UNIVERSITY *of the*
WESTERN CAPE

Faculty of Community and Health Sciences

NURSING STUDENTS' SELF-REPORTED KNOWLEDGE OF BIOSCIENCE AND ITS RELEVANCE TO CLINICAL PRACTICE

A mini thesis submitted in partial fulfilment of the requirements for the Degree of Master in Nursing (Education) in the School of Nursing, Faculty of Community and Health Sciences, University of the Western Cape

By

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Keywords

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Abstract

Background: Bioscience subjects remain a significant problem in preregistration nursing programmes worldwide. Bioscience subjects are essential as they allow nurses to have a clear understanding of the patient's condition and ultimately this allows them to provide appropriate and timeous care. However, learning and teaching of these modules is currently not at the level expected by the profession.

Aim: The aim of the study was to investigate the nursing students' self-reported knowledge of bioscience and its relevance to clinical practice.

Methods: A quantitative research approach using a descriptive survey design was employed. The sample (n=211) included second-, third- and fourth year undergraduate nursing students. A three-part self-administered questionnaire was adapted and used to collect the data. Data were analysed using Statistical Package for Social Sciences software version 26.0 with the help of a statistician. Descriptive statistics and Chi-squared test were performed.

Ethics: Ethics approval was granted by the Research Ethics Committee. Permission to conduct the study was obtained from the University Registrar and the Director of the School of Nursing. The researcher maintained the ethical principles of autonomy, beneficence, confidentiality, anonymity and justice.

Results: Findings indicated that the majority of respondents indicate adequate understanding of all bioscience modules. Respondents rated their understanding of the application of Human Biology and Pharmacology as good 86 (40.76%) and 88 (41.71%) respectively; they rated their understanding of the application of Physics and Chemistry as adequate 80 (37.91%) and 85 (40.28%) respectively. Respondents self-rated a significant preference for more information on Human Biology and Pharmacology than Physics and Chemistry. The majority of respondents

rated Human Biology and Pharmacology as essential and Physics and Chemistry as relevant to nursing practice. However, they rated Physics and Chemistry as not relevant to monitoring a patient's vital signs. Most respondents performed at Task specific on the Akinsanya's Bionursing model, suggesting an overall understanding of the foundational concepts and principles of bioscience.

Conclusion: The findings of the study provided evidence of the students' self-reported knowledge, understanding and perception of the relevance of bioscience and indicates a need for more emphasis on the importance of bioscience integration in nursing practice.

Declaration

I, Bronwynne Anita Rafferty, declare that **Nursing students' self-reported knowledge of bioscience and its relevance to clinical practice** is my own work, that it has not been submitted before for any degree or examination to any other university, and that all sources I have used or quoted have been indicated and acknowledged as complete references.

Name: Bronwynne Anita Rafferty

Date: 11 November 2021

Signature: 

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List of Abbreviations

BNur	Bachelor of Nursing
CHS	Community and Health Science
DoH	Department of Health
ECP	Extended curriculum programme
HEI	Higher Education Institution
NSC	National Senior Certificate
SA	South Africa
SANC	South African Nursing Council
SAQA	South African Qualifications Authority
SC	Senior Certificate
SoN	School of Nursing

R425	Regulation for registration as registered nurse (general psychiatric and community) and midwife
RN	Registered Nurse
UWC	University of the Western Cape
UK	United Kingdom

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

This chapter presents the background of the study with reference to bioscience in nursing education and practice from a global as well as a local perspective. The significance of the study, problem statement, research aim, objectives and a brief outline of the research methodology, as well as an outline of the succeeding chapters, will be presented.

1.2 BACKGROUND

Internationally, there is a recurrent theme of concern that relates to the role bioscience plays in nursing education. Furthermore Taylor, Ashelford, Fell and Goacher (2015) notes that there has been published literature that focuses on the methodology used to integrate bioscience into the undergraduate curriculum. Bioscience is inclusive of Anatomy, Physiology and Pathophysiology modules and it is crucial that the practising registered nurse has the ability to comprehend these modules (Clifton & McKillup, 2016). While the comprehension of the latter is crucial, it has been reported that the bioscience content in the curriculum has diminished (Fawcett, Waugh, & Smith, 2016). Furthermore, it was noted that there is a perception that bioscience modules are difficult (Craft, Hudson, Plenderleith, Wirihana, & Gordon, 2013) and that the unstructured nature of the curriculums is challenging. Nurse educators have detailed issues with the pedagogy of bioscience modules (Taylor et al., 2015) and the absence of a national prospectus. In addition, restricted time in a congested curriculum has been identified (Taylor et al., 2015; Jensen, Knutstad, & Fawcett, 2018). Therefore, it is noted that the bioscience modules in the nursing curriculum in South Africa have been under scrutiny over

the last decade by various researchers such as Nxumalo (2011), Mohudi (2014), Rafferty and Kyriacos (2016) and Mthimunye and Daniels (2018).

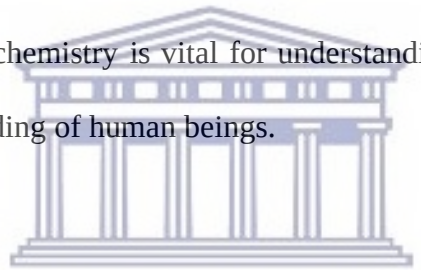
It is well documented that bioscience modules underpin the curricula of the health professions and nurses thus need a good foundational knowledge of bioscience (Andrew & Mansour, 2014). Historically there has been international concern about the role bioscience plays in nursing education around the world. As noted by Clifton and McKillup (2016), comprehension of bioscience such as Anatomy, Physiology and Pathophysiology are crucial for practising as a registered nurse. Although its importance is recognized, it is noted that bioscience content has been diminishing in recent years (Fawcett, Waugh, & Smith, 2016) and the challenges of accomplishing substantial bioscience have been well established (Taylor et al., 2015; Jensen et al., 2018). Challenges such as an unstructured curriculum, absence of a national prospectus, as well as restricted time in a congested curriculum (Taylor et al., 2015) was documented in literature.

Furthermore, nurse educators have also detailed issues with the pedagogy of bioscience modules. This is evident in a survey approach study conducted by Taylor et al. (2015) which sought to document the experiences and opinions of lecturers involved in teaching bioscience to nursing students in the United Kingdom (UK). Evidence revealed that lecturers were concerned about the lack of science entry criteria, large student intakes and a dearth of clear national guidelines for bioscience.

1.2.1 Bioscience in nursing education and practice

1.2.1.1 Bioscience in nursing practice

Unarguably, the core objective of nursing education is to ensure that registered nurses are equipped with necessary knowledge and that they use this acquired knowledge to contribute positively towards high-quality patient care (Perkins, 2019). Likewise, registered nurses are required to progressively apply their bioscience based interpretation skills to recognize cases of concern (Grant & Crimmons, 2018). Due to the time spent in healthcare settings with patients, registered nurses are most likely to be the initial person to detect changes in a patient's condition (Clifton & McKillup, 2016). However, to be able to make these observations, registered nurses need to be able to correlate clinical practice with bioscience (Perkins, 2019). The idea is further supported by Jensen et al. (2018) who acknowledged that the knowledge of Anatomy, Physiology and Biochemistry is vital for understanding of the concepts of illness and diseases and the understanding of human beings.



For example, Bourbonnais and Caswell (2014) noted that registered nurses play a vital role in medication-related patient safety due to their core role in the administration of medication. Therefore, bioscience should form a significant part of the nurses' knowledge as it is vital for nursing competence (Efstathiou & Bailey, 2012). Registered nurses who have succeeded in bioscience are confident and skilled practitioners who have the ability to deliver clinically effective patient care (Montayre & Sparks, 2017).

Nurses, midwives and allied healthcare workers require an awareness of interactions between anatomical and physiological systems in pathological processes, the impact of medication and

care, and the potential outcomes for the patient (Prowse & Lyne 2000, McVicar & Clancy 2001, Prowse 2003, Smales 2010).

1.2.1.2 What is the content of bioscience

According to the European directive 2005/36/EC, the bioscience modules provide the theoretical foundation of nursing practice. These modules include Anatomy, Physiology, Pathology, Microbiology, Biophysics, Biochemistry, Radiology, Pharmacology and Dietetics (Nursing and Midwifery Council, 2010). In the South African context, however, the South African Nursing Council (SANC) Regulation 425 of the Nursing Act of 2005 as amended, General Nursing Science is a compulsory module in the nursing curriculum. It forms the foundation of nursing science by promoting an understanding of Anatomy, Physiology, Pathophysiology, Physics, Chemistry and Pharmacology (Mthimunye & Daniels, 2017). Scrooby, Reitsma, and Waggie (2019) further explain Anatomy as the core subject that defines the normal structure of the human body and develops a foundation for subsequent study of Physiology and Pathophysiology.

1.2.1.3 Bioscience knowledge

Bioscience in nursing practice and undergraduate curriculums has been under scrutiny worldwide. The demand for bioscience has grown as nurses are becoming more autonomous (Taylor et al., 2015), are required to solve intricate health problems (McVicar, Andrew, & Kemble, 2015), and are required to possess critical thinking skills and make rational and safe scientific conclusions (Logan & Angel, 2011). However, maintaining a prescribed degree of bioscience education appears to be a worldwide issue at tertiary institutions (Bakon, Craft, Christensen, & Wirihana, 2016). Nursing programmes are being challenged by increased

failure rates in biosciences and it is frequently noted that nursing education has not dedicated adequate resources to these modules (Bakon et al., 2016). Furthermore Nxumalo (2011) also highlights the global concern regarding the association between theory and clinical practice. Bakon et al. (2016) noted that students struggle to acquire bioscience knowledge in higher education and also find it difficult to apply bioscience in clinical practice.

There have been notable concerns about the apparent deficiency of bioscience content within the undergraduate programmes (Davis, 2010). In the study by Davis (2010), over 40% of registered nurses commented that bioscience content had not prepared them for their role as registered nurses; this was further substantiated by a descriptive and cross-sectional mixed methods study by Craft, Hudson, Plenderleith, and Gordon (2016) where 54.5% (n=22) of recently graduated registered nurses from an Australian university noted that bioscience modules were a tremendous challenge during the undergraduate programme. In addition, they had minimal confidence in their ability to explain the biological foundation of nursing.

English, Mathematics and Life Sciences foundations are essential for the comprehension of the scientific underpinning of nursing practise (McEwen & Wills, 2017). An inadequate background knowledge in biological sciences at entry has been found to be an issue for students who are confronted with scientific terminology and concepts for the first time (Mortimer-Jones & Fetherston, 2018). In South Africa, the student is required to pass their National Senior Certificate (NSC) with a minimum of 30% in the language of instruction in order to qualify for admission into a Bachelor's degree programme at the respective higher education institution (HEI) (Umalusi, 2013). However, where the language of instruction is English, students may be put at a disadvantage. In a descriptive observational study conducted with a sample of 76

final year nursing students at a nursing college in the Western Cape, it was evident that English was a second language for the majority of the students (Rafferty & Kyriacos, 2016), and this may also be a contribution to an inadequate understanding of bioscience. Whilst undergraduate nursing students have a well-documented love-hate relationship with bioscience (Whyte, Madigan, & Drinkwater, 2011), a survey conducted by Taylor et al. in 2015 reported that students deem bioscience an essential element of evidence-based care as well as safeguards safe practice (Taylor et al., 2015). However, their perception that bioscience is challenging may result in anxiety and a lack of confidence (Craft et al., 2013). Nursing students reflected that they ought to know more than what they actually do (Molesworth & Lewitt, 2016). This was further emphasized by participants in the study of Craft, Hudson, Plenderleith and Gordon (2017), where there was a consensus among newly qualified registered nurses that their bioscience modules were relevant in clinical practice.

1.2.2 Bioscience in Nursing education in South Africa

It is clear that South Africa (SA) possesses a nurse-driven healthcare system. According to the Department of Health, 80% of healthcare professionals in SA are nurses of different categories (Department of Health, 2011). The nursing profession held a summit in 2011 at which strategic issues that required attention to reinforce the nursing profession were identified. This was done specifically as they are the key role players in the Human Resources for Health (HRH) model for South Africa (Department of Health, 2011).

Due to the dire shortage of highly qualified and skilled nurses in South Africa (Mthimunye & Daniels, 2017), nursing roles are frequently expanded and the delivery of patient care is

influenced by the prevailing diverse challenges (Kyriacos, Jordan, & Van Den Heever, 2005). For example, in South African rural areas, there is restricted access to medical doctors (Rafferty & Kyriacos, 2016) and other resource constraints (Kyriacos et al., 2005). This evidence is critical as rural areas contain 43.6% of the population but are assisted by only 12% of the doctors and 19% of nurses (Department of Health, 2011). The statistics indicate that nurses are required to practice independently and autonomously.

To meet the needs of the expanded role, the South African Nursing Council (SANC) integrated specialist post-registration training into the four-year diploma and degree programmes, resulting in nurses being licensed as a Midwife and Nurse (general, community and psychiatry) in Regulation 425 of 22 February 1985 (SANC, 1985). It is noted that there are diverse admission requirements for different nursing programmes in South Africa. In particular, a comparison of diploma programmes and degree programmes show that admission requirements for diploma nursing programmes appear to be lower than those of degree nursing programmes (Ndwambi & Roets, 2020). The nursing degree students' exit qualifications are on level 8 of the National Qualification Framework, whereas diploma students exit on level 7 (Rabie, Rabie, & Dinkelmann, 2020). Even though their exit levels are different, all newly qualified registered nurses who have completed either the four-year degree or diploma course are registered with the same specialities at the South African Nursing Council (Rabie et al., 2020).

The need for ever-increasing professional autonomy means that the registered nurses' need for practical application of bioscience in the clinical environment has never been greater (Fawcett et al., 2016). With the appropriate application of bioscience knowledge, registered nurses can

make informed clinical decision-making that will avoid health harm and maximize health impact (Perkins, 2019).

In SA undergraduate student nurses are required to complete 4000 hours of clinical placements; these include general, community, psychiatry, and midwifery placements under the supervision of clinical mentors and registered nurses (SANC R425, 1985). According to the South African Nursing Council (2016), respective year levels in the undergraduate nursing programme must complete an exact number of clinical hours that are recorded by the School of Nursing. These hours are guided by the SANC completion document. Practical hours are: 1900 hours for General Nursing Science (GNS), 600 for Psychiatric nursing science and 1000 for Midwifery. The rest of the hours consist of theory lectures (SANC, 1985).

Bioscience modules are the fundamental modules specified by the SANC in the curriculum for R425 of 22 February 1985 (SANC 1985). Undergraduate nursing students are placed in different types and levels of health facilities once they have completed their undergraduate training, where they are required to complete a one-year community service programme before being registered as a registered nurse. However, to undertake this broad role it is crucial that nursing students are capable of confidently applying bioscience to their nursing practice (Rafferty & Kyriacos, 2016). The regulation does require the incorporation of bioscience with major nursing modules across the course; however, the means of integration is not documented and fewer periods are assigned to bioscience than to major nursing science modules, thereby demoting bioscience to the status of a subordinate subject (Mohudi, 2014).

1.2.2.1 Requirements for admission into the Undergraduate Nursing Programme

According to Umalusi (2018), the minimum admission requirements to Bachelor's degree studies is a minimum of 30% in the language of teaching and learning and an achievement rating of 4 (50%) or better in four (National Senior Certificate) NSC or Senior Certificate (SC) subjects.

Students entering undergraduate nursing programmes are expected to have a background in high school bioscience subjects. South African high school institutions offer the bioscience subjects of Life Sciences and Physical science (Department of Basic Education, n.d.). The minimum admission requirements for the undergraduate nursing programme offered at the institution used in the study are English (50–59%), another language (50–59%), Mathematics (50–59%) or Mathematics Literacy (70–79%) as well as Life Sciences (50–59%) (UWC, 2017). This is in contrast to students applying for admission into a diploma programme where requirements are: First Additional Language English (50%-59%), Home Language (50%-59%), Mathematics (40%-49%) or Mathematical Literacy (50%-59%), and Life Sciences (50%-59%) (Western Cape Government, 2019).

Although these are the minimum requirements for admission into the undergraduate nursing programme, evidence suggest that students are still performing poorly. In a study conducted by Rafferty and Kyriacos (2016), the college under study offered four-year undergraduate diploma programmes and had a failure rate of approximately 50% in the bioscience primary examination. This was substantiated by a previous study conducted by Mthimunye (2015) who found that 52.21% of the second-year nursing students in 2012-2013 who hold a National Senior Certificate did not successfully complete their second year of study at the first attempt.

Mathematics or Mathematics literacy, Life Sciences and Physical Science are compulsory entry subjects and there is evidence that proficiency/non-proficiency in these areas has a significant impact on the success of the student in nursing education (Mthimunye & Daniels, 2018). Six focus group discussions consisting of 50 participants selected from each year group from the first year Extended Curriculum Programme (ECP) across to final year participated in a recent short exploratory-descriptive study conducted by Mthimunye and Daniels (2018) at the university under study. Results from the study revealed that the second year of the undergraduate nursing programmes is perceived by nursing students as the most overwhelming year of the entire programme. This is due to the second-year level being packed with challenging modules and bioscience modules in particular, as noted in the participants' responses. Bioscience modules are now stigmatized and are regarded as "killer modules" by the respondents (Mthimunye and Daniels, 2018).

Existing literature indicates that the first and second year of the undergraduate nursing programmes are critical years during which attrition most often occurs (Roos, Fichardt, MacKenzie, & Raubenheimer, 2016). This issue was explored in a quantitative descriptive study at two universities conducted by Roos et al. (2016) on the attrition of undergraduate nursing students. Results illustrated that the 54 participants at the two universities reported that the second year is where most students discontinue their nursing studies and the main factor was found to be academic non-performance. One particular qualitative explorative study conducted by Ramahlafi (2015) pointed out that the carrying over of failed fundamental modules such as Biological Science caused the most terminations of study during nursing student training.

It is also important to note the vital role the clinical setting and clinical mentors play in the education of the student. Clinical mentors facilitate the clinical learning of students and assess their clinical skills (Rafferty & Kyriacos, 2016). The impact of their perception of bioscience relevance, knowledge base, enthusiasm as well as their ability to teach plays a role in the education of the student (Fell et al., 2016). It is noted that not only has the importance of bioscience been declining, but lower levels of supervision and clinical mentoring of students has also been of concern. Fell et al. (2016) raises concerns regarding the inconsistency in the quality of support offered to students, the lack of learning opportunities and the low priority that bioscience is given in placement education. Hall-Lord, Theander and Athlin (2013) stated that students' learning in clinical facilities and lecturers' supervision of students in direct patient care has decreased since nursing education was transferred to universities. A more recent descriptive qualitative study was conducted with 36 participants by Donough and Van Der Heever (2018) at a university in the Western Cape. Students noted that at times supervisors did not arrive for the clinical sessions, they were unprofessional, and that learning and clinical guidance did not take place. Students reflected that the mentors were focused more on compulsory assessments than clinical guidance. Such findings echo those of Logan & Angel (2011) who previously reported that a culture where the emphasis is on procedural skills can undermine theoretical underpinning and have a negative impact on student bioscience learning and application. Although students gain clinical experience in a variety of health facilities throughout their undergraduate programme they are exposed to intricate clinical situations beyond their competence due to staff shortages in clinical settings (Rafferty & Kyriacos, 2016), and consequently their guidance and support receives less attention.

1.3 SIGNIFICANCE OF THE STUDY

This study investigated nursing students' knowledge and understanding of bioscience and its relevance to clinical practice. The findings will therefore add to the body of knowledge and improve evidence-based practice. Furthermore, the findings of the study may provide relevant information to enhance the training on bioscience that in turn results in quality patient care when the students are qualified. The findings will provide evidence of the value of bioscience knowledge in the fast-changing and developing healthcare system and thus justify the need for curriculum re-assessment and change. This can ultimately assist registered nurses to provide quality patient-centred care. This, in turn, can decrease the hospital stay of patients, and prevent unnecessary financial expense for patients, the facility, and government. Competent nurses will contribute to improved clinical outcomes and a competitive nursing curriculum. This is important as nurses are the backbone of the healthcare system.

1.4 PROBLEM STATEMENT

Nationally and internationally various researchers such as McVicar, Andrew, and Kemble, (2014), Taylor et al. (2015), Mortimer-Jones and Fetherston (2018), and Perkins (2019) have demonstrated the need to emphasise bioscience in the nursing curriculum. Studies such as those of Kemsley, McCausland, Feigenbaum and Riegle (2011) have shown that many nursing student participants reported concerns regarding their understanding of bioscience and the integration of biosciences in nursing clinical practice. A recent South African study of final year undergraduate nursing students in the Western Cape illustrated that most participants indicated acceptable levels of bioscience comprehension (Rafferty & Kyriacos, 2016). While precise observations are crucial to assessing patients, merely sustaining the haemodynamic stability of the patient is not favourable for further practice growth (McVicar et al., 2014). It

appears that students understand the significant link between bioscience knowledge and the patients' condition. In the study of Fell et al. (2016), students indicated that bioscience was a fundamental knowledge foundation for role competency and for understanding patient conditions, observations and treatment. The results of the study conducted by Mthimunye and Daniels (2018) at the identified institution revealed that clustering science modules into one year of study in the second year of study unfavourably impacted the exam results of second-year students of the undergraduate nursing programme. This is substantiated anecdotally by the researcher who graduated from the identified institution and recently became a registered nurse; she noted that the training she received did not sufficiently prepare her for her role as a registered nurse.

1.5 AIM OF THE STUDY

The study aimed to investigate the nursing students' self-reported knowledge of bioscience and its relevance to clinical practice.

1.6 RESEARCH OBJECTIVES

The following objectives were formulated to guide the study:

- To establish the nursing students' self-reported knowledge and understanding of bioscience.
- To determine the nursing students' self-rated perceptions of the relevance of bioscience to nursing practice.

1.7 RESEARCH QUESTION

- What are the nursing students' self-reported knowledge and understanding of bioscience?
- What are the nursing students' self-reported perceptions of the relevance of bioscience to their practice?

1.8 RESEARCH METHODOLOGY

This section will comprise a summary of the study methodology. More details will be discussed in Chapter 3.

1.8.1 Research approach

A research approach is defined as a strategy and process that entails methods of data collection, analysis and interpretation (Chetty, 2016). For the present study, a quantitative research approach was employed.

1.8.2 Research design

A descriptive survey design was employed to establish the nursing students' self-reported knowledge and understanding of bioscience and determine their self-rated perceptions of the relevance of bioscience to nursing practice.

1.8.3 Research Context

The identified institution is one of the three institutions offering the four-year degree undergraduate nursing programme in the higher education sector in the Western Cape, South Africa. The School of Nursing at the identified institution is one of the largest departments in the Faculty of Community and Health Science (UWC, 2021).

1.8.4 Population and sampling

The target population (N = 758) comprised second-, third- and fourth-year undergraduate nursing students enrolled in the undergraduate nursing programme at the university understudy for the 2020 academic year. In a sample of 255 nursing student participants, a 95% confidence interval and a 5% margin of error was obtained by means of simple random sampling technique.

1.8.5 Instrument

A questionnaire developed by Kyriacos, Jordan, and Van Den Heever (2005) with the aim of establishing registered nurses' knowledge and use of bioscience (and later adapted by Rafferty and Kyriacos (2016) for the purpose of establishing the student nurses' self-reported knowledge and understanding of the biosciences and their perception of the relevance thereof to clinical practice) was used. This revised questionnaire was further adapted by the researcher to suit the context of the study.

1.8.5.1 Pre-test of instrument

The data collection instrument was adapted to suit the study. A pre-test was conducted to determine the reliability and validity of the adapted instrument. The Cronbach's alpha coefficient was found to be $\alpha=0.843$ which indicated that there would be no complications related to internal consistency. Face and content validity were assessed by the researcher's supervisor and co-supervisor, both of whom are experts in the field of nursing education.

1.8.6 Selection criteria

The criteria for inclusion were second-, third- and fourth-year undergraduate nursing students who have engaged in modules related to bioscience and general nursing sciences in the undergraduate nursing programme at the university.

1.8.7 Data collection

The researcher, with the aid of two research assistants, collected data from the selected sample population at the School of Nursing at the identified university in the Western Cape.

