokinetics, pharmacodynamics (Dubovi et al., 2018; Lim & Honey, 2006; Meechan et al., 2011) and toxicodynamics (Dubovi et al., 2018). Interestingly though, pharmacological ligand types were considered unimportant; however, understanding the conceptual difference between, for example, an agonist and antagonist (White et al., 2021), is needed for scaffolded learning of mechanisms of action to occur. Such a finding is congruent with the importance of co-design principles, where the outcome would be best posited by a clinical expert in the profession, but the underlying fundamental sciences to achieve that would require input from a basic sciences' specialist.

Competencies related to medication management were all considered important at a higher cognitive level that is reinforced by the scope of practice of the nurse (Republic of South Africa, 2020) and guidelines by international nursing bodies (Royal College of Nursing, 2019). Responsibilities include, among others monitoring and recording medications' effects on patients (Jordan et al., 1999; Manias et al., 2004; Royal College of Nursing, 2019), patient care interventions (e.g., timing of administration, pro re nata [as required] medicine provision) (Manias et al., 2004; Royal College of Nursing, 2019), patient education (Jordan et al., 1999; Manias et al., 2004), compiling auditable nursing care documents (Manias, 2003; Royal College of Nursing, 2019), and being aware of facility policies regarding medication management (Manias & Street, 2000; Royal College of Nursing, 2019) and controlled substances (South African Nursing Council, 2018), and reporting of adverse effects and medication errors (Durham, 2015). It is important to note that concepts related to medication

management fall prominently into the nursing profession's domain of clinical education, and thus will not appropriately fit within the scope of a basic sciences module. Many of these principles will be inferred by the molecular characteristics of the medicine, though. For example, the most appropriate route or dose, the clinical outcomes that would need to be assessed, and on what to educate a patient (Jordan et al., 1999; Lim & Honey, 2014; Lin et al., 2014; Manias et al., 2004) may originate from theoretical basic sciences, but culminate as a practical application thereof. Clinical education would invariably be appropriate from a clinical education vantage (Latter et al., 2000; Lin et al., 2014); for example, documenting nursing care plans, evaluation principles, and the nursing process. The practical aspects align with a professional scope that would best be delivered by somebody who understands the professional domain appropriately, though in itself would not be possible without sufficient horizontal and vertical integration. For example, understanding which clinical signs to assess after administration of a specific medication, such as phenothiazine antipsychotics' potential orthostatic hypotensive effect (Jordan et al., 1999), or the considerations needed before administering medication, such as checking potassium levels prior to furosemide use (Durham, 2015).

Patient education was considered important for nursing at a high cognitive level, indicating its relevance to the practice and the complexity of the tasks that associate with it. Nurses are well-placed to provide individualised education to patients on their medication due to their proximity and time spent in their care (Manias et al., 2004). By executing patient care correctly, patients can be made aware of the detriments of adverse effects caused by their medicine, or be informed of mitigation strategies for these (Jordan et al., 1999). This is further reiterated in the Standard Treatment Guidelines and Essential Medicines List for South Africa which, apart from providing the essential medicines list for primary healthcare, also categorically discusses the importance of patient education to bolster and support pharmacotherapeutic adherence (South African Department of Health, 2020). Latter et al. (2000) reported that there was often contention as to who should teach patient education relating to pharmacology: subject-specialists with a basic sciences background, or clinical nursing educators who were immersed within the real-world application. This was driven by the perception that basic sciences' educators would have a greater understanding of the complexity of the discipline and thus teach the nuances thereof more appropriately, while clinical educators would understand the contextual relevance and application more readily in terms of their patients and clinical scope (Latter et al., 2000). Supporting this, students may be more demotivated during classes due to not necessarily seeing the clinical perspective or when integration was poorly achieved, which would invariably decrease the opportunities to practise patient education (Latter et al., 2000). Deficient depth of basic sciences' knowledge has been posited to contribute to poor clinical knowledge (Latter et al., 2000; Lim & Honey, 2014), perpetuation of the theory-practice gap (Latter et al., 2000), and medication errors (Lim & Honey, 2014) that invariably also have bearing on patient education.

Medication management is important to avoid errors in the use of medicine (Manias et al., 2004) that leads to poor health outcomes (Jones, 2009; Blignaut et al., 2017; Wondmieneh et al., 2020; Wang et al., 2023). A medication error is typically defined as a preventable error while using the medication that leads to adverse outcomes or inappropriate use thereof, regardless of whether at the healthcare practitioner, patient or consumer level (Choo et al., 2010). Medication errors due to human involvement can be person-dependent (because of the healthcare practitioner) or system-dependent (due to procedural conditions that may affect

the healthcare practitioner) (Choo et al., 2010). As such, it is important to acknowledge that medication errors are multifactorial, and although such an error may culminate at a single point, it is generally a systematic contribution from various procedural deficiencies and practitioner inputs (Choo et al., 2010). For example, staff shortages or overburdening, inefficient operating procedures, and inaccessibility to medication (Choo et al., 2010; Nicholson & Damons, 2022; Truter et al., 2017) may contribute to a medication error, regardless of whether competencies were involved or not. As nurses administer medication that have been prescribed, they are ideally placed to prevent medication errors; however, this does also place them at greater risk of being the culminating point of the error (Durham, 2015; Manias et al., 2004). Various errors may occur within the nursing process, including incorrect labelling or incorrect dosage administration (Manias et al., 2004). Competencies directed to, for example, drug calculations, administration approaches and medication preparation were all considered important to include within the pharmacology curriculum, including the five rights of medication administration as a framework. Many of these practical competencies rely on a solid underpinning by cognitive competencies; for example, understanding the pharmacokinetic parameters of a drug infers and supports its route of administration. Much literature is available to indicate nursing medication errors that stem from deficient knowledge of the basic sciences (Jones, 2009; Du Preez, 2016; Blignaut et al., 2017; Matiso, 2017; Caboral-Stevens et al., 2020; Bengtsson et al., 2021; Nicholson & Damons, 2022) or clinical considerations (Dirik et al., 2019; Wondmieneh et al., 2020), preparation mistakes (Gracia et al., 2019; Lohmann et al., 2015; Truter et al., 2017), calculation errors (Oldridge et al., 2004; Jones, 2009; Matiso, 2017; Truter et al., 2017; Gracia et al., 2019; Caboral-Stevens et al., 2020), or unavailability of guidelines or training (Nicholson & Damons, 2022; Wondmieneh et al., 2020). Concerningly, medication errors are routinely underreported (Dirik et al., 2019; Wondmieneh et al., 2020; Bengtsson et al., 2021) due to among others, fear of perceived incompetence, punishment, negative reactions from patients or peers, unawareness of an error being made, or if the error is inconsequential (Dirik et al., 2019), and thus strengthen the need to address such matters within the educational context. As communicated by the Committee on Quality of Healthcare in America, Institute of Medicine landmark report in 1999, medical error, including medication errors, greatly contributed to mortality in America by approximately 44 000 to 98 000 (Kohn et al., 2000). The World Health Organization estimates one in ten individuals experience adverse effects in high-income countries, where statistics for low-to-middle income countries will invariably be higher (World Health Organization, 2021). South Africa is no exception to such medication errors (Du Preez, 2016; Blignaut et al., 2017; Matiso, 2017; Truter et al., 2017). Given these findings, it is not surprising that a series of competencies that tie directly into the improvement of healthcare practice by minimising potential medication errors becomes an imperative to bolster through curricular changes.

Pharmacovigilance was highlighted as an important concept within nursing. Nurses are positioned and expected to detect, evaluate and prevent adverse responses to medication via pharmacovigilance activities (Johansson-Pajala et al., 2015; Reumerman et al., 2018; van Eekeren et al., 2018). Concerningly, much has been published on the deficient knowledge of pharmacovigilance activities and reporting of adverse effects in nursing (Adu-Gyamfi et al., 2022; Salehi et al., 2021; Veena et al., 2021), with several reasons associated with it including deficient knowledge of the reporting procedure or that it should be reported (Adu-Gyamfi et al., 2022; Macêdo et al., 2020; Salehi et al., 2021), inefficient reporting systems, a perception of not needing to report certain adverse effects (Adu-Gyamfi et al., 2022), deficient knowledge of pharmacovigilance concepts, or a belief that it was not the nurses' role (Salehi et al., 2021).

Competencies related to sourcing and interpreting of pharmacological information, including discussion of misinformation were considered important, The COVID-19 pandemic is an ideal contextual exemplar to showcase the importance of why such competencies are required by healthcare practitioners (Dramowski et al., 2020), including nurses. Social media-born misinformation may complicate healthcare practice, particularly given the effect that it may have on the trust of patients in the healthcare system (Southwell et al., 2020). Patient education on misinformation has recommended not necessarily trying to persuade patients, but rather to assist them with understanding the origin of misinformation or what is scientifically accurate (Southwell et al., 2020), while working alongside them to foster trust in healthcare practitioners and their education to guide their use of medication (Coman et al., 2022; South African Department of Health, 2020; Southwell et al., 2020). As opposed to dietitians and physiotherapists, the nurses' scope of practice is broader in terms of patient education regarding pharmacotherapy and, as mentioned earlier, their placement within patient care necessitates their involvement to ensure correct medicinal use (Jordan et al., 1999; Manias et al., 2004; South African Department of Health, 2020). Bolstering competencies related to understanding pharmacological research or sourcing quality information further supports evidence-based practice and the scientific basis of the nursing process (Lilley et al., 2022; Yildirim & Ozkahraman, 2011; Younas, 2017). Research has shown, though, that nurses have variable use of scientific information (Aharon et al., 2021; Fossum et al., 2022; Spenceley et al., 2008), often being less prevalent than other sources, such as peers, computers (Fossum et al., 2022; Spenceley et al., 2008), social media, news and websites (Aharon et al., 2021). Furthermore, recommendations have been made to increase the competencies related to information sourcing and interpretation to bolster healthcare practice (Aharon et al., 2021; Bautista et al., 2021; Björkström et al., 2013; Spenceley et al., 2008; Squires et al., 2011) that includes computer literacy skills (Fossum et al., 2022), and understanding the role research plays within clinical decision-making and the nursing profession (Björkström et al., 2013). For example, the strength of nurses to provide patient education, scientifically-sound guidance, and healthcare support was shown with the Dear Pandemic science communication platform involving nurses to mitigate COVID-19 misinformation and pandemic-related health queries (Ritter et al., 2021).

Populations may respond differently to drugs due to underlying genetic variations (Callier et al., 2014; Campinha-Bacote, 1994), necessitating a thorough understanding of pharmacogenetics and ethnopharmacology. Genomics have been increasingly important in healthcare sciences given their involvement with disease and response to treatment, which is supported by the Delphi participants remarking it as important at a higher cognitive level. As recommended by Callier et al.(2014) registered nurses should have a good understanding of pharmacogenomics (more so than other allied healthcare professionals, and at a similar level to general physicians) to navigate personalised medicines. Callier et al. 92014) suggested that nurses be able to describe the need for pharmacogenetics, interpret such information on medication, determine the response of patients with pharmacogenetic markers, and understand the limitations of their . Participants agreed that nurses would require application abilities to interpret how pharmacogenetics may alter pharmacological responses, and to interpret pharmacogenetic information provided with medication, while recommending a lower-level expectation to understanding the limitations of their scope of practice in relation to pharmacogenetics. Furthermore, they also agreed that being able to adjust their practice based on ethnopharmacological principles was necessary. Such variability in patient care

speaks to the nursing process that highlights the need to evaluate unique factors of patients that may affect their response to medication (Andersen & Moralejo, 2015; Younas, 2017).

Participants agreed that higher order cognitive competencies were required for broad matters related to pain management. Nurses are ideally placed for facilitating pain management as it is a frequently encountered medical ailment alongside numerous conditions, such as cancer (Anekar et al., 2023; Laborde & Texidor, 1996; Sherman et al., 2004). Given the difficulty in diagnosing or objectively determining the level of pain experienced, sensitivity and expertise are needed to approach pain management appropriately (Laborde & Texidor, 1996), whether with analgesics alone, or supplemented with co-analgesics and non-pharmacological treatment (McMillan et al., 2000; Sherman et al., 2004). This is further complicated by drug dependence and addiction, and psychogenic pain, necessitating a thorough understanding of the nature of pharmacotherapy, association with pain and equianalgesic changes to opioid treatment (Laborde & Texidor, 1996). Knowledge deficiencies that contribute to improper management of pain in patients have been described (Laborde & Texidor, 1996; McMillan et al., 2000). For example, addiction concerns are often inflated for some analgesics that may hamper adequate pain management (Laborde & Texidor, 1996; McMillan et al., 2000) as well as the duration of action and scheduling of analgesics (McMillan et al., 2000). Such addictive properties, particularly considering alternative treatments and their own chronic adverse effect profiles, are contentiously discussed (Anekar et al., 2023). For example, tolerance to opioids does not equate to dependence, as disease progression or physiological adaptation should be considered (Sherman et al., 2004). Attitudes to pain management are also heavily subjective, with age, gender, disease and body language affecting decision-making processes (McMillan et al., 2000). Although aligned with end-of-life care, a comprehensive pain module was recommended by Sherman et al. (2004) that can be relevant beyond its scope as it deals with broad classes of analgesics (opioids, non-opioids and adjuvant therapies), administration routes, treatment algorithms, equianalgesia (dose changes between analgesics that deliver a same therapeutic response), and special populations. A prominent treatment algorithm, particularly in pain management in cancer, is the World Health Organization Analgesic Ladder (Anekar et al., 2023). Although the pain management ladder is promulgated as a necessary procedure, Anekar et al. (2023) describe its complexity in light of pain as a construct, and argue for necessary education and interprofessional involvement to ensure more comprehensive pain management in diverse populations. Approaching curricular change may require not only increasing knowledge of pharmacological pain management, but also promoting developing affective domain competencies to ensure attitudes do not perpetuate bad practice and inappropriate belief of pain (Sherman et al., 2004). This is particularly true for pro re nata (as needed medication) analgesic administration (Manias, 2003) that provides more flexibility and decision-making responsibility to the nurse in their administration practice (Manias, 2003; Manias et al., 2004). However, this relies heavily on their knowledge and attitudes to patients' pain management care (Sherman et al., 2004).

Antibiotic stewardship, the practice of ensuring efficient and safe use of antibiotics, was noted as important. Given the rife use of antibiotics in clinical practice that perpetuates, among others, antibiotic resistance, sufficient knowledge thereof is needed (Fleuren et al., 2019; Van Huizen et al., 2021) that reiterates the relevance of inclusion and/or bolstering of the pharmacological concepts thereof, not only in terms of the nursing process, but also the pharmacotherapeutic aspects related to antimicrobials. Nurses have a prominent role in the administration (Courtenay & Chater, 2021; Fleuren et al., 2019; Teague et al., 2023; Van

Huizen et al., 2021) and monitoring of responses to antibiotics, antibiotic dosing and de-escalation of doses, educating patients on the correct use of the medication, and supporting antibiotic stewardship (Courtenay & Chater, 2021). Knowledge deficiencies observed in nurses regarding antimicrobial stewardship (Balliram et al., 2021; Engler et al., 2021; Fleuren et al., 2019; Padigos et al., 2021; Teague et al., 2023) include the basic sciences of antibiotics and clinical considerations (Balliram et al., 2021; Teague et al., 2023).

The nursing process, a systematic guide to providing nursing care, was remarked as important at a higher cognitive level. It has long been remarked as a nursing science-based approach to yield effective care, progressing from assessment, diagnosis, planning, implementation to evaluation (Comerford & Durkin, 2024; Lilley et al., 2022; Shiferaw et al., 2020; Tadzong-Awasum & Dufashwenayesu, 2021; Younas, 2017). The influence of pharmacotherapy on the patient, whether their current treatment or something that is newly introduced, requires formal assessment and planning to ensure its appropriateness for the diagnosis (Comerford & Durkin, 2024; Lilley et al., 2022). Additionally, when introducing the intervention, the rights of medication need to be followed to ensure the correct patient receives the right dose of the right drug at the right time via the right route (Comerford & Durkin, 2024). Evaluation of the patient's response is needed to ensure patient care is effectively managed (Comerford & Durkin, 2024; Lilley et al., 2022). By following a standardised approach, clear communication is available among nurse professionals to make clinical judgement and decisions for improved health outcomes (Shiferaw et al., 2020; Tadzong-Awasum & Dufashwenayesu, 2021). A meta-analysis has shown that knowledge of the nursing process greatly improved its implementation success (Shiferaw et al., 2020) that supports the need to include it in the curriculum within the context of pharmacology. Invariably, throughout the nursing process, pharmacotherapy use will have to be clearly delineated to ensure it is acknowledged within the comprehensive nursing care plan. When such processes fail to be successfully implemented, care plans will be less scientifically-based, engaging in clinical reasoning, and importantly, lack the supportive documentation to showcase the thought process. A lack of documentation of the nursing process has been highlighted in research (Mutshatshi et al., 2020, 2022; Tadzong-Awasum et al., 2022), which does precipitate potential deficiencies in patient care (Mutshatshi et al., 2022).

4.1.2.2. Pharmacotherapeutic competencies

An additional twenty-one pharmacotherapeutic areas were recommended by participants in comparison to what is normally presented during the FAR 381 and FAR 382 modules, which emphasises the broad scope of practice of the nurse, and diseases that they may encounter. As the design of a healthcare curriculum would need to align with the disease burden of the country, relevance is drawn from South Africa's quadruple burden of disease and morbidity statistics. As discussed in Chapter 1, Section 2, South Africa's disease burden comprises non-communicable and communicable diseases, maternal and child mortality, and injury, violence and trauma (Ataguba et al., 2020). In 2012, Mash et al. (2012) reported that morbidity statistics in the South African primary healthcare sector included communicable (e.g., HIV/AIDS, upper respiratory tract infection, tuberculosis, non-specified infectious diseases, urinary tract infections, influenza and dermatophytosis) and non-communicable (e.g., hypertension, type II diabetes, osteoarthritis, gastrointestinal complaints, asthma, chronic obstructive pulmonary disease, epilepsy) disease diagnoses, as well as a broad range of symptomatic complaints, including coughs, headaches, nausea and vomiting, anorexia, pain, urological concerns,

disorders of the eye, ears and skin, musculoskeletal detriments, and gastrointestinal dysfunction. The findings of Mash et al. (2012), although dated, align with the quadruple burden of disease concerns of the country. Similarly, Achoki et al. (2022), in their Global Burden of Disease 2019 study, reported that communicable (i.e., HIV/AIDS, sexually-transmitted infections, respiratory infections, tuberculosis, enteric infection, malaria) and non-communicable diseases (nutritional deficiencies, maternal and neonatal mortality, cancer, diseases of the cardiovascular, digestive, integumentary, musculoskeletal, respiratory and neurological systems, and mental health disorders) contributed to healthcare concerns in South Africa, suggesting that concerns have remained similar in the past decade. In 2019 the Institute for Health Metrics and Evaluation reported that mortality causes were aligned with the quadruple disease burden of South Africa, including HIV/AIDS; ischaemic heart disease; stroke; lower respiratory tract infections; diabetes; tuberculosis; road injuries; interpersonal violence; neonatal disorders, and diarrhoeal diseases (Institute for Health Metrics and Evaluation, n.d.). Alongside this, new diseases, such as COVID-19 would be relevant to discuss (Dramowski et al., 2020; Ritter et al., 2021). As such, the nurse's exposure to disease in the healthcare sector is quite extensive, and although one cannot assume expertise should be present for all, given their variable frequency of encounters, it suggests that educational platforms will need to cater for a diversity of healthcare concerns that in themselves complicate maintaining appropriateness of delivery within any professional qualification.

As described in Section 4.1.2.1, the nursing process will require of graduates to have a thorough understanding of the basic sciences of various pharmacotherapeutic areas to ensure that they can properly plan, intervene and monitor patients that require or are already taking medication. Additionally, given their role of medication managers, graduates would need to have knowledge of generic drug names, classes of the pharmacotherapy, their clinical indications, dosing ranges and administration considerations with which they are engaging (Dubovi et al., 2018; King, 2004). To facilitate discussion of the diversity of diseases indicated as important at high cognitive levels, focus will be placed on some of those that have been indicated as new in the Delphi study within broad groupings of the diseases. Many of the pharmacotherapeutic areas that were suggested would in general have overlap with already established sessions; however, the context and indications thereof would inherently be different. As documented in the accreditation of the Bachelor of Nursing Science, pharmacology (alongside other disciplines) must be included within the nursing process for formal assessment to allow for quality care to be achieved (South African Qualifications Authority, 2018b).

Participants indicated that competencies were needed for medication that would be involved in emergency or high-risk settings: high-alert medicine; resuscitation medicine; and intensive care unit procedures (although at a lower cognitive level). High-alert medicine comprises those that carry an increased consequence should an error take place, and thus have a greater detriment to patient outcomes (Institute for Safe Medication Practices, 2018). South Africa does not have a current list of such medicine in place, apart from isolated medicine safety warnings from the South African Health Products Regulatory Authority, and thus knowledge is drawn from the Institute for Safe Medication Practice (Institute for Safe Medication Practices, 2018). Although broad classifications are used for some medicines, context and/or individual drugs may become more important for some. Some notable examples include adrenergic agonists (i.e., adrenaline) and antagonists (i.e., propranolol); anaesthetic agents (i.e., ketamine); antiarrhythmics (i.e., lidocaine); antithrombotic agents (i.e., warfarin; apixaban);

chemotherapeutic drugs; inotropic agents (i.e., digoxin); liposomal formulations of some drugs (i.e., amphotericin B); opioids; neuromuscular blockers (i.e., succinylcholine), and hypoglycaemics (i.e., glyburide) (Institute for Safe Medication Practices, 2018). Supporting the need to bolster such competencies, reports have indicated that there is insufficient teaching and knowledge of high-alert medicines (Güneş et al., 2021; Lo et al., 2013; Pereira et al., 2021; Sullivan et al., 2013); for example, which drugs are considered high-alert medicines (Sullivan et al., 2013), potassium chloride and sodium chloride infusions, calculations relating to certain medicine, and unit expressions (Güneş et al., 2021; Pereira et al., 2021). As such, competencies directed to such areas of use should be included that are supported for inclusion both in undergraduate curricula and via continuing education platforms (Lo et al., 2013). Importantly, high-alert medicines should not be seen from one perspective alone, as frequent medication errors unique to institutions may suggest more individualised lists need to be developed (Schepel et al., 2018; Sullivan et al., 2013). Given the breadth of high-alert medicine, the contextual relevance of their high risk can be discussed alongside their general basic sciences' aspects in systems-based pharmacotherapeutic sessions; for example, cardiovascular pharmacology for those acting on the heart, vasculature or coagulation system. At present, risks are discussed alongside adverse effects; however, their unique position as high-alert medicine is not currently discussed nor emphasised in the FAR 381 and FAR 382 modules.

Pharmacotherapy is seen as supportive to advanced cardiac life support and resuscitation procedures, though needs to be integrated appropriately with non-pharmacological modalities to ensure that interference between interventions does not occur (Dager et al., 2006; Günaydin, 2005; Vallentin et al., 2020). As such, competencies need to align with standardised algorithms for intervention (Resuscitation Council of Southern Africa, n.d.), but also with the considerations of risk versus benefit when using pharmacotherapy during advanced cardiac life support (Dager et al., 2006). Various drugs are considered relevant during resuscitation, including cardiovascular drugs altering the heart rate, blood pressure and coagulation, and reversal agents for poisoning or overdoses (Dager et al., 2006; Günaydin, 2005; Resuscitation Council of Southern Africa, n.d.; Vallentin et al., 2020). As with high-alert medicine, such medicines are not necessarily only pertinent under the blanket of resuscitation medicine, and thus contextually can be dealt with during systems-based pharmacology. However, clinical contextualisation would be needed, and invariably may be more relevant from a clinical educator's perspective to integrate the basic sciences' aspects of such emergency conditions with the unique pharmacological considerations. As the Resuscitation Council of Southern Africa has standardised algorithms for advanced cardiac life support (Resuscitation Council of Southern Africa, n.d.), alignment with South African guidelines would be most appropriate to ensure adherence to national approaches and provide further contextual education.

Wound management is a basic service generally provided within primary healthcare settings that often involve nurses (Giaquinto-Cilliers et al., 2022). Wounds can be acute or chronic, and involve a myriad of origins necessitating adaptability of the treatment, for example, those from burns (Boersema et al., 2021). As such, competencies related to the pharmacotherapy that serve as adjunct modalities during wound management become necessary to ensure adequate treatment and a prevention of worsening of the wound (Markiewicz-Gospodarek et al., 2022). Various pharmacological agents may be used during wound management that include those used in burn wounds: analgesics, anti-inflammatory drugs, and some neurological agents, including antidepressants, anxiolytics, and antipsychotics (Markiewicz-

Gospodarek et al., 2022) that can be discussed within the broader context of their drug classes rather than a specific disease. Overlapping with the importance of antibiotic stewardship competencies discussed in Section 4.1.2.1, knowledge of the appropriate use of antibiotics in wounds is necessary, considering the potential risk of antibiotic resistance (Boersema et al., 2021).

Cancer remains a global challenge, and its contribution to morbidity and mortality in South Africa is well-described (Achoki et al., 2022). Cancer care would generally be approached from a specialist perspective (Challinor et al., 2020; Young et al., 2020); however, nurses would also require an understanding of the drugs that patients may be prescribed during chemotherapeutic regiments. Apart from oncotherapeutic drugs, palliative nursing care often arises as well, for example, in terms of pain management (Maree et al., 2023). As such, palliative care should be included in nursing curricula (Van der Plas et al., 2020) that also aligns with the pain management competencies described in Section 4.1.2.1. Unfortunately, knowledge deficiencies in nurses have been noted for such competencies (McMillan et al., 2000).

4.1.2.3. Generic competencies

All generic competencies were considered important to the development of nurses that aligns with the critical cross-field outcomes (South African Qualifications Authority, 2000), the accreditation documents (South African Qualifications Authority, 2018b), and University of Pretoria attributes (University of Pretoria, 2022). These competencies can be justified in terms of several core competencies discussed earlier, and thus will be contextualised below to showcase their importance.

The nursing process is considered a problem-orientated approach that provides nurses with a greater sense of autonomy within a systematic framework for decision-making (Yildirim & Ozkahraman, 2011). As such, it has been remarked as a problem-solving activity where illnesses are defined as nursing problems (Yildirim & Ozkahraman, 2011) that necessitate critical thinking and problem-solving as important attributes to support nursing diagnoses (Bayram et al., 2022). To facilitate such problem-solving and allow for engagement with clinical decision-making, nurses should attain critical thinking skills (Falcó-Pegueroles et al., 2021; Fesler-Birch, 2005). Furthermore, critical thinking promotes research-mindedness, thus promoting nurses' ability to engage with research (Falcó-Pegueroles et al., 2021), which speaks to an evidence-based practice. As discussed in Section 4.1.2.1, research practice is also necessary for patient education and mitigating misinformation (Aharon et al., 2021; Bautista et al., 2021; Björkström et al., 2013; Spenceley et al., 2008), and is also reliant on computer (Fossum et al., 2022) and media literacy skills (Bautista et al., 2021). Such abilities critically to analyse problems for creative solutions, engage in research practice, and navigate new resources (such as technological) are also included within the exit level outcomes of the Bachelor of Nursing Science (South African Qualifications Authority, 2018b).

Patient education is a core function of the nurse as described in Section 4.1.2.1 that requires interpersonal competencies for social and cultural interaction and communication. Given the sensitivity necessitated by patient interactions, patient education needs to take into consideration barriers typically encountered, such as attitudes or beliefs of the treatment; social and economic support; healthcare practitioner-related barriers, such as patient

relationship or discussions not being ideal, and treatment-related factors, such as complexity, misunderstandings, and concerns of adverse effects (South African Department of Health, 2020). Persuasion may not be the most appropriate format for patient education, but rather to assist patients to understand the considerations involved with their healthcare (Southwell et al., 2020) and afford them a trusting environment (Coman et al., 2022; South African Department of Health, 2020; Southwell et al., 2020). Such sensitivity in approaching healthcare and education is also needed, for example, in palliative care (Maree et al., 2023). Without the ability to manage inter- and intrapersonal settings, educating patients thus becomes a more tenuous exchange, and likely will not incorporate person-centredness, a competency highlighted as important by the Delphi participants. Such person-centred care is also emphasised within the current accreditation of the Bachelor of Nursing Science to ensure that respect for the uniqueness of individuals is afforded within the nursing process, as well as that education is dealt with appropriately (South African Qualifications Authority, 2018b).

The aforementioned competencies are also important alongside collaborative and interdisciplinary teamwork to improve healthcare outcomes. Healthcare is not an isolated environment and requires a network of healthcare practitioners with their unique scopes of practice. For example, interprofessional working between nurses and other healthcare practitioners has been espoused as necessary for antibiotic stewardship with pharmacists, medical doctors and other healthcare specialists (Schellack et al., 2016, 2018), supporting wound care specialists in wound management (Boersema et al., 2021; Iretiola et al., 2020), engaging with multidisciplinary palliative care teams (Maree et al., 2023; Van der Plas et al., 2020), and ensuring appropriate pharmaceutical care with pharmacists (De Baetselier et al., 2021, 2022). Working within diverse healthcare teams is considered important within the Bachelor of Nursing Science, and is mentioned several times in different contexts, including for the nursing process, patient education, and healthcare systems (South African Qualifications Authority, 2018b).

4.2. Targeted needs assessment

The targeted needs analysis is discussed in a stratified format according to the development of pharmacological competencies, scaffolded learning from physiology and alignment of the proposed pharmacology curriculum. This incorporates both the curriculum mapping and focus group interviews given the cohesive nature thereof.

4.2.1. Development of pharmacological competencies

Curriculum mapping was done for both the current and the proposed pharmacology curricula, with the former serving as a platform to assess strengths and limitations of the current curriculum, and to guide the focus group. Several study guides from the Bachelor of Nursing Science programme could be obtained; however, those for Midwifery and certain Nursing Practice Education modules were not recovered and thus can be seen as limitations to the mapping process. Regardless of this shortcoming, module content in the yearbook did expand on some of these gaps (University of Pretoria, 2024c), even if they lacked specific learning outcomes and assessment criteria. With the available information, the number of links between the assessment criteria of the pharmacology curricula could be assessed relative to the learning outcomes of the associated modules. A general concern was the low level of linkages between the core modules (Nursing Studies and Nursing Practice Education) and

Pharmacology. Although these increased for the proposed pharmacology curriculum, they remained low (4.32% to 36.69%), indicating a potential lack of explicit learning outcomes and assessment criteria. Without clear learning outcomes, curriculum mapping becomes more unclear, and thus fails to indicate whether there is a lack of scaffolding or alignment between modules, leading to potential gaps or deficiencies that hinder the learning process. Given the importance of clearly aligned outcomes (Balzer et al., 2016; Treadwell et al., 2019), study guides would need to provide sufficient information to allow for curriculum mapping to occur. The curriculum mapping process may be seen as a point to instil quality assurance during the process as outcomes would likely require reworking to adhere to good practice (Treadwell et al., 2019) that would serve the Bachelor of Nursing Science programme beneficially.

When queried whether participants believed that students were developing pharmacological competencies, mixed opinions were raised, but overtly centred on students not developing contextualised, relevant and integrated competencies that would be needed to survive, adapt and contribute to their working environments. Given the mapping performed, this is evidenced by the misalignment with various pharmacotherapeutic areas not being acknowledged within the core modules, and vice versa, where several diseases within the core modules have no scaffolding from the pharmacology curriculum. Literature supports the challenges nurses face to adapt within their immediate environment due to a lack of pharmacological understanding, particularly in terms of their clinical scope (Achike & Ogle, 2000; Bucknall et al., 2019; Desai, 2009; Foster et al., 2017; Manias et al., 2004; Manias & Bullock, 2002). Participants reported that students struggled to apply knowledge in their clinical platform, for example, basic mechanistic information of drugs for application, recognising the most important pharmacotherapy on the emergency trolley, posology and addressing medication management appropriately. Many of these concerns have their origin in the core concepts of pharmacology that have already been discussed in Section 4.1.2.1. Such concepts are necessary for the understanding of clinical indications, rationale for medicine use, administration and dosing (Dubovi et al., 2018; King, 2004) as they become encapsulated in clinical understanding (Jefferies et al., 2010; Rikers et al., 2004) and are important for clinical decision-making (Bandiera et al., 2013; Jefferies et al., 2010). Furthermore, the core concepts, particularly pharmacokinetics and pharmacodynamics are recognised in the practical nursing curriculum (Idaho State Department of Education, 1992; Mississippi Research and Curriculum Unit for Vocational and Technical Education State College, 1995; Ohio State Department of Education, 2001) as they impart to students the ability to engage in psychomotor competencies. Deficits in the core concepts have already been noted for nurses that invariably may predispose them to medication errors tied to a function of the nurse (Oldridge et al., 2004; Jones, 2009; Lohmann et al., 2015; Du Preez, 2016; Blignaut et al., 2017; Matiso, 2017; Dirik et al., 2019; Gracia et al., 2019; Caboral-Stevens et al., 2020; Wondmieneh et al., 2020; Bengtsson et al., 2021; Nicholson and Damons, 2022), for example, based on calculations (Oldridge et al., 2004; Jones, 2009; Matiso, 2017; Gracia et al., 2019; Caboral-Stevens et al., 2020), or administration practice (Gracia et al., 2019; Lohmann et al., 2015). The overarching concern raised by this is the possibility of inefficient daily activities of the nurse, such as approaching the nursing process that relies on the application of core concepts. Should patient education, medication management, posology and monitoring of biological effects be hindered, medication errors can occur leading to detriments in a patient's therapeutic outcomes. For example, in a similar way that reports have indicated limited knowledge of high-alert medicine (Güneş et al., 2021; Lo et al., 2013; Pereira et al., 2021; Sullivan et al., 2013), participants reported that students struggled to identify which medicines would be needed on

the emergency trolley. Such lack of clarity may have detrimental effects within an emergency setting, and may potentially lead to medication errors due to, for example, administration of the incorrect medication, incorrect dose selection, or the inability to react within the necessary timeframe.

In support of the focus group feedback, literature also posits that various factors contribute to medication errors, such as non-educational (e.g., illegible prescriptions; similar drug names) or education reasons (e.g., insufficient training; limited clinical exposure; lack of pharmacological contextualisation) (Haroun, 2018; Kid, 2019; Musharyanti et al., 2019; Vaismoradi et al., 2014). As discussed in Section 4.1.2.1, statistics related to medication errors leading to preventable patient morbidity and mortality showcase the importance, among other non-educational factors, to bolster and develop pharmacological competencies to allow for efficient medication management. Medication errors may degrade the trust placed in healthcare practitioners, for example as reported for the George Mukhari Academic Hospital's neonatal ICU and paediatric wards in 2017 that involved both nurses and doctors (Juta Medical Brief, 2017). Important to acknowledge within the aforementioned news article is that many of the medication errors were cumulative flaws of the system, and not a singular point of blame (Truter et al., 2017). However, they invariably culminated in the administration of medicine, which is a function of the nurse. Given participants' concerns, students are struggling to develop their nursing process competencies in relation to pharmacotherapy that thus predisposes them to similar inadequacies as presented by literature. Nurses have provided variable views on their role within medication management, for example, not necessarily recording medication effects of patients after administration, being conservative in the administration of pro re nata medication, or deferring patient medication education to other healthcare practitioners, such as pharmacists (Manias et al., 2004). An audit of nursing care documentation found that deficiencies in recording of pain assessment, pharmacological and non-pharmacological interventions, and outcomes of the interventions were present (Manias, 2003). A similar lack of documenting the nursing process, which hinders successful care, has also been described (Bassah et al., 2023). Furthermore, mental healthcare nurses reported that although much of their time was spent monitoring patients' medication, they often lacked structured formats of assessment or pharmacology knowledge to allow for thorough execution thereof (Jordan et al., 1999). Overall, a thorough understanding built from appropriate education on the competencies of medication management is needed to ensure that the scope of practice of a nurse is adhered to, and that graduates can perform satisfactorily in their professional environment.

The theory-practice gap was acknowledged by participants where students were incapable of using their knowledge appropriately within the clinical setting for decision-making purposes. Participants posited that the lack of integration between pharmacology and the clinical aspects of nursing, inauthenticity in the classroom, and the overt basic sciences focus of the module contributed to the theory-practice gap. Students failing to see the patient within the theory to which they were being exposed made it difficult for them to apply their knowledge within the wards when such a patient was being cared for. As shared by one participant, the nursing profession's link to pharmacotherapy was more than just the mechanism of action or biological mediators involved, and thus practical authenticity deviated away from the theory. Participants' views have been echoed in literature suggesting that the theory-practice gap was widened by limited pharmacology education (King, 2004), lack of integration between basic and clinical sciences (Cheraghi et al., 2010; Ugwu et al., 2023; Zenani, 2016), ineffective classroom

practices, and professional tension between teaching staff (Cheraghi et al., 2010; Ugwu et al., 2023), which decreased patients' therapeutic outcomes (Cheraghi et al., 2010). The theory-practice gap may also be affected by inadequate nursing process competencies. Research has indicated that there are concerns with the nursing process due to its resource-intensive nature (Mutshatshi et al., 2020; Tadzong-Awasum & Dufashwenayesu, 2021), compounded by an overt deficiency in knowledge of the nursing process (Mutshatshi et al., 2020; Tadzong-Awasum et al., 2022; Tadzong-Awasum & Dufashwenayesu, 2021). Nursing diagnosis has been remarked as being challenging to execute correctly, hampering the success of the process (Bassah et al., 2023; Mutshatshi et al., 2020). Inadequate knowledge of the nursing diagnosis precipitates a theory-practice gap that subsequently leads to misdiagnoses and a systemic failure of implementation of the nursing process (Tadzong-Awasum et al., 2022). Such inability accurately to employ the nursing process may predispose students to inefficient application of their pharmacological knowledge in medication history-taking, evaluation of its effect within the patient's treatment, and downstream aspects of monitoring, such as pharmacovigilance.

Interestingly, participants remarked that the professional identity of the nurse contributed to competency development concerns, such as what was opined by Cheraghi et al. (2010) and Ugwu et al. (2023). Two major points of discussion emerged from their identity: i) teamwork within the nursing profession, and ii) diminishment of the nursing profession. Participants believed that nurses acted in a militaristic fashion, laying claim to their professional territory, which included their teaching platform. Cheraghi et al. (2010) reported that junior nurses felt that senior colleagues were more dominant in the structure and unwilling to accept change in practice, often creating tension within the teaching environment (Cheraghi et al., 2010). Similarly, participants in the study by Ugwu et al. (2023) felt that professional tension between nurses and doctors worsened the theory-practice gap, which was also bolstered by the perception that clinical educators did not want to teach or respect their students (Ugwu et al., 2023). In such a way, professional tension may debilitate the environment where clinical educators and basic scientists need to work together to establish a more appropriate curriculum. This is compounded by potential internal struggles that nurses may feel within their professional identity. The hierarchal challenges reported by Cheraghi et al. (2010) and Ugwu et al. (2023) are echoed by Combrinck et al. (2020) and Mbalinda et al. (2023) in that nurses' identity may become belittled by others within the medical hierarchy (including their senior nursing colleagues) that ultimately affects the way in which they see their competence (Combrinck et al., 2020; Mbalinda et al., 2023). As one participant stated, the patient should be seen centrally within the healthcare discussion, similar to what was noted by Black et al. (Black et al., 2008), and thus elements relating to the professional identity should not become barriers to developing competencies.

The negative perception of pharmacology was raised by participants, and echoed by my own fears of what students feel about the module. Although pharmacology is often seen as interesting, it is also described as difficult due to the complexity of the topics, drug names, diversity of mechanisms, and overload of content (Ahsan & Mallick, 2016; Bhosale et al., 2013; Jalgaonkar et al., 2012; Lymn & Mostyn, 2010; Manias & Bullock, 2002). Such perceptions of difficulty create a demotivating environment for students to approach their learning. Such stressors within the learning environment, bolstered by the potential repeat of the year should they not pass FAR 381 and FAR 382, perpetuate fear rather than excitement for the module, which in such a way may also hamper valuation of the discipline within their profession. This

may invariably affect how competency development occurs, as poor motivation results in a less amenable learning milieu with improper intrinsic driving forces to excel within the discipline (Ryan & Deci, 2020). Although external regulators, such as the fear of failure (Ryan & Deci, 2020) may motivate students acutely to perform, a lack of competence potentiates demotivation and may yield inadequate achievement of outcomes. As addressed within their meta-analysis, Howard et al. (2021) reported that amotivation was linked to inadequate mastering of outcomes, while intrinsic motivation yielded greater student performance (Howard et al., 2021).

4.2.2. Scaffolded learning from physiology

As mentioned in Chapter 3, Section 4.2, the content of the Physiology modules was generally broad, but learning outcomes and assessment criteria allowed for a certain level of explicit description of what would be covered in their modules. As the Bachelor of Dietetics share these modules, similar missing scaffolds were observed for the nursing curriculum, and thus is not discussed again within this chapter bar the contextual importance. Importantly, horizontal and vertical integration will need to be ensured (Faingold & Dunaway, 2002), particularly due to concerns raised by the focus group participants regarding the lack of contextualisation and application within their core discipline. Although the number of linkages in the proposed pharmacology curriculum has increased, concerningly, there is still a low level obtained for Physiology modules (14.39% [Year I] and 11.51% [Year II]) that highlights scaffolding challenges that may be encountered. The physiology platform allows for scaffolding of several core concepts of pharmacology, including elements of pharmacokinetics and pharmacodynamics. However, the lack of modules relating to molecular and cell biology, chemistry and biochemistry creates deficient scaffolding of learning of concepts such as ionisation, cellular membrane structure, and enzyme kinetics relating to absorption, distribution, metabolism and excretion pharmacokinetic principles (Gaohua et al., 2021; Manallack et al., 2013), and aspects of pharmacodynamics (Testa et al., 2012). Similar to the findings from the Dietetics group, most aspects related to pharmacodynamics have no explicit scaffold, and thus these concepts would invariably require a larger input from the proposed curriculum to develop, which draws away from the mandate of the module. Participants in the focus group shared their concerns that students' underlying physiological knowledge was insufficient to create a platform for pharmacology education, and impacted their broader nursing education (such as interpretation of diagnostic parameters or biochemical results).

The physiology education provided in the first two years, bolstered by the pathophysiological discussions in the Nursing Studies modules between Years I and III, may allow for a generalised perspective of the healthy and diseased gastrointestinal, respiratory, integumentary, cardiovascular, renal, and certain neurological systems; however, whether there is an adequate platform for discussion of feasible drug targets is unclear. Between Psychology, Nursing Studies and Nursing Practice Education modules, sufficient coverage of mental health-related diseases should be available to promote understanding of pharmacotherapy associated with their treatment, though based on the mapping activity, the underlying physiological frameworks for it may not be sufficient. Midwifery modules would provide support to Physiology, Nursing Studies, and Nursing Practice Education modules for a broader understanding of the reproductive system and its clinical associations. Systems that may be under-discussed include those relating to allergies, and nausea and vomiting. The lack of biochemistry may further impact understanding of certain functions related to proteins

and carbohydrates, and their involvement in diseases such as diabetes. Participants were concerned that students lacked the ability to relate the pathological changes that cause disease in a physiological system, and how to approach these during daily nursing care procedures. As with the pharmacological competencies, a concern of a theory-practice gap was evident, most likely attributed to decontextualised or non-integrated education that occurs within their physiology education. The basic sciences, which include physiology, share many perceptions in educational programmes, such as difficulty, decontextualisation and content-heaviness (Bhosale et al., 2013; Fincher et al., 2009; Gaur et al., 2020; Rangachari, 1997; Sani et al., 2020), and thus the finding is not unexpected. As physiology falls outside of the domain of the research study, it does highlight a larger need acknowledged by the participants: a formal programme review for curriculum realignment. Due to the concerns raised between basic and clinical sciences-focused modules, the clear need for more integration, greater teamwork, and mapping, the pharmacological competency issue will not be possible to resolve in isolation.

As opposed to the Bachelor of Dietetics, nursing students do have three second-year Medical Microbiology modules that provide them with a broad platform for an understanding of bacteria, viruses, fungi and parasites. Such a background is imperative for integration with pharmacology in their third year, as well as eventual vertical integration into their clinical practice. The proposed pharmacology curriculum spans several types of microorganisms, including those involved in bacterial (e.g., tuberculosis), viral (e.g., HIV, severe acute respiratory syndrome coronavirus-2 [SARS-CoV-2]), fungal and parasitic (e.g., helminths, malaria) infections. Unfortunately, there are no explicit assessment criteria detailing the depth of discussion for these microorganisms; however, pharmacologically-relevant drug targets span those that are critical for the survival and normal functioning of microorganisms. By ensuring that integration of microbiology and pharmacology (Steinel et al., 2019) occurs in a structured fashion between both modules, a more appropriate scaffold will be created that negates the need for reiteration of the microbiological features during class time (such as is currently taking place). Within a focused module for each healthcare practitioner, this also becomes less consequential than for those groups that do not have the prerequisite education for scaffolding to occur.

The nursing group is the only healthcare practitioner group from the three assessed that is enrolled for Medical Terminology, a module that affords students an understanding of the etymology of medical terms (University of Pretoria, 2024c). Medical Terminology is imperative in a functioning healthcare system as it provides a clear discourse between healthcare practitioners that prevents ambiguity (Hull, 2016; Iwasaki, 2018). By fostering a better understanding of medical terminology in the nursing group, students gain an advantage of the etymological design of many relevant terms (Iwasaki, 2018) that thus also reduce the need for memorisation of different words themselves. For example, by understanding the etymology of hepatomegaly (enlarged liver) as comprising conjunction of hepar(liver) and megas (large) (OpenMD, n.d.-c), students can extrapolate into other terminology, such as hepatitis (inflammation of the liver; hepar and itis [inflammation]) (OpenMD, n.d.-b) or acromegaly (enlargement of areas of the body, such as head, feet and thorax; akron [tip or extremity] and megas) (OpenMD, n.d.-a). Given the diversity and complexity of medical terms, being able to deduce their meaning from etymological origins simplifies language and understanding. Although the naming of drugs does not follow the etymological parameters of medical terminology (such as Greek or Latin origins (Iwasaki, 2018)), given that a learning opportunity

may easily refer to a range of indications, contraindications or adverse effects based on medical terminology, this does help reduce some of the burden of learning at least. Drug names follow a different set of principles based on the International Nonproprietary Names (INN) for pharmaceutical substances (Kopp-Kubel, 1995). The INN provides guidance on general prefixes, substems and stems that allow for some convention in naming of drugs (Kopp-Kubel, 1995), such as the -olol stem referring to β-adrenoreceptor antagonists (e.g., propranolol and atenolol) or -grel for platelet platelet aggregation inhibitors (e.g., clopidogrel and dazmegrel). These naming conventions are not addressed in class but are provided as a supplementary resource in FAR 381 and FAR 382 for students as self-study.

4.2.3. Alignment of the proposed pharmacology curriculum

Although a range of new pharmacotherapeutic areas was included during the Delphi study, their alignment within the current programme was overtly constrained by similar concerns of limited scaffolded learning. Participants did not comment on any pertinent area that was included as important or redundant, but rather suggested that topics be included in brief where possible and relevant. Participants recommended that areas or drugs with similarity be discussed in groupings, which would decrease the potential overload of information related to them. Although true, this is already being done in practice in FAR 381 and FAR 382 from a predominant systems physiology-based approach. For example, when discussing hypertension, the broad categories of the disease are discussed, as well as the various antihypertensives available. Alongside this, specific types of hypertension, such as gestational hypertension, which is applicable to pregnancy are acknowledged with their pharmacotherapeutic alterations. This would be more difficult in diseases where pharmacotherapy has not yet been discussed, such as cancer, or indications that require broad contextualisation given the diversity of symptoms that may arise, such as with dermatological disorders. As such, more time would be necessitated within the curriculum.