1.8.8 Data analysis and interpretation

Descriptive and inferential statistics were conducted using IBM Statistical Package for Social Sciences (SPSS version 26.0). Descriptive statistics included measures of central tendencies (mean, mode, median and standard deviation). Inferential statistical tests (Chi-squared) were used to analyse interval data. The Bionursing Framework by Akinsanya (1987) was used to analyse qualitative responses.

1.8.9 Ethics

Permission to conduct the study was sought from all gatekeepers. A description of the ethical principles which guided the researcher is discussed in Chapter 3 (section 3.6).

1.9 OPERATIONAL DEFINITIONS

1.9.1 Bioscience

Bioscience modules are components in the nursing program and primarily comprise Physiology, Anatomy, Pathophysiology and Pharmacology (Craft, Hudson, Plenderleith, & Gordon, 2017). The bioscience modules at the identified institution are Human Biology, Chemistry, Physics and Pharmacology; all these are taken within the first and second year of the undergraduate nursing programme.

1.9.2 Clinical practice

Clinical practice is a method of providing health care by healthcare professionals such as doctors and nurses (Medical Dictionary, n.d.). This is an important aspect of nursing education as it provides nursing students with the opportunity to practice and apply the knowledge and skills acquired from lecturers in a real-life patient setting, under the supervision of a registered nurse (Ewertsson, Bagga-Gupta, Allvin, & Blomberg, 2017).

1.9.3 Higher education institution (HEI)

A higher education institution is any institution that delivers higher education on a full-time, part-time or distance basis. This is an establishment which is recognized or declared as a public

high education institution or provisionally registered as a private higher education institution under the Higher Education Act. SAQA (Higher Education Act 101 of 1997, 2010).

1.9.4 Knowledge

Knowledge is defined as an understanding of a science or technique, the fact of knowing something with the familiarity gained by experience (Merriam-Webster Dictionary, 2019). This refers to what has been learned by the respondents in their undergraduate programme.

1.9.5 Nursing student

This study refers to students registered in the four-year undergraduate degree or diploma course leading to registration as a professional nurse (general, psychiatry and community) and midwife/ accoucheur under the SANC R425 of 1985.

1.9.6 Previous qualifications

Qualification is defined as an official record presented as proof that a training course has been completed, or the required skills have been obtained (Cambridge Dictionary, 2021). For the purpose of this study, “previous qualification” is defined as previous skills or training in nursing prior to admission into the undergraduate nursing programme.

1.9.7 Relevance

Relevance is the extent to which something is related to what is occurring or being discussed (Cambridge Dictionary, n.d.). For the purpose of the present study, relevance is defined as the extent to which bioscience modules are related to nursing practice

1.9.8 Umalusi

Umalusi is a council in South Africa which sets and monitors standards for general and further education and training in South Africa; it is also responsible for the certification of the Senior Certificate, National Senior Certificate, TVET college qualifications (N3 and NCV) and adult learning centre qualifications (general education and training certificate) at private institutions (Umalusi, 2019).

1.9.9 Understanding

Understanding is defined as having knowledge about a subject, or how something works (Cambridge Oxford Dictionary, n.d.). In the present study, understanding is defined as the ability to assimilate and grasp bioscience knowledge.

1.10 OUTLINE OF THE STUDY

1.10.1 Chapter 1: Introduction

This chapter presents a description of the background of the study, the problem of the study, the significance of the study, aims and objectives, and a brief description of the research methodology implemented in the study.

1.10.2 Chapter 2: Literature review

This chapter discusses literature on bioscience in nursing. The review gives a detailed description of the clinical importance of biosciences in patient care, its importance in the nursing profession particularly in South Africa, and the global challenges of bioscience in the undergraduate nursing programme, as well as some recommendations made by authors. The Bionursing conceptual model (Akinsanya, 1987) used in the data analysis is also discussed in this chapter.

1.10.3 Chapter 3: Research methodology

This chapter presents an overview of the research approach and design, research context, study population, sampling method and sample size, inclusion and exclusion criteria, data collection tool, pre-testing of the instrument, reliability and validity of the research tool. The data collection process will also be discussed.

1.10.4 Chapter 4: Data analysis and interpretation

The findings of the data analysis and the interpretation of the study findings are presented.

1.10.5 Chapter 5: Summary of findings and discussion, limitations, conclusion and recommendations

In this chapter, the researcher discusses research-based recommendations and conclusions in relation to the findings of the study.

1.11 SUMMARY

This chapter has presented an overview of the study and included the introduction and background to the study. The problems noted from the literature were included as well as the aim and objectives of the present study. The following chapter focuses on the literature review.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

For the purpose of this study, the biosciences that underpin nursing practice are defined as Human Biology, Chemistry, Physics and Pharmacology. The keywords biosciences, nursing, nurse education and student nurse were used to guide the literature search. Google Scholar, Tandfonline, Science Direct, Wiley, ERIC and Research Gate were used to search for literature that was applicable to the topic. The literature review discusses the literature explored by the researcher in an effort to gather existing information on the study.

Polit and Beck (2017) define a literature review as a critical summary of existing research on a topic, performed with the aim of placing a research problem in context or to recapitulate current evidence. The purpose of conducting the review of the literature is to discover the most recent and most relevant information about a particular phenomenon (Gray et al., 2017). The review provides an answer to the question of what is known about this topic; it may be a combination of research findings or an account of knowledge on a topic (Paré, Trudel, Jaana, & Kitsiou, 2015). The review also reveals whether the proposed study has already been done by other researchers. Older articles were used for seminal value.

The literature review was undertaken to establish what information had been published on the current global situation of bioscience in nursing as well as nursing education. It was also

performed to provide a fuller understanding of the context that established the aim of this study and to indicate what gaps exist in the published literature.

2.1.1 Background of bioscience

Registered nurses are required to possess an adequate understanding of biosciences as a foundation for safe and effective clinical practice (Fawcett et al., 2016); therefore, the solid foundation of sciences is a crucial part of the development of the practitioner (Whyte et al., 2011). Nursing students learn about the Anatomy, Physiology and Pathophysiology of the human body, the causes of these changes and the indications or mechanism of actions of various medications that are used as treatment (Montayre, Dimalapang, Sparks, & Neville, 2019). Comprehension of these crucial bioscience concepts permit nursing students to express the reasons for providing care (Montayre et al., 2019). However it is well documented that bioscience content in the undergraduate nursing curriculum has been declining and devalued (Fawcett et al., 2016; Logan & Angel, 2011) and the difficulty of learning and teaching bioscience is multifactorial (Efstathiou & Bailey, 2012).

2.2 OUTCOMES OF ENHANCED BIOSCIENCE

Biological science is an important subject as it provides the scientific underpinning for nursing practice (Akinsanya, 1987) and it has been seen that good biological knowledge will lead to good patient care (Jordan & Reid, 1997; Taylor, Ashelford, Fell, & Goacher, 2015). It is suggested that according to Maslow's Hierarchy of needs, an individual's physiological and safety requirements should be met before other hierarchal needs can be fulfilled (Torrance & Jordan, 1995).

Bioscience knowledge has resulted in an increase in students' confidence to carry out their role and challenge practice if required (Fell, Dobbins, & Dee, 2016). A study conducted by Sulosaari, Suhonen, and Leino-Kilpi (2011) pointed out that in-depth knowledge of Anatomy and Physiology is a key foundation for understanding the principles of Pharmacology as it gives the student an ability to share knowledge and information as part of a multi-disciplinary team, and enables them to act as patient advocates.

This can only serve to enhance the student's credibility with both patients and employers (Fell et al., 2016). Patients consequently become more proactive in their own care regime and seek information about the pathology of their disease and available options for intervention. Therefore, comprehension of the scientific foundation of health and illness is a crucial responsibility of a knowledgeable nurse (See, Chee, Rajaram, Kowitlawakul, & Liaw, 2020).

Clinical decision-making requires a level of expertise in problem-solving. In the context of bioscience, clinical decision-making entails awareness of how complex anatomical and physiological systems interact during pathological processes to produce symptoms of the disorder, the impact of medication and care, and the potential outcomes for the patient (McVicar, Andrew, & Kemble, 2014). A study by Stern et al. (2017) contains evidence that knowledge of bioscience gives healthcare professionals an increased understanding of pain; this resulted in a decrease in patient pain and improved outcomes which in turn decreased the usage of preventable services.

Recently there have been substantial improvements in medical science research regarding the recognition of a biological base for numerous forms of mental illness (Fawcett, Waugh, & Smith, 2016). Primary health care nurses also need knowledge of bioscience, because nursing co-existing chronic diseases requires a robust knowledge of the combined health problems and treatment to ensure safe and effective diet, exercise, medication, condition monitoring advice and treatment to be given (Perkins, 2019). Findings of studies conducted by Redmond, Davies, Cornally, Fegan, and O'Toole (2016), and Sulosaari, Suhonen, and Leino-Kilpi (2011) illustrate how an increased depth of biological science knowledge can impact positively on the healing time of wounds.

A solid grounding in the basic sciences is a crucial step in the development of skilful practitioners. Thus, it is important to gain the necessary knowledge, level of clinical competency and complex decision-making skills required in today's highly technical and rapidly evolving health care environment (Whyte, Madigan, & Drinkwater, 2011).

Worldwide, bioscience modules have underpinned curricula for the health professions. To ensure patient safety, nurses need a good foundational knowledge of bioscience (Andrew & Mansour, 2014). Since the beginning of nursing education, it has been observed that foundational knowledge of nursing depends significantly on the strength of the Life Sciences foundation, in particular the Anatomy, Physiology, Microbiology and Pharmacology modules.

The fundamental purpose of registered nursing is to positively influence health outcomes. To increase students' confidence to undertake their role and challenge practice if necessary, it is

imperative that they have a good understanding and knowledge of bioscience (Fell et al., 2016). The nursing profession requires nurses to attain science knowledge to inform their decisions and, more importantly, to develop it. This is particularly crucial in South Africa as graduate nurses are required to work in rural areas (Valiga & Ironside, 2012). This was further emphasized in a recent study conducted by Rafferty and Kyriacos (2016) where the authors noted that in order to improve health consequences for the population of South Africa, predominantly in rural areas that have limited access to health care professionals such as doctors, the nurse must be comprehensively trained. Therefore, to fulfil this role properly it is crucial that final year undergraduate nursing students are able to confidently apply bioscience knowledge to their practice (Rafferty & Kyriacos, 2016).

2.3 BIOSCIENCE IN NURSING

Whilst nursing education has progressed in recent times, the role of the nurse has expanded as nurses are expected to be independent (Taylor et al., 2015). Employers expect them to not only possess a specialised knowledge base, but to also competently apply this knowledge to solve multifaceted health problems through effective approaches of care (McVicar, Andrew, & Kemble, 2015). This requires knowledge of bioscience and its application to the nursing care of the patient. Therefore, the capability of applying theoretical bioscience concepts to clinical practice is crucial (Taylor et al., 2015). The constant shift of patient demographics is another factor that requires nurses to have increased bioscience knowledge (Perkins, 2019).

However, the lack of foundation in bioscience knowledge means that a registered nurse is lacking in bioscience knowledge on registration, and therefore lacks guidance on how to get to

a point where they have adequate knowledge (Davis, 2010). Studies of registered nurses in the UK who worked for approximately five years revealed issues concerning their professional confidence and application of bioscience in clinical practice (Craft, Christensen, Bakon, & Wirihana, 2017). Healthcare colleagues and patients have also voiced issues. Literature has illustrated that doctors and patients anticipate a higher degree of bioscience knowledge in registered nurses than they actually possess (Molesworth & Lewitt, 2016).

Although Davis (2010) argues that a lack of bioscience knowledge from the clinical setting is harmful to the patient and the deficiency of applied bioscience knowledge has a negative effect on a registered nurse's ability to carry out their duties, McVicar et al. (2014) do not agree and noted that there have been minimal indications that a low level of bioscience understanding poses an actual risk to patient safety. Perkins (2019) maintains that patient morbidity and mortality are constantly associated with the inadequate knowledge of biosciences in registered nurses and that this could be avoided.

A UK study by McVicar et al. (2010) presented postoperative clinical scenarios to surgical case nurses and discovered that they generally were conscious of the importance of observations; however, they were not able to clarify the physiological deviations that could have possible implications on patient well-being (McVicar et al., 2014). McVicar et al. (2014) noted that while precise observations are crucial to assessing patients, merely sustaining the status quo is not favourable for further practice growth. Understanding the rationale for nursing work is central to professional competence and this is reinforced by experience rather than by obeying medical instructions (Akinsanya, 1987). Nurses should take professional responsibility by ensuring that they understand the importance of the patient observations they

have documented, and should be capable of physiologically justifying the probable reasons for these recorded observations (Kisiel & Perkins, 2006).

Since South Africa achieved democracy in 1994, the nurses' role has been expanded because the South African government has established primary healthcare clinics with registered nurses as lead professionals to meet the health needs of the rural population (Kyriacos et al., 2005).

In the analysis of the SANC hearings of misconduct between January to August 2002, Ka Mzolo (2002) illustrated that charges against registered nurses consisted of an inability to maintain clear and accurate records of patients' conditions, and an inability to assess, diagnose and monitor deviations in patients' conditions, summon a medical practitioner when required, and provide prescribed pain relief during labour. This analysis indicates that nurses hold inadequate scienific and clinical knowledge (Kyriacos et al., 2005).

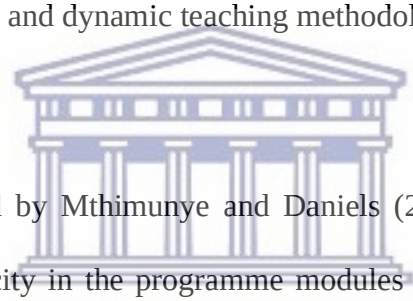
2.4 BIOSCIENCE AND THE CURRICULUM

2.4.1 Challenges related to the curriculum

Nursing has often been defined as an art and a science. Based on this theoretical definition, it is fundamental that nursing education accommodates both social and biological science (Mthimunye & Daniels, 2017). The balance of social and biological sciences exists in the curriculum as nursing education is expected to prepare students to provide nursing care in a multifaceted healthcare setting; they are required to display wide-ranging competency based on foundational nursing, biomedical science, and psychological literature (Bourbonnais & Caswell, 2014). Andrew, McVicar, Zanganeh and Henderson (2015) opined that the aim of the nursing curriculum was to ensure that students are found to be competent in the application of

basic human bioscience proportional to their nursing proficiency, observation skills, analysis, and problem-solving abilities.

While the best-practise recommendations are documented, facilitating the required bioscience education is challenging. This stems from nursing students questioning their competency in bioscience (Birks, Cant, Al-Motlaq, & Jones, 2011). Also, students are unable to correlate the relevance of biosciences to practice and subsequently they experience anxiety and have poor confidence in appropriately applying concepts to patient conditions (Birks et al., 2011). Another challenge is that student feedback surveys and literature reflect the students' perception that there is insufficient bioscience content in the curriculum; to rectify this they requested improved application and dynamic teaching methodologies (Taylor et al., 2015).



Findings in a study conducted by Mthimunye and Daniels (2018) revealed that educators described a lack of synchronicity in the programme modules and this adversely influences consistent learning. They noted that because modules are taught separately, students are incapable of comprehending the association between programme modules. These findings concur with Mortimer-Jones and Featherston (2018) who noted that not sharing the bioscience content with other disciplines may give students the erroneous impression that bioscience modules are separate from nursing modules. Additionally, despite the fact that a graduate attribute requires the students to possess the ability to apply knowledge and implement problem-solving skills, most of the teaching time concentrates on the transfer of knowledge and does not teach knowledge-application methods (Evans, Berry, & Mate, 2013).

It is important to note the transitional changes in nursing education. McVicar, Andrew, and Kemble (2015) stated that there has been a move from a biological science focus to a behavioural science focus. This shift was influenced by the need to recognise the distinctive influence of nursing as an emergent profession and detach itself from medicine (Clarke, 1995). Consequently, this has led to an overreaction of the curriculum rather than a balanced curriculum (Davis, 2010). For several years bioscience knowledge has been devalued in clinical and education practice and literature argues that this has resulted in a curriculum that does not improve the clinical work of the student (Logan & Angel 2011). This claim is supported by Molesworth & Lewitt (2016) who described how bioscience learning is perceived as inferior to the various nursing activities that the students are expected to undertake during training (Molesworth & Lewitt, 2016). The review of literature provides evidence of a recurrent theme that nurse education has not dedicated adequate resources to these modules (Bakon et al., 2016) and, as a result of this continuous deficit of approaches for learning and teaching of biosciences content in nursing, the educational development in this crucial area is restricted (Ralph, Birks, Cant, Tie, & Hillman, 2017).

There are numerous problems that occur when teaching bioscience to nursing students. These include issues around the course curriculum such as an unstructured curriculum, lack of a national curriculum and inadequate time to cover a compact curriculum (Smales, 2010). Other issues include the need for safeguarding the required learning environment, course organization and suitable support for students at the early stages of their curriculum when they are learning the principles of bioscience (McVicar et al., 2015). Further factors that impacted students' success comprise demographic, academic and personality or behavioural factors (McVicar et al., 2015). There is a deficiency of science entry criteria, a large student intake, no clear national

guidelines for biosciences (Taylor et al., 2015), lack-lustre teaching approaches, and the lecturer's capability and curriculum time (Davis, 2010).

Investigation of the importance of bioscience has shown that the impact of the pre-university curriculum has a great impact on students' subsequent performance in bioscience modules. Mthimunye and Daniels (2017) found that performance in Grade 12 Mathematics and Life Sciences is a significant predictor of student nurses' performance in first-year science modules. Similar findings were noted in a more recent descriptive quantitative design research study conducted by Ndwambi and Roets (2020) where they observed that students who passed Grade 12 Life Sciences had a significantly greater chance of passing Biological and Natural Science modules.

In agreement with previous studies, a recent South African study conducted by Mhlongo and Masango (2020) highlighted some factors related to students' failure in Anatomy and Physiology. The factors reflected by the students were poor teaching strategies, lack of after-class sessions, shorter study periods and language barrier (Mhlongo & Masango, 2020). The issue of language barrier can be linked to students who were taught bioscience subjects in high school in their native language and now must transition to learning in the English language. The impact of English as a second language cannot be underestimated and it has been reported that many students have difficulties with the English language in the first semester of study; this affects the success of first-year nursing students and leads to high failure rates (Langtree, Razak, & Haffejee, 2017). Many respondents in the study of Mhlongo and Masango (2020) reported that the language barrier contributes to the number of student nurses who fail Anatomy and Physiology.

Increasing student numbers in the undergraduate nursing programmes were also noted due to predicted workforce shortages (Pitt, Powis, Levett-Jones, & Hunter, 2012). Durai, Hassan, Panduragan, Abdullah, and Mat (2012) reported that the failure frequency of students at the university in Malaysia was 35-45% each semester. More recently, results from an analysis at the Charles Johnson Memorial Nursing Campus in Anatomy and Physiology between 2014 to 2017 indicated a variability in students' performance, with results fluctuating between 54% and 70% (Mhlongo & Masango, 2020). It is often one of the most content dense and theoretically challenging modules that student nurses experience during their degree and many battle to grasp key concepts (Smales, 2010).

It is clear that evidence such as student feedback, surveys and literature constantly reflect that the bioscience content in the curriculum is perceived by students to be insufficient and that improved application and further dynamic teaching methodologies are required (Taylor et al., 2015).

2.4.2 Challenges related to knowledge of teaching staff

The curriculum model of nursing education has led to the debate of the appropriate educator for bioscience modules (Mortimer-Jones & Fetherston, 2018). Akinsanya (1987) and Ralph et al. (2017) maintained that the basis of knowledge of bioscience is to be taught by the nurses themselves to inhibit dependence on medical science. Mortimer-Jones and Fetherston (2018) noted that registered nurses support the view of nurses teaching bioscience in the nursing curriculum. However, it has been suggested that for students to understand the relevance of bioscience, nurse educators should have a good knowledge foundation in this area (Casey,

1996; Evans, Berry, & Mate, 2013). Nurse educators will also not be able to simplify and educate bioscience effectively if they have a deficit in the depth of knowledge of bioscience (Mortimer-Jones & Fetherston, 2018).

In numerous universities, including the university under study, scientists are employed to teach bioscience to nursing students. Concerns have been raised that the scientists may never have been exposed to the clinical environment and this lack of context can lead to the student's poor integration of bioscience theory into the clinical setting (Craft et al., 2013). This is exemplified by an Australian study conducted by Smales (2010) where it was noted that another issue may influence the delivery of bioscience in nursing curricula. In Australia teaching staff are predominantly scientists who are often without clinical expertise and this leads to a possible disconnect regarding the intrinsic relationship between bioscience and clinical practice. Furthermore, Jensen et al. (2018) conducted a literature review which revealed that bioscience lecturers in nursing courses are usually not registered nurses but have science qualifications. These difficulties create a continuous deliberation in nurse education as to whether the bioscience content should be organized in relation to the different disciplines or be patient-centred (Jensen et al., 2018). Christensen, Craft, Wirihana and Gordon (2015) consequently proposed that bioscience should be taught by nurses as well as science lecturers.

Although bioscience academics are advised to focus and integrate bioscience towards the content that has the greatest significance (Craft et al., 2017), they will not be able to do so if they are not nurses (Mortimer-Jones & Fetherston, 2018). Bioscience academics' ability to correlate the theoretical knowledge with clinical context, and thereby enhance the quality of science curriculum, has been questioned (Ralph et al., 2017). Additionally, non-nurse

academics were especially uncertain about the appropriate depth of science content taught for clinical practice (Ralph et al., 2017). Enhancing the scientific knowledge base of all nursing educators in order to demonstrate the relevance of theory in the clinical setting through its integration into nursing practice will result in addressing the issues nursing students have with bioscience (Evans et al., 2013).

2.4.3 Lack of national guidelines

The deficit of clear national guidelines has led to an ambiguous transcription of bioscience in institutions of higher education. Whilst nurses must demonstrate achievement of education standards at the point of registration (NMC 2010 as cited in Taylor et al., 2015) there is no nationally defined curriculum (Taylor et al., 2015). Furthermore, the depth and scope of bioscience content are neither standardised nor agreed upon by academics (Mohudi, 2014). As a result, higher education institutions individually stipulate the theoretical content of the programme (Taylor et al., 2015). Consequently the content of bioscience in nursing programmes differs from institution to institution (Akpata, 2012).

In a study by Ralph et al. (2017), participants indicated the need for consistent national guidelines for the teaching of science in nursing curricula. Participants in another study recommended that establishing national outcomes for the level of bioscience knowledge at the point of graduation would help to change the mindset of nursing colleagues; they also recommended that the NMC should review national entry requirements and ensure that these include science (Taylor et al., 2015).

2.4.4 Criteria for students' enrolment into the undergraduate nursing programme

Prediction of undergraduate nursing student success in a programme of study is vital in determining admission criteria that allow for the selection of students most likely to be prepared for and complete the programme (Capponi & Barber, 2020). Many higher education institutions depend on their admission criteria to recruit high-quality prospective students.

There has been minimal evidence published as to whether the mathematics and science background requirements of students improves the success in their undergraduate nursing career (Mthimunye & Daniels, 2017). Many nursing schools stipulate Mathematics and Science subjects as admission criteria for undergraduate nursing programmes (Mthimunye & Daniels, 2017). Background knowledge of Anatomy and Physiology is a strict entry requirement for student admission into the four-year comprehensive undergraduate nursing courses (Mhlongo & Masango, 2020). To ensure that students have a foundation in Anatomy and Physiology, nursing education institutions do not accept applicants who have failed Life Sciences despite their overall Grade 12 score (Department of Health Studies (2010), as cited in Mlhongo & Masango, 2020). At the participating school of nursing, Life Sciences and Mathematics are compulsory subjects whilst Physical Science is a recommended subject for admission (UWC, 2020).

2.4.5 Perceptions of students about bioscience modules

Available literature indicates that students approach the discipline of Anatomy and Physiology with apprehension as they experience difficulty with the many new and complex terms and concepts that have to be learnt (Johnston, 2010) and often find the language and terminology

difficult to understand (Whyte, Madigan, & Drinkwater, 2011). They find it challenging to be learning several new concepts and terminology in Anatomy and Physiology every day (Langtree et al., 2017).