Midwifery highlighted the importance of contextualising considerations for pharmacotherapy in pregnancy, which was considered lacking at present. Pregnancy alters the physiology of a woman, which may alter the way in which pharmacological effects occur due to changes in the pharmacokinetics (Feghali et al., 2015; Pinheiro & Stika, 2020) or pharmacodynamics of a medication (Pinheiro & Stika, 2020). Additionally, many medications may be contraindicated or inappropriate during pregnancy, or require specific criteria to be used (Eke et al., 2020; Laroche et al., 2020). As some drugs are prescribed off-label in pregnant individuals, such contextual alterations to their use should also be clear (Laroche et al., 2020) to avoid contradictions or ambiguity in learning opportunities between pharmacology and midwifery. Currently, some conditions, such as hypertension, antiretroviral treatment and gastrointestinal diseases do acknowledge pregnancy considerations within treatment. Midwifery highlighted hypertension and HIV as two areas where pharmacology was lacking though, and thus it may indicate a larger concern of the inability of students to apply their knowledge within the discipline (which was acknowledged by participants as well), poor retention of knowledge, or contradictions between the various modules.

Participants remarked that an earlier introduction to pharmacology in their first year of study may help alleviate such a fearful view of the course, and help strengthen the valuation of it within the nursing programme. Participants believed that a stronger longitudinal train of pharmacological learning within the nursing programme would create enhanced horizontal

and vertical integration. Participants suggested that within their nursing-specific modules a clearer and more explicit incorporation of pharmacology learning outcomes could be incorporated to expose students in a scaffolded manner to the necessary competencies. For example, remarks were made to increase the teamwork between different departments, seeking clear outcomes that align with the nursing progression, and contextualisation of the patient within the basic sciences. This would require a much larger programme review, but as proposed by the focus group participants, such interprofessional and interdisciplinary working would be beneficial and welcome to their restructuring of the Bachelor of Nursing Science. It is interesting to note though that during the focus group discussion, assumptions of what was transpiring within the pharmacology modules was observed. This is similar to my own preconceived notions about the nursing-specific modules, and thus my positionality is acknowledged. Participants remarked in quite a few instances about the lack of speaking of clinical context or case reports in the teaching, learning and assessment of pharmacology, but this had been included several years ago. Similarly, clinical indications and considerations are part-and-parcel of the pharmacology education, but one participant assumed the discussions related only to molecular changes incurred by drugs. Although this does not undermine the comments relating to the lack of clinical context, which admittedly is an area where stronger integration can be achieved, it does highlight that more discussions between our two departments are needed to unblind the educational practice between our modules.

5. Recommendations

Several recommendations have been made for the Bachelor of Nursing Science programme, with focus on the pharmacology curriculum.

5.1. Programme level curriculum review and mapping

Curriculum mapping has indicated several scaffolding concerns related to pharmacology, particularly in terms of horizontal integration with associated disciplines, and potential inappropriate placement of learning outcomes throughout the programme. However, there does appear to be sufficient justification to assess the programme on a larger scale, as supported by the curriculum mapping exercise and the feedback from the focus group participants. Concerns most prominently related to the basic sciences not contextualising or supporting the growth of competencies adequately for the nursing profession, as well as the nursing-specific modules needing to emphasise such fundamental sciences in their clinical platform. As such, the recommendation would be that the programme undergoes a reimagining to determine the most appropriate way in which the fundamental modules could be scaffolded or integrated with one another, and allows for the opportunity to integrate vertically with nursing practice. Similarly, it would need to be determined how pharmacology would need to be interleaved throughout the programme appropriately and feasibly, which becomes clearer when all modules are considered together.

As discussed in Chapter 3, Section 5.1, LOOOP can be used to facilitate mapping, allowing for a transparent, auditable, living curriculum addressing Harden's windows (Balzer et al., 2016; Treadwell et al., 2019) that provides an additional imperative to realign learning outcomes (Treadwell et al., 2019). It should be acknowledged that this is not a quick process, and thus sufficient time would need to be allocated to allow for full stakeholder engagement and feasibility discussions. Change management is an important process to consider during

the discussion (Balzer et al., 2016; Treadwell et al., 2019), though as mentioned by the focus group participants, the time to work together is necessary to strengthen the programme and outcomes for the benefit of the patient. However, the value of such an exercise is justified to increase the alignment and quality of education provided. The Department of Education Innovation provides a myriad of opportunities to facilitate engagement with faculty development programmes, or to provide support for curriculum design, thus platforms are available to capitalise on for soundboarding. Based on such a curriculum review, considerations relating to the credit load would need to be acknowledged to maintain the 480-credit limit required by an NQF level 8 professional programme (although an allowance of exceeding the limit by 10% is possible with sufficient motivation) (Council on Higher Education, n.d.).

5.2. Integration of pharmacology throughout the curriculum

Given the disconnect between the basic sciences and clinical application, as well as the repeating student concern due to failure in the third year, the following recommendation is made to facilitate greater integration and contextualisation. Pharmacology would be appropriate to interleave in Nursing Studies, Nursing Practice Education and Midwifery modules within the clinical context of what is being discussed at that stage, however, from a basic sciences vantage. This would necessitate careful planning to identify what can be discussed within the longitudinal train of education without superseding fundamental concepts not yet introduced. The core concepts of pharmacology (White et al., 2021) would be appropriate to include once students have developed a sufficient physiological understanding that can be facilitated using the conceptual framework proposed by Guilding et al. (2024). However, when best to introduce this may be unclear at present. Although elements thereof may be possible within the first year, particularly as Nursing Science addresses some preliminary topics thereof, including routes of administration and posology, careful scaffolding will be needed for pharmacokinetics and pharmacodynamics. For example, in the current programme, routes of administration and aspects related to dosing are discussed from the nursing and pharmacological vantage in Years I and III, respectively. This may result in inappropriate scaffolding or potential contradictions to arise between the basic and clinical sciences. By assessing what is appropriate to discuss on these concepts, and introducing preliminary concepts of pharmacokinetics alongside routes of administration and posology, a more cohesive unit of learning is created that provides a basis for the development of core concepts of pharmacology. Given the lack of chemistry, biochemistry and molecular and cell biology backgrounds, such preliminary aspects may include fundamental concepts required to scaffold more complicated pharmacokinetic topics. Importantly, such integration of the basic sciences within the clinical platform is routinely remarked to allow for the risk of depth of the discipline to be lost, which may worsen the underlying pharmacological knowledge of students (Umar & Haque, 2022; Woodman et al., 2004) and precipitate misconceptions between basic and clinical educators (Manias & Bullock, 2002; Umar & Haque, 2022). Care would be needed to ensure the emphasis remains clear to allow for a broader understanding of how physiology, pathophysiology and pharmacology are associated with one another. Stakeholder discussions would be needed to determine how to approach such integration best, alongside the larger programme level redesign that is proposed.

Similarly, within the core nursing modules, various pathological aspects are discussed, and although potentially too crowded to introduce pertinent pharmacological discussions, elements

related to identifying pharmacologically-relevant drug targets could be strengthened. The breadth of harmacology that needs to be discussed would support a stand-alone Pharmacology module, though this would need to align appropriately with what is being presented in parallel in Year III, and build efficiently from concepts prominently featured during the first and second years of study to allow for vertical integration with core nursing modules. The pharmacology of drug classes and pharmacotherapeutic areas can be introduced based on a systems- or treatment-approach, with alignment to what is presented prior, in parallel, and thereafter. More contextually relevant aspects of treatment, for example, those new topics that were recommended for inclusion, could be interleaved within the nursing-specific modules based on the broader pharmacological discussions of the drugs held in the third year. For example, anti-inflammatory drugs that are used in several different diseases, can be discussed within their broad context in Year III, and then later individualised within Nursing Studies or Nursing Practice Education modules, while the pregnancy-specific considerations can be addressed in Midwifery. Whether a single full-year or two-semester modules should be created will depend on the opinions of all stakeholders; however, I would argue that the former provides a more continuous platform for students to be educated and assessed on pharmacology, while circumventing the potential of students to fail within the first semester and be disallowed entry into the second semester's module. Potential andragogy and ways to allow for integration and clinical contextualisation will be discussed in Section 6.4.

5.3. Development of generic competencies by leveraging existing platforms

As remarked by participants, generic competencies are needed by nurses in South Africa, and supported by literature. Various platforms are already currently available that can help such development. In the pharmacology curriculum, an inquiry-based assignment, within the context of nursing, can allow for a breadth of discipline-specific competencies to be targeted, as well as stimulate generic competency development. For example, due to the smaller class sizes and less singular scope of practice, clinical relevance can be highlighted by situating the assignment in a nursing context. By providing students with a broad case built around the concept of the nursing process as a simulation of real-life, students can be tasked with researching the rationale of why certain pharmacotherapy was selected, and how it would serve as beneficial to a patient with a set range of characteristics. By building in multiple layers within such an assignment, potential adverse effects monitoring and pharmacovigilance can be approached, which adds additional clinical depth to the assignment and reinforces the nursing professions reality. Such an instructional design reinforces research-mindedness, critical thinking, and problem-solving, which can be bolstered further to include collaboration, teamwork and reflection depending on whether a team-based assignment is created.

Interpersonal competencies within the context of pharmacology could also be proposed outside of the Pharmacology module in existing collaborative modules, such as the Integrated Healthcare Leadership and various research-related modules presented by the School of Healthcare Sciences, as groups within the school are already enrolled for it. Although this would bridge into the jurisdiction of another module, discussions could be held to see what opportunities may be available to help create a pharmacological context alongside other activities that stimulate interprofessionalism. For example, communication and healthcare education is approached in Year II in Integrated Healthcare Leadership (University of Pretoria, 2024b, 2024c, 2024d), which, depending on the opportunities available, could have a

contextually relevant example of patient education or interprofessional, which spans not only pharmacology, but other disciplines and professions' scopes of education.

6. Considerations of the curriculum windows based on recommendations made

Using the recommendations made in Section 5, the following considerations will need to be kept in mind when addressing the proposed curriculum. It is important to acknowledge that these will require iterative stakeholder discussions, and thus should not be seen as a finalised proposal, but rather a platform for creation of an initial proposal document.

6.1. Expected learning outcomes

Learning outcomes and assessment criteria have allowed for preliminary mapping to be performed; however, explicit relation to other modules will need to be strengthened. For integration within the LOOOP system, the modular learning outcomes and assessment criteria of the programme will need to be reworked to be unambiguous and clear in terms of what is being expected of students. Although a large resource-investment, it is value-bearing, and thus will benefit the programme's organisation. This is particularly important for exit level outcomes (South African Qualifications Authority, 2018b) that necessitate patient management with clearly delineated conditions and considerations, as this would also help create a more defined scaffolding platform. Using the SAQA accreditation document (South African Qualifications Authority, 2018b) as an overarching framework for what should be achieved, a longitudinal thread can be created throughout the curriculum map of the programme. Should learning outcomes not be linked to such exit level outcomes, their relevance to the programme may need to be reconsidered. Furthermore, given the extent of mention made to generic competencies within the exit level outcomes, it strengthens the need to address them appropriately within different authentic contexts, and enhances the validity of the assessment to ensure they have been developed.

Given the increased range of pharmacotherapeutic areas, careful planning would be needed to see which assessment criteria could be grouped together or contextualised strategically to ensure there is not an overwhelming number of areas that need to be covered within a short span of time. For example, given Nursing Studies and Nursing Practice Education's current module content, with appropriate scaffolding, pharmacotherapy discussed within the Pharmacology module could be reiterated contextually within their core modules as a contextual modification to the indication, while the underlying pharmacological content may remain the same. Additionally, as remarked earlier, some elements of pharmacology that are currently being taught in the third year are addressed during the learning outcomes of modules prior to its execution, such as routes of administration in the first year, and certain pharmacotherapeutic areas' mechanisms of action. This in itself creates the potential for duplication or contradiction as they are not dealt with by the Department of Pharmacology, and may further precipitate misalignment or incorrect scaffolding. To facilitate this, a programme level review would be justified to ensure that all disciplines speak to one another in a scaffolded fashion, particularly given the request for greater integration throughout the programme.

6.2. Curriculum content or areas of expertise covered

As opposed to the Bachelor of Dietetics, nurses have a greater need for pharmacology education in its entirety, and thus content-wise the current coverage for FAR 381 and FAR 382 would be an appropriate platform for further development and refinement. Invariably, new areas would need to be constructed that have not been taught yet, or repackaged where possible to ensure that the contextual relation is clearer to nursing. The depth of this information can clearly be aligned with those proposed by Delphi participants, which overtly remain at a higher cognitive level. Refinement of the content would need to be done alongside relevant nurse educators to ensure the professional focus is maintained and areas of deficit are targeted. These would, for example, include the concerns raised by Midwifery lecturers. Given the public healthcare training platform, the EML will continue to be used as a framework for what should be included in the curriculum. As determined via curriculum mapping, several pharmacotherapeutic-directed assessment criteria are present within Nursing Studies modules, and thus it would need to be investigated to ensure contradictions or duplication is avoided, and that their introduction is done at an appropriate level in relation to the horizontal integration achieved at that stage. As a concern, based on the physiology and pathophysiology taught at second-year level, it is not clear whether a sufficient platform will be available to discuss pharmacokinetic and pharmacodynamic aspects without the Year III Pharmacology module being introduced to highlight the core concepts.

The removal of the Bachelor of Science students would support changes in the programme as well, mostly by providing focus for the curriculum content, but also reducing content-heaviness of certain sections that tend to veer into medication used in private practice or that acknowledge future treatment options can be eliminated. Integration with more clinically-relevant competencies, such as the nursing process, would require iterative discussions to ensure that the basic sciences can contribute effectively to the context of the clinical platform. For example, when discussing posology, interleaving the learning opportunity with the relevant pharmacokinetic parameters will result in a more effective packaging of knowledge, thus showcasing how all the relevant factors that guide dosing inform one another.

6.3. Student assessment

The smaller size of the class (approximately 51 ± 5.8 based on a five-year average) creates a new opportunity for how pharmacology assessment can be approached. The current formative assessments used in FAR 381 and FAR 382 are hampered by the sheer volume of responses that would need to be assessed, and thus fewer students would facilitate more opportunities for semi-personalised feedback. In doing so, feedback-driven learning can be approached that supplements learning to a greater degree than what is currently possible within the team. The request for greater integration and clinical contextualisation would be achievable with support from clinical educators from the Department of Nursing Science to provide exemplars or vignettes that help guide a clinically-relevant case report that covers the major aspects of nursing more appropriately. A good mixture of basic sciences and clinical relation would need to be included to ensure that enough disciplinary depth is assessed within the clinical context. As the assessment is conducted within a stand-alone module, disciplinary focus will be easier to maintain within such an assessment.

It will be important to consider the potential design elements related to introducing or integrating pharmacology in relevant nursing-specific modules. The involvement of pharmacology in the assessment will need to be evaluated as either contributing to the core learning outcomes of the module, or merely providing context and support to bolster the relation of the basic sciences. For example, should Pharmacology help enrich discussions about the nursing process, medication management or posology, would this be an assessable moment within their module, or merely a way to help support the achievement of their learning outcomes? Such integrated assessments are feasible, though do require careful planning to ensure learning outcomes are assessed with sufficient coverage of all elements (Dukhi et al., 2014; Fielding & Regehr, 2017; Hudson & Tonkin, 2004; Islam et al., 2017; Islam & Schweiger, 2015) and not to create increased resource needs (Dukhi et al., 2014; Fielding & Regehr, 2017). Change management will be important to consider as several different disciplines will be required to design the assessment (Fielding & Regehr, 2017).

6.4. Learning opportunities

As discussed in Chapter 3, Section 6.4, several approaches to andragogy have already been used within the pharmacology curricula based on educational theories (Cordier & Lubbe, 2021; Mlambo, 2021; Parkar, 2021), and thus a platform is available that can be built on. Such andragogy was built for use within a large classroom setting, and thus with adaptation can be modified to allow for small-group discussions and greater contextualisation. Two separate platforms will be discussed given the recommendations made: i) the Pharmacology module, and ii) integration within other modules. Although these recommendations are made, the staff and timetable windows would need to be appropriately considered as greater collaborative working between departments would invariably have a much greater resource-intensity to it.

The Pharmacology module's learning opportunities, as in the jurisdiction of the Department of Pharmacology, can be designed in several different formats appropriate to the content being discussed. Following the University of Pretoria's flipped classroom teaching framework (University of Pretoria, n.d.-b), provision of learning material to facilitate self-regulated learning allows for more active discussion within the classroom. Given the concerns of decontextualisation, this would be the ideal time to acknowledge the patient within the classroom setting through collaborative teaching with the Department of Nursing Science. For example, clinical educators can be brought into the learning opportunity to present a real-life case relating to the disease of interest, which becomes the core focus of the discussion thereafter. Pharmacokinetics and pharmacodynamics related to such a case can then be discussed in full, with branching opportunities offered to help diversify the learning. For example, using hypertension as a platform, a patient from a specific population group with uncontrolled hypertension could be discussed based on recognised antihypertensive treatment guidelines, where later the considerations change as the patient becomes pregnant or starts to experience renal complications. Such branching would help create more contextually-relevant learning, and showcase the complexity of the nursing process as well. In doing so, more authenticity is brought into the classroom, which helps to mitigate the decontextualised nature of basic sciences and promotes seeing the real-world nature of pharmacology in their context.

An overarching platform to facilitate such a learning opportunity could incorporate small-group, case-based learning discussions, where social problem-solving promotes critical thinking

(Ahmady & Shahbazi, 2020). Integrated learning platforms that allow for more interdisciplinary working may be possible (Steinel et al., 2019) but require a much stronger collaborative environment that will call for programme evaluation to ensure scaffolding is appropriate and duplication is not done. Role play has been shown to simulate the real-world environment as well, however, may become more complex to implement within the group given logistical and time constraints (Jalgaonkar et al., 2012). However, such modalities may still be investigated for other modules' education, for example, patient education relating to pharmacology. Simulations will also help create a more authentic environment (Ginzburg et al., 2017), whether using high-fidelity mannequins or digital platforms, and promote the potential interdisciplinary discourse between basic sciences and clinical educators.

Within other modules that deal more heavily with the clinical aspects, such as the nursing process, medication management or pharmacovigilance activities, contextualised pharmacology discussions could be introduced that still overtly feature the nursing-specific elements but have sufficient basic sciences interleaved to contextualise the application of such knowledge for practical competencies. For example, by introducing a medication error case, clinical contextualisation can be achieved for the core functions of the nurse and allow for a discussion-based approach to learning about pharmacology (Mauldin, 2023). Such a practice not only allows for generic competencies such as teamwork, collaboration and reflection to be emphasised, but also incorporates a more integrated, clinical approach to learning (Mauldin, 2023).

6.5. The learning environment

Given the small group of students, venues amenable to small group discussions would be ideal; however, the size of the class would exceed what the Faculty of Health Sciences currently has for such formats. More traditional classroom settings would thus be necessitated, which, from a design perspective, complicates a comfortable group seating arrangement. However, it should not be insurmountable to achieve some semblance thereof. All classes will be possible though on Prinshof Campus, given the location of the Department of Nursing Science. With the close proximity to the Steve Biko Academic Hospital, some involvement of the pharmacology educators could be possible in the clinical platform depending on what integration is deemed appropriate.

6.6. Learning resources

Resources would most likely not be altered to a large degree from their basic sciences vantage; however, contextualisation will need to be refined as much as possible to ensure that the nursing context remains prominent. Additional learning resources will need to be investigated, particularly for those pharmacotherapeutic areas that are considered new, as well as for areas that require greater integration between other nursing fields, such as midwifery. For modules where pharmacology may be an adjunct to their learning to help create more vertical integration, care would be needed to ensure that the learning resources align with their modules' structure and scaffolding. Being more clinical in nature, it would be appropriate for clinical educators to lead the learning resource design and allow for sufficient opportunity for pharmacology to incorporate the appropriate level of basic sciences context to it. Furthermore, these learning resources would need to align with the andragogy selected for the various learning opportunities.

A valuable resource to draw from to facilitate more context would be clinical reports available, within ethical bounds, by the Department of Nursing or as published case reports that would allow for clinical contextualisation to be achieved. At present, several preparatory activities are based on published case reports related to the learning opportunities; however, their integration within the learning opportunity is often hampered by the diversity of the group's scope of practice. This would allow for a clearer relation of the patient within the classroom environment, and showcase evidence-based practice as well.

6.7. Timetable

The logistical benefits of removing the other student groups allow for clearer delineation of nursing-specific education in the curriculum. The greatest challenge, based on integration with some sessions, may be ensuring that staff members are available to provide the sufficient support and/or context to sessions. For example, assuming a clinical educator would avail themselves to provide case reports during pharmacology's learning opportunities, it may require them to be available for the majority of, if not the entire session. This could be mitigated potentially by incorporating a digital element to it, for example, pre-recording such cases, or attending the session virtually as needed. Should a full-scale programme review be performed, timetable evaluation would also consider the incorporation of the University of Pretoria's teaching framework to allow for sufficient preparatory, engagement and consolidation time, especially in the light of the clinical exposure that occurs throughout the programme as well.

6.8. Staff

As the recommendation is that the module remains stand-alone, internal staffing considerations would necessitate a course coordinator and associated lecturers, whether from the current team or the larger pool of colleagues from the Department of Pharmacology. Given the large presence of pharmacology within the nursing programme, it would be expected that a few lecturers might be needed to help ensure continuous lecturing without creating a large burden of teaching on a few individuals. Such capacity would need to be investigated though, particularly given the request that pharmacology already be incorporated from the first year of the programme. Formal staffing considerations would need to be drawn up in the light of how much teaching time this may necessitate, particularly with lateral responsibilities such as student remediation and assessment also needed. Within our modules, administration of the pharmacology curriculum, for example, lecturers, question banks and assessments would need to be done in-house. Furthermore, remedial support of Pharmacology for students will need to be allocated to the Department of Pharmacology.

For nursing-specific modules, given their jurisdiction, it would be considered prudent that in-house management of staff be done to ensure an effective exchange between the Departments of Nursing Science and Pharmacology so that a cohesive and smooth-running collaborative approach can be followed.

6.9. Curriculum management

Curriculum management will largely be the responsibility of the Department of Pharmacology, apart from matters within nursing-specific modules. As the changes would necessitate creating either a year module or two semester modules for Pharmacology, a formal application

would be necessary through the Faculty of Health Sciences' Academic Advisory Committee and the Faculty Board, as well as through the Senate of the University of Pretoria. Given that the programme's content or exit level outcomes are not envisaged to change by more than 50%, it would not necessitate reaccreditation from CHE and SAQA. This process may take approximately two years to achieve though, and thus it is envisaged that this could only be implemented as a third-year module alteration in 2029. However, it would necessitate the students from the current Bachelor of Nursing Sciences to enrol for FAR 381 and FAR 382 modules up until 2030 as a transitionary process that invariably does create a challenge for staff to manage multiple iterations of modules. As the FAR 381 and FAR 382 modules are envisaged to run in a similar fashion for the Bachelor of Science students, such a logistical concern is likely not insurmountable.

6.10. Students

The students have already been described in Section 2.3; however, the largest change envisaged would be that a single group be present within the module. As no changes within the immediate scope of practice of professional nurses are under discussion, to the best of my knowledge, a change within the envisaged identity of the nurse is not envisaged but will need to be fostered throughout the programme to ensure it develops thoroughly.

7. Conclusion

The study provides a nationally, contextually-relevant pharmacology curriculum for nursing in South Africa following a scientifically-designed approach, with further refinement for inclusion in the Bachelor of Nursing Science programme at the University of Pretoria based on their targeted needs. In doing so, a proposal for curricular change and improvement is made to help increase the quality of pharmacology education within the nursing profession.

Of 102 pharmacological and 54 pharmacotherapeutic competencies, 101 and 53 respectively were considered important for inclusion in the nursing curriculum according to the modified, reactive Delphi study. Contributions were made by a diversity of nurses, including those with postgraduate qualifications, within public and private healthcare, working within academic institutions, and associated with professional bodies or accreditation agencies. Twenty-one new pharmacotherapeutic areas were indicated, while 64 competencies related to the pharmacological needs of the nursing profession's clinical practice were included. The increased number of psychomotor domain competencies aligned well with the practical aspects of medication management and the nursing process necessitated by the nursing profession. Alongside these, all fourteen generic competencies were considered important to the profession. Delphi participants recommended that most competencies be developed at a higher cognitive level, which also aligns with the expectations of the nursing profession.

The targeted needs analysis of the current and proposed pharmacology curricula indicated several areas of potential deficiency, with a low level of linkage observed between Pharmacology, Physiology and core nursing modules. Although the proposed curriculum had a greater overall link to modules prior, in parallel and after Pharmacology, deficiencies are still present and require further assessment. This would necessitate clearer and more explicit learning outcomes and assessment criteria throughout the programme. Focus group participants remarked on similar areas of concern, where pharmacological competencies were

thought to be inadequately developed due to, among others, a lack of contextualisation and integration of nursing within the learning environment. Participants concurred that scaffolding from physiology was insufficient for pharmacology, and similarly, for their nursing-specific competencies. A programme level review was suggested to help indicate areas of weakness and strength, and to facilitate a greater level of integration between the basic sciences and clinical practice. Furthermore, more close-working relationships between basic sciences and clinical educators were recommended to ensure such clinical contextualisation is achieved. Participants believed that the standard of pharmacology education should not be reduced; however, this would not be appropriate should the clinical relation to nursing not be resolved. No pharmacotherapeutic areas of the proposed curriculum were suggested as irrelevant to the University of Pretoria nursing student. However, further discussions would be needed to determine how much of the curriculum can be adequately addressed.

Limitations of the sub-section study include the reduced response rate during the Delphi study, which may increase the bias within participant's ranking of competencies. Certain competencies by their nature are categorised as affective or psychomotor domain competencies, and thus ranking them according to the cognitive domain of Bloom's taxonomy is not appropriate. However, this was done to simplify the Delphi study process, which invariably, suffers from a low response rate the longer and more complex it becomes. Targeted needs analysis was hampered by the explicitness of learning outcomes and assessment criteria, and the unavailability of certain study guides during the data collection phase. As such, areas of deficit indicated may be overstated and do emphasise the ambiguity that is created within the curriculum mapping process.

Chapter 5
A physiotherapy-relevant pharmacology curriculum

Recovery is indeed a manifestation of the law of nature, efforts of patient and guidance from physical therapist or rehabilitation specialist.

Joerg Teichmann (Goodreads, 2024, p. 1)

1. Introduction

Chapter 5 focuses on the development of a pharmacology curriculum for the physiotherapist, with a particular focus on creating learning outcomes and assessment criteria within the context of the University of Pretoria's current Physiotherapy programme.

2. The physiotherapist

The role of the physiotherapist as one of the healthcare practitioners of interest within my undergraduate module, including their pharmacological education, will be discussed.

2.1. The scope of practice of the physiotherapist and its relation to pharmacology

Physiotherapy (or physical therapy) is defined as the assessment of physical function, and subsequent treatment, rehabilitation or prevention of physical dysfunction, injury, or pain by physical means (e.g., manipulation, exercise, bandaging, needling, application of heat) (Continuing Consolidation of the Statutes of Manitoba, 1991b; Lee & Sheppard, 1998; Fransen, 2004; Taylor et al., 2007). A physiotherapist would aim to restore or maintain an individual's physical functioning at optimal levels using non-pharmacological means and patient education, which places them well for the treatment of musculoskeletal conditions (diseases involving, for example, the muscles, cartilage and joints) (Lee & Sheppard, 1998; Fransen, 2004; Taylor et al., 2007; Melnick, 2015; Nielsen et al., 2015). However, physiotherapists' services extend beyond musculoskeletal ailments to other illnesses, such as respiratory (Lee & Sheppard, 1998; Taylor et al., 2007), neurological and cardiovascular diseases (Lee & Sheppard, 1998; Taylor et al., 2007; Melnick, 2015; Ngeh et al., 2023), and engage in sports medicine to facilitate peak performance while mitigating injury (Melnick, 2015). Physiotherapists are thus integral to improving the quality of life of patients, for example, those suffering from chronic disease (Narain & Mathye, 2019), who would also be more prone to pharmacotherapeutic intervention.

Although physiotherapists treat with physical means, Physiotherapy still benefits from pharmacotherapy or is invariably present, depending on a patient's treatment plan (Lansbury & Sullivan, 2002; Scott-Bell & Malcolm, 2015; Stenner et al., 2018). As such, physiotherapists require pharmacological knowledge to advise their patients and adjust treatment strategies appropriately (Lansbury & Sullivan, 2002; Scott-Bell & Malcolm, 2015; Stenner et al., 2018), regardless of their not necessarily being approved to prescribe pharmacotherapy.

Pharmacology is acknowledged within physiotherapy as important to consider when providing comprehensive treatment (Eksteen & Slabbert, 2001; Unger & Lochner, 2006) as medicines may alter the clinical suitability of the physical modality used (Unger & Lochner, 2006). There is an inherent need to evaluate the potential effect that pharmacotherapy (or the possible benefit of including pharmacotherapy) may have on treatment (Unger & Lochner, 2006; Onigbinde et al., 2013). Unger and Lochner reported that 72% of responding physiotherapists believed that it is important that pharmacology be included at undergraduate level, referring to the need to know of interactions between pharmacological preparations and their modalities (Unger & Lochner, 2006). For example, given their scope of practice, physiotherapists would routinely encounter pharmacological means of treatment, such as analgesics, antibiotics, bronchodilators, emergency drugs, mucolytics, muscle relaxants and non-steroidal anti-inflammatory drugs (Unger & Lochner, 2006; Onigbinde et al., 2013). Knowledge of said drugs would contribute to treating the patient comprehensively, considering the effect that pharmacotherapy may have to benefit or complicate their physical treatment.

As per the Health Professions Act 56 of 1974 (Republic of South Africa, 1976), physiotherapists in South Africa are legally allowed to guide patients' health using various forms of physical manipulation, often in relation to a medical doctor's treatment (Box 5.1). Although the Act does not specify pharmacotherapy, invariably some patients' diseases may necessitate the use of medication, or said medication may influence physical treatment. Physiotherapists are registered with the HPCSA as healthcare practitioners under the domain of the Professional Board for Physiotherapy, Podiatry and Biokinetics (Professional Board for Physiotherapy Podiatry and Biokinetics, 2023). According to the minimum standards for training guidelines set by the Professional Board for Physiotherapy, Podiatry and Biokinetics, physiotherapists must be competent to maximise the quality of life and movement potential of patients that necessitates promotion, prevention, treatment, habilitation, rehabilitation and referral skillsets aligned with their practice (Professional Board for Physiotherapy Podiatry and Biokinetics, 2023). Although the minimum standards state that pharmacology should be included (Professional Board for Physiotherapy Podiatry and Biokinetics, 2023), they lack description of the type and depth of knowledge or clinical skills needed for it. The World Physiotherapy (a global network of physiotherapy associations) recommends that Physiotherapy curricula should include pharmacology as biomedical sciences and that graduates' medical history taking should include medication (World Physiotherapy, 2011a, 2011b, 2022) so that information can be used to formulate disease and treatment strategies (World Physiotherapy, 2011a, 2011b). Similar to the minimum standards set by the Profession Board for Physiotherapy, Podiatry and Biokinetics, information is not available to help guide how to approach the pharmacology curriculum within the programme.

BOX 5.1: SCOPE OF PRACTICE OF THE PHYSIOTHERAPIST IN SOUTH AFRICA AS PER THE HEALTH PROFESSIONS ACT 56 OF 1974 (REPUBLIC OF SOUTH AFRICA, 1976). REPRODUCED VERBATIM AS PER THE ACT. NO ASPECTS EXPLICITLY REFER TO PHARMACOLOGY

The following acts are hereby specified as acts which shall for the purpose of the Act be deemed to be acts pertaining to the profession of physiotherapy. These acts shall be performed in the following fields covered by physiotherapy as a Supplementary service to medicine:

a. *Orthopaedics*, in the whole field of orthopaedics, as requested by the medical practitioner. This includes fractures, dislocations, ligamentous and soft tissue lesions, joint deformities and diseases; infections of bone, including those of the spine, and their complications; amputations; specialised branches, e.g. hand surgery and tendon and muscle transplants.

b. *Neurology and neurosurgery*, including participation by the physiotherapist in intensive care and rehabilitation.
c. *Respiratory diseases and thoracic surgery*, including inhalation therapy and participation by the physiotherapist in intensive care.
d. *Cardio-vascular diseases and surgery*.
e. *Obstetrics and gynaecology*, including pre-operative and postoperative surgical conditions, antenatal and post-natal instruction, pelvic infections and other gynaecological conditions.
f. *Intensive care units*, including coronary care, organ transplantation, dialysis, respiratory failure, tetanus, extensive paralysis, unconsciousness, accident services (multiple injuries) and burns.
g. *Rehabilitation* of the patient to his maximum potential both in work and sport. including adaptation to permanent disabilities.
h. *Sports medicine*, which includes prophylaxis and the treatment of all injuries and disabilities directly pertaining to sport.
i. *Paediatrics*, including all related fields of medicine and surgery, including cerebral palsy; care of children with minimal brain dysfunction; developmental abnormalities; the prevention of orthopaedic and postural deformities.
j. *Geriatrics*, including the care of the aged in all related fields of medicine and surgery; prophylaxis; rehabilitation and recreational activities.
k. *Treatment* of physical ailments of psychiatric patients; relaxation therapy; maintenance or restoration of physical fitness; organisation of remedial games, sports and recreational activities.
l. *Other surgical fields*, including general, plastic, urological, maxillofacial, ophtalmological, ear, nose and throat, and other surgical fields that may require physiotherapy services.
m. *Other medical fields*, including rheumatology, dermatology, ear, nose and throat fields, constitutional fields, Hansen's disease, cancer and any other medical fields that may require physiotherapy services.
n. *Community care*, including prophylactic physiotherapy services, district and domiciliary services, day hospital organisations, rehabilitation centres including schools, industries and others.

1. The scientific use of movement techniques based upon physiological principles, supplemented when necessary by massage, manipulation, electrotherapy and other physical and supportive measures and including advice to, and education of, the patient, for the prevention and treatment of injury, disease and disorders, and the facilitation of normal physiological processes and functional activities. These are used to assist rehabilitation and restoration of function, including the achievement of personal independence.
2. The use of the following procedures in the fields covered by physiotherapy as a supplementary service to medicine:
    a. Physiotherapeutic examination of patients according to the condition diagnosed by the medical practitioner or dentist, including continuous assessment of the patient's response to physiotherapy treatment and of progress made. Such examination includes the assessment of joint range; muscle power, strength, tone; endurance and co-ordination, righting, balance and equilibrium reactions; postural abnormalities, functional ability; the need for rehabilitation and degree of independence attained; the level of sensory and motor development, circumference, length (e.g. of the leg), volume, excursion and other relevant measurements; the effects of pain on movement, rest and function; gait abnormalities and other locomotor abnormalities; physical fitness tests, cardiac (exercise) tolerance tests; respiratory excursion and exercise tolerance tests and measurements; sensory tests, including stereognosis; perception tests; observation; palpitation, inspection of X-rays and X-ray reports; skin temperature and condition; the effects of soft tissue scars, adhesions and contractions on movements and function; nerve condition and innervation tests; reflex heating tests requirements for the use of artificial limbs, prostheses, aids, appliances, callipers, splints, supports, corsets, collars, etc; the need for the use of wheelchairs; and any other special tests or methods of assessment by physiotherapy that may be required for the management of patients and for the submission of reports to the medical practitioner or dentist.
    b. Selection of treatment techniques and supportive devices according to the diagnosis given by, and in consultation with, the referring medical practitioner or dentist, based on the results of the examination referred to in (2) (a) above and in conjunction with other registered supplementary health services personnel concerned with, the treatment, management and/or rehabilitation of the patient. These include any of the procedures

detailed below, as well as advice on the selection of wheelchairs and on the selection or making of permanent or temporary prostheses, aids, appliances, splints, calipers, supports, collars, corsets, walking aids or any other physiotherapeutic device or method which may be required.

c. Education of, and advice to, the patient or those responsible for his care, according to the condition diagnosed by, and in consultation with, the referring medical practitioner or dentist or any other personnel concerned with the care of the patient. These include prophylactic physiotherapy, prevention of joint and muscle strain and back strain; advice on the lifting and handling of patients and heavy objects; prevention of recurrence of mechanical disorders; functional activities, rest positions and working postures; recreational and sports activities, kinetic handling in industry; education for childbirth; the handling of disabled persons in hospital, at home, at work and during transport, recreational and sports activities; care and handling of the aged, children and infants; the use of respirators; postural drainage in hospital or at home; advice on the use of aids and appliances referred to above; and any other advice concerning the physiotherapy field which may be required.

3. The giving of the following movement and exercise therapy (i.e. the application of kinesiological and neuro-physiological principles):
   a. Passive movements
      (i) Relaxed passive movements
      (ii) Mobilisation techniques-spinal and peripheral
      (iii) Manipulation-spinal and peripheral without anaesthetic
      (iv) Soft tissue stretching
      (v) Traction-spinal and peripheral.
   b. Active movements
      (i) Facilitation.
         a. muscle contraction by the use of cold and sensory stimulation, both epicritic and proprioceptive, followed by activation;
         b. facilitation of basic and selective movement patterns and reflex mechanisms, including automatic righting, balance and equilibrium reactions in the developmental sequence;
         c. inhibition of abnormal sensory input, muscle tone, reflex mechanisms or associated reactions.
      (ii) Assisted exercises by means of manual, mechanical and hydrotherapy techniques.
      (iii) Free exercises and activities (both subjective and objective) to obtain relaxation, increase joint range, re-educate muscle function, increase muscle power and endurance, correct posture and re-educate postural and gait mechanisms.
      (iv) Resisted exercises
         (aa) by manual, mechanical and hydrotherapy techniques;
         (bb) by power and endurance programmes.
      (v) Re-education of functional activities
         (aa) re-education of and rehabilitation infunctional activities such as basic movement patterns and gait (both assisted and unassisted);
         (bb) transference, wheelchair activities and other motor activities required for daily living and sport.
      (vi) The use of gymnasia, gymnastic therapeutic apparatus, specially constructed children's apparatus, toys and adapted training circuits.
      (vii) Sporting activities these include swimming, riding and wheelchair sports.
      (viii) Group activities these include activities such as ward classes, out-patient classes, prenatal and post-natal classes, remedial games.
      (ix) Breathing exercises breathing exercises, postural drainage, mobilising exercises for the thorax, inhalation therapy (including the use of intermittent positive pressure, suction and respiratory function tests).
      (x) Splints, supports and prostheses
         (aa) training in the use of splints, supports and prostheses for motor activities, including isolated contraction for the activation of powered splints;
         (bb) the adaptation of all these methods for all age groups, including infants, children, adolescents and the aged.
4. The use of various massage techniques, including transverse frictions and connective tissue massage.

5. The giving of electrotherapy, including
   a. high frequency currents;
   b. low frequency currents;
   c. ultra sound;
   d. radiation (excluding X-rays and cosmic rays).
6. The application of heat and cold.
7. The therapeutic use of water (hydrotherapy)
8. Mechanical aids:
   a. The making and application of splints and supports.
   b. The application of braces, prostheses and other therapeutic and supportive devices, including the selection of wheelchairs.

Physiotherapy programmes invariably differ between institutions, and thus an overarching discussion of how the University of Pretoria approaches it has been provided.

2.2. The Bachelor of Physiotherapy degree at the University of Pretoria

At the University of Pretoria, the Bachelor of Physiotherapy degree is a four-year programme, where Pharmacology is taken in the third year of study alongside bachelor programmes of Dietetics, Nursing Science and Science students. Students are enrolled for both first-semester (FAR 381) and second-semester (FAR 382) Pharmacology. Fundamental and core modules are presented during the programme, where Physiotherapy and Physiotherapy Core Practice are the unique core modules of the programme (Table 5.1). Within the qualification mix of the Bachelor of Physiotherapy, physiotherapists should be able to act within a team of healthcare workers to address complex treatments (South African Qualifications Authority, 2018), which invariably will include patients with pharmacotherapeutic needs. The qualification's exit level outcomes mix (Box 5.2) (University of Pretoria, 2024a) does not provide further insight into the pharmacological competencies required though, which creates difficult in aligning the course curriculum with the exit level outcomes in relation to pharmacology.

2.3. My perspective on the current challenge

Challenges presented in Chapter 3, Section 2.3.1. remain relevant, and thus will not be reiterated to avoid duplication.

Challenges observed for the physiotherapy group are by and large related to context and relevance. As physiotherapists use non-pharmacological treatment methods, students generally query why such depth would be needed for their ability to practise within their scope. The generalised curriculum thus often lacks the inclusive discussion of pharmacotherapy alongside physiotherapeutic treatment, and thus context is easily missed. Between the three groups, the physiotherapists are most at a disadvantage in this sense according to my view as the comprehensive nature of treatment is most poorly discussed when referring to physical therapy. For example, when discussing the use of analgesics and anti-inflammatories in injuries, alignment would allow for a greater discussion of the impact such medicines may have on pain and mobility during physical manipulation. Although mentioned in class, it is often not emphasised clearly enough to facilitate contextual learning. The depth of the discussion may, in to my opinion, thus often exceed what would be needed for the clinical competencies related to physiotherapy; however, this is based on my own assumptions and biases as a basic sciences educator.

During accreditation visits, discussions of Pharmacology are generally not negative, and mostly quite complimentary towards how we approach it. However, concern is raised of the high credit load that the pharmacology curriculum has within the third year, with pertinent recommendations of reducing it to approximately 5 credits. With a relative recommendation in mind, it does often create further concern for me of how appropriately to reduce such a broad range of pharmacotherapy without creating difficulty with understanding the underlying principles related to how drugs work.

In relation to future potential for physiotherapists, it is necessary to acknowledge a global movement in non-medical prescribing (the practice of non-medical practitioners gaining the legal ability to prescribe through further training). Legislation and professional development of physiotherapists differ across the world though, where the United Kingdom granted physiotherapists in clinical specialist positions supplementary and independent prescription rights. Within the United Kingdom legislature, supplementary prescribers may prescribe from a clinical management plan co-developed by a doctor or dentist, while independent prescribers may prescribe from a limited list of controlled drugs (which is continuously reviewed) (Chartered Society of Physiotherapy, 2006). Importantly, within South Africa's current regulations, physiotherapists are not approved as prescribers; however, discussions are under way to facilitate this extension of scope of practice (Unger & Lochner, 2006; Hall, 2013; Kakono et al., 2023). Unger and Lochner (Unger & Lochner, 2006) and Kakono et al. (Kakono et al., 2023) highlighted South African physiotherapists' interest in wanting to prescribe. Reasons ranged from increased potential for service delivery to the patient, improved treatment outcomes and it would benefit the first-contract practitioner in their therapeutic approach (Unger & Lochner, 2006; Kakono et al., 2023). However, concerns were raised about inadequate knowledge and/or education and a transition of the philosophy of the physiotherapy treatment model (Unger & Lochner, 2006; Kakono et al., 2023). Currently, it's unclear whether such an extension of scope of practice would be considered as a postgraduate qualification, or to realign undergraduate qualifications to allow newly registered physiotherapists to gain this ability from the start of their careers. To acknowledge potential biases, I have a vested interest in the potential non-medical prescribing that physiotherapists may gain, and thus it forms part of the research I am conducting. Although I believe this could be an advantageous transition for South African healthcare, and thus admit that such a curriculum change (preferably as a postgraduate qualification) is justified to be investigated, I am also wary that an ill-designed programme may yield ineffective and irrational prescribers. As such, I acknowledge such a potential bias that may seep into my discussions with Physiotherapy students to ensure that I consider the effect my point of view may have on the design of the proposed curriculum.

TABLE 5.1: STRUCTURE OF THE BACHELOR OF PHYSIOTHERAPY PROGRAMME AT THE UNIVERSITY OF PRETORIA (UNIVERSITY OF PRETORIA, 2024A)

Module type	Year I	Year II	Year III	Year IV
Fundamental	• Academic Information Management • Anatomy (introductory) • Anatomy of the Limbs • Anatomy of the Torso • Anatomy of the Head and Neck • Chemistry • Physics • Psychology • Physiology (introductory, neurological, and muscle physiology) • Physiology (body fluids, haematology, cardiovascular and lymphatic physiology, body defence mechanisms) • Sepedi for Beginners • Isizulu for Beginners • Academic English • Academic Orientation	• Anatomical Pathology • Physiology (respiratory, renal and skin physiology, acid-base balance) • Physiology (nutrition, digestion, metabolism, hormonal control, reproduction) • Physiology (neuromuscular) • Physiology (applied pathophysiology) • Medical Microbiology (infection, immunity and basic bacteriology) • Medical Microbiology (systemic bacteriology) • Medical Microbiology (fungi, parasitology and virology) • Basic Emergency Care • Psychology	• Pharmacology • Pharmacology • Integrated Healthcare Leadership (communities) • Research Methodology	None
Core	• Physiotherapy • Integrated Healthcare Leadership (multidisciplinary teams and healthcare systems)	• Physiotherapy • Physiotherapy Clinical Practice • Integrated Healthcare Leadership (project management, communication, leadership)	• Physiotherapy • Physiotherapy Clinical Practice • Integrated Healthcare Leadership (end-of-life care, sexual harassment, management, ethics))	• Physiotherapy • Physiotherapy Clinical Practice • Integrated Healthcare Leadership (community-orientated care) • Integrated Healthcare Leadership (community-based care) • Research

BOX 5.2: EXIT LEVEL OUTCOMES OF THE BACHELOR OF PHYSIOTHERAPY AT THE UNIVERSITY OF PRETORIA TAKEN VERBATIM FROM THE ACCREDITATION DOCUMENTATION (UNIVERSITY OF PRETORIA, 2024A). NO EXIT LEVEL OUTCOMES EXPLICITLY REFER TO PHARMACOLOGY

- Learners must be able to identify a learner's / community's health problem in the context of his/her /it's socio-economic environment, and suggest and implement a holistic solution/plan of action to solve his/her/it's problem, professionally demonstrating and understanding the world of related systems by recognising that problem solving contexts do not exist in isolation.
- Perform his/her professional duties autonomously with confidence in collaboration with other healthcare professionals and workers and where appropriate assumes leadership in multidisciplinary tasks or projects.
- Do a critical appraisal of a colleague or a subordinate's evaluation and treatment plan.
- Continuously influence practice, based on evidence.
- Facilitate professional development of staff.
- Apply specialised knowledge, skills and expertise within the context of the changing healthcare system.
- Use flexible and innovative approaches to healthcare.
- Interact with other healthcare workers as a healthcare team member, contributing towards conflict resolution, group interaction, solution of problems and giving feedback.
- Assume different roles during group functioning in order to facilitate group interaction within organisations and /or structures, to achieve common goals.
- Demonstrate good written, verbal and non-verbal communication skills during the interaction with learners, their caregivers, healthcare team members.
- Demonstrate negotiation skills.
- Undertake and participate in health education to the public, special groups and /or healthcare team members.
- Identify the role of stress in sickness and rehabilitation and assist learners and their caregivers in stress management.
- Keep up with the current trends and changing needs for a physiotherapy service in the different regional and national communities.
- Contribute as responsible citizens to the national and international community of physiotherapists, being culturally and aesthetically sensitive across a range of social contexts and exploring education and career opportunities and develop entrepreneurial opportunities.
- Reflecting and exploring a variety of strategies to learn more effectively.
- Contribute in planning and implementing of appropriate preventative, promotive and rehabilitation qualifications to empower individuals and communities based on the structure of the healthcare system.
- Exercise professional accountability and responsibility in a changing environment, across professional boundaries, healthcare systems, and in unfamiliar situations within the scope of practice.
- Act as role model of professional practice.
- Lead and facilitate lobbying around issues that concern health.

3. Results of the study

The results of the study are presented in two separate parts as the general needs assessment (comprising the scoping review and Delphi study) and targeted needs analysis (comprising the curriculum mapping and focus group interviews).

3.1. General needs assessment

The results of the general needs assessment are first presented as the scoping review, which guided the construction of the Delphi study.

3.1.1. Scoping review

Of the 315 records that were captured, only 51 were screened as full-text sources given their potential relevance (Figure 5.1), with a moderate agreement (Cohen-κ = 0.546). After full-text screening, only five publications were included to compile the competency list. The publications alone provided justification for certain competencies but were more focused on specific areas of treatment, such as evidence-based practice, ICU treatment, pain management and pharmacogenetics (Table 5.2). Two of these publications compiled a minimum competency or training standard for knowledge of pharmacotherapy needed in the ICU and for pain management, which thus provided more detailed information of the expectations related to the competencies. Two institutional guidelines were included given their use in healthcare professions (including physiotherapy) education for undergraduate Pharmacology, and allowed for broadening of the competency list. The curricula were mostly generic across healthcare professions, and thus invariably consisted of items that may not be relevant to the physiotherapy profession.

The majority of publications (Table 5.3) were from the United States of America (n = 4), with one publication being relevant to South Africa, creating some contextual disparity for the Delphi study. However, given the nature of the Delphi panel's constituency, national relevance should be emphasised. A distribution of study types was available (quantitative [n = 1], qualitative [n = 1], mixed-methods [n = 1], with two being non-research. As such, although some research is present in pharmacological competencies in Physiotherapy, it was relatively adjunct to the main research aim of the studies. Studies were dated, with the latest publication featured in 2019.

Seventy-three competencies (25 pharmacological constructs; 34 pharmacotherapies; 14 generic competencies) were compiled from the five publications and two institutional guides (Table 5.4). The list was modified further by content- and face-validation in preparation for the Delphi study to summarise items or provide editorial refinement. Of the fifty-nine pharmacological and pharmacotherapeutic competencies, 93.2%, 5.1% and 1.7% were considered in the cognitive, affective and psychomotor domains, respectively.

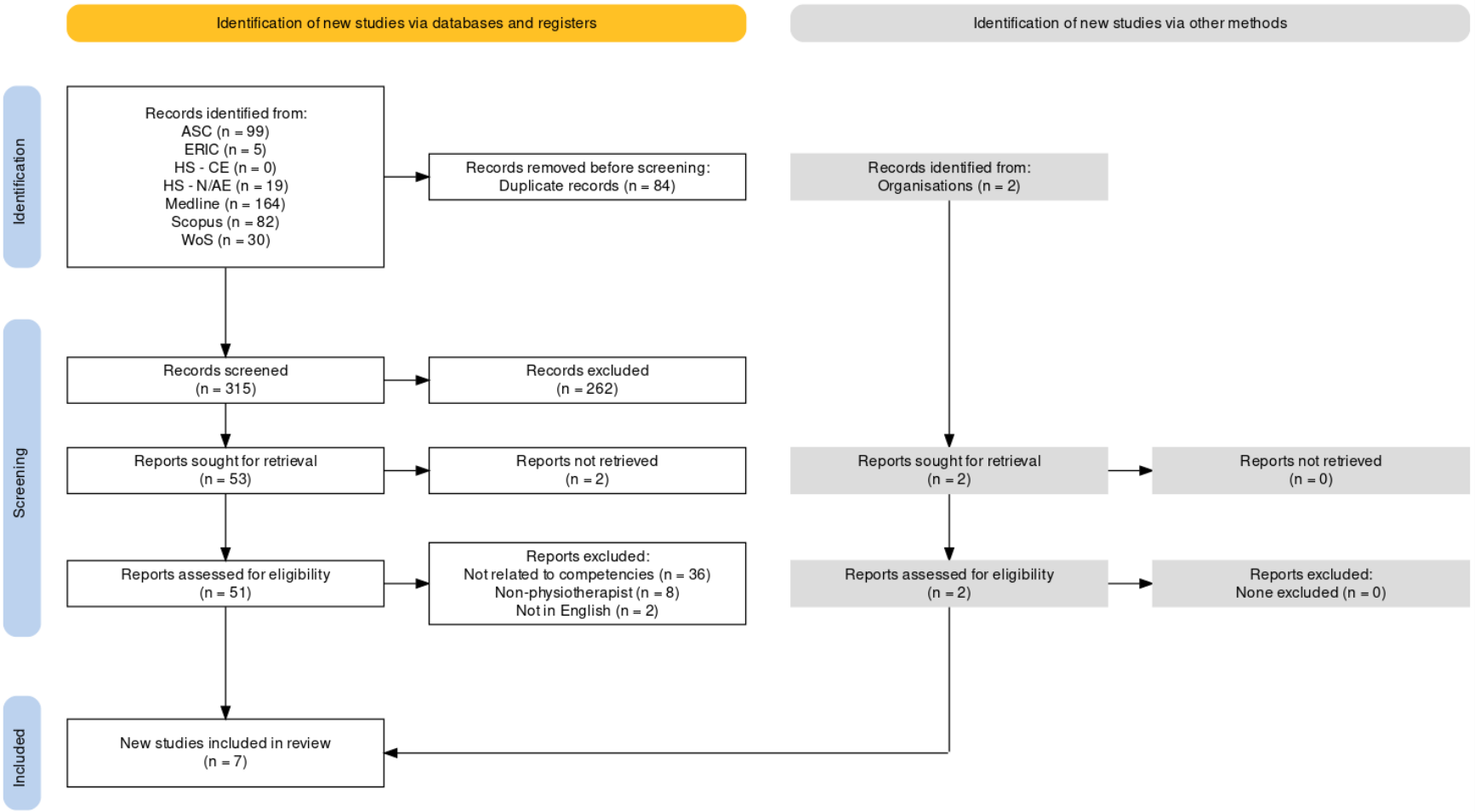

FIGURE 5.1: PRISMA DIAGRAM OF PHARMACOLOGICAL COMPETENCIES RELATING TO PHYSIOTHERAPY (HADDAWAY ET AL., 2022)

ABBREVIATIONS: ASC – EBSCOHOST ACADEMIC SEARCH COMPLETE; ERIC – EBSCOHOST EDUCATION RESOURCES INFORMATION CENTER; HS–CE – EBSCOHOST HEALTH SOURCE – CONSUMER EDITION; HS–N/AE – EBSCOHOST HEALTH SOURCE – NURSING/ACADEMIC EDITION; WOS – WEB OF SCIENCE. GENERATED BY PRISMA2020 (HADDAWAY ET AL., 2022)

TABLE 5.2: FULL-TEXT PUBLICATIONS ELIGIBLE FOR THE PHYSIOTHERAPY DELPHI STUDY

Author(s)	Article title	Format of publication	Study population	Study findings	Justification of competencies	Contextual description of what is needed from the competency
Peel and Mossberg (1995)	Effects of cardiovascular medications on exercise responses	Narrative review	Physical therapists (synonymous with physiotherapy)	Discussion of relevant medications that affect physical therapy, or vice versa	Cardiovascular medication or those that may impact exercise responses	Understanding the implication of cardiovascular medication on exercise activity, and ability to source relevant medicinal information
Pittenger and Olson-Kellogg (2012)	Leveraging learning technologies for collaborative writing in an online pharmacotherapy course	Research paper Questionnaire- and focus group-based study of pharmacotherapy learning opportunities	32 to 38 physical therapists	Collaborative addressing of pharmacotherapy-related problems	Although teaching modalities are described, they speak to competencies within the framework thereof	Communication of evidence-based medical strategies (including pharmacotherapy), but not prescribing
Callier *et al.* (2014)	Engaging the next generation of healthcare professionals in genomics: planning for the future	Narrative review and opinion piece	Medical practitioners Nurses Physician assistants Genetic councillors Pharmacists Allied health practitioners (which include physiotherapists)	Knowledge and practical skills of genomics (which include pharmacogenomics) is important for all healthcare practitioners, but dependent on their scope of practice	Importance of pharmacogenomics in management of diseases and treatment regimens	Basic understanding of pharmacogenomics with discussion of expectations
van Aswegen et al. (2017)	Developing minimum clinical standards for physiotherapy in South African ICUs: A qualitative study	Research paper Focus group-based study of competencies needed within the ICU setting	25 physiotherapists	Knowledge of intensive care unit-relevant medication, including routes of administration, precautions and rationale	Competencies required within the intensive care unit treatment locale	Knowledge of pharmacotherapy use and associated risks in intensive care unit treatment
Chevan and Heath (2019)	Developing core education principles for rehabilitation professionals in response to the opioid crisis: an	Working group	Physical therapists	Development of competencies relevant to pain management in relation to opioids	Speaks to interprofessional nature of pain management, particularly in relation to opioids	Understanding the interprofessional nature of pain management, recognising risk factors associated with opioid use (substance abuse),

Author(s)	Article title	Format of publication	Study population	Study findings	Justification of competencies	Contextual description of what is needed from the competency
	example from physical therapy education					and demonstrating the correct use of rescue medication (naloxone) for opioid abuse

TABLE 5.3: CHARACTERISTICS OF FULL-TEXT PUBLICATIONS ELIGIBLE FOR THE PHYSIOTHERAPY DELPHI STUDY

Author(s)	Article title	Country of origin	Research design (if applicable)
Peel and Mossberg (1995)	Effects of cardiovascular medications on exercise responses	United States of America	Non-research
Pittenger and Olson-Kellogg (2012)	Leveraging learning technologies for collaborative writing in an online pharmacotherapy course	United States of America	Mixed-methods
Callier *et al.* (2014)	Engaging the next generation of healthcare professionals in genomics: planning for the future	United States of America	Non-research
van Aswegen et al. (2017)	Developing minimum clinical standards for physiotherapy in South African ICUs: A qualitative study	South Africa	Qualitative
Chevan and Heath (2019)	Developing core education principles for rehabilitation professionals in response to the opioid crisis: an example from physical therapy education	United States of America	Qualitative

TABLE 5.4: PHYSIOTHERAPY COMPETENCY LIST COMPILED FROM LITERATURE AND INSTITUTIONAL RESOURCES AFTER PRELIMINARY REVIEW OF CONTENT AND FACE VALIDATORS, INCLUDING SUGGESTED DOMAINS (APART FROM GENERIC COMPETENCIES)

Theme	Competency	Domain
General pharmacological principles	The role of pharmacology in disease treatment and science	Cognitive
	Common formulations used in clinical settings	Cognitive
	Common routes of administrations used in clinical settings	Cognitive
	Principles of pharmacokinetics	Cognitive
	Pharmacokinetics: Absorption	Cognitive
	Pharmacokinetics: Distribution	Cognitive
	Pharmacokinetics: Metabolism	Cognitive
	Pharmacokinetics: Excretion	Cognitive
	Principles of pharmacodynamics	Cognitive
	The modulation of drug targets to alter (patho)physiological responses	Cognitive
	Types of ligands in pharmacotherapy	Cognitive
	Factors that alter the response to pharmacotherapy	Cognitive
	Finding relevant medicinal information	Cognitive
	Pharmacogenetics information on drug labels	Cognitive
Pharmacotherapy of diseases	Allergies	Cognitive
	Anaesthesia	Cognitive
	Anxiety	Cognitive
	Asthma	Cognitive
	Bacterial infections	Cognitive
	Cardiovascular diseases	Cognitive
	Constipation	Cognitive
	Contraception	Cognitive
	Depression	Cognitive
	Diabetes	Cognitive
	Diarrhoea	Cognitive
	Endocrine disorders	Cognitive
	Epilepsy	Cognitive
	Fungal infections	Cognitive
	Gastro-oesophageal disorder	Cognitive
	Hormone replacement therapy	Cognitive

Theme	Competency	Domain
	Infertility	Cognitive
	Inflammation	Cognitive
	Intensive care unit procedures	Cognitive
	Malaria	Cognitive
	Muscle relaxation	Cognitive
	Nausea and vomiting	Cognitive
	Obesity	Cognitive
	Osteoporosis	Cognitive
	Pain	Cognitive
	Parasympathetic nervous system disorders	Cognitive
	Parkinson's disease	Cognitive
	Peptic ulcers	Cognitive
	Respiratory disorders	Cognitive
	Schizophrenia	Cognitive
	Sedation and hypnosis	Cognitive
	Sympathetic nervous system disorders	Cognitive
	Tuberculosis	Cognitive
	Viral infections	Cognitive
Aspects particular to the health profession	The implication of cardiovascular medication on exercise activity	Cognitive
	The interprofessional nature of pain management	Affective
	The drug pyramid of analgesic, anti-inflammatory, opioid, and steroid medication	Cognitive
	The selection of non-pharmacological and pharmacological approaches to pain management	Cognitive
	Risk factors associated with opioid use (substance abuse)	Cognitive
	Demonstrate the correct use of rescue medication (naloxone) for opioid abuse	Psychomotor
Special populations	The need for pharmacogenetics testing	Cognitive
	Response to treatment in patients with or without pharmacogenetic markers	Cognitive
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	Cognitive
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	Affective
Patient education	Communication of the importance of evidence-based medical strategies	Affective
Generic competencies	Adaptability	
	Collaboration and interdisciplinary teamwork	
	Communication	
	Communication technology literacy	
	Creativity	
	Critical thinking	
	Information literacy	
	Innovation	
	Leadership and responsibility	
	Media literacy	
	Problem-solving	
	Productivity and accountability	
	Self-directedness	
	Social and cultural interaction	

3.1.2. Delphi study

The Delphi study has been stratified according to the pharmacological, pharmacotherapeutic and generic competencies within the competency list.

3.1.2.1. Participants

Response rates were 35.7%, 28.6% and 46.4% for Phases I to III of the Delphi study based on the 28 invitees (Table 5.5). Participants were South African and completed their physiotherapy degrees in South Africa, with all qualified, obtaining either a master's or

doctoral degree. Most participants had more than 21-years' experience as a physiotherapist, with the majority of these exceeding 30 years. All participants worked in the academic environment, with at least one individual representing an affiliation with the HPCSA and a professional society of physiotherapy in South Africa. Representation was also seen from those working in private practice, while no representation of the public sector was reported.

TABLE 5.5: DEMOGRAPHICS OF DELPHI PARTICIPANTS THROUGH ALL THREE PHASES.

		Phase I	Phase II	Phase III[#]
Participants		10	8	13
Highest qualification	**Masters**	4	4	6
	Doctoral	6	4	7
Years of experience	**5 to 10**	1	0	0
	11 to 15	2	3	3
	16 to 20	1	0	2
	21 to 25	1	1	2
	26 to 30	0	0	1
	>30	5	4	5
Working in academia	**South Africa**	10	8	13
	Outside South Africa	0	0	0
Affiliated with professional society	**South Africa**	1	1	1
	Outside South Africa	0	0	0
Affiliated with accreditation board	**South Africa**	1	1	2
	Outside South Africa	0	0	0
Working in private practice	**South Africa**	3	5	6
	Outside South Africa	0	0	0
Working in public hospital	**South Africa**	0	0	0
	Outside South Africa	0	0	0

[*]Participants were provided the opportunity to indicate their association with all, and thus some may be part of more than one affiliation.
#Participants increased between Phase II and III due to request for re-inclusion as they were unavailable during Phase II's time period.

3.1.2.2. Pharmacological competencies

Participants agreed that eight of the 31 pharmacological competencies were important to physiotherapists' education after Phase I, while 19 required re-testing (Table 5.6). Only eight reached consensus in terms of cognitive level, leaving 19 requiring re-testing. After Phase II (Table 5.7), 11 competencies were agreed upon as important, with only one requiring re-testing. All competencies re-tested for cognitive level achieved consensus. After Phase III (Table 5.8), the single re-tested competency achieved consensus as important.

From the 31 competencies, 20 pharmacological competencies were considered important competencies (although one lacked consensus) (Table 5.9). The majority (18; 90.00%) were considered lower order cognitive level competencies, and two (10.00%) higher order.

3.1.2.3. Pharmacotherapeutic competencies

Nine of the 25 pharmacotherapeutic competencies were agreed upon as important and in terms of their cognitive level in Phase I, requiring 25 competencies to be re-tested in each capacity (Table 5.6). After Phase II (Table 5.7), three competencies required re-testing; however, the cognitive level of these competencies was agreed upon. After Phase III (Table 5.8), only one competency lacked agreement (COVID-19); however, its median suggested importance to the field. Out of 37 pharmacotherapeutic competencies, 22 were considered

important (with one lacking consensus for it) (Table 5.9). All competencies were considered at a lower order cognitive level.

Based on the Delphi study results, a suggested national curriculum framework for pharmacology education in physiotherapy is proposed in Table 5.10 (and visually summarised in Figure 5.2). The main learning outcomes are positioned, linking up to their associated assessment criteria, for the core concepts of pharmacology, application of pharmacology within the physiotherapeutic context, and pharmacotherapeutic areas of relevance to physiotherapists.

3.1.2.4. Generic competencies

Of the 13 original generic competencies tested in Phase I (Table 5.6), 11 reached consensus on their importance; however, two required re-testing. Reflection was proposed as an additional skillset for testing in Phase II, as well combining productivity and accountability, leadership and responsibility, and splitting information literacy and communication technology literacy. After Phase II (Table 5.7), two reached consensus, with reflection remaining not agreed upon even after Phase III (Table 5.8), although its median suggested importance.

3.2. Targeted needs assessment

The results of the targeted needs assessment are first presented as the curriculum mapping to both the current and proposed pharmacology curricula, which helped inform the focus group interviews with the Department of Physiotherapy.

TABLE 5.6: COMPETENCY RANKING AFTER PHASE I OF THE DELPHI STUDY (N = 10 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**The role of pharmacology in disease treatment**	4.00	1.00	Yes	Included	10	2.00	0.50	Yes	Understand	Included
	Biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)	3.00	2.00	No	Phase II	6	3.00	2.25	No	Apply	Phase II
	Common pharmacological concepts	3.00	1.00	Yes	Included	9	2.00	1.00	Yes	Understand	Included
	Common routes of administration used in clinical settings	3.00	1.25	No	Phase II	8	2.00	1.50	No	Understand	Phase II
	Common formulations used in clinical settings	2.00	0.25	Yes	Not included	2	2.00	0.00	Yes	Understand	Not included
	Principles of pharmacokinetics (the movement of drug into, through, and out of the body)	3.00	2.25	No	Phase II	7	2.00	0.00	Yes	Understand	Phase II
	Pharmacokinetics: Absorption	2.50	2.00	No	Phase II	4	2.00	0.75	Yes	Understand	Phase II
	Pharmacokinetics: Distribution	2.00	2.00	No	Phase II	4	2.00	0.75	Yes	Understand	Phase II
	Pharmacokinetics: Metabolism	2.00	2.00	No	Phase II	4	2.00	0.75	Yes	Understand	Phase II
	Pharmacokinetics: Excretion	2.00	2.00	No	Phase II	4	2.00	0.75	Yes	Understand	Phase II
	Principles of pharmacodynamics (the response of the body to the drug)	3.50	1.25	No	Phase II	8	2.00	2.25	No	Understand	Phase II
	The modulation of drug targets to alter (patho)physiological responses	2.50	1.50	No	Phase II	5	2.00	1.00	Yes	Understand	Phase II
	Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)	2.00	1.00	Yes	Not included	Not tested					Not included
	Factors that alter the response to pharmacotherapy	3.00	2.00	No	Phase II	7	3.00	2.00	No	Apply	Phase II
	Finding relevant medicinal information	3.00	1.00	Yes	Included	9	3.00	1.50	No	Apply	Phase II
	The need for pharmacogenetics testing (where pharmacogenetics is the effect genetic factors has on drug reactions)	2.00	1.00	Yes	Not included	1	2.00	0.00	Yes	Understand	Not included
	Pharmacogenetics information on drug labels	3.00	1.25	No	Phase II	6	2.50	2.25	No	Understand	Phase II
	Response to treatment in patients with or without pharmacogenetic markers	2.00	2.00	No	Phase II	3	2.00	0.00	Yes	Understand	Phase II
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	2.00	2.00	No	Phase II	3	2.00	0.00	Yes	Understand	Phase II
	The limitations of individual pharmacogenetics expertise and	2.00	1.25	No	Phase II	2	2.50	0.75	Yes	Understand	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	need for healthcare providers with appropriate training										
	The implication of cardiovascular medication on exercise activity	4.00	0.25	Yes	Included	10	3.50	2.00	No	Apply	Phase II
	The interprofessional nature of pain management	4.00	0.25	Yes	Included	10	3.50	1.50	No	Apply	Phase II
	The selection of non-pharmacological and pharmacological approaches to pain management	4.00	1.00	Yes	Included	10	3.50	1.00	Yes	Apply	Included
	The drug pyramid of analgesic, anti-inflammatory, opioid, and steroid medication	3.50	1.00	Yes	Included	9	3.00	2.00	No	Apply	Phase II
	Risk factors associated with opioid use, such as substance abuse	3.50	1.25	No	Phase II	8	2.00	0.75	Yes	Understand	Phase II
	The correct use of rescue medication (such as naloxone) for opioid abuse	2.00	2.00	No	Phase II	4	2.50	1.75	No	Understand	Phase II
	Communication of the importance of evidence-based medicinal strategies	3.00	1.25	No	Phase II	8	3.00	0.75	Yes	Apply	Phase II
	Prescribing of pharmacotherapy	2.50	2.00	No	Phase II	5	3.00	3.50	No	Apply	Phase II
	Interpreting pre-clinical and clinical pharmacological data	1.00	1.00	Yes	Not included	1	5.00	0.00	Yes	Evaluate	Not included
	Discussing misconceptions of pharmacotherapy with patients	3.00	1.00	Yes	Included	6	2.50	1.00	Yes	Understand	Included
	Interpretation of pharmacological research in relation to clinical outcomes	2.00	2.00	No	Phase II	3	4.00	0.00	Yes	Analyse	Phase II
Pharmacotherapy against diseases competencies	Allergies	2.50	1.25	No	Phase II	5	2.00	1.00	Yes	Understand	Phase II
	Anaesthesia	2.00	2.00	No	Phase II	4	2.00	3.00	No	Understand	Phase II
	Anxiety	2.50	2.25	No	Phase II	5	3.00	1.00	Yes	Apply	Phase II
	Asthma	4.00	0.25	Yes	Included	10	3.00	1.25	No	Apply	Phase II
	Bacterial infections	3.00	1.50	No	Phase II	6	0.40	1.50	No	Understand	Phase II
	Cardiovascular diseases	4.00	1.00	Yes	Included	10	3.00	1.25	No	Apply	Phase II
	Constipation	2.00	2.00	No	Phase II	3	2.00	0.00	Yes	Understand	Phase II
	Contraception	1.50	1.25	No	Phase II	2	2.00	0.00	Yes	Understand	Phase II
	COVID-19	4.00	1.50	No	Phase II	8	2.50	1.00	Yes	Understand	Phase II
	Depression	3.50	2.00	No	Phase II	7	2.00	1.00	Yes	Understand	Phase II
	Diabetes	3.50	1.00	Yes	Included	9	3.00	1.00	Yes	Apply	Included
	Diarrhoea	1.00	1.25	No	Phase II	2	2.50	0.00	Yes	Understand	Phase II
	Endocrine disorders	2.00	2.00	No	Phase II	3	2.00	0.00	Yes	Understand	Phase II
	Epilepsy	3.00	1.00	Yes	Included	7	2.00	1.00	Yes	Understand	Included
	Fungal infections	1.50	2.00	No	Phase II	4	2.00	0.75	Yes	Understand	Phase II
	Gastro-oesophageal disorder	1.50	1.25	No	Phase II	2	2.00	0.00	Yes	Understand	Phase II
	Hormone replacement therapy	1.50	2.00	No	Phase II	3	2.00	0.00	Yes	Understand	Phase II
	Infertility	1.00	1.00	Yes	Not included	1	2.00	0.00	Yes	Understand	Not included
	Inflammation	4.00	1.00	Yes	Included	9	3.00	0.50	Yes	Apply	Included
	Intensive care unit procedures	3.00	2.25	No	Phase II	7	3.00	1.00	Yes	Apply	Phase II
	Malaria	1.00	1.25	No	Phase II	2	2.00	0.00	Yes	Understand	Phase II
	Muscle relaxation	4.00	1.00	Yes	Included	10	3.00	1.25	No	Apply	Phase II

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Nausea and vomiting	1.50	1.25	No	Phase II	2	2.00	0.00	Yes	Understand	Phase II
	Obesity	2.50	1.25	No	Phase II	5	2.00	0.50	Yes	Understand	Phase II
	Osteoporosis	3.00	1.25	No	Phase II	8	2.50	1.00	Yes	Understand	Phase II
	Pain	4.00	0.25	Yes	Included	10	3.00	1.00	Yes	Apply	Included
	Parasympathetic nervous system disorders	2.50	2.00	No	Phase II	5	3.00	2.00	No	Apply	Phase II
	Parkinson's disease	3.00	2.00	No	Phase II	6	2.50	1.00	Yes	Understand	Phase II
	Peptic ulcers	1.50	1.25	No	Phase II	2	2.00	0.00	Yes	Understand	Phase II
	Respiratory disorders	4.00	0.00	Yes	Included	10	3.00	0.25	Yes	Apply	Included
	Schizophrenia	1.00	1.25	No	Phase II	2	1.50	0.00	Yes	Remember	Phase II
	Sedation and hypnosis	1.50	2.00	No	Phase II	3	1.00	0.00	Yes	Remember	Phase II
	Sympathetic nervous system disorders	2.00	1.50	No	Phase II	4	3.00	1.50	No	Apply	Phase II
	Tuberculosis	4.00	1.00	Yes	Included	9	3.00	1.00	Yes	Apply	Included
	Viral infections	3.00	3.00	No	Phase II	6	3.00	1.50	No	Apply	Phase II
Generic competencies											
	Adaptability	4.00	1.00	Yes	Included						
	Collaboration and inter-disciplinary teamwork	4.00	0.25	Yes	Included						
	Communication	4.00	0.25	Yes	Included						
	Communication technology literacy	3.00	1.00	Yes	Included						
	Critical thinking	4.00	0.25	Yes	Included						
	Information literacy	3.50	1.00	Yes	Included						
	Leadership	3.50	1.00	Yes	Included						
	Media literacy	3.00	1.25	No	Phase II						
	Problem-solving	4.00	0.25	Yes	Included						
	Productivity	4.00	1.00	Yes	Included						
	Responsibility and accountability	4.00	0.25	Yes	Included						
	Self-directedness	4.00	1.00	Yes	Included						
	Social and cultural interaction	4.00	1.25	No	Phase II						

ABBREVIATIONS: IQR = INTERQUARTILE RANGE

TABLE 5.7: COMPETENCY RANKING AFTER PHASE II OF THE DELPHI STUDY (N = 8 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	Biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)	3.50	1.00	Yes	Included	8	2.00	0.75	Yes	Understand	Included
	Common routes of administration used in clinical settings	3.00	0.00	Yes	Included	8	2.00	1.00	Yes	Understand	Included
	Principles of pharmacokinetics (the movement of drug into, through, and out of the body)	3.00	0.75	Yes	Included	8	2.00	0.00	Yes	Understand	Included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Pharmacokinetics: Absorption	3.00	0.75	Yes	Included	7	2.00	0.00	Yes	Understand	Included
	Pharmacokinetics: Distribution	2.00	0.00	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included
	Pharmacokinetics: Metabolism	2.00	0.00	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included
	Pharmacokinetics: Excretion	2.00	0.00	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included
	Principles of pharmacodynamics (the response of the body to the drug)	4.00	0.00	Yes	Included	8	2.00	0.00	Yes	Understand	Included
	The modulation of drug targets to alter (patho)physiological responses	3.00	0.75	Yes	Included	8	2.00	0.00	Yes	Understand	Included
	Factors that alter the response to pharmacotherapy	3.00	0.75	Yes	Included	8	3.00	0.00	Yes	Apply	Included
	Finding relevant medicinal information	Consensus already reached (not tested)			Included	8	3.00	0.75	Yes	Apply	Included
	Pharmacogenetics information on drug labels	3.00	0.00	Yes	Included	8	2.00	0.00	Yes	Understand	Included
	Response to treatment in patients with or without pharmacogenetic markers	2.00	0.00	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included
	The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	2.00	0.00	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included
	The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	2.00	1.00	Yes	Not included	7	2.00	1.00	Yes	Understand	Not included
	The implication of cardiovascular medication on exercise activity	Consensus already reached (not tested)			Included	8	4.00	0.00	Yes	Analyse	Included
	The interprofessional nature of pain management	Consensus already reached (not tested)			Included	8	4.00	0.75	Yes	Analyse	Included
	The drug pyramid of analgesic, anti-inflammatory, opioid, and steroid medication	Consensus already reached (not tested)			Included	8	3.00	1.00	Yes	Apply	Included
	Risk factors associated with opioid use, such as substance abuse	4.00	0.75	Yes	Included	8	2.50	1.00	Yes	Understand	Included
	The correct use of rescue medication (such as naloxone) for opioid abuse	2.50	1.75	No	Phase III	8	2.00	0.75	Yes	Understand	Phase III
	Communication of the importance of evidence-based medicinal strategies	3.00	0.00	Yes	Included	8	2.00	0.75	Yes	Understand	Included
	Prescribing of pharmacotherapy	3.00	0.75	Yes	Included	8	3.00	0.00	Yes	Apply	Included
	Interpretation of pharmacological research in relation to clinical outcomes	2.00	0.75	Yes	Not included	3	3.00	0.00	Yes	Apply	Not included
Pharmacotherapy against diseases competencies	**Allergies**	3.00	0.00	Yes	Included	8	2.00	0.00	Yes	Understand	Included
	Anaesthesia	2.00	0.00	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
	Anxiety	3.00	0.00	Yes	Included	8	2.00	0.75	Yes	Understand	Included
	Asthma	Consensus already reached (not tested)			Included	8	3.00	0.00	Yes	Apply	Included
	Bacterial infections	3.00	0.00	Yes	Included	8	2.00	0.75	Yes	Understand	Included
	Cardiovascular diseases	Consensus already reached (not tested)			Included	8	3.00	0.00	Yes	Apply	Included
	Constipation	2.00	0.75	Yes	Not included	8	2.00	1.00	Yes	Understand	Not included
	Contraception	2.00	0.75	Yes	Not included	8	2.00	1.00	Yes	Understand	Not included
	COVID-19	4.00	1.75	No	Phase III	7	2.00	0.00	Yes	Understand	Phase III
	Depression	4.00	0.75	Yes	Included	8	2.00	1.00	Yes	Understand	Included
	Diarrhoea	1.00	1.00	Yes	Not included	8	2.00	1.00	Yes	Understand	Not included
	Endocrine disorders	2.50	1.00	Yes	Not included	8	2.00	0.75	Yes	Understand	Not included
	Fungal infections	2.00	0.75	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included
	Gastro-oesophageal disorder	2.00	1.50	No	Phase III	8	2.00	0.00	Yes	Understand	Phase III
	Hormone replacement therapy	2.00	1.75	No	Phase III	8	2.00	0.75	Yes	Understand	Phase III
	Intensive care unit procedures	3.00	0.75	Yes	Included	8	3.00	0.75	Yes	Apply	Included
	Malaria	1.00	0.00	Yes	Not included	7	2.00	1.00	Yes	Understand	Not included
	Muscle relaxation	Consensus already reached (not tested)			Included	8	3.00	0.75	Yes	Apply	Included
	Nausea and vomiting	2.00	0.75	Yes	Not included	8	2.00	0.750	Yes	Understand	Not included
	Obesity	3.00	0.75	Yes	Included	8	2.00	0.00	Yes	Understand	Included
	Osteoporosis	3.00	0.75	Yes	Included	8	3.00	0.00	Yes	Apply	Included
	Parasympathetic nervous system disorders	3.00	0.75	Yes	Included	8	2.00	0.00	Yes	Understand	Included
	Parkinson's disease	3.00	0.00	Yes	Included	8	2.00	0.00	Yes	Understand	Included
	Peptic ulcers	2.00	0.75	Yes	Not included	8	2.00	0.75	Yes	Understand	Not included
	Schizophrenia	1.00	0.00	Yes	Not included	7	2.00	1.00	Yes	Understand	Not included
	Sedation and hypnosis	2.00	0.75	Yes	Not included	8	2.00	1.00	Yes	Understand	Not included
	Sympathetic nervous system disorders	2.00	0.00	Yes	Not included	8	2.00	0.00	Yes	Understand	Not included
	Viral infections	3.00	0.75	Yes	Included	8	2.00	1.00	Yes	Understand	Included
Generic competencies	**Media literacy**	3.00	0.00	Yes	Included						
	Reflection	2.00	1.75	No	Phase III						
	Social and cultural interaction	4.00	0.75	Yes	Included						

ABBREVIATIONS: IQR = INTERQUARTILE RANGE

TABLE 5.8: COMPETENCY RANKING AFTER PHASE III OF THE DELPHI STUDY (N = 13 PARTICIPANTS)

Competency		Importance				Expected cognitive level					
		Median	IQR	Consensus on importance	Decision	Participants (n)	Median	IQR	Consensus on level reached	Proposed level	Decision
Pharmacological competencies	**The correct use of rescue medication (such as naloxone) for opioid abuse**	3.00	1.00	Yes	Included	Consensus already reached (not tested)				Understand	Included
Pharmacotherapy against diseases competencies	**COVID-19**	3.00	1.50	No	No consensus	Consensus already reached (not tested)				Understand	Included
	Gastro-oesophageal disorder	2.00	0.50	Yes	Not included	Consensus already reached (not tested)				Remember	Not included
	Hormone replacement therapy	2.00	1.00	Yes	Not included	Consensus already reached (not tested)				Remember	Not included
Generic competencies	**Reflection**	3.00	1.50	No	No consensus						

ABBREVIATIONS: IQR = INTERQUARTILE RANGE

TABLE 5.9: RESULTS OF THE FULL COMPETENCY LIST SCORED BY PHYSIOTHERAPIST PARTICIPANTS IN THE DELPHI STUDY

Competency			Importance*			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
Pharmacological competencies	**Biopharmaceutics**	**The role of pharmacology in disease treatment**	4.00	1.00	Important with consensus	2.00	0.50	Understand
		Biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)	3.00	2.00	Important, no consensus	3.00	0.75	Understand
		Common pharmacological concepts	3.00	1.00	Important with consensus	2.00	1.00	Understand
		Common formulations used in clinical settings	2.00	0.25	Not important with consensus	N/A	N/A	N/A
		Common routes of administration used in clinical settings	3.00	0.00	Important with consensus	2.00	1.00	Understand
	Pharmacokinetics	**Principles of pharmacokinetics (the movement of drug into, through, and out of the body)**	3.00	0.75	Important with consensus	2.00	0.00	Understand
		Pharmacokinetics: Absorption	3.00	0.75	Important with consensus	2.00	0.00	Understand
		Pharmacokinetics: Distribution	2.00	0.00	Not important with consensus	N/A	N/A	N/A
		Pharmacokinetics: Metabolism	2.00	0.00	Not important with consensus	N/A	N/A	N/A
		Pharmacokinetics: Excretion	2.00	0.00	Not important with consensus	N/A	N/A	N/A
	Pharmacodynamics	**Principles of pharmacodynamics (the response of the body to the drug)**	4.00	0.00	Important with consensus	2.00	0.00	Understand
		Types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)	2.00	1.00	Not important with consensus	N/A	N/A	N/A
		The modulation of drug targets to alter (patho)physiological responses	3.00	0.75	Important with consensus	2.00	0.00	Understand
		Factors that alter the response to pharmacotherapy	3.00	0.75	Important with consensus	3.00	0.00	Apply
	Pharmacogenetics	**The need for pharmacogenetics testing (where pharmacogenetics is the effect genetic factors has on drug reactions)**	2.00	1.00	Not important with consensus	N/A	N/A	N/A
		Pharmacogenetics information on drug labels	3.00	0.00	Important with consensus	3.00	0.00	Apply
		Response to treatment in patients with or without pharmacogenetic markers	2.00	0.00	Not important with consensus	N/A	N/A	N/A

Competency			Importance*			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
		The impact of pharmacogenetics and drug-drug interactions on drug pharmacokinetics	2.00	0.00	Not important with consensus	N/A	N/A	N/A
		Interpretation of pharmacological research in relation to clinical outcomes	2.00	0.75	Not important with consensus	N/A	N/A	N/A
		The limitations of individual pharmacogenetics expertise and need for healthcare providers with appropriate training	2.00	1.00	Not important with consensus	N/A	N/A	N/A
	Clinical practice	Finding relevant medicinal information	3.00	1.00	Important with consensus	3.00	0.75	Apply
		Interpreting pre-clinical and clinical pharmacological data	1.00	1.00	Not important with consensus	N/A	N/A	N/A
		Discussing misconceptions of pharmacotherapy with patients	3.00	1.00	Important with consensus	2.50	1.00	Understand
		Prescribing of pharmacotherapy	3.00	0.75	Important with consensus	3.00	0.00	Apply
		Communication of the importance of evidence-based medicinal strategies	3.00	0.00	Important with consensus	3.00	0.75	Apply
	Physiotherapy practice	The drug pyramid of analgesic, anti-inflammatory, opioid, and steroid medication	3.50	1.00	Important with consensus	3.00	1.00	Apply
		The selection of non-pharmacological and pharmacological approaches to pain management	4.00	1.00	Important with consensus	3.50	1.00	Apply
		The interprofessional nature of pain management	4.00	0.25	Important with consensus	4.00	0.75	Analyse
		Risk factors associated with opioid use, such as substance abuse	4.00	0.75	Important with consensus	2.50	1.00	Understand
		The correct use of rescue medication (such as naloxone) for opioid abuse	3.00	1.00	Important with consensus	3.00	0.75	Apply
		The implication of cardiovascular medication on exercise activity	4.00	0.25	Important with consensus	4.00	0.00	Analyse
Pharmacotherapy against diseases competencies	Autonomic nervous system	Parasympathetic nervous system disorders	3.00	0.75	Important with consensus	3.00	0.00	Apply
		Sympathetic nervous system disorders	2.00	0.00	Not important with consensus	N/A	N/A	N/A
	Cardiovascular and haematological	Cardiovascular diseases	4.00	1.00	Important with consensus	3.00	0.00	Apply
	Gastrointestinal	Constipation	2.00	0.75	Not important with consensus	N/A	N/A	N/A
		Diarrhoea	1.00	1.00	Not important with consensus	N/A	N/A	N/A
		Gastro-oesophageal disorder	2.00	0.50	Not important with consensus	N/A	N/A	N/A
		Nausea and vomiting	2.00	0.75	Not important with consensus	N/A	N/A	N/A
		Peptic ulcers	2.00	0.75	Not important with consensus	N/A	N/A	N/A
	Hormonal and reproductive	Contraception	2.00	0.75	Not important with consensus	N/A	N/A	N/A
		Hormone replacement therapy	2.00	1.00	Not important with consensus	N/A	N/A	N/A
		Infertility	1.00	1.00	Not important with consensus	N/A	N/A	N/A
		Endocrine disorders	2.50	1.00	Not important with consensus	N/A	N/A	N/A
	Immunological	Allergies	3.00	0.00	Important with consensus	2.00	0.00	Understand
		Inflammation	4.00	1.00	Important with consensus	3.00	0.50	Apply
	Intensive care	Pharmacotherapy in intensive care unit procedures	3.00	0.75	Important with consensus	3.00	0.75	Apply
	Metabolic	Diabetes	3.50	1.00	Important with consensus	3.00	1.00	Apply
		Obesity	3.00	0.75	Important with consensus	2.00	0.00	Understand
	Microbiological and infectious diseases	Bacterial infections	3.00	0.00	Important with consensus	3.00	0.75	Understand
		COVID-19	3.00	1.50	Important, no consensus	3.00	0.00	Apply
		Fungal infections	2.00	0.75	Not important with consensus	N/A	N/A	N/A
		Malaria	1.00	0.00	Not important with consensus	N/A	N/A	N/A
		Tuberculosis	4.00	1.00	Important with consensus	3.00	1.00	Apply
		Viral infections	3.00	0.75	Important with consensus	3.00	1.00	Apply

Competency			Importance*			Expected cognitive level		
			Median	IQR	Importance	Median	IQR	Proposed level
	Musculoskeletal	Anaesthesia	2.00	0.00	Not important with consensus	N/A	N/A	N/A
		Muscle relaxation	4.00	1.00	Important with consensus	3.00	0.75	Apply
		Osteoporosis	3.00	0.75	Important with consensus	3.00	0.00	Apply
	Neurological	Anxiety	3.00	0.00	Important with consensus	3.00	0.75	Understand
		Depression	4.00	0.75	Important with consensus	3.00	1.00	Apply
		Epilepsy	3.00	1.00	Important with consensus	2.00	1.00	Understand
		Parkinson's disease	3.00	0.00	Important with consensus	3.00	0.00	Apply
		Schizophrenia	1.00	0.00	Not important with consensus	N/A	N/A	N/A
		Sedation and hypnosis	2.00	0.75	Not important with consensus	N/A	N/A	N/A
	Nociception	Pain	4.00	0.25	Important with consensus	3.00	1.00	Apply
	Respiratory	Asthma	4.00	0.25	Important with consensus	3.00	0.00	Apply
		Respiratory disorders	4.00	0.00	Important with consensus	3.00	0.25	Apply
Generic competencies	Adaptability		4.00	1.00	Important with consensus			
	Collaboration and inter-disciplinary teamwork		4.00	0.25	Important with consensus			
	Communication		4.00	0.25	Important with consensus			
	Communication technology literacy		3.00	1.00	Important with consensus			
	Critical thinking		4.00	0.25	Important with consensus			
	Information literacy		3.50	1.00	Important with consensus			
	Leadership		3.50	1.00	Important with consensus			
	Media literacy		3.00	0.00	Important with consensus			
	Problem-solving		4.00	0.25	Important with consensus			
	Productivity		4.00	1.00	Important with consensus			
	Reflection		3.00	1.50	Important, no consensus			
	Responsibility and accountability		4.00	0.25	Important with consensus			
	Self-directedness		4.00	1.00	Important with consensus			
	Social and cultural interaction		4.00	0.75	Important with consensus			

ABBREVIATIONS: IQR – INTERQUARTILE RANGE; N/A – NOT APPLICABLE DUE TO INDICATION OF LACK OF IMPORTANCE. *ITEMS THAT LACKED CONSENSUS FOR IMPORTANCE WERE CATEGORISED AS SUCH

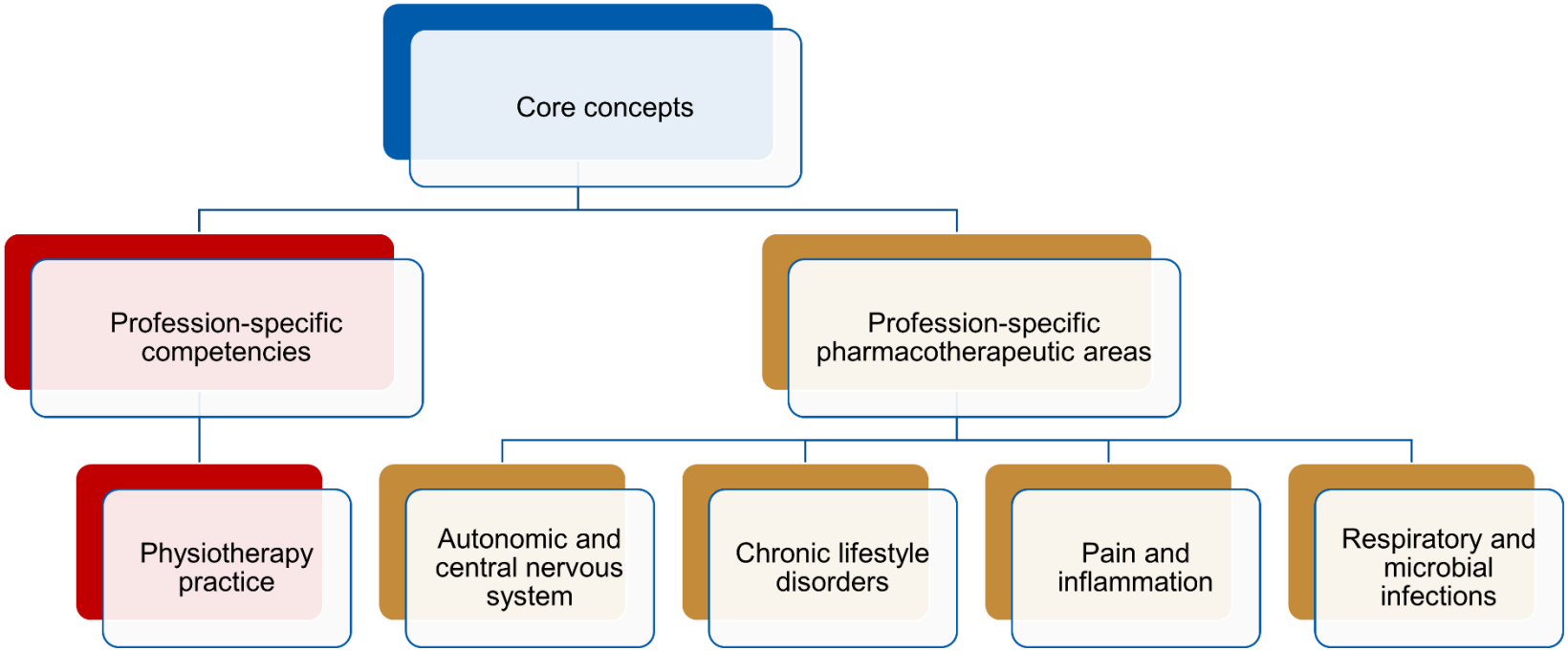

FIGURE 5.2: SUMMARISED VISUAL REPRESENTATION OF THE SUGGESTED PHARMACOLOGICAL COMPETENCY FRAMEWORK FOR PHYSIOTHERAPISTS, INDICATING THE NECESSITY OF CORE CONCEPTS, AND THEIR BASIS FOR PROFESSION-SPECIFIC PHARMACOLOGICAL AND PHARMACOTHERAPEUTIC COMPETENCY DEVELOPMENT

TABLE 5.10: SUGGESTED FRAMEWORK FOR PHARMACOLOGY CURRICULUM DESIGN OF PHYSIOTHERAPY PROGRAMMES DETAILING THE LEARNING OUTCOME (END-GOAL OF THE MODULE THAT THE STUDENT SHOULD ACHIEVE) AND ASSESSMENT CRITERIA (THE WAY IN WHICH ACHIEVEMENT OF THE LEARNING OUTCOME WILL BE DETERMINED). ITEMS PREFACED BY AN ASTERISK (*) CONTAIN ELEMENTS THAT WERE SUGGESTED AS UNIMPORTANT TO PHYSIOTHERAPY BUT ARE CONSIDERED INCLUSIVE WITHIN THE CORE CONCEPTS OF THE PHARMACOLOGY FRAMEWORK

At the end of the curriculum, students must be able to …	Assessment criteria
… understand the core concepts of biopharmaceutics, pharmacokinetics and pharmacodynamics	Discuss the role of pharmacology in disease treatment
	Discuss biopharmaceutics (relation between physicochemical properties drugs in dosage forms and the pharmacology, toxicology, or clinical response)
	Describe common pharmacological concepts
	Describe common routes of administration used in clinical settings
	Discuss the principles of pharmacokinetics (the movement of drug into, through, and out of the body)
	*Discuss absorption, distribution, metabolism and excretion as principles of pharmacokinetics
	Discuss the principles of pharmacodynamics (the response of the body to the drug)
	*Describe the types of ligands in pharmacotherapy (where ligand is a molecule that complexes to a drug target)
	Discuss the modulation of drug targets to alter (patho)physiological responses
	Relate factors that alter the response to pharmacotherapy to the clinical outcome
	Interpret pharmacogenetics information on drug labels
… apply pharmacological principles of pharmacology and evidence-based practice in physiotherapy	Discover relevant medicinal information
	Describe discussing misconceptions of pharmacotherapy with patients
	Relate prescribing of pharmacotherapy to the physiotherapy practice
	Communicate the importance of evidence-based medicinal strategies
	Apply the drug pyramid of analgesic, anti-inflammatory, opioid, and steroid medication
	Apply the selection of non-pharmacological and pharmacological approaches to pain management
	Explain the interprofessional nature of pain management
	Describe the risk factors associated with opioid use, such as substance abuse
	Illustrate the correct use of rescue medication (such as naloxone) for opioid abuse
	Explain the implication of cardiovascular medication on exercise activity
… understand the use of pharmacotherapy against diseases relevant to physiotherapy practice	Relate the use of medicine for [pharmacotherapeutic area below] to physiotherapy practice
	• Parasympathetic nervous system disorders
	• Cardiovascular diseases
	• Inflammation
	• Pharmacotherapy in intensive care unit procedures
	• Diabetes
	• COVID-19
	• Tuberculosis
	• Viral infections
	• Muscle relaxation
	• Osteoporosis
	• Depression
	• Parkinson's disease
	• Pain
	• Asthma
	• Respiratory disorders
	Discuss the use of medicine for [pharmacotherapeutic area below] to physiotherapy practice
	• Allergies
	• Obesity
	• Bacterial infections
	• Anxiety
	• Epilepsy

3.2.1. Alignment with the current pharmacology curriculum

Learning outcomes and assessment criteria from all module guides sourced for the Bachelor of Physiotherapy programme were used to map the curriculum in relation to the FAR 381 and FAR 382 modules. Assessment criteria were linked to learning outcomes from other modules before, during and/or after Pharmacology to determine the level of continuous scaffolding, or any match to modules of core interest to physiotherapy. Such modules included Physiology (Years I and II), Physiotherapy (Years I to IV), and Physiotherapy Clinical Practice (Years III and IV; Year II could not be obtained) given their scaffolding to Pharmacology (i.e., Physiology) or relation to the clinical practice and exit level outcomes of Physiotherapy.