Many students find learning and applying bioscience difficult. Consequently this can cause them great anxiety, particularly if they have not studied Life Sciences prior to entering nursing education (Craft et al., 2013). Recently qualified professional nurses reported that their engagement in other modules was compromised as they were obliged to focus most of their learning time on memorising bioscience content and that resulted in poor understanding of this content (Craft et al., 2016).

The issue of students struggling to learn bioscience modules is a longstanding one. Nursing students have negative perceptions of the process of studying bioscience but nevertheless appreciate the importance of the content in their career. The Craft et al. (2013) survey of 273 nursing students at one university found that while over 50% of the respondents were anxious about studying bioscience, 93% understood why it was necessary for their careers. These findings correspond with results from a recent sequential mixed methods study by Barton et al. (2021), where 91% of nursing students across all years of study agreed that bioscience provides useful knowledge for safe nursing practice, and 95% noted that they saw and appreciated the relationship between bioscience and nursing practice.

Craft et al. (2017) employed a further study to examine the perceptions of recently registered nursing graduates at an Australian University. Two-thirds of their sample agreed that

bioscience subjects were the most difficult subjects as it was more complex than nursing. Participants expressed concern about time restrictions that left them with no option but to memorize the subject matter in order to get through the course; this rote-learning consequently meant that they were unable to understand the content. Student nurses noted that not being able to answer the questions of the patient as well as meet their expectations was stressful (Fell et al., 2016). Based on these concerns, Davis (2010) suggested that explicit articulation of the curriculum in relation to modern nursing roles was required.

Although McVicar et al. (2015) recommended that first-year studies of bioscience should provide a foundation for progressively complicated material in the following years of training, they reported on a literature review which indicated that first-year students were critical about bioscience content and how it was linked to practice. Student nurses desired more Anatomy and Physiology in their first year (Gale, Ooms, Newcombe, & Marks-Maran, 2015). Craft et al. (2017) suggested that most of the participants in their study felt that biosciences should be taught in the final year and should relate to nursing practice. This also confirmed the hypothesis of Barton et al. (2021) who noted that, compared to more senior students, those students who had just begun their formal nursing studies tended to underrate the relevance of bioscience in clinical practice.

Participants in the study conducted by Mthimunye and Daniels (2018) felt that the pressure would be eased in the second-year level if the workload and modules were equally dispersed across the undergraduate programme equally. In a study conducted by Langtree et al. (2017), participants reflected that if the extensive workload in other modules were to be decreased they

would be able to improve their performance and understanding of Physiology and Anatomy (Langtree et al., 2017).

Of all the modules undertaken by nursing students, Anatomy and Physiology have been identified as the most difficult (White & Sykes, 2012). This was further reported in a more recent quantitative descriptive survey conducted by Langtree et al. (2017), where respondents reflected that if they had learned about Anatomy and Physiology in school, their scores in these modules during training would have been better. Previous negative learning experiences may be associated with the apparent complications in learning bioscience (Smales, 2010), therefore the anxiety experienced by these students could perpetuate their negative perception of bioscience (Craft et al., 2013). Participants noted that they are worried about failure, feel overwhelmed by studying, feel the need to develop study skills to cope with university and commonly feel isolated (Birks et al., 2013). Participants illustrated that their education programmes left them at risk of medication errors (Vaismoradi, Jordan, Turunen, & Bondas, 2014).

2.4.6 Learning environment

The nursing curriculum mandates an educational environment that comprises both practical and theoretical learning settings (Billings & Halstead, 2015). Classroom lectures are perceived as a low-cost way of presenting concepts and the relevance of Human Physiology and Anatomy to a large group of students, and to promote interest in the subject matter (Schwartz, 2014). While the classroom model is largely questioned in literature, a study by Evensen, Brataas, and Cui (2020) revealed that most students indicated classroom lectures were the most efficient

approach for teaching the material, and were generally appreciated. The results of this study showed that 61.4% of students reported that lectures were the most effective teaching method most of the time or all the time, 31.6% of the students felt classroom lectures were a useful learning experience “half of the time”, 3.5% thought that lectures did not work, and 3.5% of the students felt that classroom lectures were of little use (Evensen, Brataas, & Cui, 2020).

Efstathiou and Bailey (2012) argued that large class sizes, particularly in the first academic year where most bioscience units are taught, pose a problem as complex systems need to be explored and the students may lack confidence in the learning process. In addition, current learning and teaching environments are said to inadequately promote quality learning and teaching (Mthimunye & Daniels, 2019).

As technology evolves, higher education institutions have turned their focus to delivered teaching or online resources. Yet students are reported to learn bioscience most effectively when knowledge is related to clinical practice (Davis, 2010). Clinical placements, therefore, afford students the ideal environment in which to link bioscience theory to practice and provide the ideal environment to integrate bioscience into clinical decision making (Fell et al., 2016).

2.5 BIOSCIENCE AND CLINICAL PRACTICE

Clinical practice is another factor that influences the relevance of bioscience (Andrew et al., 2015) and is important to reinforce the relevance of associating bioscience to practice (Logan & Angel, 2011).

2.5.1 Clinical placements and integration

Fell, Dobbins and Dee (2016), and Rafferty and Kyriacos (2016) reported that the clinical environment is arguably the best environment for the application and integration of bioscience knowledge to clinical practice as it gives students a realistic environment in which to apply bioscience theory to practice (Fell et al., 2016). This is evident from results illustrated in the study of Davis (2010) who noted that all participants learned bioscience better when it was associated with their experiences in the workplace. More recently, findings from a study conducted by Craft et al. (2017) show that 82% of the newly qualified registered nurse participants concurred that if the bioscience lecturers had associated their content to clinical practice, it would have strengthened their understanding of bioscience. The participants in their study also felt that there was a disconnection between Pharmacology and biosciences and bioscience and nursing practice (Craft et al., 2017). Despite the importance of associating bioscience with clinical practice, Fell et al. (2016) stated that according to literature, nursing students reported that biosciences were not emphasised during their first- and second-year placements.

Students' learning may also be affected by the increased workload in placements (Molesworth & Lewitt, 2016) and a negative ward culture that devalues the importance of biosciences in placement environments (Fell et al., 2016). Participants also noted that they were expected to do routine and mundane tasks (Fell et al., 2016). In another study, participants said that they were expected to look motivated and enthusiastic in front of other staff and avoid appearing as though they were not contributing enough to the workload (Molesworth & Lewitt, 2016). Participants noted that definite and safeguarded time for bioscience learning was needed in the clinical placement setting (Molesworth & Lewitt, 2016).

2.5.2 Registered nurses in the clinical placement

Participants associated bioscience knowledge with the apparent capability and reliability of the registered nurse they work with (Molesworth & Lewitt, 2016). Working with suitably experienced registered nurses could help to reinforce learning, bridge the theory-practice gap, and improve skills; however, this requires that the registered nurses are confident in their understanding of bioscience (McVicar et al., 2010). Conversely, the quality of learning in the placement may be sabotaged by mentors who have weak understanding or confidence in their knowledge of biosciences (McVicar et al., 2010), and where its importance is not extensively recognized by mentors in placements (Fell et al., 2016). In some cases, qualified staff cannot even explain to patients the biological basis of their illnesses (Smales, 2010). It should not be justifiable for staff nurses to not provide the applied learning that would support students whilst on placement (McVicar et al., 2010). Therefore, McVicar et al. (2010) suggest that improving the confidence of registered nurses in what they know and evolving that knowledge further will provide a better bioscience learning environment in clinical placements.

2.5.3 Clinical mentors and bioscience integration

The mentor's role in assisting students with the application of theoretical knowledge to a specific practical context is very important as in this way knowledge is retained and becomes significantly associated with practice (Davis, 2010). Mentors facilitate students' clinical learning and assess their competence (Rafferty & Kyriacos, 2016). Students said that those mentors who appeared to disregard students' bioscience questions and/or disregard opportunities to test the mentees' knowledge were less effective. Concerns about the bioscience

knowledge of some mentors were also noted (Taylor et al., 2015; Fell et al., 2016). The lack of clinical experience of educators has clear consequences; specifically, the inadequate ability to apply theory to clinical practice (Mortimer-Jones & Fetherston, 2018).

It would seem then that in the practice environment, the integration of theory and practice is left to the learner (Jensen et al., 2018). One focus group participant emphasised that she believed the placement assessment document focussed mentors' attention on the tick boxes of the document instead of the bioscience-related aspects (Fell et al., 2016). Students noted that they have inadequate time to discuss bioscience with their mentors when in the clinical environment (Fell et al., 2016).

2.6 CONCEPTUAL FRAMEWORK (The Bionursing conceptual model)

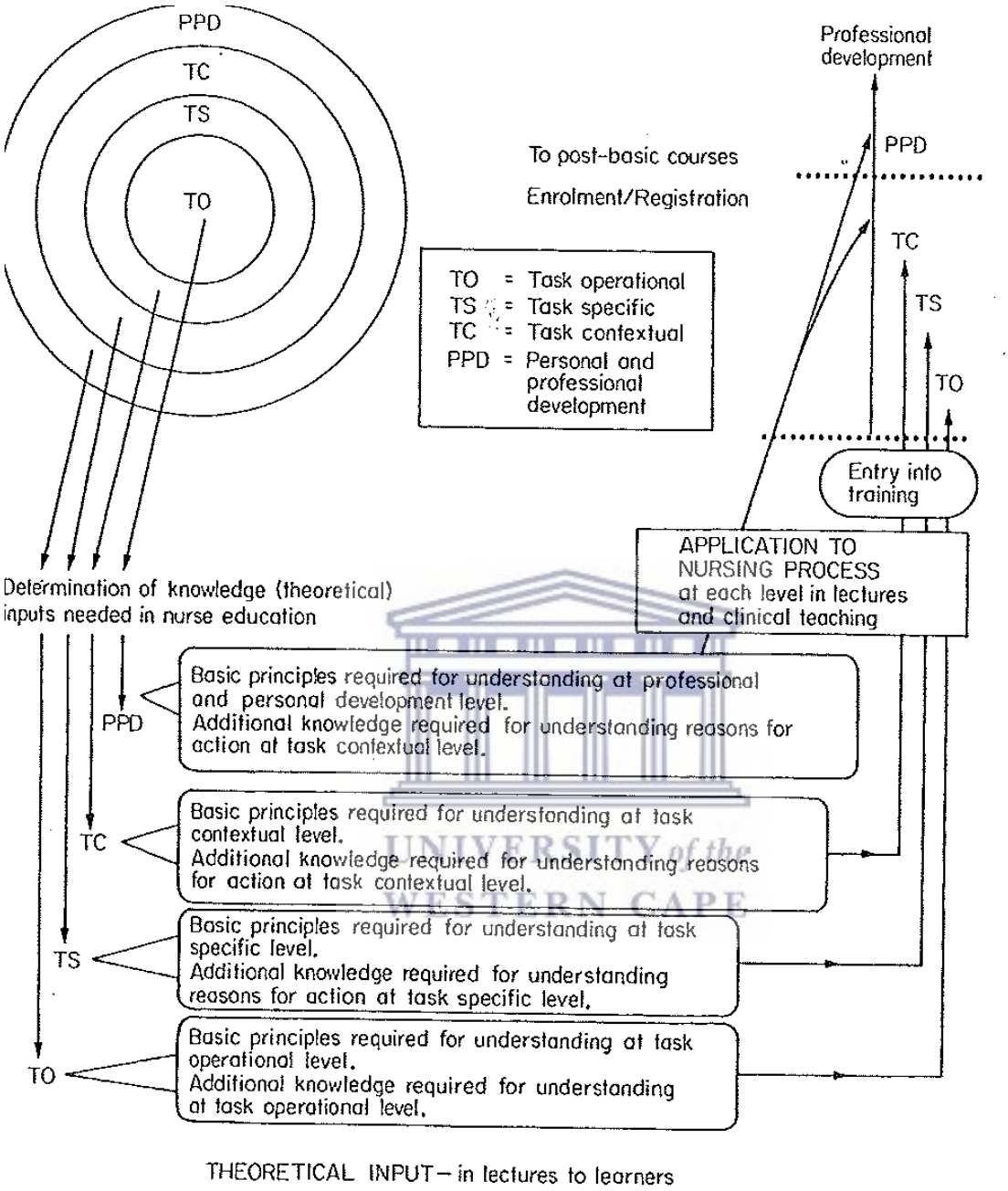


Figure 1.1 Task analysis, a model for linking theory with practice in nursing education (Akinsanya, 1987, page 273).

The conceptual model will be used to guide the analysis of the descriptive items of the questionnaire (items 12.1 and 12.2). Akinsanya (1987) suggested four levels of task

performance. These four levels note the depth of knowledge and understanding of the Life Sciences on which nursing care depends. The levels reflected upon are task operational, task specific, task contextual as well as personal and professional development. Akinsanya's bionursing model will be used as the conceptual model for data analysis for this study.

This theoretical framework was developed for the nursing curriculum as a way of strengthening the Life Science's in nursing curricula (Akinsanya, 1987). The framework was drawn from two approaches namely the 'three-phase theory' of Fitts and Posner (1967) as well as the technique of task analysis regarding component skills and knowledge (Annett & Duncan, 1967; Demaree, 1961; Edney, 1972).

Task operational denotes the activities performed by nurses which do not involve an in-depth knowledge of the biosciences. These are activities that are frequently shared with non-healthcare workers as well as nursing auxiliaries.

Task specific refers to the nurse being required to understand the foundational concepts of Life Sciences such as terms and principles intended for performing particular tasks.

Task contextual level in which the difficulty and depth of knowledge of the Life Sciences become more all-inclusive and the activities of the nurse comprise of more informed decision-making. The nursing activities hinges on accurate knowledge Of Life Sciences for patient safety.

Personal and professional development is the fourth level. This is reached at the end of pre-registration of the undergraduate programme, and permits widespread skills development that necessitates comprehensive familiarity and application of the Life Sciences. The nurse is

required to be capable of rationalizing all actions and is responsible for linking theory to practice.

2.7 SUMMARY

It is well documented that nursing students recognize the importance of biosciences in nursing practice; however, it is evident in numerous literature that learning and teaching challenges are failing to meet the requirements of professional competence in nursing. This chapter discussed the importance of bioscience in nursing practice, the learning and teaching issues in the curriculum as well as in the clinical placement of students.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes the aim, objectives, research questions, research approach and design, research context, study population, sampling method and sample size, inclusion and exclusion criteria, data collection tool, pre-testing of the instrument, reliability and validity of the research tool. The data collection process and data analysis will also be discussed in this chapter.

3.2 AIM

The aim of the study is to investigate the nursing students' self-reported knowledge of bioscience and its relevance to clinical practice.

3.3 OBJECTIVES

The following objectives are formulated to guide the study:

- To establish the nursing students' self-reported knowledge and understanding of bioscience.
- To determine the nursing students' self-rated perceptions of the relevance of bioscience to nursing practice.

3.4 RESEARCH QUESTION

- What are the nursing students' self-reported knowledge and understanding of biosciences?

- What are the nursing students' self-reported perceptions of the relevance of bioscience to their practice?

3.5 RESEARCH METHODOLOGY

3.5.1 Research approach and design

A research approach is defined as a plan and procedure that comprises steps of data collection methods, analysis and interpretation (Chetty, 2016). For this study, a quantitative research approach was employed. According to Gray, Grove and Sutherland (2017), quantitative research is a formal, unbiased, systematic study procedure applied to obtain numerical data to answer a research question. A quantitative design is aimed at examining phenomena that necessitate accurate measurement and quantification; it often involves rigorous and controlled design (Polit & Beck, 2017) and is impartially organized to improve objectivity. This method was used by the researcher to produce quantifiable data to articulate facts and reveal patterns, opinions and attitudes of the undergraduate nursing students related to biosciences and generalise it to the larger population.

A research design refers to the method the researcher selects to answer the research question after taking into consideration the target population, method of data collection, and if required intervention of the (Polit & Beck, 2018). Rigor in quantitative research imparts a great degree of accuracy, consistency and attention to all measurable aspects of research. Thus an appropriate research design is the first step in ensuring a rigorous study aimed at yielding results that are pertinent to the question (Gray et al., 2017). A descriptive survey design was employed to investigate students' self-reported knowledge and understanding of bioscience

and its relevance to practice as well as investigate the issues found in the literature. Descriptive research is aimed at accurately and systematically describing and identifying characteristics, frequencies and trends in a population, situation or phenomenon (McCombes, 2020). This design was employed to determine the problem as well as quantify the results that emerged from the data by means of statistical analysis.

3.5.2 Research context

The research context is the location where a study is conducted. This study was conducted at a university in the Western Cape, South Africa. The university has seven faculties, one of which is the Community and Health Science (CHS) Faculty where the School of Nursing (SoN) is located. This faculty also affords study opportunities in various disciplines such as Physiotherapy, Occupational Therapy, Dietetics, Psychology, Social Work, Sport, Recreation and Exercise Science, Public Health and Natural Medicine (UWC, 2013). The School of Nursing at this institution offers both postgraduate and undergraduate education and training opportunities in nursing. The programmes offered at the institution are recognized by the SANC for registration and are registered with the South African Qualifications Authority (SAQA) (UWC, 2013). The undergraduate training at the identified institution falls under regulation R425 of the SANC. Students are comprehensively trained in General Nursing Science, Community Nursing Science, Midwifery and Psychiatric nursing. Students are required to be competent in the application of Biological Science, Psycho-Social Science, Natural Science and Pharmacology in providing safe nursing care (SANC, 2016). At the time of the study, there were 1005 undergraduate nursing students registered for the undergraduate nursing programme.

3.5.3 Study population

According to Babbie (2011), a study population is the subset of a group from which the study sample is drawn; this forms the focal point from which conclusions are drawn. Polit and Beck (2017) define a population as the entire set of individuals or objects which contains some common characteristics. The target population (N = 758) comprised undergraduate nursing students who have had exposure to bioscience-related modules. This included second-, third- and fourth-year nursing students for the 2020 academic year i.e., 306, 256 and 196 students respectively. This cohort of year levels were specifically chosen by applying the following criterion:

- Nursing students who were currently undertaking bioscience modules;
- Nursing students who had already undertaken bioscience modules and were applying it to practice; or
- Nursing students in their final year of undergraduate nursing programme.

Each group had experience with the bioscience modules and were able to appropriately answer the questions in the questionnaire. A summary of the study population is shown in Table 3.1.

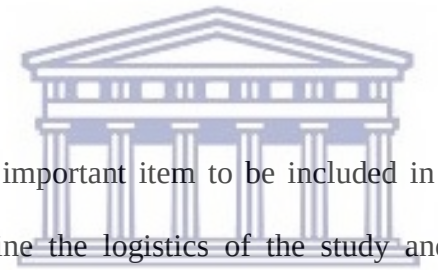
Table 3.1: Summary of the study population

Students per year level	Population (N)
Second year	**306**
Third year	**256**
Fourth year	**196**
TOTAL	**N = 758**

3.5.4 Sampling method and sample size

3.5.4.1 Sampling method

A sample is defined as a subgroup of the population chosen to participate in a study (Polit & Beck, 2017). Sampling is the process of selecting a portion of the population to represent the entire population (Polit & Beck, 2017). Sampling methods can be classified as probability or non-probability sampling. Probability sampling is the selection of sampling units from a population by using random processes, while non-probability sampling emphasises the selection of sampling units from a population based on non-random processes (De Vos, Delport, Fouché, & Strydom, 2011). Simple random sampling was used as the sampling strategy for this study. Elements are at random from a sampling frame (Gray et al., 2017).



3.5.4.2 Sample size

Sample size calculation is an important item to be included in the project to reduce error, respect ethical standards, define the logistics of the study and improve its success rates (Martínez-Mesa, González-Chica, Duquia, Bonamigo, & Bastos, 2016). The sample size equations as noted below revealed that an adjusted sample of 255 was required to represent the population of 758 participants. Two formulas were used to attain the final sample population.

The first equation established the sample size required to represent the population.

$$n = \frac{(p)\,(1\text{-}p)\,(Z)^2}{e^2}$$

n- sample size; p- proportion of target population; Z-95% confidence interval; e-(5%) error rate.

The second equation was used to calculate the adjusted sample size.

$$n_a = \frac{n}{(1 + (n - 1)/N)}$$

n_a- adjusted sample size; N-population size

3.5.4.3 Inclusion criteria

Polit and Beck (2017) define inclusion criteria as a guideline that stipulate the characteristics that the population must have to be considered for inclusion. In order to answer the research question, the researcher uses an inclusion criterion which is defined as the main characteristics of the target population (Patino & Ferreira, 2018). This is to ensure a consistent, uniform and objective selection of the participants (Garg, 2016). Likewise, a well-defined inclusion criterion enhances the internal and external validity of the study by ensuring homogeneity of the sample and reducing the risk of bias (Patino & Ferreira, 2018).

For the purpose of the present study, the sample comprised students who:

- Were registered for the four-year undergraduate nursing programme at UWC.
- Were currently in their second, third and fourth year of the undergraduate nursing programme.
- Had engaged in bioscience and general nursing sciences related modules in the undergraduate nursing programme at the university.
- Had and were repeating bioscience modules.
- Had access to internet resources.

3.5.4.4 Exclusion criteria

An exclusion criterion is defined as the characteristics of the possible study participants who have met the inclusion criteria; however they have features that may interfere with the success of the study and increase the probability of an adverse outcome (Patino & Ferreira, 2018). Unavailable students, i.e., those who had no internet resources or those who were not able to participate in the study on the day of data collection, were excluded from the present study. First year BNur, ECP1 and ECP2 students were excluded from the study as they had not completed the bioscience modules presented in the questionnaire.

3.5.5 Data collection instrument

A data collection instrument is a tool such as a questionnaire in quantitative research used by researchers to collect data in the research process (Ngulube, 2019). The central purpose of a questionnaire in research is to acquire appropriate information in the most reliable and valid manner. Therefore, the accuracy and consistency of the questionnaire is an important characteristic of research methodology which is identified as reliable and valid (Taherdoost, 2016). The study's validity and reliability are discussed in detail in section 3.5.6.

Permission to use and adapt the questionnaire was granted (Appendix 1). This three-part self-administered questionnaire was first used in a study conducted by Kyriacos, Jordan, and Van Den Heever (2005) with the aim of establishing the depth of registered nurses' knowledge and use of biosciences. The questionnaire of Kyriacos et al. (2005) was grounded on preceding research in the United Kingdom (Jordan et al., 1999; Davies, Murphy & Jordan, 2000) on the main concerns described in the published literature on bioscience in nursing education. These

main issues were understanding the biosciences (Davies et al., 2000); learning experiences resulting from the application of theory to practice (Jordan, 1998); and the value and relevance of bioscience to nursing practice (Akinsanya, 1987; Jordan et al., 1999). The questionnaire was later adapted by Rafferty and Kyriacos (2016) to establish the fourth-year student nurses' self-reported knowledge and understanding of the biosciences and their perception of the relevance thereof to clinical practice. Reliability was tested by Rafferty and Kyriacos (2016) by using the Cohen's Kappa test which revealed that raters were all above 0.6. This indicates agreement between the raters (McHugh, 2012).

The questionnaire by Rafferty and Kyriacos (2016) was adapted to fit the study context (Appendix 2). The changes that were made include renaming some of the modules to reflect the bioscience modules that are being offered at the identified institution. The modules were renamed as follows: Anatomy and Physiology to Human Biology, Biophysics to Physics, and Biochemistry to Chemistry. Pharmacology remained unchanged. Items related to Microbiology were removed as Microbiology-related content is covered by various modules throughout the programme and not as a stand-alone module. Demographic questions such as ethnicity and gender were added to the instrument in order to better understand the characteristics of the respondents. The question relating to previous work experience has been changed to previous nursing work experience. The following section will provide a detailed discussion of the contents of the data collection instrument.

The first section comprised demographic items as well as the items to rate the students' understanding of bioscience and its application to practice. Data pertaining to demographics included age, gender, ethnic group and previous nursing experience which allowed the researcher to determine the characteristics of the study population. To meet the first objective,

the respondents' understanding of bioscience was examined using a 3-point Likert scale. The rating was operationalised as follows: superficial understanding = 3; adequate understanding = 2; deep understanding = 1. Item 8 used a 5-point Likert scale to rate the students' self-reported level of understanding of the application of bioscience to practice.

The respondents' knowledge of bioscience was examined in part one, item 9, where respondents were required to rate which subject during their undergraduate training they would have preferred more information. In part two, respondents were required to describe a critical incident from their experience and explain how their bioscience knowledge had ensured a satisfactory patient outcome.

To meet the second objective, part one (item 10) required respondents to rate the relevance of each bioscience subject to practice using a 3-point Likert scale. The rating was operationalised as follows: Not relevant = 3; Relevant = 2; Essential = 1. Additionally, part 3 (items 13.1 to 13.3) of the questionnaire was used to determine the nursing students' perceptions of the relevance of bioscience to nursing practice. The picture interpretations illustrated nursing activities and respondents had to rate their perceptions of the relevance of bioscience to each scenario (Binary-Relevant = 1 or Not relevant = 0).

The section involving the picture interpretation included qualitative questions relating to the reasons for their responses for the relevance or irrelevance of the modules in the activity presented to students. This qualitative section was removed as it did not fit the scope of the study.

3.5.6 Reliability and validity of the research instrument

De Vos et al., (2011) define a pre-test of a research instrument as a procedure for testing and validating an instrument by administering it to a small group of participants from the intended test population. A pre-test of the questionnaire was done on a small group of students prior to data collection. Polit and Beck (2017) denote a pre-test as an experimental administration of a recently developed instrument in order to recognize possible weaknesses as well as to determine whether the instrument is useful in generating desired information. Twelve (12) undergraduate nursing students who met the inclusion criteria were recruited to participate in the pre-testing of the questionnaire.

3.5.6.1 Reliability

Reliability refers to the extent to which a measurement of a phenomenon provides stable and consistent results (Taherdoost, 2018). Reliability occurs in degrees and is typically expressed as a correlation coefficient with 1.00 demonstrating perfect reliability and 0.00 demonstrating no reliability (Gray et al., 2017). Internal consistency describes the extent to which all the items in a test measure the same concept or construct (Mohsen, 2011). Cronbach's alpha is a measure used to assess the reliability, or internal consistency, of a set of scale or test items (Goforth, 2015). According to Javali (2011), Cronbach's alpha coefficients range from 0.00, demonstrating no internal consistency or reliability, to a coefficient of 1.00, demonstrating perfect internal consistency or reliability with no measurement error. An acceptable reliability score is one that is 0.7 and higher (Taber, 2018).

It was noted that the Likert-scale rating was inconsistent for item 7.1 to 7.4. These inconsistencies were also reflected when testing the Cronbach's alpha coefficient which

resulted in a negative value due to a negative average covariance amongst items. The inconsistencies were corrected in question 7 by adopting the following scale: deep understanding = 1; adequate understanding = 2; superficial understanding = 3.

No questions were removed from the adapted instrument as all questions reflected a Cronbach's alpha score of α=<0.8. After corrections, Cronbach's alpha revealed acceptable reliability of α=0.843.

3.5.6.2 Validity

The validity of an instrument determines the degree to which the instrument actually measures what it is supposed to measure (Polit & Beck, 2017). The appropriateness and accuracy of the questionnaire was checked with face validity and content validity. McLeod (2013) maintains that face validity is revealed by testing whether the purpose of the instrument is clear, in other words it is the assessment of whether it is appropriate, sensible and unambiguous (Oluwatayo, 2012). Face validity was measured by the two supervisors (who are both experts in learning and teaching) to ensure the accuracy of the instrument. Content validity addresses the extent to which items of an instrument adequately represent the content being measured (Zamanzadeh et al., 2015). The researcher submitted the questionnaire to two experts in the field of nursing education: the supervisor and co-supervisor. The research instrument was refined and grammatical errors were corrected. When students were asked to reflect on their experience and understanding of the questionnaire, no issues were noted. The students fully understood the questions they were being asked, and they answered appropriately.

3.5.7 Data collection process

Data collection is defined as a systematic method of gathering and measuring information from different sources to get a comprehensive and precise depiction of an area of interest (McLaughlin, 2020). Data was collected from second-, third- and fourth-year undergraduate nursing students during September and October 2020 at the School of Nursing at the University of the Western Cape. A self-administered questionnaire was used to collect data.

Following the selection of the sample (n = 255) from the target population (N = 758), the researcher, with the help of two research assistants, approached students who were willing to participate in the study. Due to the COVID-19 pandemic and regulations implemented to reduce the spread of infection, student numbers were limited therefore multiple sessions were required to reach the target sample population. Completed questionnaires included consent forms which students signed, inserted into envelopes and placed in boxes.

3.5.8 Data analysis

Data were cleaned, coded and captured on Microsoft Excel Version 2016 spreadsheets before being exported to IBM Statistical Package for Social Sciences version 26 (IBM SPSS-26) for analysis. Invalid data points and incorrect entries were corrected or removed and organised under their respective categories. A statistician was consulted for statistical support throughout the data analysis process. Descriptive and inferential statistics were used to analyse the data. Pairwise deletion according to Kang (2013) is defined as a method which removes information only when a specific data-point required to test a particular assumption is missing; if there is missing data elsewhere in the data set, remaining values are used in the analysis. Pairwise

deletion was used to manage missing data. The frequency of responses and proportions were described for all open-ended questions.

3.5.8.1 Descriptive statistics

Descriptive statistics were used to describe nursing students' demographics, knowledge and understanding of bioscience and its relevance to practice. For descriptive statistics, the measure of central tendency, proportion and percentage were used to analyse all data collected. Min-max was analysed for age to show measures of dispersion. These results are presented and interpreted in tables, frequencies and percentages.

3.5.8.2 Inferential statistics

According to Plichta, Kelvin and Munro (2013), inferential statistics (Chi-squared test) are performed based on the sample data to draw conclusions and make inferences about a population. A Chi-squared test was performed on SPSS to discover if there was a relationship between year level and any of the categorical/ordinal variables: *analyse, descriptive statistics, crosstabs.* The p-value for significance was set at 0.05 (McLeod, 2019). Four pre-listed bioscience modules were indicator variables for the ordinal 3-point rating scale, ordinal 5-point rating scale and the binary questions.

3.5.8.3 The Bionursing Framework by Akinsanya

For the items relating to the critical incident (item 12.1 and item 12.2), students were asked to describe one incident which fitted into one of four categories in Akinsanya's (1987) Bionursing Framework (task operational, task specific, task contextual, and personal and professional

development). Students were required to provide reasons for relevance/non-relevance of bioscience modules with regards to monitoring a patient's heart rate, blood pressure and temperature. Responses were analysed using frequency and proportion.

3.6 ETHICS

Gray et al. (2017) note that when doing research, the researcher's purpose should always be ethical; this requires the protection of the rights of participants and others within the setting. Ethical clearance (HS20/2/4) was sought from the University of the Western Cape's Humanities and Social Sciences Research Ethics Committee (Appendix 3). The researcher requested permission to conduct the study at the School of Nursing at the University of the Western Cape from the Registrar and Director of the School of Nursing (Appendix 4). Permission to conduct the study at UWC was granted by the Registrar of the University (Appendix 5) as well as the Director of School of Nursing (Appendix 6). On commencement of the study, the researcher provided a comprehensive explanation of the objectives of the study to the prospective participants and stated their role in the study; this is included in the participants' information sheet (Appendix 7) as well as the consent form (Appendix 8). The selected study population consisted of adults and they were informed that they might withdraw at any time during the study without discrimination or prejudice. The principles of beneficence and non-maleficence were ensured as the research was conducted under the supervision of an experienced supervisor. Anonymity occurs if the participants' identity cannot be connected to their responses at any point during the research study (Ryerson University, 2017). Students' identification such as name, contact details and student numbers were not reflected in the study. All data were kept in a safe and secure place to maintain confidentiality and will be destroyed after five years (Gray et al., 2017). Data will be made available upon request to researchers.

3.7 SUMMARY

This chapter described the methodology that was employed in the study. The research process and pre-testing and use of the data collection instrument was discussed. Ethical considerations were explained.

CHAPTER 4

RESULTS AND INTERPRETATION

4. 1. INTRODUCTION

This chapter presents the results and interpretation of the descriptive and inferential statistics. Pairwise deletion was performed when managing missing data. Akinsanya's (1987) Bionursing Framework was used to guide the analysis of the respondents' description of an experienced critical incident where perception of bioscience knowledge was required in the incident (Section 4.3.5).

4.2. DESCRIPTION OF THE POPULATION AND SAMPLE

The adjusted sample size for 255 participants was calculated based on the population size of 758 students. Of the 255 questionnaires that were distributed, 211 questionnaires were completed, resulting in an 82.74% response rate. The SPSS analysis for the description of the sample population is shown in Appendix 9.

4.2.1 Respondents per year level

The respondents' distribution per year level is shown in Table 4.1. Of the 211 responses, one missing response was observed and excluded from the analysis. The majority of respondents were in their third year (46.19%), followed by second-year students (36.19%), and lastly the fourth-year students (17.62%).

Table 4.1: Description of respondents per year level

Year level	Population (N)	Sample (n)	Percentage (%)
Second year	306	76	36.19%
Third year	256	97	46.19%
Fourth year	196	37	17.62%
Missing	0	1	0.47%
Total	**758**	**211**	**100%**

4.2.2 Age distribution

At the time the questionnaires were completed, the youngest student was 18 years old and the oldest was 44 years old. The median age of the respondents was 21 years while the mean age was 22 with a standard deviation (SD) of 3.508. The distribution of age is illustrated in Table 4.2.

Table 4.2 Respondents' age distribution

	Minimum	maximum	Median	Mean	SD
Age	18	44	21	22.38	3.508

4.2.3 Gender and ethnicity [1]

For the respondents' gender distribution, data revealed that out of 211 responses, 167 (79.15%) were females, making them the most represented gender of the sample group. As expected, the male students were the minority and were represented by 44 (20.85%) respondents. Analysis

[1] Statistics South Africa continues to classify people into population groups, since moving away from the past apartheid-based discrimination. This classification uses a population-based group.

of the ethnical diversity among the study respondents revealed that the sample was dominated by 144 (68.25%) black students followed by 54 (25.59%) coloureds, 11 (5.21%) white students, and lastly 2 students (0.95%) who classified themselves as Indian. The distribution of gender and ethnicity is illustrated in Table 4.3.

Table 4.3 Respondents' gender and ethnicity distribution

Ethnicity	Female	Male
Black	106	38
Coloured	48	6
Indian	2	0
White	11	0
Total	**167 (79.15%)**	**44 (20.85%)**

4.2.4 Previous nursing work and nursing qualification

Data analysis revealed that 208 (98.58%) respondents had no previous qualification in nursing while only 3 (1.42%) respondents indicated a previous nursing qualification. Likewise, 206 (97.63%) respondents did not have previous nursing work experience, while 5 (2.37%) respondents indicated having previous experience in nursing work. Data of previous nursing experience and qualifications are illustrated in Table 4.4.

Table 4.4 Previous nursing work and nursing qualifications

	Previous nursing work	Previous Nursing qualification
No	206 (97.63%)	208 (98.58%)
Yes	5 (2.37%)	3 (1.42%)

4.3. The results of Chi-squared tests

A Chi-squared test was used to answer the research questions and to address the study objectives. Sections 4.3.1, 4.3.2, 4.3.3 and 4.3.5 respond to the first objective while sections 4.3.4 and 4.3.6 respond to the second objective of the study.

4.3.1. Respondents' self-reported understanding of biosciences

Data for the respondents' self-reported understanding of bioscience are presented in Table 4.5. For respondents' understanding of bioscience, coding was operationalised as follows: Superficial understanding = 3; Adequate understanding = 2; Deep understanding = 1. Missing responses were excluded from the analysis. An example of the SPSS analysis is shown in Appendix 10.

4.3.1.1. Human Biology

For Human Biology, a total of 209 responses were analysed. There were two missing values. Of the 209 responses, 107 (51.20%) respondents indicated adequate understanding, 81 (38.76%) reported deep understanding, and lastly 21 (10.05%) reported superficial understanding. The results of the Chi-squared test indicated no statistical significance between the respondents' year level and their self-reported understanding of Human Biology (χ^2=8.100 (df 4), $p>0.05$). Additionally, the results revealed that understanding of Human Biology is not dependent upon level of study, even though students gain more experience and knowledge as they progress through the undergraduate programme.

4.3.1.2. Physics

There were 210 responses with one missing value. Among the responses, 103 (49.05%) respondents reported having adequate understanding, 61 (29.05%) reflected having superficial understanding and 46 (21.9%) reported deep understanding. No statistical significance was noted between the respondents' year level and their self-reported understanding of Physics (χ^2=6.118 (df 4), p>0.05). These results indicate that understanding of Physics is not dependent upon the student's year level even though they gain more experience and knowledge as they progress through the undergraduate programme.

4.3.1.3. Chemistry

For Chemistry, 210 responses were analysed and one missing value was excluded from the analysis. Of the 210 responses, 103 (49.05%) of the respondents reported adequate understanding, 63 (30%) reported superficial understanding and 44 (20.95%) reported deep understanding. No statistical significance between the respondents' year level and self-reported understanding of Chemistry was noted (χ^2=7.679 (df 4), p>0.05). These results suggest that the respondents' understanding of Chemistry is not dependent upon their year level as evidenced by superficial to adequate rating.

4.3.1.4 Pharmacology

For Pharmacology, there were 209 responses with two missing values. Of the reported responses, 134 (64.11%) respondents reported adequate understanding of Pharmacology, 43 (20.57%) indicated superficial understanding and 32 (15.31%) deep understanding. No statistical significance was noted between respondents' year level and their self-reported understanding of Pharmacology (χ^2=5.857 (df 4), p>0.05). The results revealed that the majority of respondents have adequate to deep understanding; this could be explained as the representative population are third-year students who are repeating or have completed the

Pharmacology module and are applying it to practice. In contrast, the results of the Chi-squared test revealed that understanding of Pharmacology is not dependent upon students' year level even though they gain more experience and knowledge as they progress through their studies.

Table 4.5 Respondents' self-reported level of understanding of bioscience

Subject	Superficial understanding n (%)	Adequate understanding n (%)	Deep understanding n (%)	χ^2 (df) = 4	p-value
Human biology (n=209)	21 (10.05%)	107 (51.20%)	81 (38.76%)	8.100	.088
Physics (n=210)	61 (29.05%)	103 (49.05%)	46 (21.9%)	6.118	.190
Chemistry (n=210)	63 (30%)	103 (49.05%)	44 (20.95%)	7.679	.104
Pharmacology (n=209)	43 (20.57%)	134 (64.11%)	32 (15.31%)	5.857	.210

4.3.2 Respondents' self-reported understanding of the application of bioscience theory to practice

Respondents were required to rate their perceived level of understanding of the application of bioscience theory to practice. Coding was operationalised as follows: Very poor = 5; Poor = 4; Adequate = 3; Good = 2; Very good = 1. Missing responses were excluded from this analysis. The statistical results of respondents' self-reported understanding of the application of bioscience theory to practice is illustrated in Table 4.6. The SPSS data analysis is shown in Appendix 11.

4.3.2.1. Human Biology

The majority of respondents reported their understanding of the application of Human Biology theory to practice as ranging between 86 (40.76%) good and 84 (39.81%) very good respectively, while a small group of 2 (0.95%) respondents reported poor and 1 (0.47%) very poor understanding of the application of Human Biology theory to practice. These findings suggest that overall the respondents understood the application of Human Biology theory in practice. Chi-squared test results showed no statistical significance between the respondents' self-reported understanding of the application of Human Biology theory to practice and their year level (χ^2=5.248 (df 8), p>0.05). This indicates that the respondents' understanding of the application of Human Biology is not associated with the respondents' year level.

4.3.2.2. Physics

For Physics, no missing responses were noted. The majority of respondents, 80 (37.91%), reported their understanding of the application of Physics to practice to be adequate; this was followed by 63 (29.86%) with good understanding and 36 (17.06%) poor understanding, while the 23 (10.90%) minority reported very good understanding, and lastly 9 (4.27%) respondents reported very poor understanding of the application of Physics to practice. Overall, it is observed that the respondents reported an understanding of the application of Physics to practice. No statistical significance (χ^2=3.955 (df 8), p>0.05) was noted between the respondents' understanding of the application of Physics theory to practice and their year level. Therefore, these results indicate that respondents' application of Physics to practice is not dependent on their year level.

4.3.2.3. Chemistry

Among 211 responses, 85 (40.28%) respondents reported having adequate understanding of the application of Chemistry to practice; this was followed by 59 (27.96%) respondents who

reported a good understanding, 31 (14.69%) respondents who reported a poor understanding, 26 (12.32%) respondents who reported a very good understanding, and lastly 10 (4.74%) respondents who reported a very poor understanding. This evidence suggests that the majority of respondents have an understanding of the application of Chemistry to practice. The Chi-squared test results indicated no statistical significance (χ^2=5.127 (df 8), p>0.05) between the respondents' self-reported understanding of the application of Chemistry theory to practice and their year level. The results therefore suggest that the respondents' understanding of the application of Chemistry to practice is not dependent on their year level.

4.3.2.4. Pharmacology

Among 211 responses, respondents reported their understanding of the application of Pharmacology to practice as ranging from 88 (41. 71%) good to 55 (26.97%) very good, whilst the minority of respondents reported 10 (4.74%) poor and 4 (1.90%) very poor understanding of Pharmacology to practice. The evidence therefore suggests that overall the respondents have an understanding of the application of Pharmacology to practice. The Chi-squared test results show no statistical significance (χ^2=5.427 (df 8), p>0.05) between the respondents' self-reported understanding of the application of Pharmacology theory to practice and their year level. Although descriptive evidence suggests respondents understand the application of Pharmacology to practice, inferential results indicate that it is not associated with their year level.

Table 4.6 Respondents' self-reported understanding of the application of bioscience theory to practice

Subject	Very poor n (%)	Poor n (%)	Adequate n (%)	Good n (%)	Very good n (%)	χ^2 (df)=8	p-value
Human biology (n=211)	1 (0.47%)	2 (0.95%)	38 (18.01%)	86 (40.76%)	84 (39.81%)	5.248	.731
Physics (n=211)	9 (4.27%)	36 (17.06%)	80 (37.91%)	63 (29.86%)	23 (10.90%)	3.955	.861
Chemistry (n=211)	10 (4.74%)	31 (14.69%)	85 (40.28%)	59 (27.96%)	26 (12.32%)	5.127	.744
Pharmacology (n=211)	4 (1.90%)	10 (4.74%)	54 (25,59%)	88 (41.71%)	55 (26.07%)	5.427	.711

4.3.3 Respondents' self-reported knowledge of bioscience modules per year-level

Respondents were required to rate which subject they would have liked more information in their undergraduate training programme (Yes/No). Missing responses were excluded from the analysis. The results in Table 4.7 suggests that 144 (70.24%) of respondents would have liked more information on Human Biology and 185 (88.94%) would have liked more information on Pharmacology. Interestingly, the results also suggest that 142 (70.65%) respondents and 118 (59%) respondents would have not wanted Physics and Chemistry in their training respectively. These results indicates that respondents do not see the relevance of Physics and Chemistry in nursing practice. The Chi-squared test shows no significant association between respondents' knowledge of bioscience modules and their year level ($p>0.05$). The SPSS data analysis is shown in Appendix 12.

4.3.3.1. Human biology

For the analysis of Human Biology, there were 6 (2.84%) missing values. Therefore, 205 responses were analysed. Among the reported responses, 144 (70.24%) respondents indicated that they would have wanted more Human Biology in their training whereas 61 (29.76%) respondents would have not wanted more Human Biology in their training. The Chi-squared test results show no statistical significance (χ^2=.117 (df 2), p>0.05) between respondents' knowledge in Human Biology and their year level. These results indicate that the majority of respondents require more information in Human Biology. This may be due to an increase in demand for deeper knowledge for Human Biology as they progress through the undergraduate programme. This result is confirmed by the study of Barton et al. (2021) where study findings suggest that nursing students reported a desire for more bioscience as they progressed through the year levels. However, the results also indicated that the need for more information in Human Biology is not associated with the respondents' year level.

4.3.3.2. Physics

For Physics there were 10 (4.37%) missing values, thus 201 responses were analysed. Among the responses, 142 (70.65%) respondents indicated they did not want more Physics in their training whereas 59 (29.35%) respondents indicated they would have liked more Physics in their training. No statistical significance (χ^2=.428 (df 2), p>0.05) was noted between the respondent's self-reported knowledge in Physics and their year level. These results indicate that majority of respondents would not have liked more information on Physics. This may be due to students not enjoying the module as they may not see its relevance in nursing practice. The Chi-squared test indicate that their disinclination for Physics knowledge is not associated with their year level.

4.3.3.3. Chemistry

For Chemistry, there were 11 (5.21%) missing values, thus 200 responses were analysed. Among the reported responses, 118 (59.00%) did not want more Chemistry in their training, while 82 (41%) respondents indicated they would have liked more Chemistry in their undergraduate training. The Chi-squared test results show no statistical significance (χ^2=5.540 (df 2), p>0.05) between respondents' self-reported knowledge in Chemistry and their year level. The results indicate that majority of respondents would not have liked more information on Chemistry. This may be due to students not enjoying the module as they may not see its relevance in nursing practice. Nevertheless, the Chi-squared test results indicate that their disinclination for Chemistry information is not associated with their year level.

4.3.3.4. Pharmacology

For Pharmacology, there were 3 (1.42%) missing values and therefore 208 responses were analysed. Among the reported responses, 185 (88.94%) respondents indicated they would have liked more Pharmacology in their training, whereas 23 (11.06%) indicated they did not want more Pharmacology in their undergraduate training. The Chi-squared test results show no statistical significance (χ^2=2.474 (df 2), p>0.05) between the respondents' self-reported knowledge in Pharmacology and their year level. The results indicate that majority of respondents would have preferred more information on Pharmacology. This may be due to an increase in demand for deeper knowledge for Pharmacology as they progress through the undergraduate programme. Nevertheless, the Chi-squared test results indicate that their enthusiasm for more information in Pharmacology knowledge is not associated with their year level.

Table 4.7 Respondents' self-rated knowledge

Subject	Yes n (%)	No n (%)	χ^2 (df)=2	p-value
Human biology (n=205)	144 (70.24%)	61 (29.76%)	.117	.943
Physics (n=201)	59 (29.35%)	142 (70.65%)	.428	.807
Chemistry (n=200)	82 (41.00%)	118 (59.00%)	5.540	.063
Pharmacology (n=208)	185 (88.94%)	23 (11.06%)	2.474	.290

4.3.4 Respondents' rating of the relevance of bioscience modules to nursing practice.

Respondents were required to rate the degree of relevance of bioscience modules to nursing practice (Not relevant; Relevant; Essential). The respondents' rating of the relevance of bioscience modules to practice coding was operationalised as follows: Not relevant = 3; Relevant = 2, Essential = 1. An example of the SPSS data analysis is shown in Appendix 13. Responses in Table 4.8 summarise the perception of bioscience modules relevance to nursing practice.

4.3.4.1. Human Biology

For Human Biology, 3 (1.42%) missing responses were noted and removed from the analysis, therefore a total of 209 responses were analysed and reported. Of the responses that were analysed and reported, 175 (83.73%) respondents rated the relevance of Human Biology to nursing practice as essential, 31 (14.83%) rated Human Biology to be relevant and 3 (1.44%) rated Human Biology as not relevant to nursing practice. Overall results indicate that the respondents perceived the degree of relevance of Human Biology to be essential to nursing practice. The Chi-squared test results showed no statistical significance (χ^2=5.001 (df 4),

p>0.05) between the respondents' rating of the relevance of Human Biology to practice and their year level. The results indicate that majority of respondents felt that Human Biology was essential to nursing practice. The Chi-squared test results indicates that the respondents' perception of the significance of Human Biology to nursing practice is not associated with their year level.

4.3.4.2. Physics

For Physics, 2 (0.94%) missing responses were noted and excluded from the analysis therefore a total of 209 responses were analysed and reported. Among the responses, 129 (61.72%) respondents rated Physics to be relevant to practice, 51 (24.40%) rated it not relevant, and 29 (13.88%) rated Physics to be essential to nursing practice. Evidence indicates that the majority of respondents felt that Physics was relevant to practice however, it is concerning that more respondents rated Physics not relevant to nursing practice when compared to essential to nursing practice as the majority of respondents are assumed to have completed the module. The Chi-squared test results show no statistical significance (χ^2=1.781 (df 4), p>0.05) between the respondents' rating of the relevance of Physics to practice and their year level. The results indicate that the majority of respondents felt that Physics was relevant to nursing practice. Nonetheless, the Chi-squared test results indicate that the respondents' perception of the relevance of Physics to nursing practice is not associated with their year level.