Where possible, publicly available content of the modules has been quoted (University of Pretoria, 2024a). Direct statements within module guides were not possible given the intellectual property associated with the University of Pretoria and its jurisdiction outside of the Department of Pharmacology. The module content in the yearbook varied in explicit discussion of modules' focal points that created some ambiguity of the scope of discussion. Broad concepts related to systems physiology were described, while Physiotherapy and Physiotherapy Clinical Practice modules tended to detail their learning approach and coverage more. The individual module guides' learning outcomes and assessment criteria were not consistently described and varied in terms of explicitness, so although a broad overview was available, it did create challenges in linking pharmacology-related assessment criteria. The core disciplines, particularly, highlight discussion of both theoretical aspects of the module, and demonstrate practical competencies related to the outcomes of the module, for example, assessing and treating patients. The majority of these learning outcomes and assessment criteria made use of Bloom's taxonomy effectively to indicate the expectations of the students, though pharmacology-related terminology was often inferred within broader description of comprehensive treatment.

The assessment of the alignment with the current curriculum does not suggest maintaining the programme as such, but rather sought to understand the current strengths and challenges within the curriculum to inform and support the focus group, and provide clarity on larger changes that may be needed to support the proposed pharmacology curriculum.

3.2.1.1. Mapping of FAR 381

A total of 163 (70.26%) pharmacological assessment criteria in FAR 381 were linked in the Bachelor of Physiotherapy programme (Table 5.11); however, the majority of these were within the first year (70.26%), and a single criterion linked before and in parallel to FAR 381. No further links were observed through the modules, particularly for modules in Year IV. Physiology had 43.10% and 40.09% linkage in Years I and II, respectively. Few linkages were observed for Physiotherapy in Years II (1.72%) and III (0.43%), with none noted for Physiotherapy Clinical Practice.

The Bachelor of Physiotherapy programme shares the same Physiology modules as the Bachelor of Dietetics and Bachelor of Nursing Science students; however, they have two additional modules in the second year presented quarterly. Although they are also enrolled for a Chemistry module, it differs from the two modules presented to the dietetic students. They share a single Psychology module with nursing students, as well as all Anatomy and Medical

Microbiology modules. Although lacking Molecular Cell Biology and Biochemistry modules, they do have a Physics, Anatomical Pathology and Basic Emergency Care module. As with the previous groups, a clear difference in biomedical sciences education is present, suggesting that a mixed group enters the Pharmacology module with varying levels of understanding of the concepts involved.

TABLE 5.11: THE NUMBER OF ASSESSMENT CRITERIA IN FAR 381, FAR 382 AND THE PROPOSED PHARMACOLOGY CURRICULUM, AND THE LINK THEY HAVE TO OTHER MODULES (WITH AVAILABLE OR RELEVANT MODULE GUIDES) LEARNING OUTCOMES, INCLUDING THOSE OF PHYSIOLOGY AND THE AVAILABLE CORE DISCIPLINES (PHYSIOTHERAPY AND PHYSIOTHERAPY CLINICAL PRACTICE). NEWLY ADDED ASSESMENT CRITERIA REFER TO THOSE THAT HAVE BEEN INCLUDED BY THE DELPHI STUDY IN THE NEW CURRICULUM RELATIVE TO THE CURRENT CURRICULA

Linkage of assessment criteria	FAR 381 232 assessment criteria n (%)	FAR 382 168 assessment criteria n (%)	Proposed curriculum 41 assessment criteria n (%)
Pharmacology-related assessment criteria	213 (91.81%)	128 (45.83%)	139 (100%)
Physiology-related assessment criteria	19 (8.19%)	40 (23.81%)	0 (0.00%)
Newly added assessment criteria	N/A	N/A	15 (36.59%)
Assessment criteria linked to another module's learning outcome	163 (70.26%)	101 (60.12%)	37 (90.24%)
Assessment criteria linked to a module(s) prior to Year III	162 (69.83%)	83 (49.40%)	13 (31.71%)
Assessment criteria linked to modules prior to and during Year III	1 (0.43%)	12 (7.14%)	12 (29.27%)
Assessment criteria linked to module(s) during Year III	0 (0.00%)	6 (3.57%)	4 (9.76%)
Assessment criteria linked to module(s) after Year III	0 (0.00%)	0 (0.00%)	0 (0.00%)
Assessment criteria linked to modules before and after Year III	0 (0.00%)	0 (0.00%)	3 (7.32%)
Assessment criteria linked to modules during and after Year III	0 (0.00%)	0 (0.00%)	0 (0.00%)
Assessment criteria linked to modules through Years I to IV	0 (0.00%)	0 (0.00%)	5 (12.20%)
Assessment criteria linked to Year I Physiology	100 (43.1%)	18 (10.71%)	17 (41.46%)
Assessment criteria linked to Year II Physiology	93 (40.09%)	38 (22.62%)	18 (43.90%)
Assessment criteria linked to Year I Physiotherapy	0 (0.00%)	3 (1.79%)	3 (7.32%)
Assessment criteria linked to Year II Physiotherapy	4 (1.72%)	8 (4.76%)	12 (29.27%)
Assessment criteria linked to Year III Physiotherapy	1 (0.43%)	0 (0.00%)	3 (7.32%)
Assessment criteria linked to Year IV Physiotherapy	0 (0.00%)	0 (0.00%)	4 (9.76%)
Assessment criteria linked to Year III Physiotherapy Clinical Practice	0 (0.00%)	0 (0.00%)	00 (0.00%)
Assessment criteria linked to Year IV Physiotherapy Clinical Practice	0 (0.00%)	0 (0.00%)	6 (14.63%)

Anatomy prepares the physiotherapy students in the first year for the broad anatomical regions (limbs, torso, head and neck), osteology, embryology and histology (University of Pretoria, 2024a). Such background helps support students for pharmacological concepts related to the placement, structure, blood supply and neuronal innervation of systems, which ties in appropriately to selected pharmacokinetic parameters and pharmacotherapeutic areas.

Physiology is presented from a systems-based approach in relation to the healthy physiological processes of the central nervous, cardiovascular, haematological, immunological, muscular, renal and respiratory system at various stages in the two years. As per Chapter 3, Section 3.2.1.1, the elements of the core concepts of pharmacology would benefit from the systems physiology discussion of physiology, particularly certain topics of pharmacokinetics (University of Pretoria, 2024a). Chemistry provides additional support to pharmacokinetics properties involving ionisation, where acids, bases and ionic compounds are discussed (University of Pretoria, 2024a, p. 9). As described in Chapter 3, Section 3.2.1.1, similar to the Dietetic students, the autonomic nervous system's coverage is unclear, but is bolstered by the Year I Psychology module (University of Pretoria, 2024a). A platform is thus created for various elements of the central nervous system to be discussed and scaffolded from. The Physiotherapy students are provided additional education on neuromuscular physiology and applied pathophysiology from two separate Physiology modules (University of Pretoria, 2024a). These modules focus more on the integration of the nervous system with the control of body posture, movement and pain, as well as the pathophysiology of the renal, cardiovascular, gastrointestinal, endocrine, thermoregulatory, nutrition, reproductive, respiratory, haematological, immunological and central nervous system. Such enriched discussion of neuromuscular control and pain serves an added link to discussions surrounding anaesthesiology, neuromuscular blockade and analgesia. The Anatomical Pathology module in Year II helps to enrich pathophysiological discussions by focusing on necroses, reversible cell damage, reparation and abnormalities of growth, circulation disturbances, acute and chronic infections, classification of the spreading of tumours and carcinogenesis. Directed course in systematic pathology, with specific reference to cardiovascular system, respiratory system, locomotor system and neurophathology [sic] (University of Pretoria, 2024a, p. 14). Such a background supports the high level of alignment of pharmacology assessment criteria with the learning outcomes of Year II modules, and supports the pharmacotherapeutic areas presented in FAR 381: autonomic nervous system, cardiovascular, haematological, reproductive and renal pharmacology.

Physiotherapy modules present cardiorespiratory, inflammatory and pain-related (such as spinal cord injury) and neurological conditions that align with aspects of FAR 381-associated assessment criteria linked to analgesics, anti-inflammatory agents, and cardiovascular pharmacology.

3.2.1.2. Mapping of FAR 382

One hundred and one assessment criteria (60.12%) were linked to modules through the physiotherapy programme (Table 5.11). A total of 49.40%, 7.14% and 3.57% of assessment criteria for FAR 382 were linked to modules prior to, prior to and in parallel, and in parallel to Pharmacology, respectively. No other matches were observed, particularly for Year IV modules. The Physiology module in Year I (10.71%) and Year II (22.62%) linkages were observed, while only 1.69% and 4.76% association were present for Year I and Year II Physiotherapy modules, respectively.

The additional Physiology modules bolster alignment with pathophysiology of the gastrointestinal, respiratory, immunological and central nervous system (particularly epilepsy); however, limited explicit discussion of schizophrenia and Parkinson's disease occurs. Certain aspects of psychiatric-related conditions, specifically anxiety, depression and schizophrenia

are provided in the Year I, second-semester Psychology module. Physiotherapy (Diseases of lifestyle, chronic disease, the impact of HIV on disability and on patients with trauma, mental health. Impact of physical/economic/political [University of Pretoria, 2024a, p. 22]) and Physiotherapy Clinical Practice modules (Comprehensive clinical management is applied where relevant on infant health, during childhood, adolescence, in women's and men's health, and health and disease in middle age and geriatrics, diseases of lifestyle, chronic disease, impact of HIV on disability, victims of trauma, and/or a mental health condition [University of Pretoria, 2024a, p. 23]) aligns with chronic lifestyle diseases, HIV and mental health conditions, which would support FAR 382's pharmacotherapeutic topics; however, no explicit learning outcomes are available to underscore this.

Furthermore, the Medical Microbiology modules cover the broad topics of Bacterial cells and the classification of disease-causing bacteria, Commonly occurring bacterial infections and the bacteria that cause them, and Fungi, parasitology and virology (University of Pretoria, 2024a, p. 16), which allows for discussion of antimicrobial therapies in FAR 382.

3.2.2. Alignment with the proposed pharmacology curriculum

To ensure no duplication of physiology education was built into the proposed pharmacology curriculum, all physiological assessment criteria were removed.

Of the 41 assessment criteria, 37 (90.24%) were aligned, with 15 (36.59%) new assessment criteria (Table 5.11). Most links made to FAR 381 were before its presentation (31.71%), or before and parallel to its presentation (29.27%). Although few links were observed for assessment criteria in parallel (9.76%), before and after Pharmacology (7.32%) and throughout the whole programme (12.2%), there was a higher number relative to FAR 381 and FAR 382. Physiology linkages were similar to FAR 381, where 41.46% and 43.90% were observed for Years I and II, respectively. The number of linked assessment criteria increased for Physiotherapy (Years I [7.32%], II [29.27%], III [7.32%] and IV [9.76%]) and Physiotherapy Clinical Practice modules (Year IV [14.63%]).

Newly proposed competencies related to patient education, evidence-based practice, algorithms relating to analgesics, anti-inflammatory agents, opioids and steroids, and exercise-related considerations align well with Year II Physiotherapy and Physiotherapy Clinical Practice modules (Comprehensive clinical management of patients with communicable, non-communicable diseases and conditions, patients who have an impairment or disability due to the impact of physical/economic/political/psychosocial environment on health and well-being) (University of Pretoria, 2024a) that overtly speak to clinical management of diseases associated with Physiotherapy's scope of practice. Furthermore, Year IV Physiotherapy Clinical Practice module highlights the student demonstrating scholarship and competency towards evidence-based practice to source relevant information for treatment purposes.

Newly proposed pharmacotherapeutic areas, such as ICU-related pharmacotherapy, osteoporosis, and respiratory diseases, align with the Physiotherapy and Physiotherapy Clinical Practice modules throughout Years II and III. Additionally, ICU-related pharmacology aligns with the module content of Basic Emergency Care in Year II, covering basic life support, automated external defibrillation, and first aid treatment to the suddenly ill or injured patient

(University of Pretoria, 2024a). Apart from the areas of potential physiology deficits and alignment noted, osteoporosis does not have sufficient explicit discussion of the pathophysiological elements related to the disease according to learning outcomes.

3.2.3. Focus group interview

Participants were asked three core questions: i) whether students developed pharmacological competencies, ii) whether their physiological knowledge was sufficient to develop pharmacological competencies, and iii) whether there was alignment of the new proposed curriculum with their graduate needs. Direct quotations are provided verbatim with limited cleanup via the use of brackets to reinforce readability, but not in such a way to alter their meaning. Furthermore, quotations are prefaced with the following abbreviations in Table 5.12 to indicate the participant role alluded to within their feedback.

TABLE 5.12: ABBREVIATIONS USED TO DELINEATE PARTICIPANT ROLES. ROLES ARE DELINEATED BY PARTICIPANT FEEDBACK, AND THUS MAY NOT BE INCLUSIVE OF ALL THEIR ROLES WITHIN THE BACHELOR OF PHYSIOTHERAPY

Abbreviation	Description
P #	Participant number
CC	Course coordination
L	Lecturer
N	Involvement in neurological teaching
P	Involvement in paediatrics teaching
S	Involved in sports physiology teaching

The focus group was attended by ten members of the Department of Physiotherapy who have experience throughout all four years of the Physiotherapy group, have different lecturing responsibilities and course coordination, and have historical understanding of the programme. A single additional interview was done by recommendation of the focus group.

Five themes were evident from their feedback: achievement of competencies; deficiencies in competencies; perceived barriers to competency development; perceived facilitators of competency development, and alignment of competencies within the proposed curriculum (Table 5.13).

TABLE 5.13: THEMES THAT DEVELOPED DURING THE PHYSIOTHERAPY FOCUS GROUP INTERVIEW

Theme	Subthemes
Achievement of competencies	Development of knowledge regarding pharmacology and pharmacotherapy
Deficiencies in competencies	Deficient, isolated or decontextualised competencies
Perceived barriers to competency development	Content overload and misalignment to scope of practice
	Inadequate physiological understanding
	Lack of integration and contextualisation
Perceived facilitators of competency development	Integration and clinical contextualisation
	Alignment to scope of practice
Alignment of competencies within the proposed curriculum	Alignment to scope of practice
	Programme review

3.2.3.1. Development of pharmacological competencies

Participants remarked that students were developing pharmacological competencies, and had sufficient knowledge of the various drugs, but in an isolated and more theoretical perspective.

Furthermore, they opined that the students had the capacity to succeed in their learning, and often showcased their theoretical knowledge. A prominent concern, though, was the content burden that was associated with Pharmacology that greatly exceeded what was required for their scope of practice. This led to a greater emphasis on passing Pharmacology rather than properly understanding it, precipitating limited application of clinical skills. The fear of pharmacology was highlighted as a potential barrier to their learning, as well as a redirection from their primary physiotherapeutic modalities.

[P2; CC; L] "[…] but you see that I'm [*repeating words*] back to the application. Yeah, they've got the baskets of the [*repeating words*] knowledge but [*repeating words*] they don't have the one thing to bridge that."

[P3; L] "I definitely think they do have the competency to do it. In my opinion, is that maybe it is so much information that they actually have too much information to exactly know 100% where to use it, yes."

[P5; L; N; P] "I don't know if it [*repeating words*] would probably help bring in real [*repeating words*] live examples because I just found it seems like the knowledge, the theory knowledge is there but the application, especially when we start [*repeating words*] asking. 'So, what would be the side effects? How will this now influence this child if they are on these medications? Antiepileptics and [*repeating words*] what should we look out for?"

[P10; L; S] "I think they do, and I think they're overdoing it in the sense of what they get. It is almost in line with [*repeating words*] a very strong working towards prescribing […]. But for the context that they need currently, I think they get over and above, yeah."

[P10; L; S] "I think some of our top students will be able to [*in reference to applying pharmacological competencies*]. But in in the discussions that I have with them, there's some lack in it. So, it feel to me they study pharmacology, get in the third year, their afraid of the thing. They study pharmacology for the sake of passing the thing; they wangle it. So, it's [*repeating words*] not a lot of translation into fourth year because they don't get exposed to it really again. So, at fourth-year level where I work with sports students, the lack of knowledge is already evident or the confidence to be able to do it.

Participants highlighted several examples where students were incapable of applying their knowledge within the clinical environment, showcasing a level of knowledge about the drug, but not understanding the integration of various physiological and pharmacological systems, application of their knowledge within the clinical setting, or clinical relation.

[P5; L; N; P] "I mean something silly example, if you would ask the students: 'So why is this child receiving paracetamol?' Then they go 'For pain'. 'No. What else? The GPs choice for pain and fever.' So, it's almost like they cannot cross the border again. So, like [*repeating words*] making the link that sometimes paracetamol would be used for pain but sometimes it can be used for something else, so anti-pyretic.

[P7; L] "[…] I was with students today, and the question asked was: 'My patient is not an epileptic. I cannot remember anything in the file that's epilepsy. So why is she taking an anti-epileptic?' He didn't ask the doctor […] but the understanding was that anti-epileptic meds can influence spasms as well."

[P10; L; S] "Basic example: […] they identify a bursitis clinically, and now if I question them on how do you go about it, the base prescription of anti-inflammatories, […] they struggle with that, they don't know how to go about it."

Various barriers to their learning were identified, beyond the content burden mentioned previously, including the misalignment with the scope of practice and veering into associated

pharmacotherapeutic areas rather than their primary areas of concern. The over-crediting of Pharmacology was highlighted that almost took away emphasis of physiotherapy as the primary treatment modality.

[P4; L] "I think they have enough information, it just becomes an overload. Because there are those that are specific to us, and then there's other related ones, and then to put it all together in one bowl, it's sort of makes them short circuit. […] because some of them don't understand why we do it. And I think it's because it so broad. They [*repeated words*] sort of get sidetracked."

[P5; L; N; P] "This feedback that I've received from some of the students, where they've actually said that they spent way more time on pharmacology versus physiotherapy, and then they're actually here to become physiotherapists."

3.2.3.2. Scaffolded learning from physiology

The physiology scaffold was remarked as a potential barrier to learning, and that concerns were present beyond the confines of pharmacology, also stretching to physiotherapy-specific competencies as well. Participants highlighted that the integration and scaffolding between physiology, pathophysiology, pharmacology and physiotherapy was inappropriate, which suggested a potential programme level review. Concerns were raised that the expectations between physiology and pharmacology were not entirely aligned, thus hindering the ability fully to apply pharmacology within the physiological framework. From an accreditation standpoint, Physiology had been remarked as also requiring a curriculum realignment that necessitates larger discussions between stakeholders to ensure constructive alignment is achieved. Acknowledgement was made, though, that time constraints were evident given the nature of the programme and the diversity of fields within physiotherapy.

[P1; L] "What I'm thinking […] how is the physiology? […] Because you know you've got that hypertensive patients, and renal physiology is important. Now, if we're not, they're not taught systemic physiology, it's [*repeating words*] difficult for them to understand the application of pharmacology. […] But when it comes to application, because this they don't understand how the cardiovascular system work, maybe how the renal system works, it's going to be a lot of difficult trying to apply pharmacology in practice. […] Pathophysiology must also be emphasised."

[P2; CC; L] "If I [*repeating words*] look at the curriculum, and what is dealt with in physiology, I'm not sure the depth of the physiology is enough to make the connection to pharmacology. And if I can quickly take Bloom's [*taxonomy*] […], it's where the physiology content is on the lower level and we ask them now to go a bit of an higher level and I [*repeating words*] don't know how we can bridge that. […] The same with muscle function […], because they do [*repeating words*] physiology that [*reference to specific module codes*] muscle and skin and all of that. And then they do [*anatomical pathology*] first semester, and then they do neuro second semester, so it's [*repeating words*] actually the wrong way around."

[P2; CC; L] "Number 7, please correct me if I'm wrong, but that was also a suggestion from the previous HPCSA evaluation we had. Physiology was mentioned specifically." and [P7; L] "You're correct. We need to get on that, otherwise we would have to answer in three years' time."

[P10; L; S] "In my mind is, where I see the practical issues coming. A lot of your subject, it seems like it does not have a big enough base for physiology, […] so that's what concerns me a little bit, It looks like it covers the fields but [*repeating words*] I don't know, it [*repeating* words] seems they struggle to apply it going through to yours. It becomes a difficult answer."

[P10; L; S] “That's going to have to be discussions with the with the physiology department. So, this is our needs. This, for example, […] sports physiotherapy, and I need them to understand […] endurance training, how these systems work together. Are you touching on this? So, I think that'll be a larger alignment. Physiotherapy is difficult because there's so many fields within physiotherapy. So, this will have to come from a neurological firm, from musculoskeletal firm, and […] missing in my context, exercise physiology.”

3.2.3.3. Alignment of the proposed pharmacology curriculum

Important pharmacotherapeutic areas were acknowledged, pertinently highlighting the acute phases of injury, chronic diseases and aspects related to sports Physiotherapy. Much of the discussion was aligned with prominent areas of treatment within Physiotherapy, including respiratory ailments, muscle spasms, pain and inflammation. This was also raised in terms of what they may see based on referrals, and acknowledging that they would need to be able to deal with what pharmacotherapeutic effect may now complicate their physical therapy. Additionally, it was necessary to acknowledge that medication could be used for more than just one indication, and thus could be repurposed depending on dosing and rationality of use.

[P2; CC; L] “To understand the differences in the different types of [*repeating words*] pain medication, […] huge emphasis currently in physiotherapy on chronic pain and the […] relationship between the pain meds and antidepressants, and how they link with one another in in the context of the patient.”

[P4; L] “So, if we can streamline it for them, I think it will make their life much easier. […] So, for example, we work a lot with the acute phase where there's inflammation and things like that. So, if they understand what anti-inflammatories are needed and why.”

[P6; L] “[…] it can be streamlined, so the emphasis can be placed on […] chronic medications. Because a lot of our patients are, you know, being treated for example, like a stroke and […] then there’s anti-hypertensives, and then there's diabetic medication, there's the cholesterol medication, there's medication for antidepressants and things like that. So, it's those ones that the patients come with or are now going to be taking on chronic basis. So not just, you know, the [*repeating words*] acute medication, but also sometimes what they are going to be taking for long periods. And then obviously the side effects that we'll come over a period of time with those ones as well.”

[P8; L] “[…] I do think they have to have a knowledge of the antiviral medications and antibacterial medications. If they work in ICU and have lung patients […]. […] they must know the difference between medication that has a central mechanism for decrease of spasticity and those that work on an antispasmodic way more peripherally. That they know when patients need Baclofen or just something for muscle spasms.”

[P8; L] “For example, some of the antidepressants can also be used to decrease pain. If you use SNRIs instead of the SSRIs, that they know that, for something like Trepilene, that you can also [*repeating words*] give in a low dose for pain management, not just depression.”

[P10; L; S] “[…] for me and my field, corticosteroids is probably one of the biggest things where it is so common medical practice. You get referrals. ‘I've injected this guy three times now and then I don’t get the response’, where it's common knowledge in literature to [*repeating words*] not do it. Stop it; it stops the healing.”

[P10; L; S] “I think it's because [*repeating words*] we deal with what happens [*referring to a consequence of pharmacotherapy*]. We don’t have a decision, so it’s identified. Okay this is [*altered to ‘bad’ due to language edit*] but now how do I react to it?”

The overt focus remained understanding where pharmacotherapy assisted or affected their treatment, and thus would cover the bases of indications, adverse effects, and considerations in patients. For example, sleeping medication was raised both in the context of assistance with combatting pain-related insomnia, but also the contextually relevant use in long transit time of athletes, and the potential effect thereof on their performance.

[P5; L; N; P] So, for us it links with what are precautionary measures and safety measures to consider while working with the patient. […] So, what are the side effects and why is it indicated for the patient? Why are they receiving this medication? What are the side effects and what should be, besides the patient having had a stroke, so now they have decreased balance. Maybe the medication can also have an effect on their gait or being ambulant."

[P5; L; N; P] "Can I [*repeating words*] add on the [*repeating words*] paediatrics, please. So, I think […] what we've seen in many of the patients with your ARVs, so the types and the dosages and how long it should be taken. Obviously, your TB medication as well, and then all your meds for ADHD. So why is this child on Concerta or whatever the case might be, or why should they probably be on Concerta? So that that might also be now together with the with the side effects."

[P9; L] "[…] sleeping pills and so on, whether they are aware of that, because sometimes GPs prescribe that, you know, with pain. Sometimes they can't sleep and so without telling them when to start weaning. Now, so perhaps sometimes it says start weaning after four weeks and they just give a few months. So, the context […] we always ask what and look what medications patients are on and I think we are in a privileged position to pick up something like that for referral."

[P10; L; S] "The Bulls are playing in Australia. They're playing now […], but he's sleeping on the plane, waking up massively tired on that side. So [*repeating words*] to understand that in the sporting context that you have planned this session as physio, but the GP has pumped this guy with [*sleeping*] medication, so just understand the after-effects."

[P10; L; S] "It's a lot more athletes on antidepressants […] will it affect us in any way? […] it feels to me like every second guy I'm talking to now is actually on an antidepressant, especially in high-performance sport, so that may need to be brought in. […] team-base sports is fine where you can get away with. I can [*repeating words*] float in the system. Sports, like sprinting, is milliseconds and […] you need to be on top of it. Then if an antidepressant is affecting that. I mean we need to have the discussion. How bad is it needed? And obviously it's needed, but […] how it affects you."

[P10; L; S] "Its in the same line as certain antibiotics as well. Like fluoroquinolones. […] it tones down the intensity at where their playing at."

Polypharmacy and the interaction of exercise and medication, from a pharmacokinetic perspective, was also highlighted as being important given its potential to alter disease outcomes for the better or worse.

[P1; L] "Yeah, but speaking from experience, just like she said, we deal with chronic patients. Patients you know that have chronic diseases, and many of them, polypharmacy is a common thing. Many of them are up to five to six medications. […] Now if they're on such medications and you're expected to, you know, administer physiotherapeutic care intervention many times you will have […] either increasing the absorption rate of the drugs that are taking or reducing it. […] but if you end up decreasing the absorption […], they're not doing well, even though they're getting their treatment or maybe. […] So emphasis must be placed on drug exercise interaction."

Within the sporting context, areas of importance not indicated in the Delphi study were raised. Performance-enhancing drugs were of concern as Physiotherapy aligned prominently with

sports medicine and the rehabilitation of athletes. The sensitivity of dealing with patients using performance-enhancing drugs, such as anabolic steroids, was acknowledged including the trust that is placed in physiotherapists to keep such matters private between themselves and the client. Patient education, particularly how such drugs can negatively affect the system, or implicate them in illicit use that may transgress sporting regulations (whether by ignorance or explicitness) was emphasised.

[P10; L; S] "Of course, there's a big part of physiotherapy that is sport, and this is [*repeating words*] especially in our country. […] in schoolboy level, where they will need to [*repeating words*] identify [*referring to performance-enhancing drug use*]. But they come and tell you when you gain their confidence, but what implications would you have? What you need to consider in your treatment and the rehab education? So, it is important. […] Again, the basics of it. Of identifying what's the issues that affect me as a physio, how will it affect my schoolboys, and what does he need to know. And often it stays between you. He tells you, "don't tell anyone else"."

[P10; L; S] "[…] anabolic steroids and these things come into play […] understanding the issue with it and [*repeating words*] how does it affect pathology and [*repeating words*] going forward, but [*repeating words*] they get very little exposure to that yet."

[P10; L; S] "It's very contextual to support, but it's maybe like banned substances and drug-free sport has this as approach that they list. At least what we should avoid, but maybe a small bit of understanding of why, because players come to you, and they say: 'Listen physio'. […] Physio is a job where you spend a lot of time with the patient. You probably build the best relationship. So, they open up sensitive stuff to you. And you're not a psychologist, but we need the correct information to 'Hey, why can't I use this substance? I see it's on the list. Guys I'm not going to test this weekend and why can't I push it?' […] the potential to highlight to them and it's a lot of guys coming up that [*repeating words*] gets tested positive and they say 'Yeah, it's my cough syrup'. They probably try to [*altered to 'play' due to language edit*] the system, but it's [*repeating words*] for the guy who really didn't know. To inform those guys as well and what to look out for. The physio has […] to understand these substances […] what is banned in our country or largely international."

Acknowledgement was made that physiotherapists should act within their scope of practice that reinforced an interprofessional working environment with other practitioners, such as medical doctors and pharmacists using pharmacotherapeutic modalities. Importantly, the scope of practice of the physiotherapist was highlighted to necessitate maintaining an appropriate professional guidance, rather than exceeding the boundaries of what is allowed for by legislation. This was specifically important where patients may approach them for information on medication, or where they would need to deal with misinformation thereof.

[P1; L] "You don't just want to because you're part of your team. You don't just want to do your own thing."

[P6; L] "[…] we are still first line practitioners, and every now and then you do have a patient who whilst you're treating them, […] then you'll want to say to them, you know you need to take a course of anti-inflammatories. And then if patients will say: 'OK what do you suggest?' So to be able to have that information on, you know, […] when to suggest a Myprodol, but then when will a Cataflam. You know, just the scheduled ones, or even now like with the neuro patients, sometimes it's a topical, you know for pain or for something inflammation […]. 'What do you think would be best?' So, if then, you know, the physios, you know where the line is, what they want is possible, but then other than that what to send to the doctor for."

[P7] "The awareness [*referring to misinformation of medicine*] is important, but they need to know their scope. Otherwise, they get in trouble."

[P10; L; S] "[…] then we put it in place that you chat to your pharmacist over-the-counter: 'This guy needs anti-inflammatories.' But you take the guidance from them. For example, at the LC clinic, they deal with the student athletes that do not have medical aids and it's a long process to come and sit in the queues and see a GP. So, they can't see anyone else really [*repeating words*] that's going to help them from now until the event on Saturday. So, [*repeating words*] the students are trained to identify this is an inflammatory condition. It needs anti-inflammatories. But, but their skill in how, and how much, and how frequently, that they don't know. So, this is what we're bringing to the system in my sports programme is then: add this thing, over-the-counter. You can get your anti-inflammatory, take the pharmacist's advice. What's the duration of this? This is about how we're trying to [*repeating words*] cover ourselves."

The matter of scope of practice extended further into the potential for physiotherapists to prescribe in future, where acknowledgement was seen as possible, but not of pertinent concern. The emphasis remained on students' understanding what their scope of practice would allow, and what their training would capacitate them to do as physiotherapist.

[P7; L] "I think the South African physios are aware that the national undergrad curricula firstly are different, but the students aren't ready [*referring to prescription extension of scope of practice*], so they can be made aware that its been discussed. But when we do finally decide to go certain physios can prescribe it will have to be a postgraduate […]."

Several recommendations were made for how to approach the new curriculum from a teaching perspective, with prominent focus on small group activities allowing for clinical contextualisation, as well as integration between different disciplines. However, it was maintained that pharmacology should be a stand-alone module so that biomedical training could be focused. This did not undermine the potential for Physiotherapy staff members to be involved with the module as potential contextual trigger points for students, for example, to highlight the value of pharmacotherapy in a specific disease or physiotherapeutic treatment. By allowing for a focused approach of teaching pharmacology within the clinical context of Physiotherapy, it was thought that better engagement could be achieved, with a higher level of understanding achieved within their scope of practice.

[P1; L] "I thought to say, something like, that there are small groups […] where [*repeating words*] they're going to be discussing […] reports. I was just thinking it's possible to get physiotherapists, not just pharmacologists. OK, because now we're talking about clinical application."

[P1; L] "So as many case reports as possible: different conditions. You know how exercise, of our own modalities, would interfere […]. So as many case reports."

[P2; CC; L] "So we have always a group that we do case reports on, and that will then be in [*repeating words*] the end of the year. We've got combined case reports that will be a nice one to then bring in this kind of a discussion."

[P3; L] "It's my opinion […] will be to keep it as a service module. In person, my own pharmacology knowledge is not that great to teach things. […] rather the way of continuing, and integrate specific physiotherapy."

[P5; L; N; P] The previous institution where I worked; we actually did that with the anatomy department. So, we had a bit of a bit of interaction because there, what we found was for instance, the interpretations of MRIs and scans of the brain [*referring to inappropriate understanding*]. So, I mean, students study the Netter and they [*repeating words*] know what [*repeating words*] the structures are. Then all of a sudden they get to the hospital. They see actually a similar thing because that's what a CT scan is and all of a sudden they cannot interpret it. So, it was almost like that the bridge couldn't be built from what we've seen in class.

[…] The application just within a different context, so [*repeating words*] there what we did was we then brought in CT scans together when they're [*repeating words*] doing those modules on [*repeating words*] neuroanatomy. And that really actually made quite a difference because then it showed the students that this is actually how they should be implemented because now we've never done CT scans, we've done anatomy."

[P10; L; S] "I want to train students to go out in the clinical field. […] I want the pharmacology department. I want the dietetics in our small groups, and I understand it's workload. And […] becomes the logistical nightmare […], but that would have been the ideal. Give me the baseline and you got higher levels of understanding."

4. Discussion

To facilitate a structured discussion, the general needs analysis has been approached separately but contributes sequentially to the targeted needs analysis.

4.1. General needs assessment

The general needs analysis is discussed first as the scoping review, which helps create a preamble for the discussion of the Delphi study results.

4.1.1. Scoping review

The scoping review yielded very few articles detailing pharmacological competencies related to physiotherapy that created complexity in literature-guided design of a focused curriculum. As such, supplementation of generic pharmacology curricula was needed to allow for a large enough base of information for the Delphi study.

Peel and Mossberg (1995) opined that physiotherapists required sufficient understanding of how cardiovascular medication could influence exercise for the better or worse (Peel & Mossberg, 1995). Pharmacotherapy such as β-adrenergic receptor antagonists, diuretics, vasodilators and positive inotropes may alter cardiovascular function, such as the heart rhythm, blood pressure and electrolyte balance, which, in turn, could impact exercise ability (or vice versa) (Peel & Mossberg, 1995). Such awareness thus prepares the physiotherapist more appropriately to adjust treatment plans in light of pharmacotherapy.

In their focus group interviews, Van Aswegen et al. (2017) spoke to South African physiotherapists' minimum clinical standards to approach duties within an ICU setting, where a broad list of knowledge, skills and attributes was defined (Van Aswegen et al., 2017). Knowledge of associated pharmacotherapy, including routes of administration, risks and precautions of use, and cardiovascular medication was opined as necessary for their education (Van Aswegen et al., 2017). Similarly, Chevan and Heath (2009) developed a collaborative model for opioid education, where focus on non-pharmacological pain management strategies were exemplified in parallel to understanding the role of opioids, their risks, and ways to treat an overdose (Chevan & Heath, 2019). As such, both cognitive and psychomotor competencies were highlighted to ensure that an opioid overdose could be identified, but also treated with relevant medication, such as naloxone in a physical manner (Chevan & Heath, 2019).

The potential for underlying genomic difference to alter health and therapy was acknowledged as important for healthcare practitioners, including physiotherapists (Callier et al., 2014). Importantly, such competencies would need to align with the scope of practice of the practitioners, and where physiotherapists were recommended to understand pharmacogenomics (i.e., how genetics will alter the outcome of pharmacotherapy) at a basic level (Callier et al., 2014). Pittenger and Olson-Kellogg (2012) raised the importance of collaborative strategies in the communication of evidence based medical strategies, thus speaking more to patient education (Pittenger & Olson-Kellogg, 2012).

As expected from the list, most pharmacological competencies were listed in the cognitive domain. This is evident as pharmacotherapy is a supplement to the physiotherapeutic, rather than involving pertinent psychomotor competencies. At present, physiotherapists are not allowed to prescribe medication in South Africa, although, concerted effort has been made by the South African Society of Physiotherapists and HPCSA Board for Physiotherapy, Podiatry and Biokinetics to construct guidelines for the extension of the scope of practice (Unger & Lochner, 2006; Hall, 2013). Changes to the scope of practice have not yet been made, albeit the discussion is still ongoing, and physiotherapists continue to display interest in the potential to do so (Kakono et al., 2023).

4.1.2. Delphi study

4.1.2.1. Pharmacological competencies

Given the spread of data, there appeared to be a much larger disagreement on the relevance of certain pharmacological concepts in Physiotherapy than in previous groups discussed in Chapters 3 and 4, including core competencies of pharmacokinetics, pharmacogenetics, prescription, and opioid abuse. No additional pharmacological competencies were recommended.

As described in Chapters 3 and 4, Section 4.1.2.1 the foundation of pharmacological competency development rests on the core concepts of pharmacology (White et al., 2021). Participants agreed on the importance of several of these, including biopharmaceutics, and the overarching descriptive principles of pharmacokinetics and pharmacodynamics; however, contradictory opinions were noted for specific sub-items. Although the absorption of drugs was considered necessary, distribution, metabolism and excretion were not regarded as such. The latter three pharmacokinetic principles impact treatment success and occurrence of adverse effects (White et al., 2021) and thus cannot be excluded from the broader discussion of a drug's effect on clinical outcomes. Similarly, while the modulation of drug targets and the factors that influence clinical response were recommended for inclusion, the different types of ligands in pharmacotherapy were recommended for exclusion. Additionally, it was recommended that all core concepts be aimed at a lower cognitive level, suggesting broad descriptive understanding would be sufficient for their scope of practice. It is important to note that for scaffolding to more complex learning outcomes, such as rationalising of pharmacotherapeutic treatment and clinical decision-making, students may inherently struggle to achieve competencies without a sufficient educational base of these core concepts. A compromise should thus be reached to ensure sufficient focus is spent on the core concepts of pharmacology to facilitate competency development, but not exceeding the discussion thereof to exceed their scope of practice. As stated by White et al. (2021), core concepts allow

for the development of conceptual frameworks and allow for the integration of knowledge relevant to each healthcare profession (White et al., 2021), which emphasises creating a thorough platform for it to build from.

Pharmacogenetics, a burgeoning field contributing to personalised medicine, was regarded as unimportant to physiotherapists in the undergraduate curriculum. Although recommended in literature to be included at an appropriate level in different healthcare practitioner's education (Callier et al., 2014), the only aspect remarked as important by participants was applying pharmacogenetic information on drug labels to practice. Application may be difficult if the underlying concepts of genetics and pharmacogenetics are not discussed.

Sourcing of relevant information and communication of evidence-based medicine strategies were all considered important aspects of clinical practice, with recommendations at an application level. Evidence-based medicine is a practice during which best evidence is used explicitly, conscientiously and judiciously to inform decision-making in the care of patients (Castellini et al., 2020). Although considered important, challenges regarding sourcing of information and interpretation thereof have been noted for physiotherapists (Castellini et al., 2020; Paci et al., 2021). Depending on how andragogy is approached, using an inquiry-based assignment may help overcome such deficiencies by requiring students to source relevant research to support best practice within the specific topic provided. However, interpretation of pharmacological evidence was not considered important, suggesting that such competencies would be more appropriate to develop outside of the pharmacology curriculum to focus on physiotherapy practice, or incorporating a comprehensive case to allow for broader interpretative ability. Participants also felt that discussing pharmacological misconceptions was important; however, not only at a lower cognitive level, suggesting students were only expected to have a broad understanding thereof rather than the ability thoroughly to evaluate information. Given the scope of practice not focusing on pharmacotherapy, this may reinforce the appropriateness of the scope of practice to engage in patient education relevant to their primary treatment modality, rather than venturing into pharmacotherapeutic areas that are beyond their current education.

Prescribing was considered important; however, only at a level indicating understanding. Non-medical prescribing has been increasingly discussed as an extension of the scope of practice of physiotherapists. Although the United Kingdom has approved such practice (Chartered Society of Physiotherapy, 2006), South Africa has not yet done so, which supports the low level of understanding needed on the topic rather than the ability to engage with higher order expectations of learning. There is a current drive by the Board for Physiotherapy, Podiatry and Biokinetics of the Health Professions Council of South Africa to do so. Similarly, other countries have also investigated this, such as Australia (Noblet et al., 2019), Nigeria (Onigbinde et al., 2013), and New Zealand (Raghunandan et al., 2017). Nationally, South African physiotherapists agreed to the inclusion of prescribing in their practice (Unger & Lochner, 2006; Kakono et al., 2023), citing increased service delivery, reduced treatment costs, and multi-professional consultations as beneficial outcomes (Kakono et al., 2023). However, inadequate education was remarked as a prominent concern (Kakono et al., 2023). Medicine deemed appropriate for prescribing in such a limited formulary included analgesics, anti-inflammatory agents, muscle relaxant, mucolytics and bronchodilators (Unger & Lochner, 2006; Onigbinde et al., 2013; Kakono et al., 2023).

Given the role of physiotherapy in exercise, participants highlighted the importance of understanding the effects of cardiovascular medicine during strenuous activity. Various cardiovascular medicines may affect the way in which the body responds to exercise, for example, altering the heart rate or blood pressure, or may not necessarily be clinically effective during exercise, thus affecting their suitability during such a time (Peel & Mossberg, 1995). Pain management is a common feature in physiotherapy (Chevan & Heath, 2019) that supports its ranking as important in the framework. According to the pain management ladder, non-pharmacological modalities, such as physical therapy would be opted for in many cases, with pharmacological treatment only started should pain not be controlled or become too severe (Leung, 2012). Analgesics and anti-inflammatory agents may thus supplement non-pharmacological treatment by, for example, allowing for greater flexibility and mobility during manipulation (Lansbury & Sullivan, 2002). Although important, depending on the responsibilities afforded by the national scope of practice, care should be taken not to overstep legal authorisation of using such agents (Braund & Abbott, 2011). The importance of careful use of analgesics (Braund & Abbott, 2011; Leung, 2012; Chevan & Heath, 2019), particularly opioids, is needed given their abuse potential (Leung, 2012; Chevan & Heath, 2019). In support, participants agreed that understanding the risk factors associated with abuse, the interprofessional nature of pain management, and the use of opioid antagonists as rescue medication was important.

4.1.2.2. Pharmacotherapeutic competencies

The pharmacotherapeutic areas aligned well with the scope of practice of physiotherapists, with participants emphasising the level of education needed for treatment modalities aligned with their scope of practice. Allergies, obesity, bacterial infections, anxiety and epilepsy were considered important, but at a lower cognitive level of understanding. Considering neurological and mental health-related conditions, pharmacotherapy associated with anxiety and depression was considered lower and higher order cognitive level competencies, respectively. Psychiatric physiotherapy has been noted as an adjuvant to pharmacotherapy and psychotherapy given its impact on physical wellbeing (Almirón et al., 2020; Ölund et al., 2020). Although physiotherapists interact with patients living with epilepsy, knowledge deficiencies have been reported that may lead to misconceptions of the disease and its pharmacological management (Amoudi et al., 2021). Parkinson's disease, a debilitating neurodegenerative condition characterised by motor dysfunction, requires pharmacotherapeutic intervention for symptomatic control. However, physiotherapy benefits treatment as an adjunct that necessitates consideration of the medicine present in the medical profile of the patient (Radder et al., 2020).

Various respiratory conditions, whether microbial (Rogers, 2005; Holland, 2014; Mohammed & Thornton, 2021) or non-microbial in origin (Holland, 2014; Bruton et al., 2018), may require pulmonary rehabilitation alongside a physiotherapist. Participants' agreement of viral (including COVID-19) and bacterial (including tuberculosis) therapies are understandable, given their concomitant use in infectious pulmonary diseases. For example, rehabilitation may be required for COVID-19 whether it be related to airway clearance (although exudate accumulation is uncommon) or mobilisation upon recovery (Thomas et al., 2022), and thus an understanding of the pharmacotherapy would be needed. Even beyond the pulmonary implications of infections, the impact of treatment on physiotherapeutic modalities should also be considered. For example, fluoroquinolones are well-known to incur tendinopathy with

potential rupture that should be taken into consideration when applying or recommending physical therapy (Lewis & Cook, 2014).

Obesity and diabetes were considered important, which is supported by the vast number of musculoskeletal disorders that may occur in such conditions (Smith & Burnet, 2003). Similarly, muscle relaxants in musculoskeletal conditions are considered an important drug class for physiotherapists given their beneficial impact on treatment (Unger & Lochner, 2006; Kakono et al., 2023). Pain and inflammation impact musculoskeletal health. Invariably, physiotherapists will commonly encounter patients using such medication to assist with their physical recovery (Braund & Abbott, 2011; Leung, 2012). Physiotherapists in the United Kingdom already have access to the prescription of pain relief medication, such as certain benzodiazepines and opioid analgesics (Chartered Society of Physiotherapy, 2006). Education within this domain should not exceed the scope of practice, though. For example, a group of surveyed New Zealand musculoskeletal physiotherapists reported recommending using non-steroidal anti-inflammatory drugs and paracetamol outside of their scope of practice, with deficiencies in knowledge noted that may impact clinical success and safety (Braund & Abbott, 2011).

The following areas were noted to be unimportant for education: sympathetic nervous system disorders; gastrointestinal disorders (such as altered bowel movement, gastro-oesophageal reflux disorder, nausea and vomiting, and peptic ulcers), hormonal and reproductive disorders (including contraception, infertility, and endocrine disorders), fungal and malarial infections, anaesthesia, schizophrenia and sedation.

4.1.2.3. Generic competencies

Generic competencies are not specific to pharmacology, but affect the success of a student within their prospective profession. Such skills have been remarked as imperative in the modern day, particularly with the ever-changing digital landscape (Weber, 2006; Van Heerden, 2013), to adapt to the needs of the country (Van Heerden, 2013), accommodate changes to their scope of practice (Kakono et al., 2023) and achieve higher order thinking (Binkley et al., 2014). Such skills resemble the critical cross-field and developmental outcomes recommended by the South African Qualifications Authority (South African Qualifications Authority, 2000). For example, evidence-based practice, remarked as important earlier, requires critical thinking, problem-solving and information literacy to develop (Albarqouni et al., 2018) that may be deficient in many cases (Castellini et al., 2020; Paci et al., 2021; Płaszewski et al., 2022).

Reflection did not reach consensus, though it is unclear why there was a lack of agreement on the concept. Literature supports reflection for several reasons, including professional development (Ziebart & MacDermid, 2019), clinical reasoning, evidence-based practice (Roche & Coote, 2008; Sole et al., 2019; Ziebart & MacDermid, 2019) and confidence (Roche & Coote, 2008). From a broad competency development vantage, reflection is included in the exit level outcomes of the Bachelor of Physiotherapy degree at the University of Pretoria (South African Qualifications Authority, 2018), thus would need to be developed. The Bachelor of Physiotherapy further highlights the need for communication, collaboration, accountability, responsibility and health education to be addressed during education (South African Qualifications Authority, 2018).

4.2. Targeted needs assessment

The targeted needs analysis is discussed in a stratified format according to the development of pharmacological competencies, scaffolded learning from physiology, and alignment of the proposed pharmacology curriculum. This incorporates both the curriculum mapping and focus group interviews, given the cohesive nature thereof.

4.2.1. Development of pharmacological competencies

Curriculum mapping was done for both the current and the proposed pharmacology curricula, with the former serving as a platform to assess strengths and limitations of the current curriculum, and to guide the focus group. Most module guides could be sourced for the Bachelor of Physiotherapy, apart from the second year Physiotherapy Clinical Practice module. In general, learning outcomes and assessment criteria allowed for a level of alignment to be assessed within the curriculum, bolstered by module content available for the programme (University of Pretoria, 2024a); however, gaps were present, particularly for modules of interest. Although the learning outcomes and assessment criteria were structured appropriately to reinforce the management of physiotherapeutic modalities, the integration of pharmacotherapeutic aspects was unclear, apart from certain diseases. This is supported by the lack of any linkage present in Years III and IV of the programme. The proposed pharmacology curriculum, however, showed a minor increase in such links being formed, though still not greater than 14.63% at highest. It would be prudent to assess the learning outcomes of the core modules to ensure that more explicit alignment can be done for mapping purposes, which allows for a clearer relation in the curriculum management process (Balzer et al., 2016; Treadwell et al., 2019). Although the learning outcomes and assessment criteria are considered well-constructed, review may be called for (Treadwell et al., 2019) to highlight whether comprehensive treatment with other modalities, including Physiotherapy, is present in the expectations thereof, and how to accommodate it.

Although few links were present, participants remarked that students were exceeding the breadth of pharmacology needed by their profession, inferring that much of what they would require would be covered. Additionally, participants believed the students were developing theoretical knowledge of pharmacology, though faced several challenges in applying it within the clinical setting. For example, it was posited that the breadth of content confounded the ability to apply it, or created an inappropriate view of the importance of pharmacotherapy in relation to physiotherapy. Participants highlighted the majority of areas that are covered in the proposed pharmacology curriculum as important, and welcomed the removal of the broader list of pharmacotherapeutic areas.

Competency development related to the treatment of pain, inflammation, and spasticity were used as exemplars for where students failed adequately to apply their theoretical background, as well as realising that drug classes could be used for more than one indication. Physiotherapists' scope of practice largely involves musculoskeletal conditions where potential dysfunction or associated pain of muscles, tendons and cartilage may be present (Lee & Sheppard, 1998; Fransen, 2004; Taylor et al., 2007; Melnick, 2015; Nielsen et al., 2015). Appropriate knowledge of such drugs is thus needed adequately to address patient morbidity, and as opined by one participant, is often a case of managing what has been referred to them already after pharmacotherapeutic treatment has commenced (whether good

or bad). For example, the inappropriate use of corticosteroids for the treatment of tendinopathy was highlighted, where the long term-use has been opined to be ineffective or detrimental in a meta-analysis (Irby et al., 2020; Puzzitiello et al., 2020). Incompetence in such a treatment modality may precipitate further concerns, for example, an increased need for revision surgery (Puzzitiello et al., 2020) that will have downstream repercussions for a physiotherapist during rehabilitation services.

4.2.2. Scaffolded learning from physiology

As discussed in Chapter 4, Section 4.2, physiology learning outcomes and assessment criteria were broad, but provided a degree of information to support curriculum mapping. The Bachelor of Physiotherapy modules share the physiology modules with the Bachelor of Nursing Science, though have enrolment for two additional Physiology modules focusing on further discussion of musculature, neurological and pain systems, and broad pathophysiological processes. This integrates with the Anatomical Pathology discussion within the second year, and in such a way helps create a base for discussion of subsequent processes reliant on physiology. The majority of such links were present for the underpinning modules, such as Physiology and Medical Microbiology. However, as opined by participants, scaffolding appeared to be inadequate to support pharmacology and physiotherapy education, which hinders competency development. For example, physiology related to the muscle system as well as sports physiology, created some level of disconnect, which included, among others, the potential of being incorrectly aligned with the second-year programme. Without sufficient scaffolding of the underpinning biomedical sciences, horizontal and vertical alignment become impacted and debilitates learning (Faingold & Dunaway, 2002).

Given the overlapping education provided, discussions of the core concepts of pharmacology and their importance to the profession are similar to those done for the nursing profession (Chapter 4, Section 4.2). The increased focus on pain provided in the additional Physiology module allows for a clearer and explicit relation to analgesic pharmacotherapeutic areas, while the pathophysiological discussions cover the broad base of all physiological systems. However, as mentioned by participants, there does appear to be an underlying concern of whether the expected level of understanding is developed to propagate pharmacological competencies. My perceptions concur with this finding, where, although there appears to be overt general grasp of concepts, it is not sufficient to integrate the pharmacological modulation of physiological processes to alter clinical outcomes. As such, it would be appropriate to review the physiology curriculum in alignment with physiotherapy, especially as participants remarked on the HPCSA recommendations to assess its structure.

Similar to the Bachelor of Nursing Science students, Year II Medical Microbiology modules provide Physiotherapy students with a platform for understanding the antimicrobial properties of drugs. The proposed pharmacology curriculum highlights relevant microbial infections that impact the respiratory system, and as such integrates with the respiratory physiotherapy practice originating from bacterial (Marguet et al., 2021) and viral infections (Lalwani et al., 2021).

4.2.3. Alignment of the proposed pharmacology curriculum

Participants welcomed the alterations of the pharmacology curriculum, and were positive about streamlining the curriculum to the scope of practice of the physiotherapist profession. The proposed curriculum was accepted as is, with three contextually relevant fields included: sleeping medication, performance-enhancing drugs, and exercise-drug interactions. The importance of the various pharmacotherapeutic areas has already been discussed, and thus focus is placed on those that have been highlighted here. As an overall opinion, participants highlighted that the predominant areas that would need to be targeted included pain, inflammation, several chronic diseases (such as diabetes and neurological conditions), musculoskeletal complaints (such as spasticity), and respiratory ailments (including those with microbial origins). Several important considerations were highlighted regarding such pharmacotherapy that overtly spoke to understanding the adverse effects that could occur during use, and how these would alter physiotherapeutic modalities; longside this, how the medication could supplement physical therapy.

Physical exercise can alter the pharmacokinetics and pharmacodynamics of various drugs, and consequently alters their efficacy and safety profiles in clinical treatment (Lenz et al., 2004; Lenz, 2010; Gladson & Myslinksi, 2011; Niederberger & Parnham, 2021). For example, exercise may alter blood flow to various organs and reduce gastrointestinal motility, which, in turn, would alter the absorption, distribution, metabolism, and excretion of drugs (Lenz et al., 2004; Lenz, 2010; Gladson & Myslinksi, 2011; Niederberger & Parnham, 2021). There is contention, though, regarding how prominent any changes may be, given the heterogeneous nature of exercise, and as such, whether clinical outcomes may be significantly altered is often unclear (Lenz et al., 2004). Reviews have suggested that drugs such as insulin, warfarin (Lenz et al., 2004) and digoxin (Joreteg & Jogestrand, 1984; Lenz et al., 2004) may be of risk of having notable changes to their therapeutic outcomes, and thus care should be taken when patients are prescribed such therapy. As the current curriculum already addresses pharmacokinetics and pharmacodynamics, integrating the concept of exercise-based alterations thereof should be possible while maintaining contextual relevance without exceeding the necessary credit load for it.

Sleeping medication is generally used to help reduce the occurrence of insomnia, but is also associated with several concerns of tolerance and dependence (Staub, 2019). Within the context of physiotherapy, patients may be under physical duress and pain that affect sleep hygiene, and thus should be aware of the consequences of such medication to their patients' health (Staub, 2019). An additional concern, as raised by one of the participants, is the contextual relevance of sleeping medication used in sports. Although the relevance thereof was more linked to the potential effect of the sleep hygiene of the athlete during transit, literature speaks to the potential contention of sleeping medication being administered to athletes by sports physiotherapists (Anderson, 2010, 2012). Concerns have been raised about the potential litigatory aspects of such practice, but also the knowledge that physiotherapists have of such medication (Anderson, 2010, 2012). Such discussions broach not only the importance of the basic sciences of sleeping medication, but also into the scope of practice of physiotherapists, and understanding their role within the healthcare system based on legal rights.

Physiotherapists invariably would also assist athletes in rehabilitation to facilitate peak performance and recovery (Melnick, 2015). As opined by one participant, an area that is currently lacking within the curriculum is acknowledgement of performance-enhancing drugs, such as anabolic steroids, and the potential safety and legal repercussions of use. The concern was further supported by the placement of the sports physiotherapist within the patient relationship as a confidant and educator (Henning et al., 2017; Patterson et al., 2023). Performance-enhancing drugs are often used to promote sports performance in a variety of different contexts; however, their use remains contentious (Wajeeha & Javed, 2020). Within the sporting environment, a stringent list of prohibited medication is provided by the World Anti-Doping Agency as a measure to protect the integrity of sport; however, it does acknowledge therapeutic use exemption where such medication is required for therapeutic reasons (World Anti-Doping Agency, 2024). For a physiotherapist, a prominent focal point should be to ensure not only the safety of their athletes by educating on risks associated with performance-enhancing drugs (Chyka, 2003), but also by trying to ensure accidental doping does not take place in unassuming athletes (Patterson et al., 2023). Such a concern was raised by a participant to ensure that those that are already using such medication are aware of the risks and can be educated appropriately, but also to ensure that athletes that are not partaking in such practices do not inadvertently complicate their careers due to unwitting use of illicit substances.

5. Recommendations

5.1. Programme level curriculum review and mapping

Given participant feedback and the difficulty in ensuring explicit linking of learning outcomes, it is recommend that the Bachelor of Physiotherapy be reviewed to ensure that scaffolding of the biomedical sciences is appropriate to allow for the development of core competencies, including those related to pharmacological intervention. This stems most prominently from my own perspective of limited prerequisite understanding of physiology being present in the student group, but also supported by feedback from participants. This can be supplemented by a complete mapping of the programme on LOOOP to ensure that a transparent and dynamic curriculum is available to accommodate changes in the future.

In doing so, horizontal and vertical integration can more easily be achieved given the broader understanding of how all concepts interlink in the Physiotherapy programme. Furthermore, should a greater focus be placed on refining the focus of the biomedical sciences towards the physiotherapy profession, credit load can be reduced to allow for a more structured and paced learning experience.

5.2. Contextualisation of pharmacology within the physiotherapy profession

As requested by participants, the Department of Pharmacology should preferentially continue to offer Pharmacology as a stand-alone module, however, with a more refined focus as allowed for by the proposed curriculum. Although informal discussions have requested reduction to a 5-credit weight, this does not appear to be feasible given the breadth of information that needs to be covered. More realistically, 10 credits should be an achievable goal, which does decrease the current credit load by 28 credits in total. Should more integration be possible between Physiotherapy and Physiotherapy Clinical Practice modules,

there may be a potential to reduce this further; however, it would be inappropriate to interleave too much basic sciences' theory within their core discipline. Alternatively, one could rather contextualise the relevant medication within small group discussions in their core discipline, as opined by participants. In doing so, not only is there clearer vertical integration between pharmacology and physiotherapy, but it also allows for clinical context to be emphasised. Furthermore, the potential for Physiotherapy educators to enter the Pharmacology module to provide their view of the discipline within their profession also allows for greater valuation of the pharmacotherapeutic modality as an adjunct or inherent possibility within their primary treatment.

5.3. Developing generic competencies by leveraging existing platforms

Participants agreed that a variety of generic competencies were needed for their profession, which is also supported by their exit level outcomes (South African Qualifications Authority, 2018). The pharmacology curriculum already makes use of inquiry-based learning to support research and information sourcing; however, the context can be shifted towards Physiotherapy to accommodate a more professional case that accommodates pharmacotherapeutic intervention. The small class sizes also allow for a greater team-based approach to be opted for, thus stimulating interpersonal skillsets to a larger degree.

The Integrated Healthcare Leadership and various research-related modules already allow for an interprofessional platform to be developed, with relevant communication and healthcare education competencies introduced at second-year level in Integrated Healthcare Leadership (University of Pretoria, 2024b, 2024c, 2024a). Should the possibility arise, pharmacotherapeutic modalities can be interleaved in such activities further to contextualise and strengthen the importance of the discipline within the healthcare profession.

6. Considerations of the curriculum windows based on recommendations made

Using the recommendations made in Section 5, the following considerations will need to be kept in mind when addressing the proposed curriculum. It is important to acknowledge that these will require iterative stakeholder discussions, and thus should not be seen as a finalised proposal but rather a platform for the creation of an initial proposal document.

6.1. Expected learning outcomes

In general, curriculum mapping highlighted a deficiency in clearly relating pharmacological competencies to core modules. As such, their alignment with exit level outcomes becomes more tenuous and inferred, thus opening the possibility of curriculum design flaws. To facilitate a clearer link, it would be prudent to modify assessment criteria explicitly to state where pharmacotherapy may be necessary to include within learning. This would also help strengthen mapping of the curriculum in LOOOP, and thus provide a dynamic plan for management by course coordinators. The exit level outcomes of the Bachelor of Physiotherapy speak to the ability to manage complex patient profiles to ensure thorough management of their unique considerations in disease management (South African Qualifications Authority, 2018), thus such clear alignment would bolster achieving this outcome. As the number of pharmacotherapeutic areas has also decreased, learning

outcomes become more focused on the profession, and thus facilitate the reduction of the number of credits linked to the programme itself.

6.2. Curriculum content or areas of expertise covered

Although the core concepts of pharmacology remain similar to what is currently presented, their contextualisation would need to accommodate a more physiotherapeutic outlook. This would require, for example, a greater involvement of how exercise alters the pharmacokinetic and pharmacodynamic profile. Exercise, and the alterations to the physiological system, are likely to be more appropriately addressed by Physiology; however, given the current lack of sports physiology education, stakeholder discussions would be needed to ascertain the best placement thereof. This, for example, would support evaluating the programme to a greater degree as recommended in Section 5.1.

Given the removal of most pharmacotherapeutic areas, much time can thus be saved to reduce the content-heaviness of the current Pharmacology module. Although the basic sciences aspects of the pharmacotherapeutic areas that remain can largely stay the same, the context of clinical repercussions will need to accommodate a specific discussion point for physiotherapy. This would by and large constitute addressing why a physiotherapist may encounter such a medicine, how it would affect their treatment (or vice versa), and relevant adverse effects to assess. New material would need to be generated for the discussion of performance-enhancing drugs.

6.3. Student assessment

The smaller size of the class (approximately 56 ± 6.7 based on a five-year average) allows for altered assessment practices to be accommodated, supported by the focus on more physiotherapy-relevant competencies. As such, case report-specific assessments can be generated that allow for a more comprehensive and integrated view of the use of pharmacotherapy within their clinical practice. The recommendation would be that such cases be provided by the Department of Physiotherapy to facilitate a more authentic environment for assessment to take place. This could be done in both formative and summative assessment practice to ensure the value thereof is continuously emphasised.

6.4. Learning opportunities

As discussed in Chapter 3, Section 6.4, various andragogies have already been implemented that support student-centred learning (Cordier & Lubbe, 2021; Mlambo, 2021; Parkar, 2021). The reduction of class sizes and focus on a single profession allows for the opportunity to strengthen the clinical context for teaching. It would be sensible to contextualise learning opportunities for the various sessions in a patient-directed manner, thus showcasing why a physiotherapist may see a specific medication when approached.

6.5. The learning environment

The small group size allows for a much greater platform for group discussions; however, Faculty of Health Sciences venues are generally constructed more according to standard lecture formats. However, it can be evaluated how to approach such activities within the

constraints of the learning environment. The single group also facilitates sessions to take place on Prinshof Campus, thus simplifying the need for continuous travel of students between various sites, given their overlapping schedules.

6.6. Learning resources

Resources, similar to Chapter 4, Section 6.6, would not require a large alteration apart from the contextualisation with the physiotherapy profession. Furthermore, new material would need to be created for performance-enhancing drugs. Given the interest in making use of the academic staff of the Department of Pharmacology within Physiotherapy-directed modules, it would be prudent to assess how such resources would need to be modified to accommodate a streamlined interleaving of the discipline. As with the nursing science group, clinical cases generated by the Department of Physiotherapy would be the ideal platform for contextualised, authentic learning to be achieved.

6.7. Timetable

By focusing the module on a single group, the logistics of the module becomes more simplified as it can fit well within the Bachelor of Physiotherapy's structure. Scheduling would need to be accommodated by the departmental programme manager to ensure sufficient time is available for the flipped classroom approach of the University of Pretoria to be facilitated.

6.8. Staff

As remarked by participants, Pharmacology should be approached as a service module still, and thus remain stand-alone. However, this does not imply that integration with clinical physiotherapy education should not be aimed for. Internal staffing considerations would necessitate a course coordinator and associated lecturers, whether from the current team or the larger pool of colleagues from the Department of Pharmacology. The focused nature of the module may justify keeping the team small to allow for a more dedicated teaching platform to be developed, gaining expertise for the specific context of the profession. Such capacity would need to be investigated to ensure that a work-life balance of the academic staff members is maintained. Administration of the curriculum would need to be accommodated in-house, which includes coordination, question bank development, moderation and so forth.

6.9. Curriculum management

Curriculum management will be done by the Department of Pharmacology; however, given the large alteration to the Pharmacology module, such as a 28-credit, approval would need to be sought through all relevant channels apart from matters within nursing-specific modules. As the Pharmacology module would most likely become a single semester module, the Faculty of Health Sciences' Academic Advisory Committee and the Faculty Board, as well as the Senate of the University of Pretoria, would need to approve the change to the Bachelor of Physiotherapy programme. Since no alteration is made to the exit level outcomes or the core disciplines, it would not necessitate reaccreditation from SAQA. This process may take approximately two years to complete, and thus realistically may be implemented at third-year level in 2029 only. A transitionary period would be needed, though, to enrol students prior to

2029 in the FAR 381 and FAR 382 modules up until 2030. This does affect the staffing considerations as teaching workload may invariably increase.

6.10. Students

The students have already been described as part of Section 2.3, and little change is expected in the group within the next few years.

7. Conclusion

Using the Delphi study approach, a framework for curriculum development of nationally relevant competencies in the physiotherapy profession has been proposed, with further tailoring to accommodate the context of the University of Pretoria. Of 31 and 37 pharmacological and pharmacotherapeutic competencies, 20 and 22 were considered important for inclusion in the physiotherapy curriculum. Contributions were predominantly made by academic members from national institutions; however, support was available from those in the healthcare sector and accreditation or professional bodies. The competencies listed as important were by and large cognitive in nature, and directed towards the scope of practice of physiotherapy, such as pain, inflammation, spasticity and chronic diseases. Alongside these, all fourteen generic competencies were considered important to the profession. Delphi participants recommended that most competencies be developed at a lower cognitive level, which aligns with the non-pharmacotherapeutic nature of the physiotherapy profession.

The targeted needs analysis highlighted potential gaps in physiological scaffolding that may necessitate a further programme review to ensure all necessary fields are approached at the correct depth. In doing so, curriculum mapping of the programme can also be approached to ensure that a living and transparent curriculum is achieved that becomes more proactive towards changes in the national healthcare sector and profession. Participants were appreciative of the changes recommended, with adoption of the proposed pharmacology curriculum. Three items were highlighted as required for the University of Pretoria graduate, including performance-enhancing drugs, sleeping medication and exercise-drug interactions.

Limitations of the study included the low response rate during the Delphi study, thus bias may invariably be present for some competencies. Targeted needs analysis was complicated by the learning outcomes and assessment criteria's limited discussion of pharmacotherapeutic involvement in the physiotherapy practice, thus reducing the potential accurately to identify links to core disciplines in the programme. Areas of deficit may thus be overstated, though in themselves emphasise consideration of reworking learning outcomes for clarity.

Chapter 6
Group comparison, recommendations and conclusions

Teamwork is the ability to work together toward a common vision. The ability to direct individual accomplishments toward organizational objectives. It is the fuel that allows common people to attain uncommon results.

Andrew Carnegie (Schindler, 2015, p. 154)

1. Introduction

Chapter 6 serves as a comparative conclusion, inclusive of recommendations for the refined curriculum design and implementation, changes that may directly affect the Department of Pharmacology, and my own reflections on growth throughout the research project. The overarching research question was based on which pharmacological competencies Dietetics, Nursing and Physiotherapy students would need within their education, and how to contextualise these to the University of Pretoria. The research study successfully developed national competency frameworks relevant to these healthcare professions, and generated substantive data to allow for recommendations to be proposed for focusing the curricula at the University of Pretoria's School for Healthcare Sciences. This included an investigation of the main concerns of the various departments that can guide curriculum design and development.

2. Comparing the groups

The study allowed for the generation of context-specific competency frameworks for South African dietitians, nurses and physiotherapists guided by a research-based approach to support recommendations with evidence from relevant stakeholders. These frameworks were further used to help construct individualised pharmacology curricula for each prospective healthcare practitioner at the University of Pretoria, with recommendations for refinement and implementation. In doing so, overlapping and diverging competencies were compiled, allowing for contextual discussion of each group in Chapters 3 to 5.

2.1. The current combined pharmacology curriculum

Curriculum mapping, supported by focus group interviews, highlighted that although there was trust in the way in which pharmacology education was presented and a belief of quality facilitation, it was considered decontextualised, lacked integration with the core discipline, and lost focus of the scope of their specific audience. The basic sciences' nature of the course was understood as important by the participants, and belief was present that students understood aspects thereof. However, the curricula were seen as excessive while students could not apply their knowledge appropriately within the clinical setting. As such, a concern of limited pharmacological competency development was present that varied in terms of urgency depending on the scope of the healthcare practitioner. Of particular concern was the unique

attribution of the competency to the scope, for example, drug-food interactions for dietetics, musculoskeletal adverse effects affecting treatment for physiotherapists, or posology and administration of pharmacotherapy for nurses. All these matters were remarked as either not being displayed, developed or retained by their groups, which thus showed the limitations of a generalised pharmacology curriculum for the healthcare practitioners. Participants opined that focused curricula would benefit their programmes to a much higher degree.

The diversified foundational nature of the respective healthcare practitioners further complicated approaching competency development as each programme differs in their foundational years. Curriculum mapping yielded low levels of linkages between learning outcomes of core disciplines and pharmacology. Although most alignment was seen for modules presented prior to Pharmacology, at times it was isolated or insufficient for the learning that would be needed to contextualise pharmacology within the biological framework. For example, although Dietetic students have a background in biology, nursing and physiotherapy students lacked such education, while only Nursing had access to a formal Medical Terminology module. Similar distinctions were present for Anatomy, Biochemistry, Chemistry and Physiology modules. Pathophysiological training was approached differently in each group as either an integration within their core discipline (Bachelor of Dietetics and Bachelor of Nursing Science) or bolstered by an additional Physiology module (Bachelor of Physiotherapy). As such, the baseline biological education of students approaching the pharmacology curriculum differs, and thus students will inherently have access to differing levels of prerequisite knowledge. Of concern, scaffolding of some of the physiological and pathophysiological education in relation to the core discipline and pharmacology was remarked during the focus group as not being aligned well, thus further hindering competency development. All groups had a perception that the students' underlying physiology knowledge was insufficient for pharmacology or the core discipline. Based on anecdotal reporting, a likely factor to consider within each of the programmes is the content-heaviness, precipitating cognitive overload, and decontextualised teaching of the basic sciences in general.

The greatest barriers to competency development identified by participants in the focus group were the content-heaviness, decontextualised nature of the curriculum, and the lack of integration with other disciplines, particularly their core disciplines. Perceptions of the participants were that the students feared pharmacology, found it overwhelming, and regarded it as something that needed to be passed. The belief was held that by reinforcing a more focused, contextualised and integrated curriculum (whether still stand-alone or integrated into other core modules), students would find more value in pharmacology, particularly if also introduced earlier in the programme. All participants were in favour of incorporating small group discussions highlighting pharmacology within clinical cases, and involving pharmacology educators within their clinical platform to support their students' learning adjunct to the curriculum.

2.2. Overlapping core and generic competencies

The core concepts of pharmacology were considered important for each group, albeit at varying levels of expectations, with Nursing expecting higher cognitive order competencies from their students. The core concepts have recently been posited as the platform from which further pharmacological knowledge is developed, given their overarching integrated nature, and thus although the contextualisation thereof may require focused approaches, they still

have a similar base of instruction to draw from. Inclusive of this, various pharmacotherapeutic areas were important to all three healthcare practitioners, the majority of which are already included in the FAR 381 and FAR 382 modules. The common pharmacotherapeutic areas included those of the autonomic nervous system, pain, inflammation, metabolic syndromes, microbial infections and cardiovascular diseases. This highlights the relevance to the quadruple burden of disease that South Africa faces, as these diseases are pivotally centred within the various categories of our health concerns. Importantly, all participants indicated that their students needed to approach pharmacology within their scope of practice, thus patient guidance on medicinal use would be directed by the regulations underpinning them.

All generic competencies were considered important for the healthcare practitioners, highlighting their relevance to their professions within their exit level outcomes of the degrees, as well as the critical cross-field outcomes and University of Pretoria graduate attributes. Although not considered discipline-specific, these competencies exemplify the underpinning competencies required by higher education graduates, with literature supporting the necessity of these within the professional duties, particularly for matters relating to patient education, clinical decision-making and interprofessional collaborative working. Reflection was included for physiotherapists by request of the Delphi panel, though inherently is expected to develop for all graduates throughout their education by the University of Pretoria and the SAQA.

2.3. Divergent core competencies

Each healthcare practitioner had competencies represented within their professional scope only, which was supported by their exit level outcomes and available literature. An important distinction that was present was the greater number of psychomotor domain competencies for the nursing group, which showcases their greater involvement as medication manager. Pharmacology is inherently interlinked to their nursing process, and thus although the Pharmacology module approaches education from a basic sciences vantage, it reinforces the need to ensure it translates into a practical competency. Participants believed integrating pharmacology educators into the clinical education platform would help create value and better context to their students learning. Nursing students also presented with the largest number of competencies requested for development, and the most diverse range of pharmacotherapeutic areas, highlighting their involvement as an underpinning of the primary healthcare setting as carers.

For Dietetic and Physiotherapy students, competencies were categorised in the cognitive domain, which is supported by their more proximal nature to pharmacotherapy and focus on therapeutic nutrition and physiotherapeutic modalities, respectively. Although Dietetics had a broad list of pharmacotherapeutic areas, their additions were predominantly focused on those attributed to their scope of practice, such as nutritional disorders, metabolic syndromes and cardiovascular diseases. Furthermore, a prominent area for dietetic competency development, confirmed by the focus group, was nutritional alterations caused by pharmacotherapy, drug-food interactions and the prevention of such occurrences. Participants posited that their students lacked such knowledge, and displayed limited competency therein during their clinical exposure. Although nurses had a similar need for drug-food interaction knowledge, it was not to the depth or breadth of the dietetic group, thus showcasing the importance of focusing and aligning curricula with graduate needs.

The Physiotherapy group had the largest reduction in the proposed pharmacology curriculum that aligns with their treatment modality involving physical means rather than a molecular one. Pharmacotherapeutic competencies aligned with pain, inflammation, pulmonary diseases and cardiovascular disorders, which are part and parcel of the physiotherapy scope of practice. Additional depth was recommended in terms of pain and inflammatory management, including the potential for substance-abuse with opioid analgesics, and the effect of exercise on phrmacotherapy. Focus group participants highlighted the need to discuss pharmacokinetic alterations incurred by exercise, and the importance of acknowledging performance-enhancing drugs to their group.

The frameworks developed highlighted that generic curricula are inappropriate for the development of core competencies for the three healthcare practitioners, and emphasised the need for focused and constructively-aligned programmes that allow for relevant graduate competencies to develop. By doing so, not only does it allow for a reduction of irrelevant topics from the curriculum, but also allows for more contextualised development of the competency in relation to the scope of practice.

3. Recommendations and effect on the Department of Pharmacology

Apart from the recommendations contextualised in Chapters 3 to 5, inclusive of the considerations of Harden's windows of the curriculum, overarching recommendations are made for the refinement and implementation of the pharmacology curricula with a particular view of the effect it may have on the Department of Pharmacology.

3.1. Programme review and curriculum mapping

Each healthcare practitioner programme would benefit from a full programme review to ascertain its alignment with graduate competencies and the exit level outcomes of the degree. The curriculum review as well as the focus group interviews indicated a need to review learning outcomes and assessment criteria of modules to ensure relevance to the programme, and to facilitate the curriculum mapping process. Furthermore, participants also remarked on the potential of underlying basic sciences curricula not being integrated, contextualised or appropriately structured for their programme. Using the LOOOP platform to facilitate mapping would allow for a living, transparent curriculum for each programme that would be more adaptable to changes within the context of the healthcare setting.

An important aspect of such programme review would be stakeholder consultation among all service departments and the department housing the group, which includes the clinical education platform as well. This, in itself, will necessitate proper change management given the inherent state of flux and stress that such a review process may incur. By allowing for interdisciplinary and interprofessional working groups to develop, co-construction of a clear curriculum map can be made, of which pharmacology would be a portion. The research-based approach used in this study highlighted the importance of such intermingling of experts ranging from basic to clinical sciences, and the need for informative documents being available for review.

As the new Bachelor of Science in Nutrition and Dietetics is already in advanced development stages at the Faculty of Health Sciences, urgency is needed to ensure review occurs by the

2026 implementation date. Although no immediate programme changes are envisaged for the Bachelor of Nursing Science and Bachelor of Physiotherapy, it would be appropriate to discuss such reviews, given concerns raised during their focus groups. While the Bachelor of Physiotherapy may have more localised changes, such as the implementation of a single Pharmacology module, the Bachelor of Nursing Science may require larger changes given their requests for greater integration to be achieved. Any change in the programme structure of such a nature will necessitate formal approval processes to be followed, inclusive of the Academic Advisory Committee and the Faculty Board of the Faculty of Health Sciences, and the University of Pretoria Senate. It is unlikely, though, that the Bachelor of Nursing Science and Bachelor of Physiotherapy would necessitate reaccreditation through SAQA, given the targeted level of change expected and lack of alteration to the exit level outcomes. A transitionary period will occur though, which itself is a complicated procedure where two programmes will need to overlap at differing year levels, to accommodate different enrolment years of students. For the Bachelor of Science in Nutrition and Dietetics, this would occur as soon as 2026, with Pharmacology being phased out in the Bachelor of Dietetics programme in totality by 2027 (bar repeating students).

Important to note would be challenges that may be experienced at different institutions that may wish to implement to proposed curriculum. Each institution will present with their unique challenges, strengths and limitations, which ultimately impacts how such an implementation may be approached. Programmes may differ greatly between institutions, regardless of their alignment to professional bodies' minimum essential standards, and be directed towards their target audience, the national needs within their immediate location, or the expertise which has developed within their academic settings. Implementation would require targeted analysis at each institution to ensure that curriculum alignment, appropriate scaffolding, and integration is present so that redundancy, duplication and educational gaps do not form. This will, in itself, also assist with change management procedures to ensure a cohesive curriculum design approach is used.

3.2. Contextualisation of pharmacology within learning opportunities

As a concern for each group was the lack of clinical contextualisation of pharmacology within their profession, clever and appropriate design of learning opportunities would be needed to help ensure learning material, the way in which learning and assessment occurs, and how it integrates with the programme is appropriate and constructively aligned. All participants agreed that clinical cases in pharmacology sessions would be beneficial to student learning, particularly if aligned with small group discussion sessions. In many ways, this would allow for a larger valuation and contextualisation of the pharmacotherapy within the nature of the profession. Clinical cases would be best to source from the Departments of Human Nutrition, Nursing Science and Physiotherapy directly, and if possible, to include clinical educators within selected portions thereof to bring further context into the discussion. However, such a task may prove complicated with academic scheduling, and thus can be navigated using alternative means, such as digital introductions to the cases by said clinical educators. Furthermore, to help reinforce pharmacology within the clinical platform, pharmacology educators may help enrich such clinical education within the various core modules where they are not formally integrated to reinforce pharmacological competencies beyond their initial introduction; this recommendation was posited by the focus groups and aligns well with a co-teaching modality. Co-teaching will help reinforce the interdisciplinary and interprofessional nature of the

healthcare sector, thus showcasing the importance of each healthcare practitioner in the treatment of patients, as well as the underpinning basic sciences informing clinical decision-making.

3.3. Considerations for the Department of Pharmacology

The Department of Pharmacology will be affected in numerous ways by the proposed curricular changes. The largest change that will need to be considered is the addition of two new modules within its jurisdiction (assuming the Bachelor of Nursing Science will be a year module, and the Bachelor of Physiotherapy a single-semester module). The Bachelor of Science in Nutrition and Dietetics will take over the module coordination duties from pharmacology given its integrated nature, however, will still require a liaison to ensure planning aligns appropriately. Such a large change in the number of modules and approach to them will necessitate either additional staff members or an alteration in the workload of the current academic staff to accommodate more coordination and lecturing duties. Invariably, this will be accompanied by internal change management, and thus will need to be approached carefully and constructively to highlight the findings of the study as a scholarly justification for the changes to be made. The transitionary periods will further increase the workload that may be placed on some academic staff members until programmes can officially discontinue FAR 381 and FAR 382 from their rosters.

The Department of Pharmacology has a base of learning material directed to numerous topics; however, most from a generalised perspective or aligned with the broader medical context. As such, much of the learning material, should it be redirected for such modules, will require contextualisation to the need for the various professions. For example, bolstered drug-food interaction information may be needed for dietetic students, while treatment alteration may become more apparent to Physiotherapy students. Furthermore, areas not yet developed, such as those relating to performance-enhancing drugs, would need to be compiled anew. Of course, it would benefit all learning material to be reviewed in alignment with the most appropriate andragogical modality, otherwise it may precipitate more lecturer-centred teaching modalities than creating student-centred opportunities, or potentially lead to generalised discussions even though in a focused module. This will be dependent on the academic members associated with the modules, and their teaching philosophies. The potential to include generic competency development platforms within this would need to be assessed, but opportunities exist for creative authentic andragogical modalities to allow for learning and assessment of more than just disciplinary aspects. For example, by creating assignments that are directed towards misinformation or topical concepts within the profession, such as navigating complex dietary interactions with pharmacotherapy, or person-centred physiotherapeutic needs complicated by adverse effects, it affords generic competency development.

Integration points would require various stakeholder engagements with the Departments of Human Nutrition, Nursing Science and Physiotherapy, and thus it would be sensible to identify course coordinators from the start to help refine curriculum development. In doing so, it allows for accountability in the curriculum design, rather than transitioning a designed programme over to someone who had less involvement in its construction. It further creates additional opportunities for collaboration to develop, thus strengthening the working relationships between different departmental representatives. Faculty development would allow for

educational practice to be bolstered, which during such a transitionary state may necessitate building confidence and competence in all staff involved.

Although these changes are challenging, there are numerous benefits that will come from them. More focused curricula would allow for a stronger potential for students to obtain the pharmacological competencies necessitated by their healthcare professions that capacitate them to a greater degree to affect the healthcare setting when pharmacotherapy is present. Furthermore, by focusing curricula, it minimises the cognitive overload precipitated by the generalised curricula, and also increases the potential for students to see the value of pharmacology in their practice. Such focused curricula are also more easily adaptable, as an iterative process of Kern's medical curriculum design model, as less confounding factors would need to be considered from other practitioners' needs. By increasing the focus in education, a platform for more appropriate interprofessional engagement in relation to pharmacology can be created, as students would be more explicitly aware of the expectations of their knowledge and interaction in such an environment.

Apart from the educational benefits for students and the healthcare system, the logistical and curricular repercussions associated with FAR 381 and FAR 382 will also be mitigated due to the removal of three groups of students. As such, only the Bachelor of Science students would need to be accommodated, which also allows for a more directed curriculum for them in the future. By separating groups, it also creates opportunities for developing learning opportunities at the level necessitated by each healthcare practitioner, based on the unique structures of their programmes underlying prerequisite education. In doing so, challenges encountered in a mixed group, such as differing levels of physiology knowledge, absence of medical terminology, or contextual diversity can be avoided that in theory, should allow for a reduction of the potential number of confounding factors associated with their education. From an accreditation standpoint, by creating focused curricula, it also affords the Department of Pharmacology greater compliance with the professional development necessitated by each programme, and thus elevates their relationship as a service module to the housing department.

4. Reflecting on my growth

The following section delves into my growth during the research study, separated into several personas: health professions education researcher, curriculum designer, and supervisor.

4.1. As a health professions education researcher

When I approached this study, I believe I had a very specific vision in mind of what could and would happen during its execution. Realising that my time was already stretched as a basic pharmacologist with an imperative not to discontinue my biological research (due to my own passion for it, as well as the hard science disciplinary view that permeates the academic environment and its career development platforms), I invariably underestimated the challenges that would run in parallel to something that, in essence, would be considered part of my duty as a module coordinator. Approaching the curriculum design process from an evidence-based approach added multiple layers of factors to be considered, notwithstanding the additional ones that would be tied to it being framed within a research degree. Upon reflecting, I realise why curriculum design often occurs as it does – it is not something to

approach lightly, and if done with all processes in mind, the complexity thereof increases exponentially given the multiple stakeholders, committee structures and change management in tow. I've seen throughout my career as an academic the changes being implemented in curricula that seem to have not followed due diligence, and the repercussion thereof, while I look up to those that have put in place a well-constructed platform for learning.

When this project started, I was already teetering on the verge of burnout, underpinned by an improper work-life balance and an apparent profession identity crisis in the making. The subsequent year saw me transition into a year-long stint as the Acting Head of Department of Pharmacology, which, as Murphy had seen fit to overlay on top of it, the COVID-19 pandemic. Immediate transitions to remote working, teaching, learning and assessment, coupled to 54 consecutive days of not leaving the house, an inability to see family and friends, and the death of a few close colleagues had an impact on my life. My academic research suffered, not only due to the myriad of additional responsibilities and continuous firefighting, but also the broader issues with obtaining the necessary committee approvals from the various stakeholders associated with the project. While I, against my expectations, kept my sanity throughout this time, the transition out of the Acting Head of Department role was akin to a dam breaking – with the opportunity to release many ad hoc responsibilities, I burnt out with some associated somatic, cardiovascular symptoms that placed a considerate emphasis on restoring some sense of balance in my life. Additional stressors would permeate the next few years, ranging from personal to professional, which made me question completion of the project many a time. It was not without the support of my family, friends, supervisors and mentors that this could have been finalised. An overarching realisation did dawn on me during this time: at no point did I lose passion or belief in what I was doing, what it meant, or what it could lead to. My passion for educational practice, health professions education research, and my students' growth as healthcare practitioners, helped cup my internal flame from the winds of distress.

If anything, all that has transpired has shown me where my heart lies, and where I believe I will have impact in the world.

4.2. As a curriculum designer

I have come to appreciate the complexity of curriculum design, and the pivotal role of scholarship in it. Within my specific field, too little has been done to research the curriculum and competencies of professions outside of medicine, nursing, pharmacy and dentistry that create difficulty to approach design from a well-researched base. The lack of contextually relevant information further complicates this, necessitating laying down more groundwork than what would be needed for other professions. Although this is exciting, it is also concerning – pharmacology education research, in all its facets, should be acknowledged as a valuable source of evidence, just as other niches within the field would be. Within a country such as South Africa, with its rich history and ever-transforming landscape, it becomes an imperative not merely to think of what is necessary for the discipline as a generic field, but what is necessary for the survival and evolution of the people it services.

As a curriculum designer, I have grown more experienced in the nuances and integrated nature of the various windows, some of which I have often taken for granted. Having reviewed the larger programme structures of the three groups, it became fairly obvious why certain groups would experience more challenges in specific elements of pharmacology. All have

entered the pharmacological journey from a different route, with a different set of tools and experiences, and their unique baggage to carry. With the knowledge that I cannot alter the current structure of the module, it does raise challenges for me as an educator; however, it has capacitated me in ways to personalise remedial support more for each group based on their strengths and deficiencies.

Stakeholder engagements have also featured heavily in my current circumstances, not only serving as the lead in the curriculum discussions for pharmacology in these modules, but also as a soundboard for various educational matters related to future changes in the curriculum. As an introvert, much of this often drains me emotionally and physically after deliberations; however, I always seem to find joy, excitement, and energy for it – a further sign that education fills my proverbial cup. The importance of positionality in these discussions is also heavily acknowledged. As the pharmacologist in the session, I often found that the professions had a perception that they would not be able to advise on the pharmacology curriculum due to their adjunct nature to it, though this was exactly where their power lay. By informing me of the role of pharmacology within the clinical profession it also allowed me to see what was important to add to the curriculum as competencies, to align our expectations, and to position myself as a service module to them. The power of collaborative thinking in curriculum design and the interplay between basic and clinical experts were exemplified in the approach followed.

Although not a heavy focus of the project, the determination of healthcare practitioners' opinion on generic competencies highlighted the belief that they should be achieved. However, with this came the realisation that it is also not within my role to develop each and every non-disciplinary competency. It does not negate my involvement, but rather guides my thinking of how generic competencies can be introduced or reinforced, where appropriate, in my andragogical approaches.

4.3. As a supervisor

Being an active researcher already, with several postgraduate students throughout various levels of study, I was humbled by being a postgraduate candidate again. The stress of supervisory meetings, failure to meet deadlines, asking inept questions, proving yourself, passing committees, and so forth, loomed over my continuously. I once again realised the power (both for good and the bad) that I have as a supervisor that transformed the way I approach my role as supervisor. I have become a more well-balanced mixture of understanding and firm in my points of view, allowing for students to develop their intrinsic motivation for their projects, encouraging responsibility and accountability, and self-directed thinking, though also being supportive in my role as a mentor to promote their self-actualisation.

By involving my students in my interest, I was able to capacitate several postgraduate students in research linked to health professions education. Although their context may not necessarily be directly educational, their research contributes to it, whether from the healthcare practitioner competency or knowledge vantage. Of these studies, one has already been published, with a second one in drafting phase. Additionally, students have been awarded conference awards for their research that showcases their skill and the importance of the research within the field. In such a way, it has allowed for a feasible research niche to develop with active collaborations in place.

5. Conclusion

In conclusion, the study allowed for the construction of three pharmacology curricula aligned with the healthcare practitioner competencies for dietetics, nursing and physiotherapy in a national context. Although based on the needs of South Africa, given the paucity of information, frameworks for Dietetics and Physiotherapy may prove useful as starting points for targeted needs analysis within global contexts as well. The study emphasised the need for evidence-based practice in curriculum design through general needs assessment, as well as a targeted needs assessment. In doing so, the proposed pharmacology frameworks could be focused on the programmes accredited for the University of Pretoria, highlighting areas of clear alignment, and those of deficiency. The curriculum mapping exercise, bolstered by the focus group interviews, showcased the current complications within the pharmacology curricula, as well as ways in which to approach programme changes for implementation of more focused curricula.

6. Limitations

The study was not without limitations, and thus results for Chapters 3 to 5 have been positioned with acknowledgement of these. The scoping review was originally broadened in terms of keyword selections giving preliminary findings, suggesting limited articles available, or often within a more generalised pharmacological discussion that could miss a healthcare practitioner not directly identified due to their allied moniker. This yielded an unruly number of citations, and thus extended the review phase. It did, however, reinforce the suspicions about the paucity of pharmacological literature in the dietetic and physiotherapy professions. Additionally, the majority of literature arose from a non-South African base, and thus the contextual relevance of the source material was low in relation to diseases or pharmacotherapy of national importance, and potential scope of practice differences between countries. Given the non-South African perspective that dominated the scoping review, acknowledgement is given to the potential biases that may be present. However, given the Delphi-study focussing on South African participants, it should mitigate and refocus decision-making.

The Delphi study suffered from a low response rate for all three groups for several reasons. The extended committee approval processes at the various institutions and the prolonged data collection ran across the COVID-19 pandemic, which unfortunately delayed finalisation thereof. Several national institutions were not included due to inaccessibly or non-responsiveness of their research ethics committees, gatekeeper clearance committees and/or healthcare practitioner departments, though it is acknowledged that this was likely due to more crucial, high-priority matters being addressed at that time. This is coupled to the limited number of experts that could be called upon within the institutions and professional bodies, which further reduced the sample size. The length of the competency survey itself would also likely dissuade participants from completing it, particularly those with less interest or experience in education. As such, the potential for biases to arise is acknowledged; however, it is recommended to be mitigated through targeted needs analysis at the respective institutions to allow for further alignment with their unique needs.

The simplification of the taxonomical ranking system used during the Delphi study also raised limitations, particularly for those aligned with psychomotor and affective domain skills.

Although this was done to reduce the complexity of the Delphi study for the participants, it did limit the accurate assignment of a correct level of expectation to the competency, which then required inference from the cognitive domain. During implementation, it would be important to assess the cognitive domain level in the pharmacology curriculum from a matrix view of the cognitive process and the knowledge, as recommended by Bloom's taxonomy, to get a clearer alignment with the graduate expectation.

The curriculum documents of the current programmes varied in terms of explicitness and usability for the curriculum mapping process. Furthermore, certain module guides were not available to extract learning outcomes or assessment criteria from, or if available, lacked them. As such, linking learning outcomes to the pharmacology curricula was hindered and may leave gaps or assumptions within the curriculum map. Although the focus group helped clarify many of these, it reinforced the need to review curriculum material for the programme to ensure constructive alignment throughout the whole programme. Given the reliance of pharmacology on other fundamental and core disciplines, localised changes should not have as a pronounced effect on graduate competencies should prerequisite knowledge not be developed, or integration into the core discipline be ineffectively approached.

Two of the focus groups had a small sample size given the availability or expertise of staff in the Departments of Human Nutrition and Nursing Science, which may lead to bias. For the Department of Human Nutrition, although only three academic members partook in the focus group, these were the individuals seen to have the most direct knowledge of the Dietetics students and curriculum, and thus their appropriateness to the discussion was high. For the Department of Nursing Science, a larger number of clinical educators would help elaborate on clinical translation; however, there was representation within the group to advise on such contextual elements being addressed in the new curriculum. It is acknowledged, though, that with each of the healthcare practitioners, further iterative discussions would be needed to help refine the curriculum proposal to ensure a feasible plan is co-constructed that expands on the current research.

Assessing the students' view of the curriculum was originally envisaged but could not be completed within the span of the project. This is planned to occur as a follow-up to the study in parallel to further refinement of the proposed pharmacology curriculum. Students would likely not be able to advise on the importance of pharmacological competencies given the limited clinical experience; however, their views on the competency development platform will yield important information on what is working well within their programmes, where deficiencies are arising, and what their most prominent struggling blocks are.

Broadening future perspectives to include other appropriate stakeholders, including patients, industries and other employers will further yield insights into the modern-day and national needs of the healthcare practitioners of interest.

7. Future research

Several future research prospects have been identified to address certain limitations within the study, and also promote a more structured implementation alongside continuous evaluation.

Student, pharmacology educator, and patient feedback on currently experienced challenges associated with their healthcare associated with pharmacotherapy will be investigated to provide a full view of the targeted implementation of the proposed curricula. In such a way, patient perspectives from rural to urban areas can be investigated to address further alignment to primary healthcare needs. Furthermore, alongside student feedback, their concerns related to instructional design and integration within their programme will be assessed more fully.

The assessment practice, which itself may serve as a learning tool, will be approached via a structured design process to allow for a more predictive modelling of student outcomes and success. In such a way, preventative strategies to student failure can be implemented, which furthermore may provide more personalised feedback and growth for the candidates.

Continuous monitoring-and-evaluation of the curriculum will further permit insight into whether the national needs associated with the healthcare practitioners are met, particularly in terms of their cognitive, psychomotor and affective domain competencies. In parallel, the reciprocal nature of regulatory and accreditation bodies on the curriculum will be evaluated, including alterations to the scope of practice, whether medicine regulatory authorities are ensuring sufficient information for educated decision-making in pharmacotherapeutic use, and the alignment to minimum essential standards.

References

Abacioglu, C. S., Volman, M., & Fischer, A. H. (2020). Teachers' multicultural attitudes and perspective taking abilities as factors in culturally responsive teaching. *British Journal of Educational Psychology*, *90*(3), 736–752. https://doi.org/10.1111/bjep.12328

Academy of Science of South Africa. (2018). *Reconceptualising health professions education in South Africa: Consensus study report*. Acadamy of Science of South Africa.

Achike, F. I., & Ogle, C. W. (2000). Information overload in the teaching of pharmacology. *The Journal of Clinical Pharmacology*, *40*(2), 177–183. https://doi.org/10.1177/00912700022008838

Achoki, T., Sartorius, B., Watkins, D., Glenn, S. D., Kengne, A. P., Oni, T., Wiysonge, C. S., Walker, A., Adetokunboh, O. O., Babalola, T. K., Bolarinwa, O. A., Claassens, M. M., Cowden, R. G., Day, C. T., Ezekannagha, O., Ginindza, T. G., Iwu, C. C. D., Iwu, C. J., Karangwa, I., … Naghavi, M. (2022). Health trends, inequalities and opportunities in South Africa's provinces, 1990-2019: Findings from the Global Burden of Disease 2019 Study. *Journal of Epidemiology and Community Health*, *76*(5), 471–481. https://doi.org/10.1136/jech-2021-217480

Adigun, A. Q., & Mudasiru, Z. (2002). Clinical effects of grapefruit juice-nifedipine interaction in a 54-year-old Nigerian: A case report. *Journal of the National Medical Association*, *94*(4), 276–278.