4.3.4.3. Chemistry

For Chemistry, a total of 2 (0.94%) missing responses were noted and excluded from the analysis, thus only 209 responses were analysed and reported. Among the responses, 133 (63.64%) respondents rated the subject to be relevant to nursing practice, 38 (18.18%) respondents rated Chemistry to be essential to practice and 38 (18.18%) respondents rated the subject not relevant. The Chi-squared test results shows no statistical significance (χ^2=1.114

(df 4), p>0.05) between respondents' rating of the relevance of Chemistry to practice and their year level. The evidence therefore shows that the majority of respondents felt that Chemistry was relevant to nursing practice. However, the Chi-squared test results indicates that the respondents' perception of the relevance of Chemistry to nursing practice is not associated with their year level.

4.3.4.4. Pharmacology

For Pharmacology, 1 (0.47%) missing response was noted and excluded from the analysis, thus only 210 responses were analysed. Among the analysed responses, 181 (86.19%) respondents rated the subject to be essential to practice, 24 (11.43%) rated the subject relevant to practice and 5 (2.38%) respondents rated the subject as not relevant. The Chis-square test results shows no statistical significance (χ^2=3.623 (df 4), p>0.05) between the respondents' rating of the relevance of Pharmacology to practice and their year level. The evidence therefore shows that the respondents predominantly perceived Pharmacology to be essential to nursing practice. However, the Chi-squared test results indicate that the respondents' perception of the significance of Pharmacology to nursing practice is not associated with their year level.

Table 4.8 Respondents' self-rated perception of bioscience modules relevance to nursing practice.

Subject	Not relevant n (%)	Relevant n (%)	Essential n (%)	χ^2 (df)=4	p-value
Human biology (n=209)	3 (1.44%)	31 (14.83%)	175 (83.73%)	5.001	.287
Physics (n=209)	51 (24.40%)	129 (61.72%)	29 (13.88%)	1.781	.776
Chemistry (n=209)	38 (18.18%)	133 (63.64%)	38 (18.18%)	1.114	.892
Pharmacology (n=210)	5 (2.38%)	24 (11.43%)	181 (86.19%)	3.623	.459

4.3.5 Respondents' description of an experienced critical incident and perception of bioscience knowledge required in the incident

Respondents' descriptions of a specific critical incident from their experience where the application of their bioscience knowledge and understanding was required to ensure good outcomes for the patient were analysed for frequency of responses as well as the practicality of bioscience. An example is shown in Appendix 14. Akinsanya's (1987) Bionursing model was used to analyse and quantify the data according to task levels namely: Task operational, Task-specific, Task contextual, and Personal and Professional Development. A total of 136 (64.4%) responses were noted during the analysis of a description of critical incident and practicality of bioscience. 3 (2.20%) were invalid due to the form of responses given, 2 (1.4%) responded with uncertainty and 2 (1.4%) responses were not clarified/clear. Of the total participants who responded, 54 (39.70%) were rated at task operational, 57 (41.91%) at task specific, 16 (11.76%) at task contextual and 2 (1.4%) at personal and professional development. The analysis of respondents' description of a specific critical incident from their experience according to the Akinsanya's (1987) Bionursing model task levels coding was operationalised as follows:

4.3.5.1 Task operational

Activities performed by nurses which do not require an in-depth knowledge of the biosciences. These tasks are often shared with members of the public or nursing auxiliaries. The following concepts were derived from the analysis for task operational: Basic knowledge of medication (n=22; 40.74%); knowledge of anatomy and physiology of the body (n=16; 29.62%); knowledge of vital signs (n=8; 14.81%); explaining procedures (n=3; 5.55%); reporting

incidents (n=2; 3.70%); stopping bleeding (n=2; 3.70%); and knowledge of cardiac compressions (n=1; 1.85%).

4.3.5.2. Task specific

The nurse is required to have an understanding of the foundational concepts of the life sciences such as terms and principles aimed at carrying out specific tasks. The following concepts were derived from the analysis for task specific: understanding administration of medication, its risks, contraindications and pharmacokinetics (n=19; 33.33%); understanding the rationale for actions (n=18; 31.57%), understanding Anatomy and Physiology concepts (n=16; 28.07%), and understanding the importance of procedures/monitoring (n=4; 7.01%).

4.3.5.3. Task contextual

The nurse is required to have deep knowledge and understanding of biosciences and is required to be capable of applying its concepts to activities performed. The following concepts were derived from the analysis for task contextual: applying bioscience concepts to problem-solving (n=8; 50%), knowledge of physiological responses to certain procedures (n=4; 25%), knowledge evaluation after a specific task (n=2; 12.5%), and understanding risks (n=2; 12.5%).

4.3.5.4. Personal and professional development

Bioscience application facilitates extensive skills development as it requires in-depth knowledge and application of the Life Sciences. The nurse must be able to rationalize every action and take responsibility for linking theory with practice. The following concepts were derived from the analysis for personal and professional development: Understanding the consequences of actions and applying actions to prevent them (n=1; 50%), and scientifically rationalizing actions (1; 50%).

4.3.6 Respondents' perception of the relevance of bioscience for monitoring heart rate, blood pressure and temperature.

Respondents were required to rate the relevance of bioscience to the specific task indicated in the picture interpreted (monitoring a patient's heart rate, monitoring a patient's blood pressure, monitoring a patient's temperature). SPSS analysis was used to analyse the self-rated responses, and reasons for relevance was analysed by frequency of responses. Table 4.9 summarises the respondents' perception of the relevance of bioscience to monitoring a patient's heart rate.

4.3.6.1 Respondents' perception of the relevance of bioscience for monitoring heart rate

Respondents were required to rate their perception of the relevance of bioscience to monitoring a patient's heart rate (Relevant=1; Not relevant=0). The SPSS data analysis is shown in Appendix 15. For monitoring a patient's heart rate, the quantitative data analysis results illustrated that 206 (99.52%) and 138 (70.41%) respondents perceived Human Biology and Pharmacology as relevant respectively. On the contrary, 112 (60.54%) and 126 (68.85%). respondents rated Chemistry and Physics as not relevant. The Chi-squared test results shows no significance ($p>0.05$) between the respondents' rating of the relevance of bioscience modules in monitoring a patient's heart rate and respondents' year level.

4.3.6.1.1 Human biology

For Human Biology, 4 (1.89%) missing responses were noted and excluded from the analysis and therefore 207 responses were analysed and reported. Of the reported responses, 206 (99.52%) respondents indicated Human Biology to be relevant to monitoring a patient's heart rate whereas only 1 (0.48%) respondent indicated that Human Biology was not relevant to monitoring a patient's heart rate. The Chi-squared test results shows no statistical significance ($\chi^2=4.745$ (df 2), $p>0.05$) between respondents' rating of respondents' perception of the

relevance/non-relevance of Human Biology in monitoring a patient's heart rate and their year level. The evidence, therefore, indicates that respondents predominantly perceived Human Biology to be relevant in monitoring a patient's heart rate. However, the Chi-squared test results indicate that the respondents' perception of the relevance of Human Biology to monitoring a patient's heart rate is not associated with their year level.

4.3.6.1.2. Physics

For Physics, only 185 responses were analysed and reported as 26 (12.32%) missing responses were noted and thus excluded from the analysis. Of the reported responses, 112 (60.54%) respondents indicated Physics to be not relevant whereas 73 (39.46%) indicated Physics to be relevant for monitoring a patient's heart rate. The Chi-squared test results shows no statistical significance (χ^2=4.642 (df 2), p>0.05) between the respondents' perception of the relevance/non-relevance of Physics in monitoring a patient's heart rate and their year level. The evidence therefore indicates that more than half of the study population perceived Physics as not relevant in monitoring a patient's heart rate. However, the Chi-squared test results indicate that the respondents' perception of the significance/insignificance of Physics to monitoring a patient's heart rate is not associated with their year level.

4.3.6.1.3. Chemistry

For Chemistry, 28 (13.27%) missing responses were noted and excluded from the analysis and therefore only 183 responses were analysed and reported. Of the reported responses, 126 (68.85%) respondents indicated Chemistry to be not relevant whereas 57 (31.15%) indicated that it was relevant for monitoring a patient's heart rate. The Chi-squared test results shows no statistical significance (χ^2=2.7966 (df 2), p>0.05) between the respondents' perception of the relevance/non-relevance of Chemistry in monitoring a patient's heart rate and their year level. The evidence therefore indicates that more than half of the sample perceives Chemistry as not relevant in monitoring a patient's heart rate. However, the Chi-squared test results indicate that

the respondents' perception of the insignificance of Chemistry in monitoring a patient's heart rate is not associated with their year level.

4.3.6.1.4. Pharmacology

For Pharmacology a total of 15 (7.10%) missing responses were noted and excluded from the analysis; therefore 196 responses were analysed and reported. Of the 196 reported responses, 138 (70.41%) respondents indicated the relevance of Pharmacology to monitoring a patient's heart rate whereas 58 (29.59%) indicated Pharmacology to not be relevant in monitoring a patient's heart rate. The Chi-squared test results shows no statistical significance (χ^2=3.581 (df 2), p>0.05) between the respondents' perception of the relevance/non-relevance of Pharmacology in monitoring a patient's heart rate and their year level. Evidence therefore suggests that respondents predominantly felt that Pharmacology was relevant to monitoring a patient's heart rate. However, the Chi-squared test results indicates that the respondents' perception of the relevance of Pharmacology to monitoring a patient's heart rate is not associated with their year level.

Table 4.9: Respondents' self-rated perception of the relevance of bioscience to monitoring a patient's heart rate

Subject	Relevant n (%)	Not relevant n (%)	χ^2 (df)=2	p-value
Human Biology (n=207)	206 (99.52%)	1 (0.48%)	4.745	.093
Physics (n=185)	73 (39.46%)	112 (60.54%)	4.642	.098
Chemistry (n=183)	57 (31.15%)	126 (68.85%)	2.7966	.247
Pharmacology (n=196)	138 (70.41%)	58 (29.59%)	3.581	.167

4.3.6.2 Respondents' perception of the relevance of bioscience for monitoring blood pressure

For monitoring a patient's blood pressure, the quantitative data analysis results illustrated that 206 (99.52%) and 149 (76.02%) respondents perceived Human Biology and Pharmacology as relevant respectively. Conversely, 95 (50.53%) and 113 (61.41%) respondents perceived Physics and Chemistry as not relevant. Data in Table 4.10 indicated that the Chi-squared test results shows a significant association (χ^2=6.871 (df 2), $p<0.05$) between Chemistry for monitoring a patient's blood pressure and the year level of respondents. Nonetheless, the Chi-squared test results shows no significance ($p>0.05$) between Human Biology, Physics and Pharmacology and the respondents' year level.

4.3.6.2.1 Human Biology

For Human biology, 4 (1.89%) missing responses were noted and excluded from the analysis therefore a total of 207 responses were analysed and reported. Of the 207 respondents, 206 (99.52%) respondents indicated Human Biology to be relevant, 1 (0.48%) respondent indicated Human Biology as not relevant to monitoring a patient's blood pressure. The Chi-squared test results shows no statistical significance (χ^2=1.151 (df 2), $p>0.05$) between the respondents' year level and their perception of the relevance/non-relevance of Human Biology in monitoring

a patient's blood pressure. Evidence therefore indicates that the respondents predominantly felt that Human Biology is relevant to monitoring a patient's blood pressure. Nevertheless, the Chi-squared test results indicate that the respondents' perceived relevance of Human Biology to monitoring a patient's blood pressure is not associated with their year level.

4.3.6.2.2. Physics

For Physics, 23 (10.90%) missing responses were excluded from the analysis; therefore, a total of 188 responses were analysed and reported. Of the reported responses, 95 (50.53%) respondents reported Physics as not relevant, while 93 (49.47%) reported Physics as relevant to monitoring a patient's blood pressure. The Chi-squared test results shows no statistical significance (χ^2=0.407 (df 2), p>0.05) between the respondents' year level and their perception of the relevance/non-relevance of Physics in monitoring a patient's blood pressure. The evidence, therefore, indicates that more than half the respondents perceive Physics as not relevant to monitoring a patient's blood pressure. However, the Chi-squared test results indicate that the respondents' perception of the irrelevance of Physics when monitoring a patient's blood pressure is not associated with their year level.

4.3.6.2.3. Chemistry

Among the responses, 27 (12.79%) missing responses were noted and excluded from the analysis and therefore 184 were analysed and reported. Of the reported responses, 71 (38.59%) respondents rated Chemistry relevant, whereas 113 (61.41%) respondents rated the subject not relevant to monitoring a patient's blood pressure and this was statistically significant (p<0.05). This indicates that there is a significant association (χ^2=6.871 (df 2), p<0.05) between the respondents' perception of Chemistry being irrelevant in monitoring a patient's blood pressure and the year level of the respondent. Results indicates that the respondents predominantly felt that Chemistry is not relevant to monitoring a patient's blood pressure and therefore this is statistically significant.

4.3.6.2.4. Pharmacology

Out of the 211 respondents, 15 (7.10%) missing responses were noted and excluded from the analysis, therefore only 196 responses were analysed and reported. Of the reported responses, 149 (76.02%) respondents indicated Pharmacology to be relevant, and 47 (23.98%) respondents indicated Pharmacology not relevant to monitoring a patient's blood pressure. The Chi-squared test results shows no statistical significance (χ^2=4.129 (df 2), p>0.05) between the respondents' year level and their perception of the relevance/non-relevance of Pharmacology in monitoring a patient's blood pressure. The evidence therefore indicates that the respondents predominantly felt that Pharmacology was relevant to monitoring a patient's blood pressure. However, the Chi-squared test results indicate that the respondents' perception of the relevance of Pharmacology to monitoring a patient's blood pressure is not associated with their year level.

Table 4.10 Respondents' self-rated perception of the relevance of bioscience to monitoring a patient's blood pressure

Subject	Relevant n (%)	Not relevant n (%)	χ^2 (df)=2	p-value
Human Biology (n=207)	206 (99.52%)	1 (0.48%)	1.151	.562
Physics (n=188)	93 (49.47%)	95 (50.53%)	0.407	.816
Chemistry (n=184)	71 (38.59%)	113 (61.41%)	8.871	.032
Pharmacology (n=196)	149 (76.02%)	47 (23.98%)	4.129	.127

4.3.6.3 Respondents' perception of the relevance of bioscience for monitoring temperature

Respondents were required to rate their perception of the relevance of bioscience to monitoring a patient's temperature (Relevant=1; Not relevant=0). The SPSS data analysis is shown in Appendix 15. For monitoring a patient's temperature, the quantitative data analysis results

illustrated that 200 (97.09%) and 145 (73.98%) respondents perceived Human Biology and Pharmacology as relevant respectively. This was followed by 105 (55.85%) for Chemistry and lastly 104 (55.91%) for Physics. In Table 4.11 the Chi-squared test results shows no significance ($p>0.05$) between bioscience modules in monitoring a patient's temperature and the respondents' year level.

4.3.6.3.1. Human biology

For Human Biology, 5 (2.36%) missing responses were noted and excluded from the analysis, therefore 206 responses were analysed and reported. Of the reported responses, 200 (97.09%) respondents indicated Human Biology to be relevant, and 6 (2.91%) indicated that Human Biology was not relevant to monitoring a patient's temperature. There was no statistical significance ($\chi^2=1.189$ (df 2), $p>0.05$) between the respondents' year level and their perception of the relevance/non-relevance of Human Biology in monitoring a patient's temperature. The evidence therefore indicates that the respondents predominantly felt that Human Biology was relevant to monitoring a patient's temperature. Nonetheless, the Chi-squared test results indicate that the respondents' perception of the relevance of Human Biology to monitoring a patient's temperature is not associated with their year level.

4.3.6.3.2. Physics

For Physics, 25 (11.84%) missing responses were noted and excluded from the analysis, therefore only 186 responses were analysed and reported. Of the reported responses, 104 (55.91%) respondents indicated Physics to be relevant, and 82 (44.09%) respondents indicated Physics was not relevant to monitoring a patient's temperature. The Chi-squared test results shows no statistical significance ($\chi^2=2.551$ (df 2), $p>0.05$) between the respondents' perception of the relevance/non-relevance of Physics in monitoring a patient's temperature and respondents' year level. Evidence suggests that more than half of the population felt that Physics is relevant to monitoring a patient's temperature. Nonetheless, the Chi-squared test

results indicate that the respondents' perception of the relevance of Physics to monitoring a patient's temperature is not associated with their year level.

4.3.6.3.3. Chemistry

For Chemistry, a total of 23 (10.90%) missing responses were noted and excluded from the analysis, therefore only 188 responses were analysed and reported. Of the reported responses, 105 (55.85%) respondents indicated Chemistry to be relevant, and 83 (44.15%) respondents indicated Chemistry not relevant to monitoring a patient's temperature. The Chi-squared test results shows no statistical significance (χ^2=4.491 (df 2), p>0.05) between the respondents' perception of the relevance/on-relevance of Chemistry in monitoring a patient's temperature. Evidence suggests that just over half the sample population felt that Chemistry is relevant to monitoring a patient's temperature. Nonetheless, the Chi-squared test results indicate that the respondents' perception of the relevance of Chemistry to monitoring a patient's temperature is not associated with their year level.

4.3.6.3.4 Pharmacology

For Pharmacology, a total of 15 (7.10%) missing responses were noted and excluded from the analysis; therefore only 196 responses were analysed and reported. Of the reported responses, 145 (73.98%) respondents indicated Pharmacology as relevant, and 51 (26.02%) respondents indicated Pharmacology not relevant to monitoring a patient's temperature. The Chi-squared test results shows no statistical significance (χ^2=2.935 (df 2), p>0.05) between the respondents' perception of the relevance/non-relevance of Pharmacology in monitoring a patient's temperature. Results indicates that the respondents predominantly felt that Pharmacology is relevant to monitoring a patient's temperature. Nonetheless, the Chi-squared test results indicate that the respondents' perception of the relevance of Pharmacology to monitoring a patient's temperature is not associated with their year level.

Table 4.11 Respondents' self-rated perception of the relevance of bioscience to monitoring a patient's temperature

Subject	Relevant n (%)	Not relevant n (%)	χ^2 (df)=2	p-value
Human Biology (n=206)	200 (97.09%)	6 (2.91%)	1.189	.552
Physics (n=186)	104 (55.91%)	82 (44.09%)	2.551	.279
Chemistry (n=188)	105 (55.85%)	83 (44.15%)	4.491	.106
Pharmacology (n=196)	145 (73.98%)	51 (26.02%)	2.935	.230

4.7 SUMMARY

This chapter reported the descriptive findings of the study using tables. Furthermore, the results of the Chi-squared test conducted to assess the statistical differences were presented. This chapter also presented the respondents' experienced critical incidents where bioscience knowledge was used. Additionally, the respondents' self-reported reasons for the relevance/non-relevance of bioscience in monitoring a patient's vital signs are presented in the chapter. The results of the present study indicated that majority of respondents were female black students, with the average age of 22 years. The majority of respondents were in their third year of training in the undergraduate nursing programme. The overall majority of the population had no prior nursing experience or a nursing qualification. The findings of the present study suggests that the respondents generally have a better understanding of Human Biology and Pharmacology than of Physics and Chemistry. Furthermore, the findings indicated that respondents felt that Human Biology and Pharmacology are more relevant to nursing practice than Physics and Chemistry.

CHAPTER 5

SUMMARY OF FINDINGS, DISCUSSION, LIMITATIONS, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Chapter 5 presents the discussion of results, conclusion and recommendations based on scientific evidence that emerged from the study. The limitations as well as recommendations for future research are also presented in the chapter. The following objectives and research questions guided the study:

5.1.1 Objectives

- To establish the nursing students' self-reported knowledge and understanding of biosciences.
- To determine the nursing students' self-rated perceptions of the relevance of bioscience to nursing practice.

5.1.2 Research question

- What are the nursing students' self-reported knowledge and understanding of biosciences?
- What are the nursing students' self-reported perceptions of the relevance of bioscience to their practice?

5.2 SUMMARY OF FINDINGS

The aim of the study was to investigate the nursing students' self-reported knowledge of biosciences and its relevance to clinical practice. The results indicated that the participants' age was between 18-44 years. The mean age of the study population was 22 years. The majority of students were female, and the minority male; the demographics of the study showed that ethnic distribution of participants was predominantly black, followed by coloured. Generally, the participants had no nursing experience or nursing qualifications prior to taking the course. The participants were either in the process of undertaking the bioscience modules for the first time, repeating bioscience modules or had completed their bioscience modules. The majority of students were in their third year of study.

Registered nurses are required to have adequate understanding of biosciences as a foundation for safe and effective clinical practice (Fawcett et al., 2016). However, it is noted that nursing students and registered nurses acknowledged their difficulties in understanding the biosciences that support nursing care (McVicar et al., 2015). Students in the present study have self-reported their knowledge of bioscience to be adequate but it is evident in this study that they find Physics and Chemistry to be irrelevant. This could be due to poor integration of these subjects into nursing practice. Furthermore, it is concerning that many students could not rationalise their reasons for the relevance/non-relevance of bioscience modules with regards to monitoring a patient's vital signs. This lack of rationalisation indicates a poor knowledge of bioscience, poor integration and poor decision-making skills. The following section will compare the study findings with the published findings.

5.3 DISCUSSION OF STUDY FINDINGS

5.3.1 Self-reported knowledge of bioscience

Bioscience in nursing education comprises a wide-ranging set of disciplines and is the foundation of clinical assessments and critical thinking in nursing practice (Barton et al., 2021b). Bioscience knowledge is arguably the backbone of nursing practice and its value cannot be overlooked (Andrew et al., 2015; Gordon et al., 2017; Montayre et al., 2019). A quantitative study conducted in Australia with a sample size of 126 final year nursing students reported that the majority of the participants acknowledged that bioscience underpins nursing practice (Gordon et al., 2017). Similar findings, particularly for Human Biology and Pharmacology, were noted in the study. The majority of respondents indicated that they would have liked to have more Human Biology and Pharmacology in their undergraduate training; this ranged from 144 (70.24%) and 185 (88.94%) for Human Biology and Pharmacology respectively. Interestingly, the same cannot be said about Physics and Chemistry. The findings revealed that 142 (70.65%) and 118 (59.00%) of the respondents had no desire to gain more information for Physics and Chemistry respectively. These students placed more importance on Human Biology and Pharmacology than Physics and Chemistry in their undergraduate training.

Another concern is that academics may not be giving these subjects the necessary attention. In an Australian cross-sectional survey conducted by Birks, Ralph, Cant, Hillman and Chun Tie (2015) with 30 academics who teach science to nursing students, the results of the study revealed that academics rated Microbiology, Chemistry and Physics as a moderate priority, and topics related to biomechanics of movement were given low ranking. Thus, if academics do not prioritize these subjects, it is clear that the students will not see the need to gain more knowledge in these modules.

5.3.2 Self-reported understanding of bioscience

A clear understanding of Anatomy, Physiology and Biochemistry is vital for understanding the physiology of the human body as well as the pathophysiology of illness and diseases (Jensen et al., 2018). It is therefore important for nurses to understand bioscience as their responsibilities in general are increasing (Fell et al., 2016). According to Fell et al. (2016) understanding of bioscience enhances clinical reasoning and ultimately patient care/outcomes. Regrettably, literature reveals that nursing students perceive science to be the most strenuous course of the programme and that they struggle to understand bioscience (Craft et al., 2013).

The results of the present study revealed that the majority of respondents reported an adequate level of understanding of bioscience modules. Their self-reported adequate level of understanding ranged from 103 (49.05%) for both Physics and Chemistry, 107 (21.20%) for Human Biology, and the highest response rate was Pharmacology with 134 (64.11%). Nevertheless, evidence suggests that newly qualified nurses have self-rated limited knowledge and understanding of bioscience (Andersson & Edberg, 2010; McVicar, Clancy, & Mayes, 2010; Kemsley et al., 2011; Craft et al., 2016). A study by McVicar et al. (2010) further reported that newly qualified nurses only gained this limited knowledge and understanding of bioscience once they were qualified (McVicar, Clancy, & Mayes, 2010).