Adu-Gyamfi, P. K. T., Mensah, K. B., Ocansey, J., Moomin, A., Danso, B. O., Agyapong, F., & Arthur-Mensah, R. J. (2022). Assessment of knowledge, practices, and barriers to pharmacovigilance among nurses at a teaching hospital, Ghana: A cross-sectional study. *BMC Nursing*, *21*(242). https://doi.org/10.1186/s12912-022-00965-4

Ağagündüz, D., Çelik, M. N., Dazıroğlu, M. E. Ç., & Capasso, R. (2021). Emergent drug and nutrition interactions in COVID-19: A comprehensive narrative review. *Nutrients*, 13(5), 1550. https://doi.org/10.3390/nu13051550

Aharon, A. A., Ruban, A., & Dubovi, I. (2021). Knowledge and information credibility evaluation strategies regarding COVID-19: A cross-sectional study. *Nursing Outlook*, *69*(1), 22–31. https://doi.org/10.1016/j.outlook.2020.09.001

Ahmad, M. N. (2021). Human nutrition and dietetics: Understanding the profession and development actions in Jordan. *Jordan Journal of Agricultural Sciences*, *17*(3), 103–115. https://doi.org/10.35516/jjas.v17i3.74

Ahmady, S., & Shahbazi, S. (2020). Impact of social problem-solving training on critical thinking and decision making of nursing students. *BMC Nursing*, *19*(1), 94. https://doi.org/10.1186/s12912-020-00487-x

Ahsan, M., & Mallick, A. K. (2016). Use of prelecture assignment to enhance learning in pharmacology lectures for the 2nd year medical students. *Indian Journal of Pharmacology*, *48*(7), S65–S68. https://doi.org/10.4103/0253-7613.193326

Albanese, M., & Mitchell, S. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine*, *68*(1), 52–81.

Albarqouni, L., Hoffmann, T., Straus, S., Olsen, N. R., Young, T., Ilic, D., Shaneyfelt, T., Haynes, R. B., Guyatt, G., & Glasziou, P. (2018). Core competencies in evidence-based practice for health professionals: Consensus statement based on a systematic review and Delphi survey. *JAMA Network Open*, *1*(2), e180281. https://doi.org/10.1001/jamanetworkopen.2018.0281

Alexander-Magalee, M. A. (2013). Addressing pharmacology challenges in older adults. *Nursing*, *43*(10), 58–60. https://doi.org/10.1097/01.NURSE.0000432926.12742.a2

Ali, L. (2018). The design of curriculum, assessment and evaluation in higher education with constructive alignment. *Journal of Education and E-Learning Research*, *5*(1), 72–78. https://doi.org/10.20448/journal.509.2018.51.72.78

Almirón, M., Barrios, I., O'Higgins, M., González, I., Castaldelli-Maia, J. M., Ventriglio, A., & Torales, J. (2020). Physiotherapists' knowledge on the provision of physiotherapy to people with mental illness. A study from Paraguay. *Medicina Clinica y Social*, *4*(3), 104–113. https://doi.org/10.52379/mcs.v4i3.157

Alrabadi, N., Shawagfeh, S., Haddad, R., Mukattash, T., Abuhammad, S., Al-Rabadi, D., Farha, R. A., Al-Rabadi, S., & Al-Faouri, I. (2021). Medication errors: A focus on nursing practice. *Journal of Pharmaceutical Health Services Research,* 12(1), 78–86. https://doi.org/10.1093/jphsr/rmaa025

Alrefaie, Z., Eldeek, B., & Ayuob, N. (2017). Effect of integrating research skills with basic sciences in an interdisciplinary integrated endocrine module on students' satisfaction and performance. *Indian Journal of Pharmaceutical Education and Research*, *51*(1), 14–19. https://doi.org/10.5530/ijper.51.1.3

American Association of Colleges of Nursing. (2000). Peaceful death: Recommended competencies and curricular guidelines for end-of-life nursing care. *American Association of Colleges of Nursing*, 1–4. www.aacn.nche.edu/publications/deathfin.htm

Amoudi, M., Nairat, Q., & Shawahna, R. (2021). Knowledge, attitudes, and practices of physiotherapists with regard to epilepsy and patients with epilepsy: A systematic scoping review. *Epilepsy and Behavior*, 124, 108367. https://doi.org/10.1016/j.yebeh.2021.108367

Andersen, D., Baird, S., Bates, T., Chapel, D. L., Cline, A. D., Ganesh, S. N., Garner, M., Grant, B. L., Hamilton, K. K., Jablonski, K., Jones, S. L., Kazaks, A. G., Konek, S. H., Leonard, K. K., McAdam, K. G., Ogata, B. N., Onuoha, E. M., Robinson, G. Y., Schmidt, D. W., … McCauley, S. M. (2018). Academy of Nutrition and Dietetics: Revised 2017 Scope of Practice for the Registered Dietitian Nutritionist. *Journal of the Academy of Nutrition and Dietetics*, *118*(1), 141–165. https://doi.org/10.1016/j.jand.2017.10.002

Andersen, E. A., & Moralejo, L. (2015). Using the Delphi process to attain expert consensus on bioscience concepts, topics, and skills in undergraduate nursing curricula. *Journal of Nursing Education and Practice*, *6*(1), 67–75. https://doi.org/10.5430/jnep.v6n1p67

Anderson, L. (2010). Travelling light-sports physiotherapists administering medications in the absence of a doctor. *New Zealand Journal of Sports Medicine*, *37*(2), 38–42.

Anderson, L. (2012). Physiotherapists administering medications under instruction. *British Journal of Sports Medicine*, 46(4), 222–223. https://doi.org/10.1136/bjsm.2011.083782

Anekar, A., Hendrix, J., & Cascella M. (2023). *WHO Analgesic Ladder*. StatPearls.

Arenas-Jal, M., Suñé-Negre, J. M., Pérez-Lozano, P., & García-Montoya, E. (2020). Trends in the food and sports nutrition industry: A review. *Critical Reviews in Food Science and Nutrition*, *60*(14), 2405–2421. https://doi.org/10.1080/10408398.2019.1643287

Arizona State Department of Education. (1982). *Health occupations curriculum. Skills and theory for practical nurse. Units 18, 19 and 20*.

Armitage, G., & Knapman, H. (2003). Adverse events in drug administration: A literature review. *Journal of Nursing Management*, 11(2), 130–140. https://doi.org/10.1046/j.1365-2834.2003.00359.x

Aronsson, P., Booth, S., Hägg, S., Kjellgren, K., Zetterqvist, A., Tobin, G., & Reis, M. (2015). The understanding of core pharmacological concepts among healthcare students in their final semester. *BMC Medical Education*, *15*, 235. https://doi.org/10.1186/s12909-015-0522-z

Asadi-Pooya, A. A., Landmark, C. J., Damabi, N. M., & Fazelian, K. (2024). Interactions between antiseizure medications and foods and drinks: A systematic review. *Epilepsia Open*, *9*, 475–485. https://doi.org/10.1002/epi4.12918

Ased, S., Ponce, J., Morrow, L. E., & Malesker, M. A. (2018). Clinically significant food-drug interactions. *The Consultant Pharmacist*, *33*, 639–657. https://doi.org/10.4140/TCP.n.2018.649

Association for Dietetics in South Africa. (2020). *Prescription rights of dietitians: The status quo*.

Ataguba, J. A., Ayo-Yusuf, O., Greeff, M., Hofman, K., Lutge, E., Madhi, S., Mathee, A., McKerrow, N., Moshabela, M., Norris, S., Rataemane, S., Reid, S., Richter, L., Van Rooyen, H., & Wright, C. (2020). COVID-19 Statement: The unanticipated costs of COVID-19 to South Africa's quadruple disease burden. *South African Journal of Science*, *116*(7–8), 1–2. https://doi.org/10.17159/SAJS.2020/STA0321

Augustine, M. B., Swift, K. M., Harris, S. R., Anderson, E. J., & Hand, R. K. (2016). Integrative medicine: Education, perceived knowledge, attitudes, and practice among Academy of Nutrition and Dietetics members. *Journal of the Academy of Nutrition and Dietetics*, *116*(2), 319–329. https://doi.org/10.1016/j.jand.2015.08.015

Avella, J. R. (2016). Delphi panels: Research design, procedures, advantages, and challenges. *International Journal of Doctoral Studies*, *11*, 305–321. https://doi.org/10.28945/3561

Aydogdu, O., & Winder, M. (2022). Teachers' perspectives on improving online seminars in pharmacology: A quantitative and qualitative study on lessons learned during the COVID-

19 pandemic. *Medical Science Educator*, *32*(5), 1131–1142. https://doi.org/10.1007/s40670-022-01634-6

Balliram, R., Sibanda, W., & Essack, S. Y. (2021). The knowledge, attitudes and practices of doctors, pharmacists and nurses on antimicrobials, antimicrobial resistance and antimicrobial stewardship in South Africa. *Southern African Journal of Infectious Diseases*, *36*(1), 262. https://doi.org/10.4102/sajid.v36i1.262

Balzer, F., Hautz, W. E., Spies, C., Bietenbeck, A., Dittmar, M., Sugiharto, F., Lehmann, L., Eisenmann, D., Bubser, F., Stieg, M., Hanfler, S., Georg, W., Tekian, A., & Ahlers, O. (2016). Development and alignment of undergraduate medical curricula in a web-based, dynamic Learning Opportunities, Objectives and Outcome Platform (LOOOP). *Medical Teacher*, *38*(4), 369–377. https://doi.org/10.3109/0142159X.2015.1035054

Bandiera, G., Boucher, A., Neville, A., Kuper, A., & Hodges, B. (2013). Integration and timing of basic and clinical sciences education. *Medical Teacher*, *35*(5), 381–387. https://doi.org/10.3109/0142159X.2013.769674

Banning, M. (2003). Pharmacology education: A theoretical framework of applied pharmacology and therapeutics. *Nurse Education Today*, *23*(6), 459–466. https://doi.org/10.1016/S0260-6917(03)00064-9

Banning, M. (2004). The use of structured assessments, practical skills and performance indicators to assess the ability of pre-registration nursing students' to apply the principles of pharmacology and therapeutics to the medication management needs of patients. *Nurse Education in Practice*, *4*(2), 100–106. https://doi.org/10.1016/S1471-5953(03)00035-0

Bass, E., & Chen, B. (2016). Step 1: Problem identification and general needs assessment. In Thomas, P. A., Kern, D. E., Mark, T., Hughes, M. T., & Chen, B. Y. (Eds) *Curriculum development for medical education: A six-step approach*, 11–28. John Hopkins University Press.

Bassah, N., Epie, N. N. E., & Ngunde, P. J. (2023). Nurses' knowledge and use of the nursing process in two major hospitals in Fako, Cameroon. *Nursing Practice Today*, *10*(1), 53–61. https://doi.org/10.18502/npt.v10i1.12257

Batt, A. M., Tavares, W., & Williams, B. (2020). The development of competency frameworks in healthcare professions: A scoping review. *Advances in Health Sciences Education*, 25(4), 913–987. https://doi.org/10.1007/s10459-019-09946-w

Bautista, J. R., Zhang, Y., & Gwizdka, J. (2021). US physicians' and nurses' motivations, barriers, and recommendations for correcting health misinformation on social media: Qualitative interview study. *JMIR Public Health and Surveillance*, *7*(9), e27715. https://doi.org/10.2196/27715

Bayram, A., Özsaban, A., Durgun, H., Aksoy, F., Turan, N., Köktürk Dalcali, B., & Oksay Şahin, A. (2022). Nursing students' perceptions of nursing diagnoses, critical thinking motivations, and problem-solving skills during distance learning: A multicentral study. *International Journal of Nursing Knowledge*, *33*(4), 304–311. https://doi.org/10.1111/2047-3095.12362

Bednarczuk, B., & Czekajło-Kozłowska, A. (2019). Role of nutritional support provided by qualified dietitians in the prevention and treatment of non-communicable diseases. *Roczniki Panstwowego Zakladu Higieny*, *70*(3), 235–241. https://doi.org/10.32394/rpzh.2019.0080

Begum, F., Mutsatsa, S., Gul, N., Thomas, B., & Flood, C. (2020). Antipsychotic medication side effects knowledge amongst registered mental health nurses in England: A national survey. *Journal of Psychiatric and Mental Health Nursing*, *27*(5), 521-532. https://doi.org/10.1111/jpm.12600

Bengtsson, M., Ekedahl, A. B. I., & Sjöström, K. (2021). Errors linked to medication management in nursing homes: An interview study. *BMC Nursing*, *20*(1), 69. https://doi.org/10.1186/s12912-021-00587-2

Benner, P. (1982). From novice to expert. *American Journal of Nursing*, *82*, 402–407. https://doi.org/10.2307/3462928

Bhosale, U. A., Yegnanarayan, R., & Yadav, G. E. (2013). Attitude, perception and feedback of second year medical students on teaching-learning methodology and evaluation methods in pharmacology: A questionnaire-based study. *Nigerian Medical Journal*, *54*(1), 33–39. https://doi.org/10.4103/0300-1652.108891

Biggs, J. (1999). *Teaching for quality learning at university*. Buckingham: SRHE and Open University Press.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2014). Defining twenty-first century skills. In *Assessment and teaching of 21st century skills*. https://doi.org/10.1007/978-94-007-2324-5_2

Björkström, M. E., Johansson, I. S., & Athlin, E. E. (2013). An attempt to improve nurses' interest in and use of research in clinical practice by means of network support to 'facilitator nurses.' *Journal of Nursing Education and Practice*, *4*(3), 58–68. https://doi.org/10.5430/jnep.v4n3p58

Blaauw, D., Ditlopo, P., & Rispel, L. C. (2014). Nursing education reform in South Africa – lessons from a policy analysis study. *Global Health Action*, *7*, 26401. https://doi.org/10.3402/gha.v7.26401

Black, J., Allen, D., Redfern, L., Muzio, L., Rushowick, B., Balaski, B., Martens, P., Crawford, M., Conlin-Saindon, K., Chapman, L., Gautreau, G., Brennan, M., Gosbee, B., Kelly, C., & Round, B. (2008). Competencies in the context of entry-level registered nurse practice: A collaborative project in Canada. *International Nursing Review*, *55*(2), 171–178. https://doi.org/10.1111/j.1466-7657.2007.00626.x

Blake, H., Fecowycz, A., Starbuck, H., & Jones, W. (2022). COVID-19 Vaccine Education (CoVE) for health and care workers to facilitate global promotion of the COVID-19 vaccines. *International Journal of Environmental Research and Public Health*, *19*(2), 653. https://doi.org/10.3390/ijerph19020653

Blignaut, A., Coetzee, S., Klopper, H., & Ellis, S. (2017). Medication administration errors and related deviations from safe practice: An observational study. *Journal of Clinical Nursing*, *26*, 3610–3623.

Boersema, G. C., Smart, H., Giaquinto-Cilliers, M. G. C., Mulder, M., Weir, G. R., Bruwer, F. A., Idensohn, P. J., Sander, J. E., Stavast, A., Swart, M., Thiart, S., & van der Merwe, Z. (2021). Management of nonhealable and maintenance wounds: A systematic integrative review and referral pathway. *Advances in Skin and Wound Care*, *34*(1), 11–22. https://doi.org/10.1097/01.ASW.0000722740.93179.9f

Bond, C. A., Raehl, C. L., & Franke, T. (2001). Medication errors in United States hospitals. *Pharmacotherapy*, *21*(9I), 1023–1036. https://doi.org/10.1592/phco.21.13.1023.34617

Boston University. (2004). *Glossary of terms and symbols used in pharmacology*. https://www.bumc.bu.edu/busm-pm/academics/resources/glossary/#m

Braakhuis, A., Monnard, C. R., Ellis, A., & Rozga, M. (2021). Consensus report of the Academy of Nutrition and Dietetics: Incorporating genetic testing into nutrition care. *Journal of the Academy of Nutrition and Dietetics*, *121*(3), 545–552. https://doi.org/10.1016/j.jand.2020.04.002

Brauer, D. G., & Ferguson, K. J. (2015). The integrated curriculum in medical education: AMEE Guide No. 96. *Medical Teacher*, *37*(4), 312–322. https://doi.org/10.3109/0142159X.2014.970998

Braund, R., & Abbott, J. H. (2011). Recommending NSAIDs and paracetamol: A survey of New Zealand physiotherapists' knowledge and behaviours. *Physiotherapy Research International*, *16*(1), 43–49. https://doi.org/10.1002/pri.472

Brenner, J., Cassara, M., Kwiatkowski, T., & Willey, J. M. (2017). Contextualizing the relevance of basic sciences: Small-group simulation with debrief for first- and second-year medical students in an integrated curriculum. *Advances in Medical Education and Practice*, *8*, 79–84.

Brinkman, D. J., Tichelaar, J., Mokkink, L. B., Christiaens, T., Likic, R., Maciulaitis, R., Costa, J., Sanz, E. J., Maxwell, S. R., Richir, M. C., Education Working Group of the European Association for Clinical Pharmacology and Therapeutics (EACPT) and its affiliated Network of Teachers in Pharmacotherapy (NOTIP), & van Agtmael, M. A. (2018). Key learning outcomes for clinical pharmacology and therapeutics education in Europe: A modified Delphi study. *Clinical Pharmacology and Therapeutics*, *104*(2), 317–325. https://doi.org/10.1002/cpt.962

Bruton, A., Lee, A., Yardley, L., Raftery, J., Arden-Close, E., Kirby, S., Zhu, S., Thiruvothiyur, M., Webley, F., Taylor, L., Gibson, D., Yao, G., Stafford-Watson, M., Versnel, J., Moore, M., George, S., Little, P., Djukanovic, R., Price, D., … Thomas, M. (2018). Physiotherapy breathing retraining for asthma: A randomised controlled trial. *The Lancet Respiratory Medicine*, *6*(1), 19–28. https://doi.org/10.1016/S2213-2600(17)30474-5

Bucknall, T., Fossum, M., Hutchinson, A. M., Botti, M., Considine, J., Dunning, T., Hughes, L., Weir-Phyland, J., Digby, R., & Manias, E. (2019). Nurses' decision-making, practices and perceptions of patient involvement in medication administration in an acute hospital

setting. *Journal of Advanced Nursing*, *75*(6), 1316–1327. https://doi.org/10.1111/jan.13963

Bullock, S., & Manias, E. (2002). The educational preparation of undergraduate nursing students in pharmacology: A survey of lecturers' perceptions and experiences. *Journal of Advanced Nursing*, *40*(1), 7–16. https://doi.org/10.1046/j.1365-2648.2002.02335.x

Burman, M. E., Hart, A. M., Conley, V., Brown, J., Sherard, P., & Clarke, P. N. (2009). Reconceptualizing the core of nurse practitioner education and practice. *Journal of the American Academy of Nurse Practitioners*, *21*(1), 11–17. https://doi.org/10.1111/j.1745-7599.2008.00365.x

Burns, H. K., Sakraida, T. J., Englert, N. C., Hoffman, R. L., Tuite, P., & Foley, S. M. (2006). Returning nurses to the workforce: Developing a fast track back program. *Nursing Forum*, *41*(3), 125–132. https://doi.org/10.1111/j.1744-6198.2006.00048.x

Caboral-Stevens, M., Ignacio, R. V., & Newberry, G. (2020). Undergraduate nursing students' pharmacology knowledge and risk of error estimate. *Nurse Education Today*, *93*, 104540. https://doi.org/10.1016/j.nedt.2020.104540

Callier, S. L., Toma, I., McCaffrey, T., Harralson, A. F., & O'Brien, T. J. (2014). Engaging the next generation of healthcare professionals in genomics: Planning for the future. *Personalized Medicine*, *11*(1), 89–98. https://doi.org/10.2217/pme.13.99

Campbell, J., Dussault, G., Buchan, J., Pozo-Martin, F., Guerra Arias, M., Leone, C., Siyam, A., & Cometto, G. (2013). *A universal truth: No health without a workforce: Vol. Forum Repo*.

Campinha-Bacote, J. (1994). Ethnic pharmacology: a neglected area of cultural competence. *Ohio Nurses Review*, *69*(6), 9–10.

Castellini, G., Corbetta, D., Cecchetto, S., & Gianola, S. (2020). Twenty-five years after the introduction of evidence-based medicine: Knowledge, use, attitudes and barriers among physiotherapists in Italy - A cross-sectional study. *BMJ Open*, *10*(6), e037133. https://doi.org/10.1136/bmjopen-2020-037133

Cate, O. T. E. N., Chen, H. C., Hoff, R. G., Peters, H., Bok, H., & van der Schaaf, M. (2015). Curriculum development for the workplace using Entrustable Professional Activities (EPAs): AMEE Guide No. 99. *Medical Teacher*, *37*(11), 983–1002. https://doi.org/10.3109/0142159X.2015.1060308

Cerulli, M. L. (2017). *Go ask the midwife: Professional identity in Cape Town, South Africa*. https://repository.upenn.edu/uhf_2017http://wolfhumanities.upenn.edu/annual-topics/translation. https://repository.upenn.edu/uhf_2017/7

Challinor, J. M., Alqudimat, M. R., Teixeira, T. O. A., & Oldenmenger, W. H. (2020). Oncology nursing workforce: Challenges, solutions, and future strategies. *The Lancet Oncology*, 21(12), e564–e574. https://doi.org/10.1016/S1470-2045(20)30605-7

Chandio, M. T., Pandhiani, S. M., & Iqbal, R. (2016). Bloom's taxonomy: Improving assessment and teaching-learning process. *Journal of Education and Educational Development*, *3*(2), 203–221.

Chartered Society of Physiotherapy. (2006). *Practice guidance for physiotherapist supplementary and/or independent prescribers in the safe use of medicines* (3rd edition). Chartered Society of Physiotherapy.

Cheraghi, M. A., Salsali, M., & Safari, M. (2010). Ambiguity in knowledge transfer: The role of theory-practice gap. *Iranian Journal of Nursing and Midwifery Research*, *15*(4), 155–166.

Chersich, M. F., Gray, G., Fairlie, L., Eichbaum, Q., Mayhew, S., Allwood, B., English, R., Scorgie, F., Luchters, S., Simpson, G., Haghighi, M. M., Pham, M. D., & Rees, H. (2020). COVID-19 in Africa: Care and protection for frontline healthcare workers. *Globalization and Health*, *16*(1), 46. https://doi.org/10.1186/s12992-020-00574-3

Chevan, J., & Heath, A. E. (2019). Developing core education principles for rehabilitation professionals in response to the opioid crisis: an example from physical therapy education. *Disability and Rehabilitation,* 43(15), 2227–2232. https://doi.org/10.1080/09638288.2019.1696416

Choi, S.-K., Wie, G.-A., Lee, S.-M., Kim, E. M., Park, M.-S., Sohn, C., Woo, M.-H., Ju, D. L., Cha, J.-A., & Seo, J.-S. (2015). Development of job standards of clinical dietitian for the clinical nutrition therapy to cancer patients in hospitals. *Journal of the Korean Dietetic Association*, *21*(2), 91–109. https://doi.org/10.14373/jkda.2015.21.2.91

Choo, J., Hutchinson, A., & Bucknall, T. (2010). Nurses' role in medication safety. *Journal of Nursing Management*, *18*(7), 853–861. https://doi.org/10.1111/j.1365-2834.2010.01164.x

Chou, W. Y. S., Oh, A., & Klein, W. M. P. (2018). Addressing health-related misinformation on social media. *Journal of the American Medical Association*, 320(23), 2417–2418. https://doi.org/10.1001/jama.2018.16865

Christmals, C. Dela, & Aidam, K. (2020). Implementation of the national health insurance scheme (NHIS) in Ghana: Lessons for South Africa and low-and middle-income countries. *Risk Management and Healthcare Policy*, 13, 1879–1904. https://doi.org/10.2147/RMHP.S245615

Chu, S. K. W., Reynolds, R. B., Tavares, N. J., Notari, M., & Lee, C. W. Y. (2017). 21st Century Skills Development through Inquiry-Based Learning: From Theory to Practice. In *Springer Science*.

Chyka, P. A. (2003). Health risks of selected performance-enhancing drugs. In *Journal of Pharmacy Practice*, 12(1), 37–44. https://doi.org/10.1177/0897190002239631

Citty, S. W., Bjarnadottir, R. I., Marlowe, B. L., Jones, S., Lucero, R. J., Garvan, C. W., Kamel, A. Y., Westhoff, L., & Keenan, G. (2021). Nutrition support therapies on the medication administration record: Impacts on staff perception of nutrition care. *Nutrition in Clinical Practice*, *36*(3), 629–638. https://doi.org/10.1002/ncp.10590

Coman, C., Bularca, M. C., Repanovici, A., & Rogozea, L. (2022). Misinformation about medication during the COVID–19 pandemic: A perspective of medical staff. *PLoS ONE*, *17*, e0276693. https://doi.org/10.1371/journal.pone.0276693

Combrinck, Y., van Wyk, N. C., & Mogale, R. S. (2020). Nurses' professional dignity in private healthcare: A descriptive phenomenological study. *International Nursing Review*, *67*(3), 395–402. https://doi.org/10.1111/inr.12602

Comerford, K., & Durkin, M. (2024). *Nursing2024 Drug Handbook* (44th edition). Wolters Kluwer.

Continuing Consolidation of the Statutes of Manitoba. (1991). *The Physiotherapists Act*. Continuing Consolidation of the Statutes of Manitoba.

Coovadia, H., Jewkes, R., Barron, P., Sanders, D., & McIntyre, D. (2009). The health and health system of South Africa: Historical roots of current public health challenges. *The Lancet*, *374*(9692), 817–834. https://doi.org/10.1016/S0140-6736(09)60951-X

Cordier, W., & Lubbe, I. (2021). Teaching pharmacology online: Not just another narration. *African Journal of Health Professions Education*, *13*(3), 201–202. https://doi.org/10.5430/jnep

Corrigan, M. L., Bobo, E., Rollins, C., & Mogensen, K. M. (2021). Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: Revised 2021 Standards of Practice and Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Nutrition Support. *Journal of the Academy of Nutrition and Dietetics*, *121*(10), 2071-2086.e59. https://doi.org/10.1016/j.jand.2021.05.026

Council on Higher Education. (n.d.). *Guidelines for completing the application for programme accreditation and qualification registration application form*.

Council on Higher Education. (2002). *A New Academic Policy for Policy for Programmes and Qualifications in Higher Education*.

Council on Higher Education. (2023). *Qualification Standard for Bachelor of Science in Dietetics and Nutrition (v12 for public comment)*. www.che.ac.za

Couper, I., Ray, S., Blaauw, D., Ng'Wena, G., Muchiri, L., Oyungu, E., Omigbodun, A., Morhason-Bello, I., Ibingira, C., Tumwine, J., Conco, D., & Fonn, S. (2018). Curriculum and training needs of mid-level health workers in Africa: A situational review from Kenya, Nigeria, South Africa and Uganda. *BMC Health Services Research*, *18*(1), 1–12. https://doi.org/10.1186/s12913-018-3362-9

Couris, R. R., Tetaronis, G. R., Dallal, G. E., Blumberg, J. B., & Dwyer, J. T. (2000). Assessment of healthcare professionals' knowledge about warfarin-vitamin K drug-nutrient interactions. *Journal of the American College of Nutrition*, *19*(4), 439–445. https://doi.org/10.1080/07315724.2000.10718944

Courtenay, M., & Chater, A. (2021). Antimicrobial stewardship: a competency framework to support the role of nurses. *Primary Healthcare*, *31*. https://doi.org/10.7748/phc.2021/e1709

Craft, J., Christensen, M., Bakon, S., & Wirihana, L. (2017). Advancing student nurse knowledge of the biomedical sciences: A mixed methods study. *Nurse Education Today*, *48*, 114–119. https://doi.org/10.1016/j.nedt.2016.10.003

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Crowley, T., & Daniels, F. (2023). Nursing education reform in South Africa: Implications for postgraduate nursing programmes. *International Journal of Africa Nursing Sciences*, *18*, 100528. https://doi.org/10.1016/j.ijans.2023.100528

Crowley, T., Mokoka, E., & Geyer, N. (2021). Ten years of nurse-initiated antiretroviral treatment in South Africa: A narrative review of enablers and barriers. *Southern African Journal of HIV Medicine*, *22*(1). https://doi.org/10.4102/SAJHIVMED.V22I1.1196

Dager, W. E., Sanoski, C. A., Wiggins, B. S., & Tisdale, J. E. (2006). Pharmacotherapy considerations in advanced cardiac life support. *Pharmacotherapy*, 26(12), 1703–1729. https://doi.org/10.1592/phco.26.12.1703

D'Alessandro, C., Benedetti, A., Di Paolo, A., Giannese, D., & Cupisti, A. (2022). Interactions between food and drugs, and nutritional status in renal patients: A narrative review. *Nutrients*, 14(1), 212. https://doi.org/10.3390/nu14010212

Davey, P., Hudson, S., Ridgway, G., & Reeves, D. (1993). A survey of undergraduate and continuing medical education about antimicrobial chemotherapy in the United Kingdom. *British Journal of Clinical Pharmacology*, *36*(6), 511–519. https://doi.org/10.1111/j.1365-2125.1993.tb00409.x

Daviaud, E., & Chopra, M. (2008). How much is not enough? Human resources requirements for primary healthcare: A case study from South Africa. *Bulletin of the World Health Organization*, *86*(1), 46–51. https://doi.org/10.2471/BLT.07.042283

Davidhizar, R. E., & Bartlett, D. (2006). Re-entry into the registered nursing work force: We did it! *Journal of Continuing Education in Nursing*, *37*(4), 185–190. https://doi.org/10.3928/00220124-20060701-09

Davis, G. M. (2010). What is provided and what the registered nurse needs – bioscience learning through the pre-registration curriculum. *Nurse Education Today*, *30*(8), 707–712. https://doi.org/10.1016/j.nedt.2010.01.008

De Baetselier, E., Dilles, T., Feyen, H., Haegdorens, F., Mortelmans, L., & Van Rompaey, B. (2022). Nurses' responsibilities and tasks in pharmaceutical care: A scoping review. In *Nursing Open*, 9(6), 2562–2571. https://doi.org/10.1002/nop2.984

De Baetselier, E., Van Rompaey, B., Dijkstra, N. E., Sino, C. G., Akerman, K., Batalha, L. M., Fernandez, M. I. D., Filov, I., Grøndahl, V. A., Heczkova, J., Helgesen, A. K., Keeley, S., Kolovos, P., Langer, G., Ličen, S., Lillo-Crespo, M., Malara, A., Padyšáková, H., Prosen,

M., … Dilles, T. (2021). The NUPHAC-EU framework for nurses' role in interprofessional pharmaceutical care: Cross-sectional evaluation in Europe. *International Journal of Environmental Research and Public Health*, *18*(15), 7862. https://doi.org/10.3390/ijerph18157862

De Queirós Costa, E., Domingues, J. R., Malheiros, L. R., & De Fátima Barros Jardim, M. (2013). Challenges to the curricular reform in an undergraduate nutrition program: Case report. *Demetra: Food, Nutrition & Health/Alimentação, Nutrição & Saúde*, *8*(3), 469–484.

Delaney, C., Vo, R., & Beck, E. (2021). Practice and perspectives of Australian dietitians in management of patients on pancreatic enzyme replacement therapy. *Nutrition and Dietetics*, *78*(2), 165–173. https://doi.org/10.1111/1747-0080.12613

Delbecq, A., van de Ven, A., & Gustafson, D. (1975). *Group techniques for program planning; a guide to nominal group and Delphi processes*. Glenview IL, Scott Foresman and Company.

Desai, M. (2009). Changing face of pharmacology practicals for medical undergraduates. *Indian Journal of Pharamacology*, *41*, 151–152. https://doi.org/10.4103/0253-7613.56062

Di Simone, E., Giannetta, N., Auddino, F., Cicotto, A., Grilli, D., & Di Muzio, M. (2018). Medication errors in the emergency department: Knowledge, attitude, behavior, and training needs of nurses. *Indian Journal of Critical Care Medicine*, *22*(5), 346–352. https://doi.org/10.4103/ijccm.IJCCM_63_18

Di Simone, E., Tartaglini, D., Fiorini, S., Petriglieri, S., Plocco, C., & Di Muzio, M. (2016). Medication errors in intensive care units: Nurses' training needs. *Emergency Nurse*, *24*(4), 24–29. https://doi.org/10.7748/en.2016.11577

DiMaria-Ghalili, R. A., Mirtallo, J. M., Tobin, B. W., Hark, L., Van Horn, L., & Palmer, C. A. (2014). Challenges and opportunities for nutrition education and training in the healthcare professions: Intraprofessional and interprofessional call to action. *American Journal of Clinical Nutrition*, *99*(5), 1184S-1193S. https://doi.org/10.3945/ajcn.113.073536

Dino, M. J. S., & Ong, I. L. (2019). Research, technology, education & scholarship in the Fourth Industrial Revolution [4IR]: Influences in nursing and the health sciences. *The Journal of Medical Investigation*, *66*(3), 7.

Dirik, H. F., Samur, M., Intepeler, S. S., & Hewison, A. (2019). Nurses' identification and reporting of medication errors. *Journal of Clinical Nursing*, *28*(5–6), 931–938. https://doi.org/10.1111/jocn.14716

Dossey, B. M. (2010). Florence Nightingale: A 19th-century mystic. *Journal of Holistic Nursing*, *28*(1), 10–35.

Dower, C., Moore, J., & Langelier, M. (2013). It is time to restructure health professions scope-of-practice regulations to remove barriers to care. *Health Affairs*, *32*(11), 1971–1976. https://doi.org/10.1377/hlthaff.2013.0537

Dramowski, A., Zunza, M., Dube, K., Parker, M., & Slogrove, A. (2020). South African healthcare workers and COVID-19: A shared responsibility to protect a precious and limited resource. *South African Medical Journal*, *110*(7), 0–1. https://doi.org/10.7196/SAMJ.2020.V110I7.14903

Druedahl, L. C., Mølby Hansen, J., Freese, E. L., Almarsdóttir, A. B., & Traulsen, J. M. (2019). Mandatory medication content in the curricula of six healthcare personnel types with patient contact in Denmark. *Basic and Clinical Pharmacology and Toxicology*, *124*(4), 431–438. https://doi.org/10.1111/bcpt.13147

Du Preez, R. (2016). *Human factors causing medication administration errors as self-reported by registered professional nurses*. Stellenbosch University.

Dubovi, I., Dagan, E., Sader Mazbar, O., Nassar, L., & Levy, S. T. (2018). Nursing students learning the pharmacology of diabetes mellitus with complexity-based computerized models: A quasi-experimental study. *Nurse Education Today*, *61*(December), 175–181. https://doi.org/10.1016/j.nedt.2017.11.022

Duff, W., Haskey, N., Potter, G., Alcorn, J., Hunter, P., & Fowler, S. (2018). Non-pharmacological therapies for inflammatory bowel disease: Recommendations for self-care and physician guidance. *World Journal of Gastroenterology, 24*(28), 3055–3070. https://doi.org/10.3748/wjg.v24.i28.3055

Dukhi, N., Southwood, S., & Srinivas, S. C. (2014). Evaluating students' experience of an integrated assessment: A case study in health promotion. *Indian Journal of Pharmaceutical Education and Research*, *48*(3), 1–5. https://doi.org/10.5530/ijper.48.3.1

Durham, B. (2015). The nurse's role in medication safety. *Nursing*, *45*(4), 1–4. https://doi.org/10.1097/01.NURSE.0000461850.24153.8b

Dytrych, C. L. (2012). *Dietitian's problem solving knowledge to promote and support breastfeeding*. https://digitalcommons.unl.edu/nutritiondiss

Eglseer, D., & Bauer, S. (2020). Predictors of dietitian referrals in hospitals. *Nutrients*, *12*(9), 1–10. https://doi.org/10.3390/nu12092863

Ehsani, S. R., Cheraghi, M. A., Nejati, A., Salari, A., Esmaeilpoor, A. H., & Nejad, E. M. (2013). Medication errors of nurses in the emergency department. *Journal of Medical Ethics and History of Medicine*, *6*, 1–7.

Eke, A. C., Olagunju, A., Best, B. M., Mirochnick, M., Momper, J. D., Abrams, E., Penazzato, M., Cressey, T. R., & Colbers, A. (2020). Innovative approaches for pharmacology studies in pregnant and lactating women: A viewpoint and lessons from HIV. *Clinical Pharmacokinetics*, *59*(10), 1185–1194. https://doi.org/10.1007/s40262-020-00915-w

Eksteen, C., & Slabbert, J. (2001). Problem based curricula and problem based learning in physiotherapy: A critical review. *South African Journal of Physiotherapy*, *57*(4), 23–28.

Engels, F. (2018). Pharmacology education: Reflections and challenges. *European Journal of Pharmacology*, *833*(June), 392–395. https://doi.org/10.1016/j.ejphar.2018.06.032

Engler, D., Meyer, J. C., Schellack, N., Kurdi, A., & Godman, B. (2021). Antimicrobial stewardship activities in public healthcare facilities in South Africa: A baseline for future direction. *Antibiotics*, *10*(8). https://doi.org/10.3390/antibiotics10080996

Fagerman, K. E., McGuigan, D., & Pixley, B. (1986). Potential interaction between enteral feeding solutions and oral tetracycline. *Nutrition in Clinical Practice*, *1*(5), 257–258. https://doi.org/10.1016/s1052-5157(18)30251-4

Faingold, C. L., & Dunaway, G. A. (2002). Teaching pharmacology within a multidisciplinary organ system-based medical curriculum. *Naunyn-Schmiedeberg's Archives of Pharmacology*, *366*(1), 18–25. https://doi.org/10.1007/s00210-002-0565-7

Falcó-Pegueroles, A., Rodríguez-Martín, D., Ramos-Pozón, S., & Zuriguel-Pérez, E. (2021). Critical thinking in nursing clinical practice, education and research: From attitudes to virtue. *Nursing Philosophy*, *22*(1). https://doi.org/10.1111/nup.12332

Farrar, F. C., White, D., & Darnell, L. (2017). Pharmacologic interventions for pain management. *Critical Care Nursing Clinics of North America*, *29*(4), 427–447. https://doi.org/10.1016/j.cnc.2017.08.004

Feghali, M., Venkataramanan, R., & Caritis, S. (2015). Pharmacokinetics of drugs in pregnancy. *Seminars in Perinatology*, *39*(7), 512–519. https://doi.org/10.1053/j.semperi.2015.08.003

Fennelly, O., Desmeules, F., O'Sullivan, C., Heneghan, N. R., & Cunningham, C. (2020). Advanced musculoskeletal physiotherapy practice: Informing education curricula. *Musculoskeletal Science and Practice*, 48. https://doi.org/10.1016/j.msksp.2020.102174

Fernandez, N., Dory, V., Ste-Marie, L. G., Chaput, M., Charlin, B., & Boucher, A. (2012). Varying conceptions of competence: An analysis of how health sciences educators define competence. *Medical Education*, 46(4), 357–365. https://doi.org/10.1111/j.1365-2923.2011.04183.x

Fesler-Birch, D. M. (2005). Critical thinking and patient outcomes: A review. *Nursing Outlook*, *53*(2), 59–65. https://doi.org/10.1016/j.outlook.2004.11.005

Fielding, D. W., & Regehr, G. (2017). A Call for an integrated program of assessment. *American Journal of Pharmaceutical Education*, *81*, 1–11.

Fincher, R. M. E., Wallach, P. M., & Richardson, W. S. (2009). Basic science right, not basic science lite: Medical education at a crossroad. *Journal of General Internal Medicine*, *24*(11), 1255–1258. https://doi.org/10.1007/s11606-009-1109-3

Fitch, K., Bernstein, S., Aguilar, M., Burnand, B., LaCalle, J., Lazaro, P., Van het Loo, M., McDonnell, J., Vader, J., & Kahan, J. (2001). *The RAND/UCLA Appropriateness Method User's Manual*. RAND Corporation.

Fleuren, L. M., Roggeveen, L. F., Guo, T., Waldauf, P., Van der Voort, P. H. J., Bosman, R. J., Swart, E. L., Girbes, A. R. J., & Elbers, P. W. G. (2019). Clinically relevant pharmacokinetic knowledge on antibiotic dosing among intensive care professionals is

insufficient: A cross-sectional study. *Critical Care*, *23*(1), 185. https://doi.org/10.1186/s13054-019-2438-1

Flexner, A. (1910). Medical education in the United States and Canada. In *Bulletin of the World Health Organization*. The Merrymount Press.

Flores, E., Xu, X., & Lu, Y. (2020). Human Capital 4.0: a workforce competence typology for Industry 4.0. *Journal of Manufacturing Technology Management*, *31*(4), 687–703. https://doi.org/10.1108/JMTM-08-2019-0309

Ford, C. K. (2023). Nutrition Considerations in Patients with Functional Diarrhea. *Current Gastroenterology Reports*, *25*(9), 198–203. https://doi.org/10.1007/s11894-023-00878-5

Fornals, A. U., Costas-Batlle, C., Medlin, S., Menjón-Lajusticia, E., Cisneros-González, J., Saura-Carmona, P., & Montoro-Huguet, M. A. (2024). Metabolic and nutritional issues after lower digestive tract surgery: The important role of the dietitian in a multidisciplinary setting. *Nutrients*, *16*(2), 246. https://doi.org/10.3390/nu16020246

Fossum, M., Opsal, A., & Ehrenberg, A. (2022). Nurses' sources of information to inform clinical practice: An integrative review to guide evidence-based practice. *Worldviews on Evidence-Based Nursing*, *19*(5), 372–379. https://doi.org/10.1111/wvn.12569

Foster, V., Collins, E., Dong, H., Nteff, G., & Pinkney, L. (2017). Teaching clinical pharmacology to undergraduate nursing students: Barriers and strategies. *Open Journal of Nursing*, *07*(08), 918–929. https://doi.org/10.4236/ojn.2017.78068

Frank, J. R., Snell, L., & Sherbino, J. (2015). *CanMEDS 2015 physician competency framework*. Royal College of Physicians and Surgeons of Canada.

Fransen, M. (2004). When is physiotherapy appropriate? *Best Practice and Research: Clinical Rheumatology*, *18*(4), 477–489. https://doi.org/10.1016/j.berh.2004.03.006

Frazee, E. N., Personett, H. A., Bauer, S. R., Dzierba, A. L., Stollings, J. L., Ryder, L. P., Elmer, J. L., Caples, S. M., & Daniels, C. E. (2015). Intensive care nurses' knowledge about use of neuromuscular blocking agents in patients with respiratory failure. *American Journal of Critical Care*, *24*(5), 431–439. https://doi.org/10.4037/ajcc2015397

French, H., Du Plessis, E., & Scrooby, B. (2011). The emotional well-being of the nurse within the multi-skill setting. *Health SA Gesondheid*, *16*(1), 1–9. https://doi.org/10.4102/hsag.v16i1.553

Frenk, J., Chen, L., Bhutta, Z. A., Cohen, J., Crisp, N., Evans, T., Fineberg, H., Garcia, P., Ke, Y., Kelley, P., Kistnasamy, B., Meleis, A., Naylor, D., Pablos-Mendez, A., Reddy, S., Scrimshaw, S., Sepulveda, J., Serwadda, D., & Zurayk, H. (2010). Health professionals for a new century: Transforming education to strengthen health systems in an interdependent world. *The Lancet*, *376*(9756), 1923–1958. https://doi.org/10.1016/S0140-6736(10)61854-5

Gahr, M., Schönfeldt-Lecuona, C., Kölle, M. A., & Freudenmann, R. W. (2013). Intoxications with the monoamine oxidase inhibitor tranylcypromine: An analysis of fatal and non-fatal

events. *European Neuropsychopharmacology*, *23*(11), 1364–1372. https://doi.org/10.1016/j.euroneuro.2013.05.009

Gaohua, L., Miao, X., & Dou, L. (2021). Crosstalk of physiological pH and chemical pKa under the umbrella of physiologically based pharmacokinetic modeling of drug absorption, distribution, metabolism, excretion, and toxicity. *Expert Opinion on Drug Metabolism and Toxicology*, 17(9), 1103–1124. https://doi.org/10.1080/17425255.2021.1951223

Gaur, U., Anwarul, M., Majumder, A., Sa, B., Sarkar, S., Williams, A., & Singh, K. (2020). Challenges and Opportunities of Preclinical Medical Education: COVID-19 Crisis and Beyond. *SN Comprehensive Clinical Medicine*, *2*, 1992–1997. https://doi.org/10.1007/s42399-020-00528-1/Published

Generali, J. A., Hogan, L. C., McFarlane, M. J., Schwab, S., & Hartman, C. R. (1981). Hypertensive crisis resulting from avocados and a MAO inhibitor. *Drug Intelligence and Clinical Pharmacy*, *15*(11), 904–906. https://doi.org/10.1177/106002808101501110

Giaquinto-Cilliers, M., Nair, A., Von Pressentin, K., Coetzee, F., & Saeed, H. (2022). A 'game of dressings': Strategies for wound management in primary healthcare. *South African Family Practice*, *64*(1), 5462.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). The new production of knowledge: The dynamics of science and research in contemporary societies. *Contemporary Sociology* (Issue 6). SAGE Publications. https://doi.org/10.2307/2076669

Ginzburg, S. B., Brenner, J., Cassara, M., Kwiatkowski, T., & Willey, J. M. (2017). Contextualizing the relevance of basic sciences: Small-group simulation with debrief for first- and second-year medical students in an integrated curriculum. *Advances in Medical Education and Practice*, *8*, 79–84. https://doi.org/10.2147/AMEP.S124851

Gladson, B., & Myslinksi, M. (2011). Possible interactions between exercise and the pharmacodynamics and pharmacokinetics of drugs. *Gerinotes*, *18*, 23–33.

Gonzalez, M. J., Miranda-Massari, J. R., Duconge, J., Martinez, J. M., Olalde, J., Gonzalez, M. J., Berdiel, M. J., Lozada, J., Smith, R. G., & Saul, A. W. (2023). *New concepts for understanding nutrient pharmacokinetics: Nutri-kinetics and nutri-dynamics*. Orthomolecular Medicine News Service. http://orthomolecular.org/subscribe.htmlandalsotheOMNSarchivelinkhttp://orthomolecular.org/resources/omns/index.shtmlareincluded.

Goodreads. (2024). Joerg Teichmann. *Goodreads*. *In Goodreads [Internet]* https://www.goodreads.com/quotes/10492641-recovery-is-indeed-a-manifestation-of-the-law-of-nature

Gracia, J. E., Serrano, R. B., & Garrido, J. F. (2019). Medication errors and drug knowledge gaps among critical-care nurses: A mixed multi-method study. *BMC Health Services Research*, *19*(1), 640. https://doi.org/10.1186/s12913-019-4481-7

Green-Thompson, L. P., Mcinerney, P., Manning, D. M., Mapukata-Sondzaba, N., Chipamaunga, S., & Maswanganyi, T. (2012). Reflections of students graduating from a

transforming medical curriculum in South Africa: A qualitative study. *BMC Medical Education*, *12*(1), 49. https://doi.org/10.1186/1472-6920-12-49

Green-Thompson, L. P. (2014). The nature of social accountability in South African medical practice and education – A qualitative reflection. Thesis, University of the Witwatersrand.

Guenter, P., & Boullata, J. (2013). Drug administration by enteral feeding tube. *Nursing 43*(12), 27–33.

Guest, D. D., Cox, T., Voss, A. C., Kelley, K., Ma, X., Nguyen, A., McMillen, K., Williams, V., Lee, J. A., Petersen, J., Lenning, K., & Yakes Jimenez, E. (2023). Assessing Impact of Nutrition Care by Registered Dietitian Nutritionists on Patient Medical and Treatment Outcomes in Outpatient Cancer Clinics: A Group Feasibility Study. *Nutrition and Cancer*, *75*(3), 923–936. https://doi.org/10.1080/01635581.2023.2170431

Guilding, C., White, P. J., Cunningham, M., Kelly-Laubscher, R., Koenig, J., Babey, A. M., Tucker, S., Kelly, J. P., Gorman, L., Aronsson, P., Hawes, M., Ngo, S. N. T., Mifsud, J., Werners, A. H., Hinton, T., Khan, F., Aljofan, M., & Angelo, T. (2024). Defining and unpacking the core concepts of pharmacology: A global initiative. *British Journal of Pharmacology*, *181*(3), 375–392. https://doi.org/10.1111/bph.16222

Günaydin, B. (2005). Pharmacotherapy in cardiopulmonary resuscitation (CPR). *Turkish Journal of Medical Sciences*, *35*, 357–364. https://journals.tubitak.gov.tr/medical:https://journals.tubitak.gov.tr/medical/vol35/iss6/2

Güneş, Ü., Ozturk, H., & Ülker, E. (2021). Nurses' knowledge level about high-alert medications. *Mehmet Akif Ersoy University Journal of Health Sciences Institute*, *9*(1), 12–20. https://doi.org/10.24998/maeusabed.803284

Haddaway, N. R., Page, M. J., Pritchard, C. C., & McGuinness, L. A. (2022). PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Methods Research Papers*, *18*, e1230.

Hall, J. (2013). Task team to look at prescription rights for physiotherapists. *Physiotherapy, Podiatry and Biokinetics News*, *May*.

Hanson, A., & Haddad, L. (2024). Nursing rights of medication administration. In *StatPearls [Internet]*. StatPearls Publishing.

Harden, R. M. (2001). AMEE Guide No. 21: Curriculum mapping: A tool for transparent and authentic teaching and learning. *Medical Teacher*, *23*(2), 123–137. https://doi.org/10.1080/01421590120036547

Harding, S., Britten, N., & Bristow, D. (2010). The performance of junior doctors in applying clinical pharmacology knowledge and prescribing skills to standardized clinical cases. *British Journal of Clinical Pharmacology*, *69*(6), 598–606. https://doi.org/10.1111/j.1365-2125.2010.03645.x

Hark, L. A., & Morrison, G. (2000). Development of a case-based integrated nutrition curriculum for medical students. *American Journal of Clinical Nutrition*, *72*, 890S-897S.

Haroun, F. (2018). *Teaching medication administration to nursing students – A scoping review with a decolonial lens*. https://scholar.sun.ac.za

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*, *32*(4), 1008–1015.

Health Professions Council of South Africa. (2014). *Core competencies for undergraduate students in clinical associate, dentistry and medical teaching and learning programmes in South Africa*. https://www.hpcsa-blogs.co.za/wp-content/uploads/2017/04/MDB-Core-Competencies-ENGLISH-FINAL-2014.pdf

Heinzer, M., Beitz, J. M., Dreher, H. M., Ambrose, M. S., Flynn, E. R., Lauterbach, S. S., Becker, P. H., Tigar, N. L., Fritz, J. F., & Wolf, Z. R. (1997). A program evaluation approach to drug administration education. *Nurse Educator*, *22*(4), 25–31. https://doi.org/10.1097/00006223-199707000-00011

Hendrich, A., Chow, M. P., Skierczynski, B. A., & Lu, Z. (2008). A 36-hospital time and motion study: How do medical-surgical nurses spend their time? *The Permanente Journal*, *12*(3), 25–34.

Henning, A., Dimeo, P., Rattray, C., & Mackintosh, I. (2017). *Social change and doping decision-making: Building a conceptual framework and survey item development*. In World Anti-Doping Agency.

Hirschi, A. (2018). The Fourth Industrial Revolution: Issues and Implications for Career Research and Practice. *Career Development Quarterly*, *66*(3), 192–204. https://doi.org/10.1002/cdq.12142

Holland, A. E. (2014). Physiotherapy management of acute exacerbations of chronic obstructive pulmonary disease. *Journal of Physiotherapy*, *60*(4), 181–188. https://doi.org/10.1016/j.jphys.2014.08.018

Howard, J. L., Bureau, J., Guay, F., Chong, J. X. Y., & Ryan, R. M. (2021). Student motivation and associated outcomes: A meta-analysis from self-determination theory. *Perspectives on Psychological Science*, *16*(6), 1300–1323. https://doi.org/10.1177/1745691620966789

Hsu, C. C., & Sandford, B. A. (2007). The Delphi technique: Making sense of consensus. *Practical Assessment, Research and Evaluation*, *12*(10), 1–8.

Hudson, J. N., & Tonkin, A. L. (2004). Evaluating the impact of moving from discipline-based to integrated assessment. *Medical Education*, *38*(8), 832–843. https://doi.org/10.1111/j.1365-2929.2004.01893.x

Hughes, M. T. (2016a). Step 2: Targeted needs assessment. In *Curriculum Development for Medical Education: A Six-Step Approach* (pp. 29–49). John Hopkins University Press.

Hughes, M. T. (2016b). Step 5: Implementation. In *Curriculum Development for Medical Education: A Six-Step Approach* (pp. 102–120). John Hopkins University Press.

Hull, M. (2016). Medical language proficiency: A discussion of interprofessional language competencies and potential for patient risk. In *International Journal of Nursing Studies*, 54, 158–172. https://doi.org/10.1016/j.ijnurstu.2015.02.015

Hurd, T. A. (2004). Nutrition and wound care management/prevention. *Wound Care Canada*, *2*, 20–24.

Hussler, C., Muller, P., & Rond, P. (2011). Is diversity in Delphi panelist groups useful? Evidence from a French forecasting exercise on the future of nuclear energy. *Technological Forecasting and Social Change*, *78*(9), 1642–1653. https://doi.org/10.1016/j.techfore.2011.07.008

Idaho State Department of Education. (1992). *Practical nursing curriculum guide. Including the expanded functions of I.V. therapy and LPN management.*

Institute for Health Metrics and Evaluation. (n.d.). *South Africa*. Retrieved April 26, 2021, from http://www.healthdata.org/south-africa

Institute for Safe Medication Practices. (2018). *ISMP List of High-Alert Medications in Acute Care Settings*.

International Confederation of Dietetic Associations. (2016). *International competency standards for dietitian-nutritionists*. https://www.internationaldietetics.org/Downloads/International-Competency-Standards-for-Dietitian-N.aspx

International Council of Nurses. (n.d.). *Nursing definitions*. Retrieved April 26, 2021, from https://www.icn.ch/nursing-policy/nursing-definitions

Irby, A., Gutierrez, J., Chamberlin, C., Thomas, S. J., & Rosen, A. B. (2020). Clinical management of tendinopathy: A systematic review of systematic reviews evaluating the effectiveness of tendinopathy treatments. *Scandinavian Journal of Medicine and Science in Sports*, *30*(10), 1810–1826.

Iretiola, B. M., Oyepata, J. S., & Usman, B. P. (2020). A survey of wound care practices by nurses in a clinical setting. *International Journal of Healthcare and Medical Sciences*, *65*, 74–81. https://doi.org/10.32861/ijhms.65.74.81

Islam, M. A., Sabnis, G., Farris, F., & Islam, M. A. (2017). The trilayer approach of teaching physiology, pathophysiology, and pharmacology concepts in a first-year pharmacy course: The TLAT model. *Advances in Physiology Education*, *41*, 395–404. https://doi.org/10.1152/advan.00047.2017.-This

Islam, M. A., & Schweiger, T. A. (2015). Students' perception of an integrated approach of teaching entire sequence of medicinal chemistry, pharmacology, and pharmacotherapeutics courses in PharmD curriculum. *Journal of Pharmacy Practice*, *28*(2), 220–226. https://doi.org/10.1177/0897190014544821

Islam, M. A., Talukder, R. M., Taheri, R., & Blanchard, N. (2016). Integration of Basic and Clinical Science Courses in US PharmD Programs. *American Journal of Pharmaceutical Education*, *80*, 1–11.

Iwasaki, E. (2018). *Medical terms and concepts: Differences in scope for physicians and nurses*. Macquarie University.

Jalgaonkar, S. V., Sarkate, P. V., & Tripathi, R. K. (2012). Students' perception about small group teaching techniques: Role play method and case based learning in pharmacology. *Education in Medicine Journal*, *4*(2), 13–18. https://doi.org/10.5959/eimj.v4i2.21

Jefferies, W. B., McMahon, K. K., Rosenfeld, G. C., Strandhoy, J. W., Szarek, J., & Wilson-Delfosse, A. (2010). Pharmacology – In the face of revisiting Flexner's view of medical education. *Medical Science Educator*, *20*, 288–292.

Johansson-Pajala, R. M., Martin, L., Fastbom, J., & Jorsäter Blomgren, K. (2015). Nurses' self-reported medication competence in relation to their pharmacovigilant activities in clinical practice. *Journal of Evaluation in Clinical Practice*, *21*(1), 145–152. https://doi.org/10.1111/jep.12263

Johnson, J. P., & Mighten, A. (2005). A comparison of teaching strategies: Lecture notes combined with structured group discussion versus lecture only. *Journal of Nursing Education*, *44*, 319–322.

Jones, J. (2002). Generic attributes an agenda for reform or control? *Language and Academic Skills Conference, University of Wollongong*.

Jones, J. R., Boltz, M., Allen, R., Van Haitsma, K., & Leslie, D. (2022). Nursing students' risk perceptions related to medication administration error: A qualitative study. *Nurse Education in Practice*, *58*. https://doi.org/10.1016/j.nepr.2021.103274

Jones, S. W. (2009). Reducing medication errors in nursing practice. *Nursing Standard*, *23*, 40–46. https://doi.org/10.7748/ns.29.20.50.e9507

Jordan, S., Hardy, B., & Coleman, M. (1999). Medication management: An exploratory study into the role of community mental health nurses. *Journal of Advanced Nursing*, *29*(5), 1068–1081. https://doi.org/10.1046/j.1365-2648.1999.01002.x

Joreteg, T., & Jogestrand, T. (1984). Physical exercise and binding of digoxin to skeletal muscle - Effect of muscle activation frequency. *European Journal of Clinical Pharmacology*, *27*, 567–570.

Just, J. M., Schulz, C., Bongartz, M., & Schnell, M. W. (2010). Palliative care for the elderly - Developing a curriculum for nursing and medical students. *BMJ Geriatrics*, *10*, 66. https://doi.org/10.1186/1471-2318-10-66

Juta Medical Brief. (2017, May 17). Pretoria teaching hospital rife with paediatric medication errors. *Juta Medical Brief*. https://www.medicalbrief.co.za/pretoria-teaching-hospital-rife-paediatric-medication-errors/

Kai, S., Chu, W., Reynolds, R. B., Tavares, N. J., Notari, M., & Lee, C. W. Y. (2017). 21st Century skills development through inquiry-based learning. *Springer Science*.

Kakono, T. V, Mathye, D., Brand, S. J., & Cordier, W. (2023). South African physiotherapists' attitudes to medicine prescription as an extension of practice. *South African Journal of Physiotherapy*, *79*(1), 1–13.

Karaksha, A., Grant, G., Anoopkumar-Dukie, S., Niru Nirthanan, S., & Davey, A. K. (2013). Student engagement in pharmacology courses using online learning tools. *American Journal of Pharmaceutical Education*, *77*, 1–10.

Karpa, K. D., & Vrana, K. E. (2013). Creating a virtual pharmacology curriculum in a problem-based learning environment: One medical school's experience. *Academic Medicine*, *88*(2), 198–205. https://doi.org/10.1097/ACM.0b013e31827c083d

Kawasaki, G. (2011). Enchantment: The Art of Changing Hearts, Minds, and Actions. *Porchlight Book Company.*

Kemp, L. K., Mangoni, A. A., & Woodman, R. J. (2014). Online survey on subjective and objective competency in clinical pharmacology skills among final year Australian medical students : A pilot study. *Therapeutic Advances in Chronic Disease*, *5*(6), 274–279. https://doi.org/10.1177/2040622314547361

Keohane, C. A., Bane, A. D., Featherstone, E., Hayes, J., Woolf, S., Hurley, A., Bates, D. W., Gandhi, T. K., & Poon, E. G. (2008). Quantifying Nursing Workflow in Medication Administration. *JONA*, 38(1), 19–26.

Kerecsen, L., Pazdernik, T. L., Doull, D. J., Norton, S., & Nelson, S. (2002). *From mainframe to web-based : 30 years of experience in computer-aided instruction of pharmacology*. Naunyn-Schmiedeberg's Archives of Pharmacology, 366, 83–89. https://doi.org/10.1007/s00210-002-0558-6

Kezar, A., & Maxey, D. (2014). The Delphi technique: An untapped approach of participatory research. *International Journal of Social Research Methodology*, *19*, 143–160.

Khullar, D. (2022). Social Media and Medical Misinformation: Confronting New Variants of an Old Problem. *JAMA*, *328*(14), 1393–1394. American Medical Association. https://doi.org/10.1001/jama.2022.17191

Kid, M. O. (2019). *Perceptions of nurses of the medication errors in primary healthcare clinics in Greater Tzaneen Municipality of Limpopo Province, South Africa*. University of Limpopo.

Kidane, H. H., Roebertsen, H., & Van der Vleuten, C. P. M. (2020). Students' perceptions towards self-directed learning in Ethiopian medical schools with new innovative curriculum: A mixed-method study. *BMC Medical Education*, *20*(1). https://doi.org/10.1186/s12909-019-1924-0

King, R. L. (2004). Nurses' perceptions of their pharmacology educational needs. *Journal of Advanced Nursing*, *45*(4), 392–400. https://doi.org/10.1046/j.1365-2648.2003.02922.x

Knowles, M. S. (1978). Andragogy: Adult learning theory in perspective. *Community College Review*, *5*, 9–20.

Koethe, J. R., Lagathu, C., Lake, J. E., Domingo, P., Calmy, A., Falutz, J., Brown, T. T., & Capeau, J. (2020). HIV and antiretroviral therapy-related fat alterations. *Nature Reviews Disease Primers*, *6*(1), 48. https://doi.org/10.1038/s41572-020-0181-1

Kohn, L. T., Corrigan, J., & Donaldson, M. S. (2000). *To err is human: Building a safer health system*. National Academy Press.

Konkin, J., Grave, L., Cockburn, E., Couper, I., Stewart, R. A., Campbell, D., & Walters, L. (2020). Exploration of rural physicians' lived experience of practising outside their usual scope of practice to provide access to essential medical care (clinical courage): An international phenomenological study. *BMJ Open*, *10*(8), 1–7. https://doi.org/10.1136/bmjopen-2020-037705

Konttila, J., Siira, H., Kyngäs, H., Lahtinen, M., Elo, S., Kääriäinen, M., Kaakinen, P., Oikarinen, A., Yamakawa, M., Fukui, S., Utsumi, M., Higami, Y., Higuchi, A., & Mikkonen, K. (2019). Healthcare professionals' competence in digitalisation: A systematic review. *Journal of Clinical Nursing*, *28*(5–6), 745–761. https://doi.org/10.1111/jocn.14710

Kopp-Kubel, S. (1995). International Nonproprietary Names (INN) for pharmaceutical substances. *Bulletin of the World Health Organization*, *73*(3), 275–279.

Kose, I., Gencyurek, G., Atan, Z., & Elmas, B. (2021). Analysis of drug-food interactions in inpatient treatment: A university hospital case. *Medical Research Archives*, *9*(2), 1–11. https://doi.org/10.18103/mra.v9i2.2345

Koziolek, M., Alcaro, S., Augustijns, P., Basit, A. W., Grimm, M., Hens, B., Hoad, C. L., Jedamzik, P., Madla, C. M., Maliepaard, M., Marciani, L., Maruca, A., Parrott, N., Pávek, P., Porter, C. J. H., Reppas, C., van Riet-Nales, D., Rubbens, J., Statelova, M., … Corsetti, M. (2019). The mechanisms of pharmacokinetic food-drug interactions – A perspective from the UNGAP group. *European Journal of Pharmaceutical Sciences*, *134*, 31–59. https://doi.org/10.1016/j.ejps.2019.04.003

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice*, *41*(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2

Kwak, G., Gardner, K., Bolaji, B., Franklin, S., Aung, M., & Jolly, P. E. (2021). Knowledge, attitudes and practices among healthcare professionals regarding complementary alternative medicine use by patients with hypertension and type 2 diabetes mellitus in Western Jamaica. *Complementary Therapies in Medicine*, *57*, 102666. https://doi.org/10.1016/j.ctim.2021.102666

Laborde, E. B., & Texidor, M. S. (1996). Knowledge and attitudes toward chronic pain management among home healthcare nurses. *Home Healthcare Management & Practice*, *9*(1), 73–77. https://doi.org/10.1177/108482239600900115

Lala, S. G., Lala, N., & Dangor, Z. (2017). The nursing crisis in paediatrics in South African state hospitals – An unaddressed problem. *South African Journal of Child Health*, *11*(2), 64–65. https://doi.org/10.7196/SAJCH.2017.v11i2.1432

Lalwani, L., Mishra, G., Gaidhane, A., Quazi, N., & Taksande, A. (2021). Chest physiotherapy in patients admitted to the intensive care unit with COVID-19: A review. *The Open Public Health Journal*, *14*(1), 145–148. https://doi.org/10.2174/1874944502114010145

Lan, Y. H., Wang, K. W. K., Yu, S., Chen, I. J., Wu, H. F., & Tang, F. I. (2014). Medication errors in pediatric nursing: Assessment of nurses' knowledge and analysis of the

consequences of errors. *Nurse Education Today*, *34*(5), 821–828. https://doi.org/10.1016/j.nedt.2013.07.019

Lansbury, G., & Sullivan, G. (2002). Advising clients about prescription medications. *Physiotherapy*, *88*(1), 18–24. https://doi.org/10.1016/s0031-9406(05)60525-1

Laroche, M. L., Blin, A., Coubret, A., Grau, M., Roux, B., & Aubard, Y. (2020). Off-label prescribing during pregnancy in France: The NéHaVi group. *International Journal of Clinical Pharmacology and Therapeutics*, *58*(4), 198–207. https://doi.org/10.5414/CP203578

Latter, S., Rycroft-Malone, J., Yerrell, P., & Shaw, D. (2000). Evaluating educational preparation for a health education role in practice: The case of medication education. *Journal of Advanced Nursing*, *32*(5), 1282–1290. https://doi.org/10.1046/j.1365-2648.2000.01599.x

Lawrance, K. J. (2002). *Complementary and alternative medicines: The knowledge, attitudes and practices of dietitians in Maine*. Electronic Theses and Dissertation. 89. http://digitalcommons.library.umaine.edu/etdhttp://digitalcommons.library.umaine.edu/etd/89

Lawrence, C., Bollinger, J., Stewart, K. A., & Moshabela, M. (2021). Improving South African medical curricula related to traditional health systems. *African Journal of Health Professions Education*, *13*(2), 146. https://doi.org/10.7196/ajhpe.2021.v13i2.1246

Lazić, E., Dujmović, J., & Hren, D. (2006). Retention of basic sciences knowledge at clinical years of medical curriculum. *Student CMJ*, *47*, 882–887.

Le Deist, F. D., & Winterton, J. (2005). What is competence? *Human Resource Development International*, *8*(1), 27–46. https://doi.org/10.1080/1367886042000338227

Lebedevs, T., & Kendrick, C. (2019). Pharmacological management of common lactation problems. *Journal of Pharmacy Practice and Research*, *49*(2), 192–198. https://doi.org/10.1002/jppr.1561

Lee, J., Briggs Early, K., Kovesdy, C. P., Lancaster, K., Brown, N., & Steiber, A. L. (2022). The Impact of RDNs on Non-Communicable Diseases: Proceedings from the State of Food and Nutrition Series Forum. *Journal of the Academy of Nutrition and Dietetics*, *122*(1), 166–174. https://doi.org/10.1016/j.jand.2021.02.021

Lee, K., & Sheppard, L. (1998). An investigation into medical students' knowledge and perception of physiotherapy services. *Australian Physiotherapy*, *44*, 239–245.

Lenz, T. L. (2010). Pharmacokinetic drug interactions with physical activity. *American Journal of Lifestyle Medicine*, *4*(3), 226–229. https://doi.org/10.1177/1559827610361565

Lenz, T. L., Lenz, N. J., & Faulkner, M. A. (2004). Potential interactions between exercise and drug therapy. *Sports Medicine*, *34*(5), 293–306.

Leung, L. (2012). From ladder to platform: a new concept for pain management. *Journal of Primary Healthcare*, *4*(3), 254–258. https://doi.org/10.1071/hc12213

Lewis, L. D., & Nierenberg, D. W. (2007). American Board of Clinical Pharmacology Fellowship training and certification in clinical pharmacology: Educational value and future needs for the discipline. *Clinical Pharmacology & Therapeutics*, *81*(1), 2005–2008. https://doi.org/10.1038/sj.clpt.6100028

Lewis, T., & Cook, J. (2014). Fluoroquinolones and tendinopathy: A guide for athletes and sports clinicians and a systematic review of the literature. *Journal of Athletic Training*, 49(3), 422–427. https://doi.org/10.4085/1062-6050-49.2.09

Lilley, L., Collins, S., & Snyder, J. (2022). *Pharmacology and the Nursing Process E-Book*. Elsevier Health Sciences.

Lim, A. G., & Honey, M. (2006). Integrated undergraduate nursing curriculum for pharmacology. *Nurse Education in Practice*, *6*(3), 163–168. https://doi.org/10.1016/j.nepr.2005.11.005

Lim, A. G., & Honey, M. (2014). New Zealand newly graduated nurses' medication management: Results of a survey. *Nurse Education in Practice*, *14*(6), 660–665. https://doi.org/10.1016/j.nepr.2014.08.005

Lim, A. G., Honey, M., & Kilpatrick, J. (2007). Framework for teaching pharmacology to prepare graduate nurse for prescribing in New Zealand. *Nurse Education in Practice*, *7*(5), 348–353. https://doi.org/10.1016/j.nepr.2006.11.006

Lin, F. Y., Wu, W. W., Lin, H. R., & Lee, T. Y. (2014). The learning experiences of student nurses in pediatric medication management: A qualitative study. *Nurse Education Today*, *34*(5), 744–748. https://doi.org/10.1016/j.nedt.2013.08.004

Lindeman, B. M., & Lipsett, P. A. (2016). Step 6: Evaluation and Feedback. In Thomas, P. A., Kern, D. E., Mark, T., Hughes, M. T., & Chen, B. Y. (Ed) *Curriculum Development for Medical Education: A Six-Step Approach* (pp. 121–167). JHU Press.

Linstone, H. (1975). V. Eight Basic Pitfalls. In Thomas, P. A., Kern, D. E., Mark, T., Hughes, M. T., & Chen, B. Y. (Eds). *The Delphi Method: Techniques and Applications*. Addison-Wesley Educational Publishers Inc.

Linstone, H. A., & Turoff, M. (1975). *The Delphi Method: Techniques and Applications*. Addison-Wesley Educational Publishers Inc. https://doi.org/10.1007/s00256-011-1145-z

Littlejohn, L., Campbell, J., Collins-McNeil, J., & Khayile, T. (2012). Nursing shortage: A comparative analysis. *International Journal of Nursing*, *1*(1), 22–27.

Liu, L., Du, X., Zhang, Z., & Zhou, J. (2019). Effect of problem-based learning in pharmacology education: A meta-analysis. *Studies in Educational Evaluation*, *60*(May 2018), 43–58. https://doi.org/10.1016/j.stueduc.2018.11.004

Lloyd, H., Hinton, T., Bullock, S., Babey, A.-M., Davis, E., Fernandes, L., Hart, J., Musgrave, I., & Ziogas, J. (2013). An evaluation of pharmacology curricula in Australian science and health-related degree programs. *BMC Medical Education*, *13*, 1–15. https://doi.org/10.1186/1472-6920-13-153

Lo, T. F., Yu, S., Chen, I. J., Wang, K. W. K., & Tang, F. I. (2013). Faculties' and nurses' perspectives regarding knowledge of high-alert medications. *Nurse Education Today*, *33*(3), 214–221. https://doi.org/10.1016/j.nedt.2012.01.004

Lohfeld, L., Neville, A., & Norman, G. (2005). PBL in undergraduate medical education: A qualitative study of the views of Canadian residents. *Advances in Health Sciences Education*, *10*(3), 189–214. https://doi.org/10.1007/s10459-005-1293-9

Lohmann, K., Ferber, J., Haefeli, M. F., Störzinger, D., Schwald, M., Haefeli, W. E., & Seidling, H. M. (2015). Knowledge and training needs of nurses and physicians on unsuitable drugs for patients with dysphagia or feeding tubes. *Journal of Clinical Nursing*, *24*(19–20), 3016–3019. https://doi.org/10.1111/jocn.12910

Lopes, H., & McKay, V. (2020). Adult learning and education as a tool to contain pandemics: The COVID-19 experience. *International Review of Education*, *66*(4), 575–602. https://doi.org/10.1007/s11159-020-09843-0

López-Entrambasaguas, O. M., Martínez-Yebenes, R., Calero-García, M. J., Granero-Molina, J., & Martínez-Linares, J. M. (2019). Newly qualified nurses' perception of their competency achievement on leaving university: A qualitative study. *International Journal of Environmental Research and Public Health*, *16*(21). https://doi.org/10.3390/ijerph16214284

Loughlin, C., Lygo-Baker, S., & Lindberg-Sand, Å. (2021). Reclaiming constructive alignment. *European Journal of Higher Education*, *11*(2), 119–136. https://doi.org/10.1080/21568235.2020.1816197

Lozano, R., Fullman, N., Mumford, J. E., Knight, M., Barthelemy, C. M., Abbafati, C., Abbastabar, H., Abd-Allah, F., Abdollahi, M., Abedi, A., Abolhassani, H., Abosetugn, A. E., Abreu, L. G., Abrigo, M. R. M., Abu Haimed, A. K., Abushouk, A. I., Adabi, M., Adebayo, O. M., Adekanmbi, V., … Murray, C. J. L. (2020). Measuring universal health coverage based on an index of effective coverage of health services in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *396*(10258), 1250–1284. https://doi.org/10.1016/S0140-6736(20)30750-9

Lubbe, J. C., & Roets, L. (2014). Nurses' scope of practice and the implication for quality nursing care. *Journal of Nursing Scholarship*, *46*(1), 58–64. https://doi.org/10.1111/jnu.12058

Lymn, J. S., & Mostyn, A. (2010). Audience response technology: Engaging and empowering non-medical prescribing students in pharmacology learning. *BMC Medical Education*, *10*(1), 73. https://doi.org/10.1186/1472-6920-10-73

Macêdo, G. G. C., Oliveira-Figueirêdo, D. S. T. de, Andrade, L. L. de, & Carvalho, M. A. P. de. (2020). Factors related to the knowledge of nursing professionals about pharmacovigilance. *Rev Rene*, *21*, e44118. https://doi.org/10.15253/2175-6783.20202144118

Mahlathi, P., & Dlamini. (2015). Minimum data sets for human resources for health and the surgical workforce in South Africa's health system: A rapid analysis of stock and

migration. *African Institute of Health & Leadership Development*. https://doi.org/10.1136/bmj.311.7010.947

Mak, S., & Thomas, A. (2022). Steps for Conducting a Scoping Review. *Journal of Graduate Medicine Education*, *14*, 565–567.

Manallack, D. T., Prankerd, R. J., Yuriev, E., Oprea, T. I., & Chalmers, D. K. (2013). The significance of acid/base properties in drug discovery. *Chemical Society Reviews*, *42*(2), 485–496. https://doi.org/10.1039/c2cs35348b

Manias, E. (2003). Medication trends and documentation of pain management following surgery. *Nursing and Health Sciences*, *5*, 85–94. https://doi.org/10.1046/j.1441-0745.2002.00140.x

Manias, E., Aitken, R., & Dunning, T. (2004). Medication management by graduate nurses: Before, during and following medication administration. *Nursing and Health Sciences*, *6*(2), 83–91. https://doi.org/10.1111/j.1442-2018.2004.00178.x

Manias, E., & Bullock, S. (2002). The educational preparation of undergraduate nursing students in pharmacology: Perceptions and experiences of lecturers and students. *International Journal of Nursing Studies*, *39*(7), 757–769. https://doi.org/10.1016/S0020-7489(02)00018-4

Manias, E., & Street, A. (2000). Legitimation of nurses' knowledge through policies and protocols in clinical practice. *Journal of Advanced Nursing*, *32*(6), 1467–1475. https://doi.org/10.1046/j.1365-2648.2000.01615.x

Maphumulo, W. T., & Bhengu, B. R. (2019). Challenges of quality improvement in the healthcare of South Africa post-apartheid: A critical review. *Curationis*, *42*(1), 1–9. https://doi.org/10.4102/curationis.v42i1.1901

Marais, A., Steenkamp, V., & Du Plooy, W. J. (2015). Conditions frequently self-treated with herbal remedies by patients visiting a tertiary hospital in Gauteng, South Africa. *South African Family Practice*, *57*(1), 8–11. https://doi.org/10.1080/20786190.2014.977066

Maree, J. E., Bingo, S. A. M., & Mgawi, O. (2023). Palliative nursing in Africa: Scoping the landscape of evidence focusing on cancer care. *Florence Nightingale Journal of Nursing*, *31*(1), S38–S44. https://doi.org/10.5152/FNJN.2023.23038

Marguet, C., Houdouin, V., Pin, I., Reix, P., Huet, F., Mittaine, M., Ramel, S., Wizla-Derambure, N., Abely, M., Dalphin, M. L., Fayon, M., Bihouée, T., Le Bourgeois, M., Deneuville, E., Corvol, H., Laurans, M., Couderc, L., Leroux, E., & Lémée, L. (2021). Chest physiotherapy enhances detection of pseudomonas Aeruginosa in nonexpectorating children with cystic fibrosis. *ERJ Open Research*, *7*(1). https://doi.org/10.1183/23120541.00513-2020

Markiewicz-Gospodarek, A., Kozioł, M., Tobiasz, M., Baj, J., Radzikowska-Büchner, E., & Przekora, A. (2022). Burn wound healing: Clinical complications, medical care, treatment, and dressing types: The current state of knowledge for clinical practice. *International Journal of Environmental Research and Public Health*, *19*(3), 1338. https://doi.org/10.3390/ijerph19031338

Markowitz, S., Adams, E. K., Lewitt, M. J., & Dunlop, A. L. (2017). Competitive effects of scope of practice restrictions: Public health or public harm? *Journal of Health Economics*, *55*, 201–218. https://doi.org/10.1016/j.jhealeco.2017.07.004

Mash, B., Fairall, L., Adejayan, O., Ikpefan, O., Kumari, J., Matheel, S., Okun, R., & Yogolelo, W. (2012). A morbidity survey of South African primary care. *PLoS ONE*, *7*(3). https://doi.org/10.1371/journal.pone.0032358

Matiso, L. (2017). *Perceptions of professional nurses on medication errors in a psychiatric hospital in the Western Cape*. University of the Western Cape.

Maton, K. (2014). *Knowledge and knowers: Towards a realist sociology of education*. Routledge. https://doi.org/10.1021/pr800484x

Mauldin, B. (2023). Bringing clinical context to the classroom in nursing pharmacology: A case study. *Nursing Education Perspectives*, *44*(1), 57–58. https://doi.org/10.1097/01.NEP.0000000000000919

Mayosi, B. M., Flisher, A. J., Lalloo, U. G., Sitas, F., Tollman, S. M., & Bradshaw, D. (2009). The burden of non-communicable diseases in South Africa. *The Lancet*, *374*(9693), 934–947. https://doi.org/10.1016/S0140-6736(09)61087-4

Mbalinda, S. N., Najjuma, J. N., Mubuuke, A. G., Kamoga, L., & Musoke, D. (2023). Understanding and barriers to formation professional identity among current and recent graduates of nurses and midwifery in two universities in a low resource setting: A qualitative study. *Research Square*. https://doi.org/10.21203/rs.3.rs-3423723/v1

Mboweni, S. H., & Makhado, L. (2020). Strategies to improve the implementation of nurse-initiated management of antiretroviral therapy (NIMART) training: A systematic review. *BMC Nursing*. https://doi.org/10.21203/rs.3.rs-16220/v1

Mbunge, E. (2020). Effects of COVID-19 in South African health system and society: An explanatory study. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(6), 1809–1814. https://doi.org/10.1016/j.dsx.2020.09.016

McCabe-Sellers, B. J., Skipper, A., & American Dietetic Association. (2010). Position of the American Dietetic Association: integration of medical nutrition therapy and pharmacotherapy. *Journal of the American Dietetic Association*, *110*(6), 950–956. https://doi.org/10.1016/j.jada.2010.04.017

McCabe-Sellers, B. J., Staggs, C. G., & Bogle, M. L. (2006). Tyramine in foods and monoamine oxidase inhibitor drugs: A crossroad where medicine, nutrition, pharmacy, and food industry converge. *Journal of Food Composition and Analysis*, *19*, S58–S65. https://doi.org/10.1016/j.jfca.2005.12.008

McGaw, L. J., Omokhua-Uyi, A. G., Finnie, J. F., & Van Staden, J. (2022). Invasive alien plants and weeds in South Africa: A review of their applications in traditional medicine and potential pharmaceutical properties. *Journal of Ethnopharmacology*, 283, 114564. https://doi.org/10.1016/j.jep.2021.114564

Mckenna, H. P. (1994). The Delphi technique: A worthwhile research approach for nursing? *Journal of Advanced Nursing*, *19*, 1221–1225.

McKimm, J. (2010). Current trends in undergraduate medical education: program and curriculum design. *Samoa Medical Journal*, *1*(2), 40–48. https://doi.org/10.12968/hmed.2011.72.6.346

McKinney, E. L., McKinney, V., & Swartz, L. (2020). COVID-19, disability and the context of healthcare triage in South Africa: Notes in a time of pandemic. *African Journal of Disability*, *9*, 766. https://doi.org/10.4102/AJOD.V9I0.766

McMillan, S. C., Tittle, M., Hagan, S., Laughlin, J., & Tabler, R. E. (2000). Knowledge and attitudes of nurses in veteran hospitals about pain management in patients with cancer. *Oncology Nursing Forum*, *27*(9), 1415–1423. https://www.scopus.com/inward/record.uri?eid=2-s2.0-0034304662&partnerID=40&md5=fe9ecbff4adb923b073e193889d42396

McMillan, S. S., King, M., & Tully, M. P. (2016). How to use the nominal group and Delphi techniques. *International Journal of Clinical Pharmacy*, *38*(3), 655–662. https://doi.org/10.1007/s11096-016-0257-x

Meechan, R., Mason, V., & Catling, J. (2011). The impact of an integrated pharmacology and medicines management curriculum for undergraduate adult nursing students on the acquisition of applied drug/pharmacology knowledge. *Nurse Education Today*, *31*(4), 383–389. https://doi.org/10.1016/j.nedt.2010.07.011

Megaw, C., Olivier, N., Cordier W. (2025). South African dietitians' knowledge and perceptions of food-drug interactions and factors affecting it. *Journal of Human Nutrition and Dietetics*, 38, e70010. https://doi.org/10.1111/jhn.70010

Melnick, S. (2015). Physiotherapy and clinical approaches – An overview. *European Journal of Physical Education and Sport Science*, *1*, 27–37. http://www.physio-europe.org/index.php?action=136

Meloncelli, N., Barnett, A., & De Jersey, S. (2020). An implementation science approach for developing and implementing a dietitian-led model of care for gestational diabetes: a pre-post study. *BMC Pregnancy and Childbirth*, *20*(1), 661. https://doi.org/10.1186/s12884-020-03352-6

Meskó, B., & Görög, M. (2020). A short guide for medical professionals in the era of artificial intelligence. *npj Digital Medicine*, *3*(1), 126. https://doi.org/10.1038/s41746-020-00333-z

Mestres, C., & Duran, M. (2009). Importance of pharmacology knowledge by dieticians. *Current Nutrition & Food Science*, *5*(1), 49–52. https://doi.org/10.2174/157340109787314749

Mestres, C., & Duran, M. (2012). Topics on pharmacology for dietitians in modern practice. *Current Nutrition & Food Science*, *8*(1), 63–67. https://doi.org/10.2174/157340112800269641

Meyer, B. A., Seefeldt, T. M., Ngorsuraches, S., Hendrickx, L. D., Lubeck, P. M., Farver, D. K., & Heins, J. R. (2017b). Interprofessional education in pharmacology using high-fidelity simulation. *Currents in Pharmacy Teaching and Learning*, *9*(6), 1055–1062. https://doi.org/10.1016/j.cptl.2017.07.015

Meyer, J. C., Schellack, N., Stokes, J., Lancaster, R., Zeeman, H., Defty, D., Godman, B., & Steel, G. (2017a). Ongoing initiatives to improve the quality and efficiency of medicine use within the public healthcare system in South Africa; A preliminary study. *Frontiers in Pharmacology*, *8*, 1–16. https://doi.org/10.3389/fphar.2017.00751

Michel, M. C., Bischoff, A., Zu Heringdorf, M., Neumann, D., & Jakobs, K. H. (2002). Problem- vs. lecture-based pharmacology teaching in a German medical school. *Naunyn-Schmiedeberg's Archives of Pharmacology*, *366*(1), 64–68. https://doi.org/10.1007/s00210-002-0570-x

Midlov, P., Hoglund, P., Eriksson, T., Diehl, A., & Edgren, G. (2015). Developing a competency-based curriculum in basic and clinical pharmacology – A Delphi study among physicians. *Basic & Clinical Pharmacology & Toxicology*, *117*, 413–420. https://doi.org/10.1111/bcpt.12436

Mississippi Research and Curriculum Unit for Vocational and Technical Education State College. (1995). *Mississippi curriculum framework for practical nursing programs CIP: 51.1613--Practical Nurse (L.P.N. Training). Postsecondary programs*.

Mitchell, J., Jones, W., Winkley, E., & Kinsella, S. M. (2020). Guideline on anaesthesia and sedation in breastfeeding women 2020: Guideline from the Association of Anaesthetists. *Anaesthesia*, *75*(11), 1482–1493. https://doi.org/10.1111/anae.15179

Mitroff, I., & Turoff, M. (1975). II. Philosophy: B. Philosophical and Methodological Foundations of Delphi. In Thomas, P. A., Kern, D. E., Mark, T., Hughes, M. T., & Chen, B. Y. (Eds.). *The Delphi Method: Techniques and Applications*.

Mlambo, S. (2021). Stimulating students' critical thinking skills in pharmacology using case report generation. *African Journal of Health Professions Education*, *13*(3), 184–185.

Moaveni, A., Conn, L. G., Health, S., Centre, S., Mobilio, M. H., & Oandasan, I. F. (2011). A Delphi approach to developing a core competency framework for family practice registered nurses in Ontario. *Nursing Leadership*, *23*, 45–60. https://doi.org/10.12927/cjnl.2011.22142

Mohajeri, M. H., Eckert, G. P., Pauly, J. R., & Butt, C. M. (2015). Pharmacology: The pharmacodynamics of nutrients and nutrient interactions in biological functions. *BioMed Research International*, 2015, 974572. https://doi.org/10.1155/2015/974572

Mohammed, J., & Thornton, J. (2021). Development, validation, and testing of a physiotherapist initiated checklist of items for implementing pulmonary rehabilitation in Nigeria. *Journal of the Pan African Thoracic Society*, *2*, 140–147. https://doi.org/10.25259/jpats_21_2021

Motala, S., Sayed, Y., & de Kock, T. (2021). Epistemic decolonisation in reconstituting higher education pedagogy in South Africa: the student perspective. *Teaching in Higher Education*, *26*(7–8), 1002–1018. https://doi.org/10.1080/13562517.2021.1947225

Moura, M. L. (2012). The importance of education of pharmacology for nursing graduate. *Educational Research*, *3*(12), 952–953.

Moyoh, W., Gondwe, K. W., Andreou, P., Philippou, E., & Papageorgiou, A. (2022). Allied health workers' role in patient education in the United States: a narrative review. *Journal of Health Sciences*, *12*(1), 1–9. https://doi.org/10.17532/jhsci.2022.1562

Mthembu, N. (2021). Relevance for traditional medicine in South Africa: Experiences of urban traditional healers, izinyanga. *International Journal of Medical and Health Sciences, 15* (3), 132-145. https://www.researchgate.net/publication/350654739

Mukwena, N. V., & Manyisa, Z. M. (2022). Factors influencing the preparedness for the implementation of the national health insurance scheme at a selected hospital in Gauteng Province, South Africa. *BMC Health Services Research*, *22*(1). 1006. https://doi.org/10.1186/s12913-022-08367-7

Mulgrave, N., & Ducanis, A. (1975). IV. Evaluation: D. Propensity to Change Responses in a Delphi Round as a Function of Dogmatism. In Thomas, P. A., Kern, D. E., Mark, T., Hughes, M. T., & Chen, B. Y. (Eds.). *The Delphi Method: Techniques and Applications*. Addison-Wesley Educational Publishers Inc.

Musharyanti, L., Claramita, M., Haryanti, F., & Dwiprahasto, I. (2019). Why do nursing students make medication errors? A qualitative study in Indonesia. *Journal of Taibah University Medical Sciences*, *14*(3), 282–288. https://doi.org/10.1016/j.jtumed.2019.04.002

Mutale, W. (2020). Integrating Traditional Healers into the Healthcare System: Challenges and Opportunities in South Africa. *Medical Journal of Zambia*, 47(4).

Mutola, S., Pemunta, N. V., & Ngo, N. V. (2021). Utilization of traditional medicine and its integration into the healthcare system in Qokolweni, South Africa; prospects for enhanced universal health coverage. *Complementary Therapies in Clinical Practice*, *43*, 101386. https://doi.org/10.1016/j.ctcp.2021.101386

Mutshatshi, T. E., Mothiba, T. M., & Malema, R. N. (2022). Exploration of In-Service Training Needs for Nurses Implementing the Nursing Process at Regional Hospitals of Limpopo Province, South Africa. *The Open Public Health Journal*, *15*(1). https://doi.org/10.2174/18749445-v15-e221014-2022-58

Mutshatshi, T. E., Mothiba, T. M., & Mamogobo, P. M. (2020). Exploring professional nurses' use of the nursing process at selected public hospitals in Limpopo, South Africa. *Africa Journal of Nursing and Midwifery*, *22*(2). https://doi.org/10.25159/2520-5293/7182

Mylopoulos, M., Brydges, R., Woods, N. N., Manzone, J., & Schwartz, D. L. (2016). Preparation for future learning: A missing competency in health professions education? *Medical Education*, *50*(1), 115–123. https://doi.org/10.1111/medu.12893

Naidu, T. (2020). The COVID-19 pandemic in South Africa. *Psychological Trauma: Theory, Research, Practice, and Policy*, *12*(5), 559–561. https://doi.org/10.1037/TRA0000812

Nallani, S. C., Baisden, K., Dinatale, M., Basham, L., Kwatra, D., & Yao, L. (2023). Clinical lactation studies of neuropsychiatric medications: Clinical pharmacology and labeling considerations. *Journal of Clinical Pharmacology*, *63*(S1), S159–S169. https://doi.org/10.1002/jcph.2251

Narain, S., & Mathye, D. (2019). Do physiotherapists have a role to play in the sustainable development goals? A qualitative exploration. *South African Journal of Physiotherapy*, *75*(1), 1–9. https://doi.org/10.4102/sajp.v75i1.466

Neely, A. H., & Ponshunmugam, A. (2019). A qualitative approach to examining healthcare access in rural South Africa. *Social Science and Medicine*, *230*(April), 214–221. https://doi.org/10.1016/j.socscimed.2019.04.025

Nightingale, F. (1863). Notes on hospitals. *Longman, Green, Longman, Roberts, and Green*.

Ngcobo, S. J., Makhado, L., & Sehularo, L. A. (2024). Managerial factors influencing the implementation of NIMART services in the mobile health clinics of eThekwini municipality in KwaZulu-Natal. *International Journal of Africa Nursing Sciences*, *20*, 100667. https://doi.org/10.1016/j.ijans.2024.100667

Ngeh, E. N., Lowe, A., Garcia, C., & McLean, S. (2023). Physiotherapy-Led Health Promotion Strategies for People with or at Risk of Cardiovascular Diseases: A Scoping Review. *International Journal of Environmental Research and Public Health*, 20(22). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/ijerph20227073

Nicholson, E. C., & Damons, A. (2022). Linking the processes of medication administration to medication errors in the elderly. *Health SA Gesondheid*, *27*. https://doi.org/10.4102/hsag.v27i0.1704

Niederberger, E., & Parnham, M. J. (2021). The impact of diet and exercise on drug responses. *International Journal of Molecular Sciences, 22*(14), 7692 https://doi.org/10.3390/ijms22147692

Nielsen, G., Stone, J., Matthews, A., Brown, M., Sparkes, C., Farmer, R., Masterton, L., Duncan, L., Winters, A., Daniell, L., Lumsden, C., Carson, A., David, A. S., & Edwards, M. (2015). Physiotherapy for functional motor disorders: A consensus recommendation. *Journal of Neurology, Neurosurgery and Psychiatry*, *86*(10), 1113–1119. https://doi.org/10.1136/jnnp-2014-309255

Nkomo, M. (2000). *The National Qualifications Framework and Curriculum Development*. http://www.saqa.org.za

Noblet, T. D., Marriott, J. F., Jones, T., Dean, C., & Rushton, A. B. (2019). Perceptions of Australian physiotherapy students about the potential implementation of physiotherapist prescribing in Australia: A national survey. *BMJ Open*, *9*(5), 1–10. https://doi.org/10.1136/bmjopen-2018-026327

Noland, D., & Raj, S. (2019). Academy of Nutrition and Dietetics: Revised 2019 Standards of Practice and Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Nutrition in Integrative and Functional Medicine. *Journal of the Academy of Nutrition and Dietetics*, *119*(6), 1019-1036.e47. https://doi.org/10.1016/j.jand.2019.02.010

Nordquist, J., Sundberg, K., & Laing, A. (2016). Aligning physical learning spaces with the curriculum: AMEE Guide No. 107. *Medical Teacher*, *38*(8), 755–768. https://doi.org/10.3109/0142159X.2016.1147541

Norris, M. E., Cachia, M. A., Johnson, M. I., Rogers, K. A., & Martin, C. M. (2020). Expectations and perceptions of students' basic science knowledge: Through the lens of clerkship directors. *Medical Science Educator*, *30*(1), 355–365. https://doi.org/10.1007/s40670-019-00913-z

Nouri, H., & Shahid, A. (2008). The Effects of PowerPoint Lecture Notes on Student Performance and Attitudes. *The Accounting Educators' Journal, XVIII*, 103–117.

Nutbeam, D., & Lloyd, J. E. (2021). Understanding and responding to health literacy as a social determinant of health. *Annual Review of Public Health*, *42*, 159–173. https://doi.org/10.1146/annurev-publhealth

Obi, C. O., Onosogbe, M., Ehimen, A. G., Olamide, O., Toluwalase, T. V., Esther, O., Joshua, D. O., & Aborode, A. T. (2022). Comparison of the integrated organ/systems-based curriculum with the traditional subjects-based medical curriculum: Short communication. *Annals of Medicine and Surgery*, *73*. https://doi.org/10.1016/j.amsu.2021.103116

OECD. (2023). *Health at a Glance 2023*.

OECD. (2024). *Nurses (indicator)*. https://doi.org/doi: 10.1787/283e64de-en

Ohio State Department of Education. (2001). *Practical nursing. FasTrak specialization integrated technical and academic competency (ITAC). Revised*. papers3://publication/uuid/A0A266F4-18E4-41C4-B1F6-EDFB58C6E8CE

Oklahoma State Department of Vocational and Technical Education Stillwater. (1990). *Pharmacology. Teacher Edition*.

Oldridge, G. J., Gray, K. M., McDermott, L. M., & Kirkpatrick, C. M. J. (2004). Pilot study to determine the ability of health-care professionals to undertake drug dose calculations. *Internal Medicine Journal*, *34*(6), 316–319. https://doi.org/10.1111/j.1445-5994.2004.00613.x

Oleribe, O. O., Momoh, J., Uzochukwu, B. S. C., Mbofana, F., Adebiyi, A., Barbera, T., Williams, R., & Taylor-Robinson, S. D. (2019). Identifying key challenges facing healthcare systems in Africa and potential solutions. *International Journal of General Medicine*, *12*, 395–403. https://doi.org/10.2147/IJGM.S223882

Oliver, A., Xue, Z., Villanueva, Y. T., Durbin-Johnson, B., Alkan, Z., Taft, D. H., Liu, J., Korf, I., Laugero, K. D., Stephensen, C. B., Mills, D. A., Kable, M. E., & Lemay, D. G. (2022).

Association of Diet and Antimicrobial Resistance in Healthy U.S. Adults. *MBio*, *13*(3). https://doi.org/10.1128/mbio.00101-22

Ölund, H., Danielsson, L., & Rosberg, S. (2020). Anxiety management: Participants' experiences of a physiotherapeutic group treatment in Swedish psychiatric outpatient care. *Physiotherapy Theory and Practice*, *36*(2), 276–290. https://doi.org/10.1080/09593985.2018.1485192

Ongole, J. J., Rossouw, T. M., Bernard Fourie, P., Stoltz, A. C., Hugo, J., & Marcus, T. S. (2020). Sustaining essential healthcare in Africa during the COVID-19 pandemic. *International Journal of Tuberculosis and Lung Disease*, *24*(6), 643–645. https://doi.org/10.5588/ijtld.20.0214

Onigbinde, A., Adebiyi, S., Bamitale, K., Kambalametore, S., M'kumbuzi, V., & Margaret, W. (2013). Changing the prescription status of physiotherapists to supplementary prescribing: Perception of Nigerian physiotherapists. *Nigerian Journal of Medical Rehabilitation*, *16*(2), 1–18.