The findings also revealed that the respondents' understanding of Physics, Chemistry and Pharmacology was superficial rather than deep. This result is to be expected as results in a comparative study of Simonsen et al. (2014) indicated that the practising nurses' medication knowledge was better than that of graduate nurses and they had a lower risk of error, yet even the experienced nurses had insufficient skills to guarantee safe medication for patients. The findings of a replica study conducted by Caboral-Stevens et al. (2020) showed that undergraduate nursing students have insufficient understanding of Pharmacology and there is

evidence of increased risk of error. Secondly, nursing students have found the study of Chemistry to be one of their key challenges in a nursing programme (Boddey & de Berg, 2015).

On the contrary, 81 (38.76%) respondents reported deep understanding of Human Biology. These findings are unsurprising as unlike the other bioscience subjects, biology is a compulsory requirement for admission into the nursing programme, thus most students relate more to this subject than to the other bioscience subjects. This is evident as a cross-sectional survey conducted by Gordon et al. (2017) revealed that the respondents with any secondary school science subject reported more confidence with learning bioscience and were able to relate bioscience to nursing practice. Furthermore, in a quantitative study by Ndwambi and Roets (2020), results illustrated a significant association between a background knowledge of secondary school Biology and the academic achievement in the Biological Science module. This is validated by the study by Clifton and Mckillup (2016), where nursing students expressed a high level of interest in understanding how the human body works.

In the present study, respondents rated their understanding of the application of Human Biology and Pharmacology to be good; however, they rated their understanding of the application of Physics and Chemistry to be adequate. This is in contrast to the argument of Davis (2010) who notes that even though nursing students and experienced nurses appreciate the bioscience knowledge they require, they do not apply it well in clinical practice.

Research also indicates that nursing students found biochemistry to be one of the most difficult subjects (Hassan et al., 2012); nevertheless, the respondents under study reported having an adequate understanding of Chemistry in nursing practice. There is a paucity of research-based evidence regarding students' self-reported understanding of the application of Physics in nursing practice. Contrary to the findings of the present study, final year undergraduate nursing

students in the study of Rafferty and Kyriacos (2016) reported their understanding of Physics and Chemistry to be superficial.

5.3.3 Relevance of bioscience theory to practice

Similar to the study of Davis (2010) and Rafferty and Kyriacos (2016), Physiology was perceived as essential for a comprehensive undergraduate nurse education. In the present study, Human Biology 175 (83.73%), and Pharmacology 181 (86.19%) were perceived as essential to practice by the respondents. In addition, Physics 129 (61.72%) and Chemistry 133 (63.64%) were perceived as not relevant to nursing practice. This is supported by similar findings where undergraduate nursing students have provided strong agreement that bioscience is highly relevant for nursing practice (McVicar et al., 2010; Montayre et al., 2019; Taylor et al., 2015). Furthermore, during discussions in a focus group with seven nursing students, conducted by Molesworth & Lewitt (2016), it became evident that the students emphasized the importance of bioscience to clinical practice. Students in the study noted the relation between theory and practice; they felt learning was reinforced when a clinical scenario was given from practice; and furthermore, they emphasised the importance of a competent practitioner understanding bioscience, particularly for patient safety, rationale for actions, and health education. In a cross-sectional survey conducted in a study by Khan & Hood (2018), students acknowledged that Pharmacology education was pivotal and was indeed relevant to nursing practice. The results of the present study further support that nursing students perceive Pharmacology subject as essential for nursing practice.

Although a cross-sectional survey conducted by Birks et al. (2018) suggests that registered nurses perceived subjects related to Anatomy, Physiology and Pathophysiology as highly relevant to nursing practice, the need to understand the principles of Chemistry which underpin

these subjects is often overlooked (Brown & Naiker, 2018). This clear gap may be the key to why more students reported Physics and Chemistry as not being relevant to nursing practice even though the general participant population found bioscience subjects important. Students' attitudes towards the value of science are constantly changing and when students find science problematic, they perceive it as less valuable to nursing practice (Crane & Cox, 2013). This was further substantiated by Andrew, McVicar, Zanganeh and Henderson (2015) who noted that students with lower expectations and self-efficacy cannot see the relevance of bioscience to practice. If nursing students disregard the importance and relevance of bioscience to their future role it might have consequences for the standard of their practice (Rafferty & Kyriacos, 2016).

5.3.3.1 Relevance of bioscience in monitoring heart rate, blood pressure and temperature

Throughout the undergraduate years of training, the most frequently assigned task for nursing students is to monitor a patient's physiological vital signs in numerous clinical disciplines (Alshehry, Cruz, Bashtawi, Almutairi, & Tumala, 2021). Nurses are required to determine the patient's condition by means of measuring and interpreting patients' vital signs. Nurses need good knowledge of bioscience to identify, understand and respond safely to deviations in a patient's health status (Kelly, Forber, Conlon, Roche, & Stasa, 2014). Respondents in the present study were required to self-rate the relevance of the four pre-listed bioscience modules to monitoring a patients' heart rate, blood pressure and temperature. The findings of this study denotes that the link between Human Biology and Pharmacology to monitoring a patient's vital signs is considered by the majority of respondents to be relevant, thus substantiating previous ratings of the relevance of these modules. It is concerning that the respondents do not find Physics and Chemistry relevant with regards to monitoring a patient's vital signs. This

confirmed that Physics and Chemistry were regarded as irrelevant to nursing practice. This is possibly due to various reasons including the lecturer's inability to explain the application of these modules to practice; the lecturer's inadequate knowledge on these modules and poor explanation of integration in nursing; and the segregation of modules which has led to students' perception that Physics and Chemistry are separate from nursing. In a cross-sectional survey conducted by Birks et al. (2015), science lecturers rated the subjects Chemistry and Physics as moderate to low priority. This suggests that the perception is reflected through the students.

The outcome of the students' perceptions of the relevance of bioscience subjects to monitoring a patient's heart rate, blood pressure and temperature is concerning for nursing education and practice because the evidence of inadequate knowledge of biosciences therefore poses a risk to patient safety.

5.3.3.2 Perception of bioscience knowledge required in critical incident

Of the total study population that responded, most 57 (41.91%) respondents seemed to perform at task specific, which suggest that these respondents understand basic concepts and application of the principles of bioscience. This was followed by 54 (39.70%) respondents who performed at task operational which suggests that these respondents understand nursing work which does not require an in-depth knowledge of bioscience. Lastly, 16 (11.76%) respondents performed at task contextual suggesting an in-depth knowledge of bioscience with decision making and only 2 (1.4%) performed at professional development on the Akinsanya's Bionursing model. The majority appear to perform at task specific suggesting basic knowledge and understanding of bioscience concepts to clinical practice. This could possibly be attributed to the interruption of their clinical exposure due to violence such as country-wide protests as well as the COVID-19 pandemic. During the period of the study, students were not allowed in placements and

therefore their clinical learning was disadvantaged. Ekstedt, Lindblad and Löfmark (2019) noted that students' experiences of clinical education is relevant as this impacts their chances of relating the theoretical part of studies with clinical practice. The majority of respondents were in their second and third year and ought to be functioning between task specific and task contextual. However, study findings indicates that the respondents understand the basic concepts of bioscience.

5.4 LIMITATIONS TO THE STUDY

Study limitations are any restrictions which are out of the researcher's control and which affect the research design, results and conclusion of the study; these limitations should be acknowledged in the paper (Theofanidis & Fountouki, 2018).

Even though the questionnaire was completed anonymously, unanswered questions were noted during data analysis. Specifically, where students were asked to report a critical incident, missing data was noted for 75 responses. The target population was not met due to the impact and unprecedented circumstances of the COVID-19 pandemic: the researcher had limited access to students due to protocols that were put in place to prevent the spread of the virus. The research was only performed at one Higher Education Institution and not stratified, therefore results cannot be generalised to other institutions.

5.4 CONCLUSION

The aim of the study was to investigate the nursing students' self-reported knowledge of biosciences and its relevance to clinical practice. The Akinsyana's Bionursing model was used to analyse the data. A total of 211 respondents participated in the present study. Study findings

indicate that the majority of respondents were females and in their third year of their undergraduate nursing programme with the mean age of 22 years. As expected, over 95% of the respondents had no previous nursing work experience or nursing qualification.

Objective 1:

- To establish the nursing students' self-reported knowledge and understanding of biosciences.

The results of the present study illustrate that between 49% to 50% of respondents have self-reported adequate understanding of Human Biology, Pharmacology, Physics and Chemistry. The findings also suggest that 20% to 30% of the respondents have superficial understanding of Physics, Chemistry and Pharmacology. Taken together, the study concludes that the students' understanding of Physics, Chemistry and Pharmacology ranges between superficial and adequate while their understanding of Human Biology ranges between adequate and deep.

Of the participants who responded, 40.76% - 41.71% respondents rated good understanding of the application of Human Biology and Pharmacology to nursing practice respectively. Furthermore, only 37.91% - 40.28% of respondents rated adequate understanding of the application of Physics and Chemistry to nursing practice. Overall, respondents' understanding of the application of Human Biology and Pharmacology ranges between adequate and good. For Physics and Chemistry, respondents' self-reported understanding of the application ranged between poor and good.

Study findings for respondents' self-rated knowledge indicates that over 70% of respondents would have liked more Human Biology and Pharmacology in their undergraduate training. Conversely, over 50% of respondents were disinclined towards more information on Physics

and Chemistry. This concludes that respondents would have preferred more information on Human Biology and Pharmacology than Physics and Chemistry.

Study findings indicate that the majority of respondents seemed to perform at task specific (n=57, 41.91%); this was followed by task operational (n=54, 39.70%), task contextual (n=16, 11.76%) and lastly by those (n=2, 1.4%) who performed at personal and professional development. These findings indicate that the majority of respondents have foundational knowledge of bioscience and are familiar with bioscience terms and concepts when carrying out a task.

Objective 2:

- To determine the nursing students' self-rated perceptions of the relevance of bioscience to nursing practice.

Over 80% of respondents rated Human Biology and Pharmacology as essential to nursing practice, whereas over 60% respondents rated Physics and Chemistry as relevant to practice. 18.18% to 24.40% rated Physics and Chemistry as not relevant to nursing practice.

Although Physics and Chemistry were reported as relevant by the majority of respondents, this was disproven in their responses in monitoring a patient's heart rate, blood pressure and temperature where the majority of respondents rated Physics and Chemistry as not relevant for monitoring a patient's vital signs.

To conclude, the majority of respondents find Human Biology and Pharmacology relevant to essential to nursing practice and they appear to have greater understanding of these modules. Nevertheless, study findings indicate that the respondents have superficial to good understanding of Physics and Chemistry and poor to adequate understanding of its application

to nursing practice; the majority of the respondents rated the subjects as not relevant to nursing practice and for monitoring a patient's vital signs.

5.5 RECOMMENDATIONS

5.5.1 For nursing education and nursing education institutions

Nurse educators should investigate ways to improve the integration of bioscience to nursing practice. This can be done through a collaborative approach involving nursing educators working closely with bioscience lecturers (especially Physics and Chemistry) to provide the best solution for this problem (Taylor et al., 2015). Alternatively, nurse educators should teach bioscience subjects to nursing students to facilitate their knowledge, understanding and application to nursing practice. Leonard and Kyriacos (2015) recommended that biological modules should include the MEWS (modified early warning score) for understanding abnormal physiology before students are exposed to the clinical environment.

The need for additional mentor training and bioscience education is highlighted along with greater incorporation of bioscience in practice assessments (Fell et al., 2016). Regular workshops should be provided for nurse educators and clinical supervisors to promote innovative learning and teaching strategies (Mthimunye & Daniels, 2018). The academic staff need to establish closer links with practice so that learners can immediately identify the relevance of bioscience content and the practice placement reality (Jensen et al., 2018). In addition, Devi, Mayya, Bairy, George and Mohan (2013) suggested that Pharmacology be taught in the clinical area as this method was preferred over tedious lectures that lacked dynamic learning.

McVicar et al., (2010) maintained that learning outside the practice environment is vital; therefore, examples from practice should be introduced into the classroom environment. It was suggested that students' needs could be met by implementing various methods to visualise and interrelate with the content (Johnston et al., 2015). Furthermore, the implementation of bioscience learning or workshops during the final year of the undergraduate programme would enhance knowledge before students become registered nurses.

The admission requirements for the nursing programme should be reviewed to include high school mathematics, physical science, and chemistry. Alternatively, prospective students with this high school subject should be given first priority for admission in the nursing programme. This will be beneficial for the student as they will have a background and understanding of the subjects and can apply it to nursing practice.

A theory-practice gap emerged from the present study. Nursing management in the clinical setting should collaborate with nurse education institutions to provide a platform for learning and opportunities for students to facilitate the application of bioscience knowledge to practice under direct supervision of the registered nurse. The student should not be viewed as a member of the workforce; instead, they are in the clinical setting to prepare for their forthcoming role as registered nurses. The clinical setting ought to be a place for students to apply the bioscience theory to practice. This will therefore improve students' attitude to learning the subjects and allow them to understand the association between theory and practice of bioscience.

5.5.2 Recommendations for future research

The researcher recommends further research on the subject to assess where improvement of curriculum is needed. Furthermore, it would be beneficial to conduct a follow up qualitative

study to identify specific problems and determine the perceptions and self-reported knowledge for each year level.

Further research needs to be conducted on:

- How nurse educators can make a clear link between bioscience and nursing practice.
- The measures that need to be taken by clinical areas and nurse educators to bridge the theory practice gap.
- The measures nurse educators can implement to ensure students' understanding of bioscience (Physics and Chemistry) and its application to nursing practice.
- Innovative methodologies to enhance learning and teaching of bioscience in nursing education.

References

Akinsanya, J. A. (1987). The life sciences in nursing: development of a theoretical model. *Journal of Advanced Nursing*, *12*(3), 267–274.

Akpata, T. V. (2012). Assessing student nurses' knowledge of microbiology for course content improvement. *Middle East Journal of Nursing*, *101*(342), 1–6.

Alshehry, A. S., Cruz, J. P., Bashtawi, M. A., Almutairi, K. O., & Tumala, R. B. (2021). Nursing Students' Knowledge, Competence and Attitudes towards Vital Signs Monitoring during Clinical Practice. *Journal of Clinical Nursing*, *30*(5–6), 664–675. https://doi.org/10.1111/JOCN.15586

Andersson, P. L., & Edberg, A.-K. (2010). The nursing programme in the rear-view mirror. Interviews with Swedish nurses one year after their graduation. *Nurse Education Today*, *30*(8), 747–751.

Andrew, S., & Mansour, M. (2014). Safeguarding in medication administration: Understanding pre-registration nursing students' survey response to patient safety and peer reporting issues. *Journal of Nursing Management*, *22*(3), 311–321. https://doi.org/10.1111/jonm.12134

Andrew, S., McVicar, A., Zanganeh, M., & Henderson, N. (2015). Self-efficacy and relevance of bioscience for nursing, midwifery and healthcare students. *Journal of Clinical Nursing*, *24*(19–20), 2965–2972. https://doi.org/10.1111/jocn.12933

Annett, J., & Duncan, K. D. (1967). *Task analysis and training design.* Journal of Occupational Psychology, 41, 211-221.

Babbie, E. R. (2011). *Introduction to social research*. Wadsworth Cengage learning.

Bakon, S., Craft, J., Christensen, M., & Wirihana, L. (2016). Can active learning principles be applied to the bioscience assessments of nursing students? A review of the literature. *Nurse Education Today*. https://doi.org/10.1016/j.nedt.2015.11.030

Barton, M. J., Bentley, S., Craft, J., Dupen, O., Gordon, C., Cayanan, E. A., … Johnston, A. N. (2021a). Nursing students' perceptions of clinical relevance and engagement with bioscience education: A cross-sectional study of undergraduate and postgraduate nursing students. *Nurse Education Today*, *99*(May 2020), 104767. https://doi.org/10.1016/j.nedt.2021.104767

Billings, D. M., & Halstead, J. A. (2015). *Teaching in nursing-e-book: A guide for faculty*. Elsevier Health Sciences. St. Louis.

Birks, M., Cant, R., Al-Motlaq, M., & Jones, J. (2011). I don't want to become a scientist": undergraduate nursing students' perceived value of course content. *Australian Journal of Advanced Nursing*, *28*(4), 20–27.

Birks, M., Chapman, Y., Ralph, N., McPherson, C., Eliot, M., & Coyle, M. (2013).

Undergraduate Nursing Studies: The First-Year Experience. *Journal of Institutional Research*, *18*(1), 26–35.

Birks, M., Ralph, N., Cant, R., Chun Tie, Y., & Hillman, E. (2018). Science knowledge needed for nursing practice: A cross-sectional survey of Australian Registered Nurses. *Collegian*. https://doi.org/10.1016/j.colegn.2017.05.005

Birks, M., Ralph, N., Cant, R., Hillman, E., & Chun Tie, Y. (2015). Teaching science content in nursing programs in Australia: A cross-sectional survey of academics. *BMC Nursing*, *14*(1), 1–9. https://doi.org/10.1186/s12912-015-0074-x

Boddey, K., & de Berg, K. (2015). The impact of nursing students' prior chemistry experience on academic performance and perception of relevance in a health science course. *Chemistry Education Research and Practice*, *16*(2), 212–227.

Bourbonnais, F. F., & Caswell, W. (2014). Teaching successful medication administration today: More than just knowing your 'rights.' *Nurse Education in Practice*, *14*(4), 391–395.

Brown, S. J., & Naiker, M. (2018). Attitude to the Subject of Chemistry in Nursing and Health Science Undergraduate Students. *International Journal of Innovation and Research in Educational Sciences*, *5*(2), 2349–5219.

Caboral-Stevens, M., Ignacio, R. V, & Newberry, G. (2020). Undergraduate nursing students' pharmacology knowledge and risk of error estimate. *Nurse Education Today*, *93*, 104540.

Cambridge Oxford Dictionary. (n.d.). UNDERSTANDING | meaning in the Cambridge English Dictionary. Retrieved November 4, 2021, from https://dictionary.cambridge.org/dictionary/english/understanding

Capponi, N., & Barber, L. A. M. (2020). Undergraduate nursing program admission criteria: A scoping review of the literature. *Nurse Education Today*, 104519.

Casey, G. (1996). Analysis of Akinsanya's model of bionursing. *Journal of Advanced Nursing*, *23*(6), 1065–1070.

Chetty, P. (2016). Importance of research approach in a research | Knowledge Tank. Retrieved October 11, 2019, from https://www.projectguru.in/publications/selecting-research-approach-business-studies/

Christensen, M., Craft, J., Wirihana, L., & Gordon, C. (2015). Pathophysiology team teaching: Bioscientist contribution to knowledge integration in a nursing subject. *Journal of Clinical Nursing*, *24*(23–24), 3739–3741.

Clarke, M. (1995). Nursing and the biological sciences. *Journal of Advanced Nursing*, *22*(3), 405–406.

Clifton, I. D., & McKillup, S. C. (2016). Why such success? Nursing students show consistently high satisfaction with bioscience courses at a regional university. *Australian Journal of Advanced Nursing*, *33*(3), 21–28.

Craft, J. A., Hudson, P. B., Plenderleith, M. B., & Gordon, C. J. (2016). Registered nurses' reflections on bioscience courses during the undergraduate nursing programme: an exploratory study. *Journal of Clinical Nursing*, *26*(11–12), 1669–1680. https://doi.org/10.1111/jocn.13569

Craft, J. A., Christensen, M., Shaw, N., & Bakon, S. (2017). Nursing students collaborating to develop multiple-choice exam revision questions: A student engagement study. *Nurse Education Today*, *59*(July), 6–11. https://doi.org/10.1016/j.nedt.2017.08.009

Craft, J., Hudson, P., Plenderleith, M., Wirihana, L., & Gordon, C. (2013). Commencing nursing students' perceptions and anxiety of bioscience. *Nurse Education Today*, *33*(11), 1399–1405.

Crane, J. W., & Cox, J. L. (2013). More than just a lack of knowledge: A discussion of the potential hidden-impact of poor pre-enrolment science background on nursing student success in bioscience subjects. *International Journal of Innovation in Science and Mathematics Education*, *21*(2), 26–36.

Davies, S., Murphy, F., & Jordan, S. (2000). Bioscience in the pre-registration curriculum: finding the right teaching strategy. *Nurse Education Today*, *20*(2), 123–135.

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 Vos, A. S., Delport, C. S. L., Fouché, C. B., & Strydom, H. (2011). *Research at grass roots: A primer for the social science and human professions*. Van Schaik Publishers.

Demaree, R. G. (1961). *Development of training equipment planning information*. PSYCHOLOGICAL RESEARCH ASSOCIATES INC ARLINGTON VA.

Department of Basic Education. (n.d.). Subject Choice and Career Pathing. Retrieved January 31, 2021, from https://www.education.gov.za/Informationfor/Learners/SubjectChoiceandCareerPathing/tabid/980/Default.aspx

Department of Health. (2011). Human Resources for Health South Africa 2030: Draft HR Strategy for the Health Sector (Consultation Document V5). *Human Resources for Health*, (August), 1–27.

Devi, E. S., Mayya, S. S., Bairy, K. L., George, A., & Mohan, M. K. (2013). Comparative analysis of the outcome of two teaching-learning approaches adopted for teaching pharmacology. *International Journal of Nursing Education*, *5*(2), 66.

Donough, G., & Van Der Heever, M. (2018). Undergraduate nursing students' experience of clinical supervision. *Curationis*, *41*(1), 1–8.

Durai, R. P. R., Hassan, H., Panduragan, S. L., Abdullah, N. A., & Mat, S. (2012). An Exploration of Issues Relating to Medical Science Subjects: Nursing Students' Perception and Experience in Universiti Kebangsaan Malaysia Medical Centre. *Procedia - Social and Behavioral Sciences*, *60*, 85–89. https://doi.org/10.1016/j.sbspro.2012.09.351

Edney, P. J. (1972). A Systems Analysis of Training. *Visual Education*, *66*, 71.

Efstathiou, N., & Bailey, C. (2012). Promoting active learning using Audience Response System in large bioscience classes. *Nurse Education Today*, *32*(1), 91–95. https://doi.org/10.1016/j.nedt.2011.01.017

Ekstedt, M., Lindblad, M., & Löfmark, A. (2019). Nursing students' perception of the clinical learning environment and supervision in relation to two different supervision models – a comparative cross-sectional study. *BMC Nursing*, *18*(1), 1–12. https://doi.org/10.1186/s12912-019-0375-6

Evans, S., Berry, C., & Mate, K. E. (2013). Targeting the bioscience-practice nexus to facilitate learning in first year nursing students. *Proceedings of the Australian Conference on Science and Mathematics Education (Formerly UniServe Science Conference)*.

Evensen, A. E., Brataas, H. V., & Cui, G. (2020). Bioscience learning in nursing: A cross-sectional survey of beginning nursing students in Norway. *BMC Nursing*, *19*(1), 1–7. https://doi.org/10.1186/s12912-019-0394-3

Ewertsson, M., Bagga-Gupta, S., Allvin, R., & Blomberg, K. (2017). Tensions in learning professional identities – nursing students' narratives and participation in practical skills during their clinical practice: an ethnographic study. *BMC Nursing 2017 16:1*, *16*(1), 1–8. https://doi.org/10.1186/S12912-017-0238-Y

Fawcett, T. N., Waugh, A., & Smith, G. D. (2016). The primacy of the biosciences: a forgotten priority in nurse education? *Journal of Clinical Nursing*, *25*(17–18), 2680–2682.

Fell, Dobbins, K., & Dee, P. (2016). Bioscience learning in clinical placement: the experiences of pre-registration nursing students. *Journal of Clinical Nursing*, *25*(17–18), 2694–2705. https://doi.org/10.1111/jocn.13097

Fitts, P. M., & Posner, M. (1967). Human Performance. *Belmont, Calif.:* Cole, Belmont, CA, 5, 7-16

Gale, J., Ooms, A., Newcombe, P., & Marks-Maran, D. (2015). Students' first year experience of a BSc (Hons) in nursing: A pilot study. *Nurse Education Today*, *35*(1), 256–264.

Garg, R. (2016). Methodology for research I. *Indian Journal of Anaesthesia*, *60*(9), 640.

Goforth, C. (2015). Using and Interpreting Cronbach's Alpha | University of Virginia Library Research Data Services + Sciences. Retrieved July 28, 2021, from https://data.library.virginia.edu/using-and-interpreting-cronbachs-alpha/

Gordon, C. J., Hudson, P. B., Plenderleith, M. B., Fisher, M., & Craft, J. A. (2017). Final year Australian nursing students' experiences with bioscience: A cross-sectional survey. *Nursing & Health Sciences*, *19*(1), 22–28. https://doi.org/10.1111/NHS.12310

Grant, S., & Crimmons, S. (2018). Limitations of track and trigger systems and the National Early Warning Score. Part 2: sensitivity versus specificity. *British Journal of Nursing* ,

27(12), 705–710. Retrieved from https://content-ebscohost-com.libezproxy.bournemouth.ac.uk/ContentServer.asp?T=P&P=AN&K=130764301&S=R&D=ccm&EbscoContent=dGJyMNLr40Sep7Q4v%2BbwOLCmr1GeprNSsqi4TbOWxWXS&ContentCustomer=dGJyMPGts0y1ra5QuePfgeyx44Dt6fIA

Gray, J., Grove, S., & Sutherland, S. (2017). *Burns and Grove's the practice of nursing research : Appraisal, synthesis, and generation of evidence* (Eighth). St. Louis, Missouri.

Hall-Lord, M. L., Theander, K., & Athlin, E. (2013). A clinical supervision model in bachelor nursing education–Purpose, content and evaluation. *Nurse Education in Practice*, *13*(6), 506–511.

Hassan, H., Marzuki, M., Abdullah, N. A., Mat, S., Letchimi, P. S., Packiavathy, R. D. R., & Suhaimi, F. H. (2012). Diagnosing the problem of traditional model of teaching and learning Medical Science subjects in a Nursing Program of UKM. *Procedia-Social and Behavioral Sciences*, *60*, 78–84.

Higher Education Act 101 of 1997. (2010). *Act 101 of 1997: Higher Education Act*. *1997*(November 1997).

Javali, S. B. (2011). *Effect of Varying Sample Size in Estimation of Coefficients of Internal Consistency*. Retrieved from http://www.webmedcentral.com/article_view/1572ArticleURL:http://www.webmedcentral.com/article_view/1649

Jensen, K. T., Knutstad, U., & Fawcett, T. N. (2018). The challenge of the biosciences in nurse education: A literature review. *Journal of Clinical Nursing*, *27*(9–10), 1793–1802. https://doi.org/10.1111/jocn.14358

Johnston, A. N.B., Hamill, J., Barton, M. J., Baldwin, S., Percival, J., Williams-Pritchard, G., … Todorovic, M. (2015). Student learning styles in anatomy and physiology courses: Meeting the needs of nursing students. *Nurse Education in Practice*, *15*(6), 415–420. https://doi.org/10.1016/j.nepr.2015.05.001

Johnston, Amy N B. (2010). Anatomy for nurses: Providing students with the best learning experience. *Nurse Education in Practice*, *10*(4), 222–226.

Jordan, S. (1998). From classroom theory to clinicalpractice: evaluating the impact of a post-registration course. *Nurse Education Today*, *18*(4), 293–302.

Jordan, S., Davies, S., & Green, B. (1999). The biosciences in the pre-registration nursing curriculum: staff and students' perceptions of difficulties and relevance. *Nurse Education Today*, *19*(3), 215–226.

Jordan, S., & Reid, K. (1997). The biological sciences in nursing: an empirical paper reporting on the applications of physiology to nursing care. *Journal of Advanced Nursing*, *26*(1), 169–179.

Ka Mzolo, B. (2002). The Nursing Council hearings. *DENOSA Nursing Update*, *26*, 34–37.

Kang, H. (2013). The prevention and handling of the missing data. *Korean Journal of Anesthesiology*, *64*(5), 402.

Kelly, M. A., Forber, J., Conlon, L., Roche, M., & Stasa, H. (2014). Empowering the registered nurses of tomorrow: Students' perspectives of a simulation experience for recognising and managing a deteriorating patient. *Nurse Education Today*, *34*(5), 724–729.

Kemsley, M., McCausland, L., Feigenbaum, J., & Riegle, E. (2011). Analysis of graduates' perceptions of an accelerated bachelor of science program in nursing. *Journal of Professional Nursing*, *27*(1), 50–58.

Khan, E. U., & Hood, P. A. (2018). Nurses' perspectives on pharmacology: why, what and at which point of the curricula should education be delivered? *British Journal of Nursing*, *27*(10), 546–553.

Kisiel, M., & Perkins, C. (2006). Nursing observations: knowledge to help prevent critical illness. *British Journal of Nursing*, *15*(19), 1052–1056.

Kyriacos, U., Jordan, S., & Van Den Heever, J. (2005). The biological sciences in nursing: a developing country perspective. *Journal of Advanced Nursing*, *52*(1), 91–103.

Langtree, E. M., Razak, A., & Haffejee, F. (2017). The effect of speaking English as a second language on the study of anatomy and physiology in the nursing programme. *South African Journal of Higher Education*, *32*(1), 129–139. https://doi.org/10.20853/32-1-793

Leonard, M. M., & Kyriacos, U. (2015). Student nurses' recognition of early signs of abnormal vital sign recordings. *Nurse Education Today*, *35*(9), e11–e18. https://doi.org/10.1016/j.nedt.2015.04.013

Logan, P. A., & Angel, L. (2011). Nursing as a scientific undertaking and the intersection with science in undergraduate studies: implications for nursing management. *Journal of Nursing Management*, *19*(3), 407–417.

Martínez-Mesa, J., González-Chica, D. A., Duquia, R. P., Bonamigo, R. R., & Bastos, J. L. (2016). Sampling: how to select participants in my research study? *Anais Brasileiros de Dermatologia*, *91*(3), 326–330.

McCombes, S. (2019). Descriptive Research Design | Definition, Methods and Examples. Retrieved July 28, 2021, from https://www.scribbr.com/methodology/descriptive-research/

McEwen, M., & Wills, E. M. (2017). *Theoretical basis for nursing*. Lippincott Williams & Wilkins.

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. *Biochemia Medica: Biochemia Medica*, *22*(3), 276–282.

McLaughlin, E. (2020). What is data collection? - Definition from WhatIs.com. Retrieved July 28, 2021, from https://searchcio.techtarget.com/definition/data-collection

McLeod, S. (2019). P-Value and Statistical Significance | Simply Psychology. Retrieved May 14, 2021, from https://www.simplypsychology.org/p-value.html

McVicar, A., & Clancy, J. (2001). The biosciences and fitness for practice: a time for review?

British Journal of Nursing, *10*(21), 1415–1420.

McVicar, A. J., Andrew, S., Henderson, N., Evangelinos, G., & Spurling, L. (2014). An Enquiry into Using Supplementary Bioscience Resources in Health. *Networks*, *17*(1), 41–46. Retrieved from http://hdl.handle.net/10540/338980

McVicar, A., Andrew, S., & Kemble, R. (2015). The 'bioscience problem' for nursing students: An integrative review of published evaluations of Year 1 bioscience, and proposed directions for curriculum development. *Nurse Education Today*, *35*(3), 500–509. https://doi.org/10.1016/J.NEDT.2014.11.003

McVicar, A., Clancy, J., & Mayes, N. (2010). An exploratory study of the application of biosciences in practice, and implications for pre-qualifying education. *Nurse Education Today*, *30*(7), 615–622.

Medical dictionary. (n.d.). Clinical practice | definition of clinical practice by Medical dictionary. Retrieved July 28, 2021, from https://medical-dictionary.thefreedictionary.com/clinical+practice

Mhlongo, X. L., & Masango, T. E. (2020). Factors contributing to poor performance of student nurses in anatomy and physiology. *African Journal of Health Professions Education*, *12*(3), 140. https://doi.org/10.7196/ajhpe.2020.v12i3.1357

Mohudi, C. M. (2014). *An analysis of college-based nursing students' performance in biological and natural science*.

Molesworth, M., & Lewitt, M. (2016). Preregistration nursing students' perspectives on the learning, teaching and application of bioscience knowledge within practice. *Journal of Clinical Nursing*, *25*(5–6), 725–732. https://doi.org/10.1111/jocn.13020

Montayre, J., Dimalapang, E., Sparks, T., & Neville, S. (2019). New Zealand nursing students' perceptions of biosciences: A cross-sectional survey of relevance to practice, teaching delivery, self-competence and challenges. *Nurse Education Today*, *79*(May), 48–53. https://doi.org/10.1016/j.nedt.2019.05.013

Montayre, J., & Sparks, T. (2017). Important yet unnecessary: nursing students' perceptions of anatomy and physiology laboratory sessions. *Teaching and Learning in Nursing*, *12*(3), 216–219.

Mortimer-Jones, S., & Fetherston, C. (2018). The nursification of a bioscience unit and its impact on student satisfaction and learning in an undergraduate nursing degree. *Nurse Education Today*, *64*(July 2017), 1–4. https://doi.org/10.1016/j.nedt.2018.02.006

Mthimunye, K. (2015). *Predictors of academic performance and throughput among second-year nursing students at a university in the Western Cape*.

Mthimunye, K., & Daniels, F. (2018). *An intervention towards the improvement of academic performance, success and retention among Bachelor of Nursing students at a higher education institution in the Western Cape*. University of the Western Cape.

Mthimunye, Katlego D.T., & Daniels, F. M. (2017). Performance in grade 12 mathematics and science predicts student nurses' performance in first year science modules at a

university in the Western Cape. *Curationis*, *40*(1), 1–6. https://doi.org/10.4102/curationis.v40i1.1776

Mthimunye, Katlego Dumisani Trevor, & Daniels, F. M. (2019). Nurse educators' challenges and corresponding measures to improve the academic performance, success and retention of undergraduate nursing students at a university in the Western Cape, South Africa. *Independent Journal of Teaching and Learning*, *14*(1), 53–67.

Ndwambi, O. M., & Roets, L. (2020a). Prerequisites included in selection criteria: A contribution to student success in nursing. *Africa Journal of Nursing and Midwifery*, *22*(2). https://doi.org/10.25159/2520-5293/6013

Ngulube, P. (2019). *Handbook of Research on Connecting Research Methods for Information Science Research*. IGI Global.

NMC. (2010). *Standards for pre-registration Nurse education*. London. https://doi.org/10.1097/00000446-197009000-00020

Nxumalo, S. J. (2011). *FACTORS THAT AFFECT THEORY-PRACTICE INTEGRATION OF STUDENT NURSES AT A SELECTED CAMPUS OF A MS SUYEKIYE JEANNETH NXUMALO submitted in accordance with the requirements for the degree of MASTER OF ARTS in the subject HEALTH STUDIES at the UNIVERSITY OF SOUT*. (June).

Oluwatayo, J. A. (2012). Validity and reliability issues in educational research. *Journal of Educational and Social Research*, *2*(2), 391.

Patino, C. M., & Ferreira, J. C. (2018). Inclusion and exclusion criteria in research studies: definitions and why they matter. *Jornal Brasileiro de Pneumologia*, *44*(2), 84.

Perkins, C. (2019). Enhanced bioscience content is urgently needed in UK pre-registration nursing curricula. *Nurse Education in Practice*, *34*(October 2018), 7–11. https://doi.org/10.1016/j.nepr.2018.10.008

Pitt, V., Powis, D., Levett-Jones, T., & Hunter, S. (2012). Factors influencing nursing students' academic and clinical performance and attrition: An integrative literature review. *Nurse Education Today*, *32*(8), 903–913. https://doi.org/10.1016/j.nedt.2012.04.011

Plichta, S. B., Kelvin, E. A., & Munro, B. H. (2013). *Munro's statistical methods for health care research*. Wolters Kluwer Health/Lippincott Williams & Wilkins.

Polit, D, Beck, C. (2017). *Resource Manual for Nursing Research* (Tenth). USA.

Polit, D., & Beck, C. (2018). *Essentials of Nursing Research: Appraising Evidence for Nursing Practice*. Lippincott Williams & Wilkins.

Prowse, M. A. (2003). Learning and using biosciences in nursing Part Two: achieving patient outcomes in perioperative practice. *Journal of Advanced Perioperative Care*, *1*, 129–136.

Prowse, M. A., & Lyne, P. A. (2000). Revealing the contribution of bioscience*-based nursing knowledge to clinically effective patient care. *Clinical Effectiveness in Nursing*, *4*(2), 67–74.

Rabie, G. H., Rabie, T., & Dinkelmann, M. (2020). Developing a competency profile for newly graduated registered nurses in South Africa. *BMC Nursing*, *19*(1), 1–16. https://doi.org/10.1186/s12912-020-00453-7

Rafferty, B., & Kyriacos, U. (2016). Final year nursing students self-reported understanding of the relevance of bioscience. *International Journal of Nursing and Midwifery*, *8*(5), 35–46. https://doi.org/10.5897/ijnm2016.0208

Ralph, N., Birks, M., Cant, R., Tie, Y. C., & Hillman, E. (2017). How should science be taught to nurses? Preferences of registered nurses and science teaching academics. *Collegian*, *24*(6), 585–591.

Ramahlafi, R. . (2015). *AN EXPLORATION OF THE FACTORS THAT HAVE AN INFLUENCE ON COMPLETION RATES AMONGST SECOND YEAR COLLEGE BASED NURSING STUDENTS*. University of Witwatersrand.

Redmond, C., Davies, C., Cornally, D., Fegan, M., & O'Toole, M. (2016). Teaching and learning in the Biosciences: the development of an educational programme to assist student nurses in their assessment and management of patients with wounds. *Journal of Clinical Nursing*, *25*(17–18), 2706–2712.

Roos, E., Fichardt, A. E., MacKenzie, M. J., & Raubenheimer, J. (2016). Attrition of undergraduate nursing students at selected South African universities. *Curationis*, *39*(1), e1–e8. https://doi.org/10.4102/curationis.v39i1.1558

Ryerson University. (2017). *Guidelines on Anonymity and*. Retrieved from https://semiprodint.ryerson.ca/content/dam/research/documents/ethics/guidelines-on-anonymity-and-confidentiality-in-research.pdf

SANC. (1985). *South African Nursing Council Notification of Completion of Training Education and Training of a Nurse (General , Psychiatric and Community) and Midwife Leading*. 3–8.

SANC. (2016). *South African Nursing Council Bachelor's degree in Nursing and Midwifery Qualification Framework*. Retrieved from www.sanc.co.za

Schwartz, T. A. (2014). Flipping the statistics classroom in nursing education. *Journal of Nursing Education*, *53*(4), 199–206.

Scrooby, B., Reitsma, G. M., & Waggie, F. (2019). A practice model for interprofessional education in a first year anatomy class. *Journal of Interprofessional Care*, *33*(3), 313–320. https://doi.org/10.1080/13561820.2019.1596890

See, M. T. A., Chee, S., Rajaram, R., Kowitlawakul, Y., & Liaw, S. Y. (2020). Missed nursing care in patient education: A qualitative study of different levels of nurses' perspectives. *Journal of Nursing Management*, *28*(8), 1960–1967.

Simonsen, B. O., Daehlin, G. K., Johansson, I., & Farup, P. G. (2014). Differences in

medication knowledge and risk of errors between graduating nursing students and working registered nurses: comparative study. *BMC Health Services Research*, *14*(1), 1–11.

Smales, K. (2010). Learning and applying biosciences to clinical practice in nursing. *Nursing Standard*, *24*(33), 35–39. https://doi.org/10.7748/ns2010.04.24.33.35.c7716

South African Nursing Council. 1985. Regulations relating to the approval of and the minimum requirements for the education and training of a nurse (general, psychiatric and community) and midwife leading to registration. *Regulation R.425, in terms of the Nursing Act (Act no 50, 1978, as amended)*. Pretoria: Government Printer.

Stern, N., Weber, L., Van Wagner, C., Niehus, D., Halperin, R., Spinelli, K., & Cruz, L. (2017). (298) Pain education in primary care and rehab services improves patient outcomes. *The Journal of Pain*, *18*(4), S50.

Sulosaari, V., Suhonen, R., & Leino-Kilpi, H. (2011). An integrative review of the literature on registered nurses' medication competence. *Journal of Clinical Nursing*, *20*(3-4), 464–478.

Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Taherdoost, H. (2016). Validity and reliability of the research instrument; how to test the validation of a questionnaire/survey in a research. *How to Test the Validation of a Questionnaire/Survey in a Research (August 10, 2016)*.

Taherdoost, H. (2018). Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research. *SSRN Electronic Journal*, (January 2016). https://doi.org/10.2139/ssrn.3205040

Taylor, V., Ashelford, S., Fell, P., & Goacher, P. J. (2015). Biosciences in nurse education: Is the curriculum fit for practice? Lecturers' views and recommendations from across the UK. *Journal of Clinical Nursing*, *24*(19–20), 2797–2806. https://doi.org/10.1111/jocn.12880

Theofanidis, D., & Fountouki, A. (2018). Limitations and delimitations in the research process. *Perioperative Nursing*, *7*(3), 155–163.

Torrance, C., & Jordan, S. (1995). Bionursing: putting science into practice. *Nursing Standard (Royal College of Nursing (Great Britain): 1987)*, *9*(49), 25–27.

Umalusi`s Role - Umalusi. (2019). Retrieved July 24, 2021, from https://www.umalusi.org.za/about/umalusis-role/

UWC. (2017). Admissions Requirements. Retrieved October 16, 2019, from http://prospectus.uwc.ac.za/educate/admissions-requirements/

UWC. (2013a). School of Nursing. Retrieved August 17, 2019, from https://www.uwc.ac.za/Faculties/CHS/Nursing/Pages/default.aspx

UWC. (2013). UWC Faculties. Retrieved August 17, 2019, from https://www.uwc.ac.za/Faculties/Pages/default.aspx

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.

Valiga, T. M., & Ironside, P. M. (2012). Crafting a national agenda for nursing education research. *Journal of Nursing Education*, *51*(1), 3–6.

Western Cape Government. (2019). How to become a nurse in the Western Cape | Western Cape Government. Retrieved December 1, 2020, from https://www.westerncape.gov.za/general-publication/how-become-nurse-western-cape

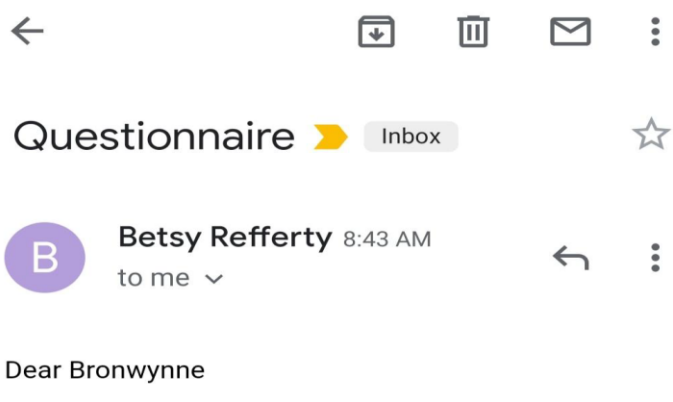
White, S., & Sykes, A. (2012). *Evaluation of a blended learning approach used in an anatomy and physiology module for pre-registration healthcare students*. ThinkMind/IARIA.

Whyte, D. G., Madigan, V., & Drinkwater, E. J. (2011). Predictors of academic performance of nursing and paramedic students in first year bioscience. *Nurse Education Today*, *31*(8), 849–854. https://doi.org/10.1016/j.nedt.2010.12.021

Zamanzadeh, V., Ghahramanian, A., Rassouli, M., Abbaszadeh, A., Alavi-Majd, H., & Nikanfar, A.-R. (2015). Design and Implementation Content Validity Study: Development of aninstrument for measuring Patient-Centered Communication. *Journal of Caring Sciences*, *4*(2), 165. https://doi.org/10.15171/JCS.2015.017

APPENDICES

APPENDIX 1: Permission to use and adapt questionnaire



Questionnaire Inbox

Betsy Refferty 8:43 AM
to me

Dear Bronwynne

I herewith give my permission as researcher for you to use and adapt the questionnaire.

All the best
B. Rafferty

APPENDIX 2: Data collection instrument

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Cell: 0793057276

E-mail: 3355229@myuwc.ac.za

Respondent Code No.

RESEARCH QUESTIONNAIRE

Principal Investigator: Bronwynne Rafferty
MCur Education candidate
School of Nursing
Faculty of Community and Health Sciences
University of the Western Cape
Contact Number: 0793057276

Supervisor: Dr. K Mthimunye
Co-supervisor: Dr M. Bimerew

Part 1: Demographics

Please fill/tick the most appropriate response to the following questions:

1. What is your age? _____
2. What is your gender?

Male	Female

3. What is your ethnic group?

White	African	Coloured	Indian

4. Do you have a previous nursing qualification?

Yes	No

5. Did you work as a nurse before enrolling for this programme?

Yes	No

6. Which year level are you?

2nd year	3rd year	4th year

Please fill/tick the most appropriate response to the following questions:

7. To what extent have you gained an understanding of each of the subjects during your training programme? Select one option only for each.

		Superficial understanding 3	Adequate understanding 2	Deep understanding 1
7.1	Human biology			
7.2	Physics			
7.3	Chemistry			
7.4	Pharmacology			

8. What is the level of your understanding of the application of theory to practice (how well you can apply your knowledge of the biosciences to a clinical situation)? Select one option only for each.

		Very poor 5	Poor 4	Adequate 3	Good 2	Very good 1
8.1	Human biology					
8.2	Physics					
8.3	Chemistry					
8.4	Pharmacology					

9. Which of the following subjects you would have liked more information on during your training programme? Select one option only for each.

		Yes	No
9.1	Human biology		
9.2	Physics		
9.3	Chemistry		
9.4	Pharmacology		

10. For each of the following subjects indicate the relevance to your practice? Select one option only for each

		Not relevant 3	Relevant 2	Essential 1
10.1	Human biology			
10.2	Physics			
10.3	Chemistry			
10.4	Pharmacology			

Part 2:

Description of one critical incident

Question 12.1

Describe one incident where you had to draw on your knowledge and understanding of the biosciences (Human biology, physics, chemistry or pharmacology) to ensure a good outcome for one or more patients. Describe the incident and your actions in the space below. Please be specific and state exactly what happened.

Question 12.2

Explain how your knowledge and understanding of the biosciences (Human biology, physics, chemistry or pharmacology) had influenced your actions described in 16.1 above.

Part 3: Picture interpretation of nursing interventions.

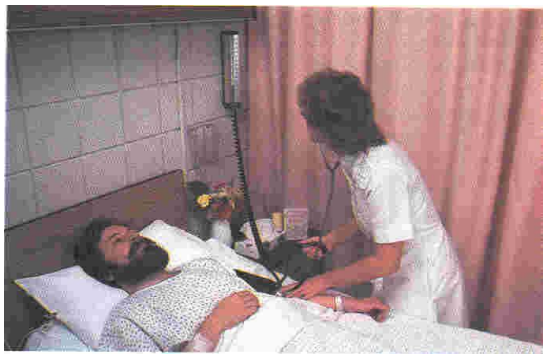
The following three pictures show nursing activities related to monitoring a patient's vital signs.

Below each picture is a box with a list of subjects: for each subject tick **one answer** to show the relevance for performing these activities to give quality care.

Question 13.1: Picture 1: monitoring a patient's heart rate (pulse)

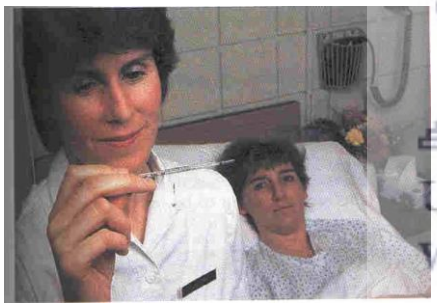
		Relevant 1	Not relevant 0
13.1.1	Human biology		
13.1.2	Physics		
13.1.3	Chemistry		
13.1.4	Pharmacology		

Question 13.2: Picture 2: Monitoring a patient's blood pressure



		Relevant 1	Not relevant 0
13.2.1	Human biology		
13.2.2	Physics		
13.2.3	Chemistry		
13.2.4	Pharmacology		

Question 13.3: Picture 3: Monitoring a patient's temperature



		Relevant 1	Not relevant 0
13.3.1	Human biology		
13.3.2	Physics		
13.3.3	Chemistry		
13.3.4	Pharmacology		

Adapted with permission from:

Rafferty, B., & Kyriacos, U. (2016). *Final year nursing students self-reported understanding of the relevance of bioscience.* (Msc dissertation). University of Cape Town, Cape Town, South Africa.