OpenMD. (n.d.-a). *Acromegaly*. Retrieved March 28, 2024, from https://openmd.com/define?q=acromegaly

OpenMD. (n.d.-b). *Hepatitis*. Retrieved March 28, 2024, from https://openmd.com/define?q=hepatitis

OpenMD. (n.d.-c). *Hepatomegaly*. Retrieved March 28, 2024, from https://openmd.com/define?q=hepatomegaly

Osuala, E. C., Tlou, B., & Ojewole, E. B. (2021). Assessment of knowledge of drug-food interactions among healthcare professionals in public sector hospitals in eThekwini, KwaZulu-Natal. *PLoS ONE*, *16*(November), e0259402. https://doi.org/10.1371/journal.pone.0259402

Ozuah, P. O. (2005). First, there was pedagogy and then came andragogy. *The Einstein Journal of Biology and Medicine*, *21*, 83–87.

Paci, M., Faedda, G., Ugolini, A., & Pellicciari, L. (2021). Barriers to evidence-based practice implementation in physiotherapy: A systematic review and meta-analysis. *International Journal for Quality in Healthcare,* *33*(2), mzab093. https://doi.org/10.1093/intqhc/mzab093

Padigos, J., Reid, S., Kirby, E., & Broom, J. (2021). Knowledge, perceptions and experiences of nurses in antimicrobial optimization or stewardship in the intensive care unit. *Journal of Hospital Infection*, *109*, 10–28. https://doi.org/10.1016/j.jhin.2020.12.003

Page, K., & McKinney, A. A. (2007). Addressing medication errors - The role of undergraduate nurse education. *Nurse Education Today*, *27*(3), 219–224. https://doi.org/10.1016/j.nedt.2006.05.002

Palmery, M., Saraceno, A., Vaiarelli, A., & Carlomago, G. (2013). Oral contraceptives and changes in nutritional requirements. *European Review for Medical and Pharmacological Sciences*, *17*, 1804–1813.

Parkar, H. (2021). Saving student interaction by saving the Starks. *African Journal of Health Professions Education*, *13*(3), 191–192.

Patterson, B., Williams, Boardley, Petróczi, & Backhouse, A. (2023). Investigating anti-doping roles of athlete support personnel working with international disabled athletes in six European nations using the COM-B Model and Theoretical Domains Framework. *SportRxiv*. https://doi.org/10.51224/SRXIV.264

Pauw, T. L. (2022). Catching up with the constitution: An analysis of National Health Insurance in South Africa post-apartheid. *Development Southern Africa*, *39*(6), 921–934. https://doi.org/10.1080/0376835X.2021.1945911

Pazdernik, T., & Walaszek, E. (1983). A computer-assisted teaching system in pharmacology for health professionals. *Journal of Medical Education*, *58*, 341–348.

Peel, C., & Mossberg, K. A. (1995). Effects of cardiovascular medications on exercise responses. *Physical Therapy*, *75*(5), 387–396. https://doi.org/10.1093/ptj/75.5.387

Pennell, P. B., Gidal, B. E., Sabers, A., Gordon, J., & Perucca, E. (2007). Pharmacology of antiepileptic drugs during pregnancy and lactation. *Epilepsy and Behavior*, *11*(3), 263–269. https://doi.org/10.1016/j.yebeh.2007.08.018

Pereira, L. N., Caon, S., Pinto, A. N., Maciel, F. H., Sempé, T. S., & Pizzol, T. S. (2021). Nurses' knowledge of high-alert medications in a large-size university hospital. *Revista Brasileira de Farmácia Hospitalar e Serviços de Saúde*, *12*(2), 567. https://doi.org/10.30968/rbfhss.2021.122.0567

Perumal-Pillay, V. A., & Suleman, F. (2017). Selection of essential medicines for South Africa – An analysis of in-depth interviews with national essential medicines list committee members. *BMC Health Services Research*, *17*(1), 1–17. https://doi.org/10.1186/s12913-016-1946-9

Petrova, E. (2010). Nurses' perceptions of medication errors in Malta. *Nursing Standard*, *24*(33), 41–48. https://doi.org/10.7748/ns2010.04.24.33.41.c7717

Picknell, G., Cropley, B., Mellalieu, S., & Hanton, S. (2024). Facilitating healthcare dieticians' communication skills: A reflective practice intervention. *International Journal of Training and Development*, *28*(1), 63–85. https://doi.org/10.1111/ijtd.12306

Pinheiro, E. A., & Stika, C. S. (2020). Drugs in pregnancy: Pharmacologic and physiologic changes that affect clinical care. *Seminars in Perinatology*, *44*(3), 151221. https://doi.org/10.1016/j.semperi.2020.151221

Pittenger, A. L., & Olson-Kellogg, B. (2012). Leveraging learning technologies for collaborative writing in an online pharmacotherapy course. *Distance Education*, *33*(1), 61–80. https://doi.org/10.1080/01587919.2012.667960

Płaszewski, M., Krzepkowska, W., Grantham, W., Wroński, Z., Makaruk, H., & Tręb ska, J. (2022). Knowledge, behaviours and attitudes towards Evidence-Based Practice amongst physiotherapists in Poland. A nationwide cross-sectional survey and focus group study protocol. *PLoS ONE*, *17*(3), e0264531. https://doi.org/10.1371/journal.pone.0264531

Preston, P., Leone-Sheehan, D., & Keys, B. (2019). Nursing student perceptions of pharmacology education and safe medication administration: A qualitative research study. *Nurse Education Today*, *74* (October 2017), 76–81. https://doi.org/10.1016/j.nedt.2018.12.006

Prideaux, D. (2003). ABC of learning and teaching in medicine: Curriculum design. *BMJ*, *326*, 268–270.

Professional Board for Dietetics and Nutrition. (2016). The roles and competencies of the nutrition professional in the well-being of the South African population. *Health Professions Council of South Africa*. http://www.hpcsa.co.za/uploads/editor/UserFiles/The new nutrition professional 2016-01-15.pdf

Professional Board for Physiotherapy Podiatry and Biokinetics. (2023). *Minimum standards for training: Physiotherapy*. www.wcpt.org/policy/ps-regulation

Puzzitiello, R. N., Patel, B. H., Nwachukwu, B. U., Allen, A. A., Forsythe, B., & Salzler, M. J. (2020). Adverse impact of corticosteroid injection on rotator cuff tendon health and repair: A systematic review. *Arthroscopy: Journal of Arthroscopic and Related Surgery*, 36(5), 1468–1475. https://doi.org/10.1016/j.arthro.2019.12.006

Radder, D. L. M., Lígia Silva de Lima, A., Domingos, J., Keus, S. H. J., Van Nimwegen, M., Bloem, B. R., & De Vries, N. M. (2020). Physiotherapy in Parkinson's disease: A Meta-Analysis of Present Treatment Modalities. *Neurorehabilitation and Neural Repair*, 34(10), 871–880. SAGE Publications Inc. https://doi.org/10.1177/1545968320952799

Raghunandan, R., Tordoff, J., & Smith, A. (2017). Non-medical prescribing in New Zealand: an overview of prescribing rights, service delivery models and training. *Therapeutic Advances in Drug Safety*, *8*(11), 349–360. https://doi.org/10.1177/2042098617723312

Rangachari, P. K. (1997). Basic sciences in an integrated medical curriculum: The case of pharmacology. *Advances in Health Sciences Education*, *2*(2), 163–171. https://doi.org/10.1023/A:1009763812617

Rani, V., Tekulapally, K., Padmavathi, V., & Simpson, G. (2016). Second year medical students' perception about pharmacology and teaching methodologies used: A questionnaire based cross sectional study. *Indian Journal of Basic and Applied Medical Research*, *5*(4), 238–245.

Reiss, M. J. (2020). Science Education in the Light of COVID-19: The Contribution of History, Philosophy and Sociology of Science. *Science and Education*, *29*(4), 1079–1092. https://doi.org/10.1007/s11191-020-00143-5

Remesh, A. (2017). *Curriculum design principles for developing a module in medical education*. *1*(1), 34–37.

Republic of South Africa. (1976). *Health Professions Act 56 of 1974: Regulations defining the scope of the profession of physiotherapy*. *5349*. http://www.hpcsa.co.za/Uploads/editor/UserFiles/downloads/legislations/acts/health_professions_ct_56_1974.pdf

Republic of South Africa. (1991). *Health Professions Act 56 of 1974: Regulations defining the scope of the profession of dietetics*. *4684*. http://www.hpcsa.co.za/Uploads/editor/UserFiles/downloads/legislations/acts/health_professions_ct_56_1974.pdf

Republic of South Africa. (2011). *Regulations relating to the keeping, supply, administering or prescribing of medicines by registered nurses*.

Republic of South Africa. (2020). *Nursing Act, 2005 (Act No. 33 of 2005): Regulations regarding scope of practice for nurses and midwives*. *521*.

Resuscitation Council of Southern Africa. (n.d.). *Algorithms*. Retrieved March 25, 2024 from https://resus.co.za/subpages/RCSA_Information/Resources/Algorithms.html

Reumerman, M., Tichelaar, J., Piersma, B., Richir, M. C., & Van Agtmael, M. A. (2018). Urgent need to modernize pharmacovigilance education in healthcare curricula: review of the literature. *European Journal of Clinical Pharmacology*, *74*(10), 1235–1248. https://doi.org/10.1007/s00228-018-2500-y

Rikers, R. M. J. P., Loyens, S. M. M., & Schmidt, H. G. (2004). The role of encapsulated knowledge in clinical case representations of medical students and family doctors. *Medical Education*, *38*(10), 1035–1043. https://doi.org/10.1111/j.1365-2929.2004.01955.x

Ringwald-Smith, K., Hill, R., Evanoff, L., Martin, J., & Sacks, N. (2022). When Reality and Research Collide: Guidelines Are Essential for Optimal Nutrition Care in Pediatric Oncology. *Journal of Pediatric Hematology/Oncology*, *44*(1), e144-e151.

Rispel, L. (2015a). Analysing the progress and fault lines of health sector transformation in South Africa. In *South African Health Review*, 17–23.

Rispel, L. C. (2015b). Transforming nursing policy, practice and management in South Africa. *Global Health Action*, 8(1) 1–4. https://doi.org/10.3402/gha.v8.28005

Rispel, L., & Bruce, J. (2014). A profession in peril? Revitalising nursing in South Africa. In *South African Health Review* (pp. 117–125).

Rispel, L. C., Blaauw, D., Ditlopo, P., & White, J. (2018). Human resources for health and universal health coverage: progress, complexities and contestations. In *South African Health Review*, 13–22.

Ritter, A. Z., Aronowitz, S., Leininger, L., Jones, M., Dowd, J. B., Albrecht, S., Buttenheim, A. M., Simanek, A. M., Hale, L., & Kumar, A. (2021). Dear Pandemic: Nurses as key partners in fighting the COVID-19 infodemic. *Public Health Nursing*, *38*(4), 603–609. https://doi.org/10.1111/phn.12903

Robertson, L. J., Maposa, I., Somaroo, H., & Johnson, O. (2020). Mental health of healthcare workers during the COVID-19 outbreak: A rapid scoping review to inform provincial guidelines in South Africa. *South African Medical Journal*, *110*(10), 1010–1019. https://doi.org/10.7196/SAMJ.2020.v110i10.15022

Roche, A., & Coote, S. (2008). Focus group study of student physiotherapists' perceptions of reflection. *Medical Education*, *42*(11), 1064–1070. https://doi.org/10.1111/j.1365-2923.2008.03178.x

Rogers, D. F. (2005). Mucociliary dysfunction in COPD: Effect of current pharmacotherapeutic options. *Pulmonary Pharmacology and Therapeutics*, *18*(1), 1–8. https://doi.org/10.1016/j.pupt.2004.08.001

Rosenbloom, S., & Nemec, E. C. (2021). Problem-Based Learning and Case Scenarios: An Interprofessional Pharmacology Experience. *Nursing Education Perspectives*, *42*(3), 190–192. https://doi.org/10.1097/01.NEP.0000000000000638

Ross, S., & Maxwell, S. (2012). Prescribing and the core curriculum for tomorrow's doctors: BPS curriculum in clinical pharmacology and prescribing for medical students. *British Journal of Clinical Pharmacology*, *74*(4), 644–661. https://doi.org/10.1111/j.1365-2125.2012.04186.x

Royal College of Nursing. (2019). *Professional Guidance on the Administration of Medicines in Healthcare Settings*.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Salehi, T., Seyedfatemi, N., Mirzaee, M. S., Maleki, M., & Mardani, A. (2021). Nurses' Knowledge, Attitudes, and Practice in Relation to Pharmacovigilance and Adverse Drug Reaction Reporting: A Systematic Review. *BioMed Research International*, 2021. https://doi.org/10.1155/2021/6630404

Sani, I., Hamza, Y., Chedid, Y., Amalendran, J., & Hamza, N. (2020). Understanding the consequence of COVID-19 on undergraduate medical education: Medical students' perspective. *Annals of Medicine and Surgery*, *58*, 117–119. https://doi.org/10.1016/j.amsu.2020.08.045

Santiago, M., Davis, E. A., Hinton, T., Angelo, T. A., Shield, A., Babey, A. M., Kemp-Harper, B., Maynard, G., Al-Sallami, H. S., Musgrave, I. F., Fernandes, L. B., Ngo, S. N. T., Christopoulos, A., & White, P. J. (2021). Defining and unpacking the core concepts of pharmacology education. *Pharmacology Research and Perspectives*, *9*(6). https://doi.org/10.1002/prp2.894

Scarpaci, L. T., Tsoukleris, M. G., & McPherson, M. L. (2007). Assessment of hospice nurses' technique in the use of inhalers and nebulizers. *Journal of Palliative Medicine*, *10*(3), 665–676. https://doi.org/10.1089/jpm.2006.0180

Scheibe, M., Skutsch, M., & Schofer, J. (1975). IV. Evaluation: C. Experiments in Delphi Methodology. In Thomas, P. A., Kern, D. E., Mark, T., Hughes, M. T., & Chen, B. Y. (Eds.). *Curriculum Development for Medical Education: A Six-Step Approach*. Addison-Wesley Educational Publishers Inc.

Schellack, N., Bronkhorst, E., Coetzee, R., Godman, B., Gous, A., Kolman, S., Labuschagne, Q., Malan, L., Messina, A., Naested, C., Schellack, G., Skosana, P., & Van Jaarsveld, A.

(2018). SASOCP position statement on the pharmacist's role in antibiotic stewardship 2018. *South African Journal of Infectious Disease*, *33*, 28–35.

Schellack, N., Pretorius, R., & Messina, A. P. (2016). 'Esprit de corps': Towards collaborative integration of pharmacists and nurses into antimicrobial stewardship programmes in South Africa. *South African Medical Journal*, *106*(10), 973–974. https://doi.org/10.7196/SAMJ.2016.v106i10.11468

Schepel, L., Lehtonen, L., Airaksinen, M., & Lapatto-Reiniluoto, O. (2018). How to identify organizational high-alert medications. *Journal of Patient Safety*, *12*(7), e1358–e1363. www.journalpatientsafety.com

Schindler, J. H. (2015). Followership: What It Takes to Lead. *Business Expert Press*.

Scott-Bell, A., & Malcolm, D. (2015). "Involved in every step": How working practices shape the influence of physiotherapists in elite sport. *Qualitative Research in Sport, Exercise and Health*, *7*(4), 539–556. https://doi.org/10.1080/2159676X.2014.968605

Shahbazi, F., Hosseini, E., & Karimpour, H. (2017). Levodopa-benserazide interaction with enteral nutrition: A case report. *Journal of Pharmaceutical Care*, *5*, 4–5.

Shaik-Peremanov, N. (2024). Decolonising South Africa's pharmacy curriculum – traditional medicine vs rational medicine: crossing the Rubicon. *South African Pharmacy Journal*, *91*, 57–61.

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education*, *104*(5), 873–894. https://doi.org/10.1002/sce.21581

Sherman, D. W., Matzo, M. L., Paice, J. A., McLaughlin, M., & Virani, R. (2004). Learning pain assessment and management: A goal of the End-of-Life Nursing Education Consortium. *Journal of Continuing Education in Nursing*, *35*(3), 107–120. https://doi.org/10.3928/0022-0124-20040501-07

Shiferaw, W. S., Akalu, T. Y., Wubetu, A. D., & Aynalem, Y. A. (2020). Implementation of Nursing Process and Its Association with Working Environment and Knowledge in Ethiopia: A Systematic Review and Meta-Analysis. *Nursing Research and Practice*, *2020*. https://doi.org/10.1155/2020/6504893

Siedner, M. J., Kraemer, J. D., Meyer, M. J., Harling, G., Mngomezulu, T., Gabela, P., Dlamini, S., Gareta, D., Majozi, N., Ngwenya, N., Seeley, J., Wong, E., Iwuji, C., Shahmanesh, M., Hanekom, W., & Herbst, K. (2020). Access to primary healthcare during lockdown measures for COVID-19 in rural South Africa: An interrupted time series analysis. *BMJ Open*, *10*(10), e043763. https://doi.org/10.1136/bmjopen-2020-043763

Singh, A., & Mathuray, M. (2018). The nursing profession in South Africa – Are nurses adequately informed about the law and their legal responsibilities when administering healthcare? *De Jure*, *51*(1). https://doi.org/10.17159/2225-7160/2018/v51n1a8

Smith, B. (2014). *Pharmacology for Nurses*. Jones and Bartlett Publishers, Inc.

Smith, L. L., Burnet, S. P, & McNeil, J. D. (2003). Musculoskeletal manifestations of diabetes mellitus. *British Journal of Sports Medicine, 37*, 30–35.

Smith, S., Elias, B. L., & Baernholdt, M. (2019). The role of interdisciplinary faculty in nursing education: A national survey. *Journal of Professional Nursing*, *35*(5), 393–397. https://doi.org/10.1016/j.profnurs.2019.03.001

Sole, G., Skinner, M., Hale, L., & Golding, C. (2019). Developing a framework for teaching clinical reasoning skills to undergraduate physiotherapy students: A Delphi study. *New Zealand Journal of Physiotherapy*, *47*(1), 49–58. https://doi.org/10.15619/NZJP/47.1.06

South African Department of Health. (2020). *Standard Treatment Guidelines and Essential Medicines List for South Africa: Primary Healthcare Level 2020 Edition*. https://www.knowledgehub.org.za/e-library

South African Department of Health. (2023). *National Strategic Plan for HIV, TB and STIs 2023-2028*.

South African Health Products Regulatory Authority. (2022). *SAHPGL-CEM-NS-02: Guideline to the scheduling of substances and medicines*.

South African Nursing Council. (n.d.). *The relationship between the scope of practice, practice standards and competencies*. http://www.sanc.co.za/pdf/Competencies/SANC Relationship between SOPs, Practice Standards and Competencies.pdf

South African Nursing Council. (2018). *Impairment Committee Report: Management of controlled scheduled medicines/substances in healthcare establishments to minimize errors and abuse caused by improper control*. https://www.sanc.co.za/wp-content/uploads/2021/06/Impairment-Committee-Report-on-substance-abuse-Feb2018.pdf

South African Pharmacy Council. (2022). *SAPC e-Note: Practice Advisory: Prescribing Nurses*.

South African Qualifications Authority. (1998). *SAQA Bulletin, 1(2)*.

South African Qualifications Authority. (2000). *The National Qualifications Framework and Curriculum Development*.

South African Qualifications Authority. (2012). *Level descriptors for the South African National Qualifications Framework*. www.saqa.org.za

South African Qualifications Authority. (2018a). *Bachelor of Dietetics (7061)*. https://regqs.saqa.org.za/viewQualification.php?id=7061

South African Qualifications Authority. (2018b). *Bachelor of Nursing Science (6083)*. https://regqs.saqa.org.za/viewQualification.php?id=6083

South African Qualifications Authority. (2018c). *Bachelor of Physiotherapy (15220)*. https://regqs.saqa.org.za/viewQualification.php?id=15220

South African Qualifications Authority. (2022). *Policy and criteria for the registration of qualifications and part-qualifications on the National Qualifications Framework*.

Southwell, B. G., Wood, J. L., & Navar, A. M. (2020). Roles for healthcare professionals in addressing patient-held misinformation beyond fact correction. *American Journal of Public Health, 110*, S288–S289. https://doi.org/10.2105/AJPH.2020.305729

Spenceley, S. M., O'Leary, K. A., Chizawsky, L. L. K., Ross, A. J., & Estabrooks, C. A. (2008). Sources of information used by nurses to inform practice: An integrative review. *International Journal of Nursing Studies, 45*(6), 954–970. https://doi.org/10.1016/j.ijnurstu.2007.06.003

Squires, J. E., Hutchinson, A. M., Boström, A. M., O'Rourke, H. M., Cobban, S. J., & Estabrooks, C. A. (2011). To what extent do nurses use research in clinical practice? A systematic review. *Implementation Science*, *6*(1), 21. https://doi.org/10.1186/1748-5908-6-21

Stamov Roßnagel, C., Fitzallen, N., & Lo Baido, K. (2020). Constructive alignment and the learning experience: relationships with student motivation and perceived learning demands. *Higher Education Research and Development*, 1–14. https://doi.org/10.1080/07294360.2020.1787956

Staub, C. (2019). Concept of diverse sleep treatments in physiotherapy. *European Journal of Physiotherapy*, *21*(3), 177–184. https://doi.org/10.1080/21679169.2018.1505948

Stäuble, C. K., Lampert, M. L., Mikoteit, T., Hatzinger, M., Hersberger, K. E., & Meyer Zu Schwabedissen, H. E. (2021). Severe adverse drug reactions to quetiapine in two patients carrying CYP2D6*4 variants: A case report. *International Journal of Molecular Sciences*, *22*(12), 6480. https://doi.org/10.3390/ijms22126480

Steinel, N., Palmer, G. C., Nowicki, E., Lee, E., Nelson, E., Whiteley, M., & Lee, M. W. (2019). Integration of microbiology, pharmacology, immunology, and infectious disease using active teaching and self-directed learning. *Medical Science Educator*, *29*(1), 315–324. https://doi.org/10.1007/s40670-018-00689-8

Steketee, C. (2015). Prudentia: A medical school's solution to curriculum mapping and curriculum management. *Journal of University Teaching & Learning Practice*, *12*(4), 1–10.

Stenner, K., Edwards, J., Mold, F., Otter, S., Courtenay, M., Moore, A., & Carey, N. (2018). Medicines management activity with physiotherapy and podiatry: A systematic mixed studies review. *Health Policy*, *122*(12), 1333–1339. https://doi.org/10.1016/j.healthpol.2018.10.004

Stevanović, A., Božić, R., & Radović, S. (2021). Higher education students' experiences and opinion about distance learning during the Covid-19 pandemic. *Journal of Computer Assisted Learning*, *37*(6), 1682–1693. https://doi.org/10.1111/jcal.12613

Sukhera, J., Watling, C. J., & Gonzalez, C. M. (2020). Implicit bias in health professions: From recognition to transformation. *Academic Medicine, 95*(5), 717–723. https://doi.org/10.1097/ACM.0000000000003173

Sullivan, K. M., Le, P. L., Ditoro, M. J., Andree, J. T., Charest, D. J., & Tuiskula, K. A. (2013). Enhancing high alert medication knowledge among pharmacy, nursing, and medical staff. *Journal of Patient Safety*, *17*(4), 311–315. www.journalpatientsafety.com

Sulosaari, V., Huupponen, R., Hupli, M., Puukka, P., Torniainen, K., & Leino-kilpi, H. (2015). Factors associated with nursing students' medication competence at the beginning and end of their education. *BMC Medical Education*, *15*, 1–11. https://doi.org/10.1186/s12909-015-0513-0

Sulosaari, V., Kajander, S., Hupli, M., Huupponen, R., & Leino-Kilpi, H. (2012). Nurse students' medication competence – An integrative review of the associated factors. *Nurse Education Today*, *32*(4), 399–405. https://doi.org/10.1016/j.nedt.2011.05.016

Swart, A. M., Chisholm, B. S., Cohen, K., Workman, L. J., Cameron, D., & Blockman, M. (2013). Analysis of queries from nurses to the South African National HIV & TB Healthcare Worker Hotline. *Southern African Journal of HIV Medicine*, *14*(4), 179–182. https://doi.org/10.4102/sajhivmed.v14i4.54

Sweet, L. R., & Palazzi, D. L. (2015). Application of Kern'ss Six-stepstep Approach to Curriculum Development by Global Health Residents. *Education for Health*, *28*(2), 138–141. https://doi.org/10.4103/1357-6283.170124

Swift, K. M. (2012). The changing landscape of nutrition and dietetics: A specialty group for integrative and functional medicine. *Integrative Medicine*, *11*, 19–20.

Tadzong-Awasum, G., & Dufashwenayesu, A. (2021). Implementation of the nursing process in Sub-Saharan Africa: An integrative review of literature. *International Journal of Africa Nursing Sciences*, *14*, 100283. https://doi.org/10.1016/j.ijans.2021.100283

Tadzong-Awasum, G., Ghislaine, M. M., Adelphine, D., Boris, K. A., & Seraphine, M. N. (2022). Nurses' experiences with the adoption and use of the nursing process in four urban hospitals. *International Journal of Africa Nursing Sciences*, *16*. https://doi.org/10.1016/j.ijans.2022.100411

Talbot, M. (2004). Monkey see, monkey do: A critique of the competency model in graduate medical education. *Medical Education*, *38*(6), 587–592. https://doi.org/10.1046/j.1365-2923.2004.01794.x

Tan, J. P. L., Choo, S. S., Kang, T., & Liem, G. A. D. (2017). Educating for twenty-first century competencies and future-ready learners: research perspectives from Singapore. *Asia Pacific Journal of Education*, *37*(4), 425–436. https://doi.org/10.1080/02188791.2017.1405475

Taylor, N. F., Dodd, K. J., Shields, N., & Bruder, A. (2007). Therapeutic exercise in physiotherapy is beneficial: A summary of systematic reviews 2002-2005. *Australian Journal of Physiotherapy*, *53*, 7–16.

Tayutivutikul, N., Wanleenuwat, P., Panapongvasin, T., Klajing, R., & Iwanowski, P. (2022). Dietary effects on antiseizure drug metabolism and management of epilepsy. *Seizure, 102*, 14–21. https://doi.org/10.1016/j.seizure.2022.09.009

Teague, E., Bezuidenhout, S., Meyer, J. C., Godman, B., & Engler, D. (2023). Knowledge and perceptions of final-year nursing students regarding antimicrobials, antimicrobial resistance, and antimicrobial stewardship in South Africa: Findings and implications to reduce resistance. *Antibiotics*, *12*(12), 1742. https://doi.org/10.3390/antibiotics12121742

Tejedor, S., Cervi, L., Pérez-Escoda, A., Tusa, F., & Parola, A. (2021). Higher education response in the time of coronavirus: Perceptions of teachers and students, and open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(1), 1–15. https://doi.org/10.3390/joitmc7010043

Testa, B., Pedretti, A., & Vistoli, G. (2012). Reactions and enzymes in the metabolism of drugs and other xenobiotics. *Drug Discovery Today,* *17*(11-12), 549–560. https://doi.org/10.1016/j.drudis.2012.01.017

Thangaratinam, S., & Redman, C. W. E. (2005). The Delphi technique. *The Obsetrician & Gynaecologist*, *7*, 120–125.

Thibault, G. E. (2020). The future of health professions education: Emerging trends in the United States. *FASEB BioAdvances*, *2*(12), 685–694. https://doi.org/10.1096/fba.2020-00061

Thiers, B. H. (2008). The challenge of managing drug interactions in elderly people. *Yearbook of Dermatology and Dermatologic Surgery*, *2008*, 250–251. https://doi.org/10.1016/s0093-3619(08)70872-4

Thistlethwaite, J. E. (2015). Interprofessional education and the basic sciences: Rationale and outcomes. *Anatomical Sciences Education,* *8*(4), 299–304. https://doi.org/10.1002/ase.1521

Thomas, P. (2016). Step 3: Goals and objectives. In *Curriculum Development for Medical Education: A Six-Step Approach: A Six-Step Approach,* 50–64. JHU Press.

Thomas, P. A., & Abras, C. N. (2016). Step 4: Educational strategies. In *Curriculum Development for Medical Education : A Six-Step Approach,* 65–101. JHU Press.

Thomas, P. A., Kern, D. E., Hughes, M. T., & Chen, B. Y. (2016). *Curriculum Development for Medical Education: A Six-Step Approach*. JHU Press.

Thomas, P., Baldwin, C., Beach, L., Bissett, B., Boden, I., Cruz, S. M., Gosselink, R., Granger, C. L., Hodgson, C., Holland, A. E., Jones, A. Y., Kho, M. E., van der Lee, L., Moses, R., Ntoumenopoulos, G., Parry, S. M., & Patman, S. (2022). Physiotherapy management for COVID-19 in the acute hospital setting and beyond: an update to clinical practice recommendations. *Journal of Physiotherapy*, *68*(1), 8–25. https://doi.org/10.1016/j.jphys.2021.12.012

Treadwell, I., Botha, G., & Ahlers, O. (2019). Initiating curriculum mapping on the web-based, interactive learning opportunities, objectives and outcome platform (LOOOP). *African Journal of Health Professions Education*, *11*(1), 27–31. https://doi.org/10.7196/ajhpe.2019.v11i1.1073

Trevelyan, E. G., & Robinson, P. N. (2015). Delphi methodology in health research: How to do it? *European Journal of Integrative Medicine*, *7*(4), 423–428. https://doi.org/10.1016/j.eujim.2015.07.002

Trinos, K., & Mudaly, R. (2020). Exploring Possibil(ities for Including Indigenous Knowledge into the Biology Teacher Education Curriculum: Leveraging Insights from Karanga Knowledge Holders. *Alternation – Interdisciplinary Journal for the Study of the Arts and Humanities in Southern Africa*, *SP36*. https://doi.org/10.29086/2519-5476/2020/sp36a5

Truter, A., Schellack, N., & Meyer, J. C. (2017). Identifying medication errors in the neonatal intensive care unit and paediatric wards using a medication error checklist at a tertiary academic hospital in Gauteng, South Africa. *South African Journal of Child Health*, *11*(1), 5–10. https://doi.org/10.7196/SAJCH.2017.v11i1.1101

Tweedie, J., Wright, H. H., Palermo, C., & Pelly, F. E. (2021). Key concepts for dietetic curriculum: An observational study of Australian dietitians' perceptions. *Nutrition and Dietetics*, *78*(5), 544–552. https://doi.org/10.1111/1747-0080.12654

Ugwu, S. N., Ogbonnaya, N. P., Chijioke, V. C., & Esievo, J. N. (2023). Causes and effects of theory-practice gap during clinical practice: the lived experiences of baccalaureate nursing students. *International Journal of Qualitative Studies on Health and Well-Being*, *18*(1). https://doi.org/10.1080/17482631.2023.2164949

Umar, B. U., & Haque, M. (2022). Changing Perspectives: Should We Integrate Pharmacology in the Clinical Phase? *Bangladesh Journal of Medical Science*, *21*(2), *249*–261. https://doi.org/10.3329/bjms.v21i2.58056

Unger, M., & Lochner, R. M. (2006). Pharmacology practice and South African physiotherapists – Part two a needs analysis. *South African Journal of Physiotherapy*, *62*, 18–22. https://doi.org/10.4102/sajp.v62i2.152

University of Pretoria. (n.d.-a). *A Quick Guide to clickUP*. Retrieved February 23, 2024 from https://www.up.ac.za/education-innovation/article/2895112/a-quick-guide-to-clickup

University of Pretoria. (n.d.-b). *Teaching and Learning*. Retrieved February 23, 2024 from https://www.up.ac.za/teaching-and-learning

University of Pretoria. (2016). *Message from the Vice-Chancellor on today's closure*. https://www.up.ac.za/news/post_2235114-message-from-the-vice-chancellor-on-todays-closure

University of Pretoria. (2022). *List of graduate attributes (S5009/20)*. https://www.up.ac.za/media/shared/102/2024%20files/informatics-departmental-brochure-2024.zp246133.pdf

University of Pretoria. (2024a). *Bachelor of Dietetics [BDietetics] (10139003)*. https://www.up.ac.za/yearbooks/2024/pdf/programme/10139003

University of Pretoria. (2024b). *Bachelor of Nursing Sciences [BNurs] (10131002)*. https://www.up.ac.za/yearbooks/2024/pdf/programme/10131002

University of Pretoria. (2024c). *Bachelor of Physiotherapy [BPhysio] (10138103)*. https://www.up.ac.za/yearbooks/2024/pdf/programme/10138103

University of Pretoria. (2024d). *Update on Hatfield Campus activity*. https://www.up.ac.za/news/post_3210304-update-on-hatfield-campus-activity

Uppsala Universiteit. (n.d.). *ISP and the basic sciences*. Retrieved August 4, 2021, from https://www.isp.uu.se/basic-sciences/

Vaismoradi, M., Jordan, S., Turunen, H., & Bondas, T. (2014). Nursing students' perspectives of the cause of medication errors. *Nurse Education Today*, *34*(3), 434–440. https://doi.org/10.1016/j.nedt.2013.04.015

Valiani, S. (2019). Public healthcare spending in South Africa and the impact on nurses: 25 years of democracy? *Agenda*, *33*(4), 67–78. https://doi.org/10.1080/10130950.2019.1683458

Vallentin, M. F., Granfeldt, A., Holmberg, M. J., & Andersen, L. W. (2020). Drugs during cardiopulmonary resuscitation. *Current Opinion in Critical Care*, *26*(3), 242–250. Lippincott Williams and Wilkins. https://doi.org/10.1097/MCC.0000000000000718

Van Aswegen, H., Patman, S., Plani, N., & Hanekom, S. (2017). Developing minimum clinical standards for physiotherapy in South African ICUs: A qualitative study. *Journal of Evaluation in Clinical Practice*, *23*(6), 1258–1265. https://doi.org/10.1111/jep.12774

Van der Horst, H. V. R., & McDonald, E. W. (2000). The problem of specifying fixed notional learning hours per type of delivery in a distance teacher education module. *South African Journal of Higher Education*, 14(1) 185–195.

Van der Plas, W. Y., Benjamens, S., & Kruijff, S. (2020). The increased need for palliative cancer care in Sub-Saharan Africa. *European Journal of Surgical Oncology*, *46*(7), 1373–1376. https://doi.org/10.1016/j.ejso.2020.03.212

Van Eekeren, R., Rolfes, L., Koster, A. S., Magro, L., Parthasarathi, G., Al Ramimmy, H., Schutte, T., Tanaka, D., Van Puijenbroek, E., & Härmark, L. (2018). What future healthcare professionals need to know about pharmacovigilance: Introduction of the WHO PV core curriculum for university teaching with focus on clinical aspects. *Drug Safety*, *41*(11), 1003–1011. https://doi.org/10.0.3.239/s40264-018-0681-z

Van Heerden, B. (2013). Effectively addressing the health needs of South Africa's population: The role of health professions education in the 21st century. *South African Medical Journal*, *103*, 21–22. https://doi.org/10.7196/SAMJ.6463

Van Huizen, P., Kuhn, L., Russo, P. L., & Connell, C. J. (2021). The nurses' role in antimicrobial stewardship: A scoping review. *International Journal of Nursing Studies*, *113*. https://doi.org/10.1016/j.ijnurstu.2020.103772

VanDenBerg, C. M., Blob, L. F., Kemper, E. M., & Azzaro, A. J. (2003). Tyramine pharmacokinetics and reduced bioavailability with food. *Journal of Clinical Pharmacology*, *43*(6), 604–609. https://doi.org/10.1177/0091270003253425

Vantini, C., & Marson, F. A. L. (2020). Coronavirus Disease: 4 Million Cases Worldwide and the Importance of Multidisciplinary Healthcare Teams During the Pandemic. *Journal of Emergency Nursing*, *46*(5), 570–571. https://doi.org/10.1016/j.jen.2020.06.004

Vashe, A., Devi, V., Rao, R., Abraham, R. R., Pallath, V., & Umakanth, S. (2019). Using an integrated teaching approach to facilitate student achievement of the learning outcomes in a preclinical medical curriculum in India. *Advances in Physiology Education*, *43*, 522–528. https://doi.org/10.1152/advan

Veena, R. M., Kalpana, L., Lavanya, S. H., Kumar, V. D. B., & Manasa, C. R. (2021). Knowledge, attitude and practice of pharmacovigilance among nursing staff in BGS GIMS hospital. *Biomedical and Pharmacology Journal*, *14*(1), 497–502. https://doi.org/10.13005/bpj/2150

Verma, S., Paterson, M., & Medves, J. (2006). Core competencies for healthcare professionals: What medicine, nursing, occupational therapy, and physiotherapy share. *Journal of Allied Health*, *35*, 109–115.

Volz-Peacock, M., Carson, B., & Marquardt, M. (2016). Action learning and leadership development. *Advances in Developing Human Resources*, *18*, 318–333. https://doi.org/10.1177/1523422316645884

Vora, M. B., & Shah, C. J. (2015). Case-based learning in pharmacology: Moving from teaching to learning. *International Journal of Applied and Basic Medical Research*, *5*(Suppl 1), S21–S23. https://doi.org/10.4103/2229-516X.162259

Voynarovska, M., & Cohen, L. B. (2008). The role of the endoscopy nurse or assistant in endoscopic sedation. *Gastrointestinal Endoscopy Clinics of North America*, *18*(4), 695–705. https://doi.org/10.1016/j.giec.2008.06.014

Wadvalla, B. A. (2020). How Africa has tackled COVID-19. *The BMJ*, *370*, 1–3. https://doi.org/10.1136/bmj.m2830

Wajeeha, & Javed, A. (2020). Doping knowledge, beliefs and practices among physiotherapists. *Khyber Medical University Journal*, *12*(3), 234–237. https://doi.org/10.35845/kmuj.2020.19718

Walsh, A. (2007). An exploration of Biggs' constructive alignment in the context of work-based learning. *Assessment and Evaluation in Higher Education*, *32*(1), 79–87. https://doi.org/10.1080/02602930600848309

Wang, J., Mu, K., Gong, Y., Wu, J., Chen, Z., Jiang, N., Zhang, G., Lv, C., & Yin, X. (2023). Occurrence of self-perceived medical errors and its related influencing factors among emergency department nurses. *Journal of Clinical Nursing*, *32*(1–2), 106–114. https://doi.org/10.1111/jocn.16200

Wang, X., Su, Y., Cheung, S., Wong, E., & Kwong, T. (2013). An exploration of Biggs' constructive alignment in course design and its impact on students' learning approaches. *Assessment and Evaluation in Higher Education*, *38*(4), 477–491. https://doi.org/10.1080/02602938.2012.658018

Wansink, B., & American Dietetic Association. (2006). Position of the American Dietetic Association: Food and nutrition misinformation. *Journal of the American Dietetic Association*, *106*, 601–607.

Watson, E. G. S., Steketee, C., Mansfield, K. J., Moore, M., Dalziel, B., Damodaran, A., Walker, B., Duvivier, R., & Hu, W. (2020). Curriculum mapping for health professions education: A typology. *Focus on Health Professional Education: A Multi-Professional Journal*, *21*(1), 91–113.

Weber, J. M. (2006). Core competencies for healthcare professionals. *Journal of Allied Health*, *35*(3), 185.

Weng, Y. H., Kuo, K. N., Yang, C. Y., Lo, H. L., Chen, C., & Chiu, Y. W. (2013). Implementation of evidence-based practice across medical, nursing, pharmacological and allied healthcare professionals: A questionnaire survey in nationwide hospital settings. *Implementation Science*, *8*(1), 1–10. https://doi.org/10.1186/1748-5908-8-112

Wentzel-Viljoen, E. (2016). The roles and competencies of the nutrition professional in the well-being of the South African population. *Health Professions Council of South Africa*, *January*.

White, P. J., Davis, E. A., Santiago, M., Angelo, T., Shield, A., Babey, A. M., Kemp-Harper, B., Maynard, G., Al-Sallami, H. S., Musgrave, I. F., Fernandes, L. B., Ngo, S. N. T., & Hinton, T. (2021). Identifying the core concepts of pharmacology education. *Pharmacology Research and Perspectives*, *9*(4). https://doi.org/10.1002/prp2.836

Wiernikowski, J. T., & Bernhardt, M. B. (2020). Review of nutritional status, body composition, and effects of antineoplastic drug disposition. *Pediatric Blood and Cancer*, *67*(S3). https://doi.org/10.1002/pbc.28207

Willig, A., Wright, L., & Galvin, T. A. (2018). Practice Paper of the Academy of Nutrition and Dietetics: Nutrition Intervention and Human Immunodeficiency Virus Infection. *Journal of the Academy of Nutrition and Dietetics*, *118*(3), 486–498. https://doi.org/10.1016/j.jand.2017.12.007

Winberg, C. (2006). Undisciplining knowledge production: Development driven higher education in South Africa. *Higher Education*, *51*(2), 159–172. https://doi.org/10.1007/s10734-004-6378-5

Winberg, C., Staak, A., Bester, M., Sabata, S., Scholtz, D., Sebolao, R., Monnapula-Mapesela, M., Ronald, N., Makua, M., & Snyman, J. (2018). In search of graduate attributes: A survey of six flagship programmes. *South African Journal of Higher Education*, *32*(1), 233–251. https://doi.org/10.20853/32-1-1642

Wittert, G. A., & Nelson, A. J. (2009). Medical education: revolution, devolution and evolution in curriculum philosophy and design. *Medical Journal of Australia*, *191*(1), 35–37.

Wix, A. R., Doering, P. L., & Hatton, R. C. (1992). Drug-food interaction counseling programs in teaching hospitals. *American Journal of Hospital Pharmacy*, *49*(4), 855–860. https://doi.org/10.1093/ajhp/49.4.855

Wondmieneh, A., Alemu, W., Tadele, N., & Demis, A. (2020). Medication administration errors and contributing factors among nurses: A cross sectional study in tertiary hospitals, Addis Ababa, Ethiopia. *BMC Nursing*, *19*(1). https://doi.org/10.1186/s12912-020-0397-0

Wong, S.-C. (2020). Competency definitions, development and assessment: A brief review. *International Journal of Academic Research in Progressive Education and Development*, *9*(3), 95–114. https://doi.org/10.6007/ijarped/v9-i3/8223

Woodman, L., Dodds, A., Frauman, A., & Mosepele, M. (2004). Teaching pharmacology to medical students in an integrated problem-based learning curriculum: An Australian perspective. *Acta Pharmacologica Sinica*, *25*(9), 1195–1203.

World Anti-Doping Agency. (2024). *World Anti-Doping Code: International Prohibited List 2024*. www.wada-ama.org

World Health Organization. (2010). *Framework for action on interprofessional education & collaborative practice health professions networks nursing & midwifery human resources for health*. http://www.who.int/hrh/nursing_midwifery/en/

World Health Organization. (2013). Transforming and scaling up health professionals' education and training. In *World Health Organization Guidelines*.

World Health Organization. (2018). *Country Cooperation Strategy at a Glance: South Africa*.

World Health Organization. (2021). *Global patient safety action plan 2021-2030: Towards eliminating avoidable harm in healthcare*. Geneva: World Health Organization.

World Physiotherapy. (2011a). *Clinical education component of physical therapist professional entry level education*.

World Physiotherapy. (2011b). *Physical therapist professional entry level education*. https://world.physio/guideline/entry-level-education

World Physiotherapy. (2022). *Guidance for developing a curriculum for physiotherapist entry level education programme*.

Yildirim, B., & Ozkahraman, Ş. (2011). Critical thinking in nursing process and education. *International Journal of Humanities and Social Science*, *1*(13), 257–262.

Yograj, S., Bhat, A. N., Gupta, R. K., Gupta, G., & Kalsotra, L. (2019). Role of basic sciences in making of a clinician: Perspectives of medical students from North India. *Journal of Education and Health Promotion*, *8*(1), 171. https://doi.org/10.4103/jehp.jehp_66_19

Younas, A. (2017). The nursing process and patient teaching. *Nursing Made Incredibly Easy! 15*, 13–16.

Young, A. M., Charalambous, A., Owen, R. I., Njodzeka, B., Oldenmenger, W. H., Alqudimat, M. R., & So, W. K. W. (2020). Essential oncology nursing care along the cancer continuum. *The Lancet Oncology*, *21*(12), e555–e563. https://doi.org/10.1016/S1470-2045(20)30612-4

Young, J. S. (1997). HIV and medical nutrition therapy. *Journal of the American Dietetic Association*, *97*, S161–S166.

Zenani, N. E. (2016). *Challenges experienced by second and third-year nursing students when integrating theory into practice in a selected clinical setting in the Western Cape Province*.

Zhang, Y., Liu, J., Xu, W., & Kong, Q. (2024). Evaluation of student performance based on integrated teaching method in pharmacology curricula. *Indian Journal of Pharmaceutical Education and Research*, *58*(2), 411–416. https://doi.org/10.5530/ijper.58.2.46.

Ziebart, C., & MacDermid, J. C. (2019). Reflective practice in physical therapy: A scoping review. *Physical Therapy*, *99*, 1056–1068. https://academic.oup.com/ptj/article/99/8/1056/5421641.

Appendix I: Plagiarism detection

Cordier W_Thesis_Final_Language edited_2024.docx

ORIGINALITY REPORT

4%	2%	3%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

Appendix II: Ethics clearance

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Make today matter
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FACULTY OF EDUCATION
Ethics Committee

Annual Renewal

27 May 2024

Dear Dr W Cordier

The application for ethical clearance for the research project described below served before this committee on 22 November 2023:

Ethics Protocol No:	**HU19/06/01**
Principal investigator:	**Dr W Cordier**
Student/Staff No:	**25072499**
Degree:	**Doctoral**
Supervisor/Promoter:	**Prof PH du Toit** **Prof DM Manning**
Department:	**Humanities Education**

The decision by the committee is reflected below:

Decision:	**Approved**
Comments:	
Period of approval:	**Three years**

The approval by the Ethics Committee is subject to the following conditions being met:

1. The research will be conducted as stipulated on the application form submitted to the Ethics Committee with the supporting documents.
2. Proof of how you adhered to the Department of Basic Education (DBE) policy for research must be submitted where relevant.
3. In the event that the research protocol changed for whatever reason the Ethics Committee must be notified thereof by submitting an amendment to the application, together with all the supporting documentation that will be used for data collection namely; questionnaires, interview schedules and observation schedules, for further approval before data can be collected. The changes may include the following but are not limited to:
   - Change of investigator,
   - Research methods any other aspect therefore and,
   - Participants.

The Ethics Committee of the Faculty of Education does not accept any liability for research misconduct, of whatsoever nature, committed by the researcher(s) in the implementation of the approved protocol.

Best wishes

Prof Funke Omidire
Chair: Ethics Committee

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Faculty of Education
Fakulteit Opvoedkunde
Lefapha la Thuto

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences

Institution: The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.
- FWA 00002567, Approved dd 18 March 2022 and Expires 18 March 2027.
- IORG #: IORG0001762 OMB No. 0990-0279 Approved for use through June 30, 2025 and Expires 07/29/2026.

Faculty of Health Sciences **Research Ethics Committee**

16 October 2024

Approval Certificate
Annual Renewal

Dear Dr W Cordier,

Ethics Reference No.: EDU056/19 – Line 5
Title: Alignment of undergraduate Pharmacology learning outcomes with healthcare practitioner workplace competencies

The **Annual Renewal** as supported by documents received between 2024-10-04 and 2024-10-16 for your research, was approved by the Faculty of Health Sciences Research Ethics Committee on 2024-10-16 as resolved by its quorate meeting.

Please note the following about your ethics approval:

- Renewal of ethics approval is valid for 1 year, subsequent annual renewal will become due on 2025-10-16.
- The Research Ethics Committee (REC) must monitor your research continuously. To this end, you must submit as may be applicable for your kind of research:
  a) annual reports;
  b) reports requested *ad hoc* by the REC;
  c) all visitation and audit reports by a regulatory body (e.g. the HPCSA, FDA, SAHPRA) within 10 days of receiving one;
  d) all routine monitoring reports compiled by the Clinical Research Associate or Site Manager within 10 days of receiving one.
- The REC may select your research study for an audit or a site visitation by the REC.
- The REC may require that you make amendments and take corrective actions.
- The REC may suspend or withdraw approval.
- Please remember to use your protocol number (EDU056/19) on any documents or correspondence with the Research Ethics Committee regarding your research.

Ethics approval is subject to the following:

- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

On behalf of the FHS REC, Dr R Sommers
MBChB, MMed (Int), MPharmMed, PhD
***Deputy Chairperson** of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria*

The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes, Second Edition 2015 (Department of Health).

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Fakulteit Gesondheidswetenskappe
Lefapha la Disaense tša Maphelo