APPENDIX 3: Ethical clearance

UNIVERSITY of the WESTERN CAPE

50 YEARS of hope, action & knowledge

08 June 2020

Ms BA Rafferty
School of Nursing
Faculty of Community and Health Sciences

Ethics Reference Number:	HS20/2/4
Project Title:	Nursing students' self-reported knowledge of bioscience and its relevance to clinical practice.
Approval Period:	08 June 2020 – 08 June 2023

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The permission to conduct the study must be submitted to HSSREC for record keeping purposes.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: HSSREC-130416-049

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

APPENDIX 4: Letters of permission to conduct research at the university understudy

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Bronwynne Rafferty
Cellphone: *0793057276*
E-mail: 3355229@myuwc.ac.za

24 April 2020

Dear Dr Shaikjee

I am currently a second year student studying Masters in Nursing Education and I am currently in the process of completing my Mini Thesis. All documentation required is attached in the email which includes the amended ethical clearance letter. Please see summary below:

Title: Nursing students' self-reported knowledge of bioscience and its relevance to practice.

Aim: The aim of the study is to describe nursing students' self-reported knowledge of bioscience and its relevance to practice.

Data collection instrument: A self-reported online questionnaire (pretesting will be taking place prior to official data collection).

The proposed study will be conducted at the School of Nursing at the University of the Western Cape.

The study population is the 2nd, 3rd and final year undergraduate nursing students at the University of the Western Cape.

Permission has been granted from the Senate Higher Degrees committee and Ethical approval has been obtained.

I herewith would like to request permission from the registrar's desk to commence my data collection at the School of Nursing at the University of the Western Cape.

Awaiting your positive response.

Kind Regards
Bronwynne Rafferty
3355229

……

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Bronwynne Rafferty
Cellphone: *0793057276*
E-mail: 3355229@myuwc.ac.za

10 June 2020

Dear Professor Chipps

I am currently a second year student studying Masters in Nursing Education and I am currently in the process of completing my Mini Thesis. All documentation required is attached in the email which includes the amended ethical clearance letter. Please see summary below:

Title: Nursing students' self-reported knowledge of bioscience and its relevance to practice.

Aim: The aim of the study is to describe nursing students' self-reported knowledge of bioscience and its relevance to practice.

Data collection instrument: A self-reported online questionnaire (pretesting will be taking place prior to official data collection).

The proposed study will be conducted at the School of Nursing at the University of the Western Cape.

The study population is the 2nd, 3rd and final year undergraduate nursing students at the University of the Western Cape.

Ethical approval has been obtained and permission has been granted from the Registrar.

I herewith would like to request permission from the School of Nursing to commence my data collection at the School of Nursing at the University of the Western Cape.

Awaiting your positive response.

Kind Regards
Bronwynne Rafferty
3355229

……

APPENDIX 5: Letter of permission from the registrar

UNIVERSITY of the WESTERN CAPE

DEPUTY REGISTRAR: Academic Administration
Administration Building, 1st Floor
ashaikjee@uwc.ac.za, nschoeman@uwc.ac.za
021 959 2110

24 April 2020

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT THE UNIVERSITY OF THE WESTERN CAPE

Name of Researcher	:	Bronwynne Anita Rafferty
Research Topic	:	Nursing students' self-reported knowledge of bioscience and its relevance to practice
Date of issue	:	24/04/2020
Reference number	:	UWCRP240420BAR

This serves as acknowledgement that you have obtained and presented the necessary ethical clearance and your institutional permission required to proceed with the above referenced project.

Approval is granted for you to conduct research at the University of the Western Cape for the period **24 April 2020** to **31 March 2023** (or as determined by the validity of your ethics approval). You are required to engage this office in advance if there is a need to continue with research outside of the stipulated period. The manner in which you conduct your research must be guided by the conditions set out in the annexed agreement: *Conditions to guide research conducted at the University of the Western Cape.*

The University of the Western Cape promotes the generation of new knowledge and supports new research. It also has a responsibility to be sensitive to the rights of the students and staff on campus. This office will require of you to respect the rights of students and staff who do not wish to participate in interviews and/or surveys.

It is also incumbent on you to first furnish this office with a copy of the proposed publication should you wish to reference the University's name, spaces, identity, etc. prior to public dissemination.

Please be at liberty to contact this office should you require any assistance to conduct your research or specifically require access to either staff or student contact information.

Yours sincerely

DR AHMED SHAIKJEE
DEPUTY REGISTRAR
OFFICE OF THE REGISTRAR

UWC
UNIVERSITY OF THE WESTERN CAPE
PRIVATE BAG X17, BELLVILLE
STUDENT ADMINISTRATION
24 APRIL 2020
This document contains a qualified electronic signature and date stamp. To verify this document contact the University of the Western Cape at researchperm@uwc.ac.za.

UNIVERSITY of the WESTERN CAPE

DEPUTY REGISTRAR: Academic Administration
Administration Building, 1st Floor
ashaikjee@uwc.ac.za, nschoeman@uwc.ac.za
021 959 2110

ANNEXURE

CONDITIONS TO GUIDE RESEARCH CONDUCTED AT THE UNIVERSITY OF THE WESTERN CAPE

The onus rests on the researcher/investigator to observe and comply with the conditions set out below with the aim to conduct responsibly ethical research. Clarity must be sought from the authorising office should the interpretation of the conditions be unclear.

1. ACCOUNTABILITY

1.1. The University reserves the right to audit the research practices of the researcher/ investigator to assess compliance to the conditions of this agreement.
1.2. Data collection processes must not be adapted, changed or altered by the researcher/ investigator without written notification issued to the authorising office.
1.3. The University reserves to right to cease research if any proposed change to the data collection process is found to be unethical or in contravention of this agreement.
1.4. Failure to comply with any one condition in this agreement may result in:
  1.4.1. Disciplinary action instituted against a researcher/investigator employed or registered at the University;
  1.4.2. The contravention reported to the organisation employing or registering the external researcher/ investigator.

2. GOVERNANCE

2.1. Approval to conduct research is governed by the Protection of Personal Information Act, No 4 of 2013, which regulates the entire information life cycle from collection, through use and storage and even the destruction of personal information and it is incumbent on the researcher/investigator to understand the implications of the legislation.
2.2. The researcher/investigator must employ the necessary measures to conduct research that is ethically and legally sound.

3. ACQUIRING CONSENT & RIGHTS OF PARTICIPANTS

3.1. It is incumbent on the researcher / investigator to clarify any uncertainties to the participant about the research.
3.2. Written consent must be obtained from participants before their personal information is gathered and documented.
3.3. Participation in the research must be voluntary and participants must not be pressured or coerced.
3.4. Participants have the right to access their personal information, obtain confirmation of what information is in the possession of the researcher / investigator and who had access to the information.
3.5. Participants have the right to withdraw from the research and insist that their personal information not be used.

UNIVERSITY of the WESTERN CAPE

DEPUTY REGISTRAR: Academic Administration
Administration Building, 1st Floor
ashaikjee@uwc.ac.za, nschoeman@uwc.ac.za
021 959 2110

4. DATA AND INFORMATION MANAGEMENT
4.1. Due diligence must be afforded by the researcher/investigator to: 4.1.1. Mitigate any risks that could compromise the privacy of participants before 4.1.2. during and after the research is conducted; 4.1.3. Collect only information that is relevant to the aim of the research; 4.1.4. Verify all personal information collected about a participant if the information is supplied by a source other than the participant; 4.1.5. Refrain from sharing participant information with a third party; 4.1.6. Apply for an exemption if the identity of participants should be revealed in the interest of the research aims. 4.2. The researcher/investigator must employ appropriate, reasonable and technical measures to protect, prevent loss of and unlawful or unauthorised access of research information.

Should you have any questions relating to this agreement **please contact:**

ashaikjee@uwc.ac.za **or**
researchpermit@uwc.ac.za

APPENDIX 6: Letter of permission from the director of School of Nursing

10 July 2020

Dear Ms BA Rafferty (3355229)

RE: PERMISSION TO CONDUCT RESEARCH AT THE UNIVERSITY OF THE WESTERN CAPE

As per you request, we acknowledge that you have obtained all the necessary permissions and ethics clearances (HS20/2/4) and are welcome to conduct your research as outlined in your proposal and communication with the School of Nursing.

Please note that while we give permission to conduct such research (i.e. interviews and surveys) staff and students at this School are not compelled to participate and may decline to participate should they wish to.

Should you wish to make use of or reference to the School's name, spaces, identity, etc. in any publication/s, you must first furnish the School with a copy of the proposed publication/s so that the School can verify and grant permission for such publication/s to be made publicly available.

Kindly contact the portfolio heads of the respective year levels to provide you with the students' contact details needed for your research:

2nd year - Ms Ilhaam Essa iessa@uwc.ac.za

3rd year - Ms Lindy van der Berg lvanderberg@uwc.ac.za

4th year – Mr Hoffmann jhoffmann@uwc.ac.za

Summary of Research

Student BA Rafferty, student number: 3355229

M Nursing Education (Dr Mthimunye and Dr Bimerew - supervisors)

Ethics Reference Number: HS20/2/4, approval period 08 June 2020 to 08 June 2021

Title: *Nursing students' self-reported knowledge of bioscience and its relevance to practice.*

Aim: *The aim of the study is to describe nursing students' self-reported knowledge of bioscience and its relevance to practice.*

UNIVERSITY of the WESTERN CAPE

SCHOOL of NURSING

Data collection instrument: A self-reported online questionnaire (pretesting will be taking place prior to official data collection).

The study population is the 2nd, 3rd and final year undergraduate nursing students at the University of the Western Cape.

Ethics approval has been obtained and permission has been granted from the Registrar.

Best wishes for success with your research.

Yours sincerely

Prof Jennifer Chipps
Director School of Nursing
Faculty of Community and Health
UNIVERSITY of the WESTERN CAPE

T: +27 21 959 3024
E: jchipps@uwc.ac.za

APPENDIX 7: Participant's information sheet

Participant's information sheet

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Bronwynne Rafferty

Cellphone: *0793057276*

E-mail: 3355229@myuwc.ac.za

INFORMATION SHEET

Project Title Nursing students' self-reported knowledge of biosciences and its relevance to clinical practice.

What is this study about?

This is a research project being conducted by Ms B Rafferty at the University of the Western Cape. We are inviting you to participate in this research project because you are a nursing student at the University of the Western Cape that has met the inclusion criteria for the proposed study. The purpose of this research project is to determine your self-reported knowledge of bioscience and perceptions of the relevance of the biosciences to clinical practice.

What will I be asked to do if I agree to participate?

You will be asked to indicate demographical information, indicate your level of understanding and your thoughts of the importance of bioscience subjects, your opinions on the lecturer's teaching, describe one critical incident that you used your bioscience knowledge in and answer three clinical scenarios that is in the questionnaire. The study will be presented at the university and will take approximately 15 minutes to complete.

Would my participation in this study be kept confidential?

The researchers undertake to protect your identity and the nature of your contribution. To ensure your anonymity, *the surveys are anonymous and will not contain information that may personally identify you, your name will not be included on the surveys and other collected data; a code will be placed on the survey and other collected data.*

To ensure your confidentiality, the researcher will at all times keep your information confidential and secure. You will be required to deposit the completed questionnaires in a sealed box on completion of the questionnaire. Your responses will be locked in a safe storage area. Each questionnaire will be given an identification number before being issued to the to you in order to safeguard anonymity. If we write a report or article about this research project, your identity will be protected.

What are the risks of this research?

There may be some risks from participating in this research study.

All human interactions and talking about self or others carry some amount of risks. We will nevertheless minimise such risks and act promptly to assist you if you experience any discomfort, psychological or otherwise during the process of your participation in this study. Where necessary, an appropriate referral will be made to a suitable professional for further assistance or intervention.

What are the benefits of this research?

This research is not designed to help you personally, but the results may help the investigator learn more about nursing students' depth of knowledge of bioscience. We hope that, in the future, other people might benefit from this study through improved understanding of bioscience in the undergraduate nursing programme.

Do I have to be in this research and may I stop participating at any time?

Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

What if I have questions?

This research is being conducted by Bronwynne Rafferty- School of Nursing at the University of the Western Cape. If you have any questions about the research study itself, please contact Bronwynne Rafferty at: 0793057276 or 3355229@myuwc.ac.za.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Prof Jennifer Chipps

Director: School of Nursing

University of the Western Cape

Private Bag X17

Bellville 7535

hschneider@uwc.ac.za

Prof Rhode

Dean of the Faculty of Community and Health Sciences

University of the Western Cape

Private Bag X17

Bellville 7535

chs-deansoffice@uwc.ac.za

This research has been approved by the University of the Western Cape's Humanities and Social Sciences Research Ethics Committee.

(Reference number: HS20/2/4)

APPENDIX 8: Consent form

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Bronwynne Rafferty

Cellphone: *0793057276*

E-mail: 3355229@myuwc.ac.za

CONSENT FORM

Title of Research Project: Nursing students' self-reported knowledge of biosciences and its relevance to clinical practice.

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve, and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.

Participant's name……..

Participant's signature…….

Date……

APPENDIX 9: SPSS analysis of the description of the sample population

Statistics

	q1Age	q2Gender	q3Ethnicity	q4PreviousNursingQualification	q5PreviousNursingWork	q6TypeOfDegree	q7YearLevel
Valid	209	211	211	211	211	211	210
Missing	2	0	0	0	0	0	1

Age distribution

Statistics

q1Age

N	Valid	209
	Missing	2
Mean		22.38
Median		21.00
Std. Deviation		3.508
Minimum		18
Maximum		44
Percentiles	25	20.00
	50	21.00
	75	23.00

Students' gender distribution

q2Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	44	20.9	20.9	20.9
	Female	167	79.1	79.1	100.0
	Total	211	100.0	100.0	

Ethnicity of students

q3Ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	White	11	5.2	5.2	5.2
	African	144	68.2	68.2	73.5
	Coloured	54	25.6	25.6	99.1
	Indian	2	.9	.9	100.0
	Total	211	100.0	100.0	

Previous nursing qualification

q4PreviousNursingQualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	1.4	1.4	1.4
	No	208	98.6	98.6	100.0
	Total	211	100.0	100.0	

Previous nursing work

q5PreviousNursingWork

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	2.4	2.4	2.4
	No	206	97.6	97.6	100.0
	Total	211	100.0	100.0	

Type of degree

q6TypeOfDegree

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BNursing	185	87.7	87.7	87.7
	BNursing Foundation	26	12.3	12.3	100.0
	Total	211	100.0	100.0	

APPENDIX 10: SPSS analysis of the respondents' self-reported understanding of bioscience

Statistics

		Human Biology	Physics	Chemistry	Pharmacology
N	Valid	209	210	210	209
	Missing	2	1	1	2
Median		2.0000	2.0000	2.0000	2.0000
Std. Deviation		.63841	.71192	.70974	.59816

Human Biology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Deep Understanding	81	38.4	38.8	38.8
	Adequate Understanding	107	50.7	51.2	90.0
	Superficial Understanding	21	10.0	10.0	100.0
	Total	209	99.1	100.0	
Missing	System	2	.9		
Total		211	100.0		

Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Deep Understanding	46	21.8	21.9	21.9
	Adequate Understanding	103	48.8	49.0	71.0
	Superficial Understanding	61	28.9	29.0	100.0
	Total	210	99.5	100.0	
Missing	System	1	.5		
Total		211	100.0		

Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Deep Understanding	44	20.9	21.0	21.0
	Adequate Understanding	103	48.8	49.0	70.0
	Superficial Understanding	63	29.9	30.0	100.0
	Total	210	99.5	100.0	
Missing	System	1	.5		
Total		211	100.0		

Pharmacology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Deep Understanding	32	15.2	15.3	15.3
	Adequate Understanding	134	63.5	64.1	79.4
	Superficial Understanding	43	20.4	20.6	100.0
	Total	209	99.1	100.0	
Missing	System	2	.9		
Total		211	100.0		

APPENDIX 11: SPSS analysis of the respondents' self-reported understanding of the application of bioscience theory to practice

Statistics

		Human biology	Physics	Chemistry	Pharmacology
N	Valid	211	211	211	211
	Missing	0	0	0	0
Median		2.0000	3.0000	3.0000	2.0000
Std. Deviation		.79220	1.00632	1.01639	.92697

Human biology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very good	84	39.8	39.8	39.8
	Good	86	40.8	40.8	80.6
	Adequate	38	18.0	18.0	98.6
	Poor	2	.9	.9	99.5
	Very poor	1	.5	.5	100.0
	Total	211	100.0	100.0	

Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very good	23	10.9	10.9	10.9
	Good	63	29.9	29.9	40.8
	Adequate	80	37.9	37.9	78.7
	Poor	36	17.1	17.1	95.7
	Very poor	9	4.3	4.3	100.0
	Total	211	100.0	100.0	

Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very good	26	12.3	12.3	12.3
	Good	59	28.0	28.0	40.3
	Adequate	85	40.3	40.3	80.6
	Poor	31	14.7	14.7	95.3
	Very poor	10	4.7	4.7	100.0
	Total	211	100.0	100.0	

Pharmacology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very good	55	26.1	26.1	26.1
	Good	88	41.7	41.7	67.8
	Adequate	54	25.6	25.6	93.4
	Poor	10	4.7	4.7	98.1
	Very poor	4	1.9	1.9	100.0
	Total	211	100.0	100.0	

APPENDIX 12: SPSS analysis of the respondents' self-reported knowledge

Statistics

		Human Biology	Physics	Chemistry	Pharmacology
N	Valid	205	201	200	208
	Missing	6	10	11	3
Median		1.0000	2.0000	2.0000	1.0000
Std. Deviation		.45830	.45652	.49307	.31436

Human Biology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	144	68.2	70.2	70.2
	No	61	28.9	29.8	100.0
	Total	205	97.2	100.0	
Missing	System	6	2.8		
Total		211	100.0		

Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	59	28.0	29.4	29.4
	No	142	67.3	70.6	100.0
	Total	201	95.3	100.0	
Missing	System	10	4.7		
Total		211	100.0		

Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	82	38.9	41.0	41.0
	No	118	55.9	59.0	100.0
	Total	200	94.8	100.0	
Missing	System	11	5.2		
Total		211	100.0		

Pharmacology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	185	87.7	88.9	88.9
	No	23	10.9	11.1	100.0
	Total	208	98.6	100.0	
Missing	System	3	1.4		
Total		211	100.0		

APPENDIX 13: SPSS analysis of the respondents' self-rated perception of the relevance of bioscience modules to nursing practice

Statistics

		Huma biology	Physics	Chemistry	Pharmacology
N	Valid	209	209	209	210
	Missing	2	2	2	1
Median		1.0000	2.0000	2.0000	1.0000
Std. Deviation		.41862	.61113	.60447	.42917

Huma biology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Essential	175	82.9	83.7	83.7
	Relevant	31	14.7	14.8	98.6
	Not relevant	3	1.4	1.4	100.0
	Total	209	99.1	100.0	
Missing	System	2	.9		
Total		211	100.0		

Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Essential	29	13.7	13.9	13.9
	Relevant	129	61.1	61.7	75.6
	Not relevant	51	24.2	24.4	100.0
	Total	209	99.1	100.0	
Missing	System	2	.9		
Total		211	100.0		

Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Essential	38	18.0	18.2	18.2
	Relevant	133	63.0	63.6	81.8
	Not relevant	38	18.0	18.2	100.0
	Total	209	99.1	100.0	
Missing	System	2	.9		
Total		211	100.0		

Pharmacology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Essential	181	85.8	86.2	86.2
	Relevant	24	11.4	11.4	97.6
	Not relevant	5	2.4	2.4	100.0
	Total	210	99.5	100.0	
Missing	System	1	.5		
Total		211	100.0		

APPENDIX 14: Students' description of a critical incident example

Akinsanya's (1987) Conceptual framework			
N=129			
Task level (Number of respondents)	Criteria	Incident example	Perception of knowledge needed in example
Task operational (54)	At this level of performance, the activities done by nurses do not require a specific depth of knowledge of the biosciences	I was working at traumas when we received a patient that was stabbed on the thigh and there was lot of bleeding(R133).	Human biology- apply pressure to stopping the bleeding to form blood clotting
Task specific (57)	The nurse being required to have an understanding of the foundational concepts of the life sciences such as terms and principles intended for performing particular tasks.	Patient had to be given an injection(R13)	Implied but not stated: Anatomy Implied but not stated: Pharmacology
Task contextual (16)	The nursing activities hinges on accurate knowledge of life sciences for patient safety. This level requires the nurse to have deep understanding and is able to apply the concepts and principles of bioscience to a particular task.	Patient came to our ward complaining of diahrea, vomiting and abdominal pain (R21)	Human biology-locating pain Physics-accurate dosage calculation of medication Chemistry-constituents of electrolyte fluids Pharmacology-medication to give to patient to reduce pain
Personal and Professional development (2)	The nurse is required to be capable of rationalizing all actions and be responsible for linking theory to practice	When I was working my midwifery block, one of the patients was losing a lot of blood (post-partum haemorrhage) and I knew I had to give Oxytocin and Voluven to ensure the safety of the patient. (R86)	No description Human biology Colloid needed for blood loss Pathophysiology: post-partum haemorrhage Pharmacology: Oxytocin given

APPENDIX 15: SPSS analysis of the respondents' self-rated perception of the relevance of bioscience to monitoring a patient's heart rate, blood pressure and temperature

Students' self-rated perception of the relevance of bioscience to monitoring a patient's heart rate

Statistics

		Human biology	Physics	Chemistry	Pharmacology
N	Valid	207	185	183	196
	Missing	4	26	28	15
Median		1.0000	.0000	.0000	1.0000
Std. Deviation		.06950	.49009	.46437	.45762

Human biology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	1	.5	.5	.5
	Relevant	206	97.6	99.5	100.0
	Total	207	98.1	100.0	
Missing	System	4	1.9		
Total		211	100.0		

Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	112	53.1	60.5	60.5
	Relevant	73	34.6	39.5	100.0
	Total	185	87.7	100.0	
Missing	System	26	12.3		
Total		211	100.0		

Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	126	59.7	68.9	68.9
	Relevant	57	27.0	31.1	100.0
	Total	183	86.7	100.0	
Missing	System	28	13.3		
Total		211	100.0		

Pharmacology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	58	27.5	29.6	29.6
	Relevant	138	65.4	70.4	100.0
	Total	196	92.9	100.0	
Missing	System	15	7.1		
Total		211	100.0		

Students' self-rated perception of the relevance of bioscience to monitoring a patient's blood pressure

Statistics

		Human biology	Physics	Chemistry	Pharmacology
N	Valid	207	188	184	196
	Missing	4	23	27	15
Median		1.0000	.0000	.0000	1.0000
Std. Deviation		.06950	.50131	.48813	.42805

Human biology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	1	.5	.5	.5
	Relevant	206	97.6	99.5	100.0
	Total	207	98.1	100.0	
Missing	System	4	1.9		
Total		211	100.0		

Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	95	45.0	50.5	50.5
	Relevant	93	44.1	49.5	100.0
	Total	188	89.1	100.0	
Missing	System	23	10.9		
Total		211	100.0		

Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	113	53.6	61.4	61.4
	Relevant	71	33.6	38.6	100.0
	Total	184	87.2	100.0	
Missing	System	27	12.8		
Total		211	100.0		

Pharmacology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	47	22.3	24.0	24.0
	Relevant	149	70.6	76.0	100.0
	Total	196	92.9	100.0	
Missing	System	15	7.1		
Total		211	100.0		

Students' self-rated perception of the relevance of bioscience to monitoring a patient's temperature

Statistics

		Human biology	Physics	Chemistry	Pharmacology
N	Valid	206	186	188	196
	Missing	5	25	23	15
Median		1.0000	1.0000	1.0000	1.0000
Std. Deviation		.16857	.49783	.49789	.43987

Human biology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	6	2.8	2.9	2.9
	Relevant	200	94.8	97.1	100.0
	Total	206	97.6	100.0	
Missing	System	5	2.4		
Total		211	100.0		

Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	82	38.9	44.1	44.1
	Relevant	104	49.3	55.9	100.0
	Total	186	88.2	100.0	
Missing	System	25	11.8		
Total		211	100.0		

Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	83	39.3	44.1	44.1
	Relevant	105	49.8	55.9	100.0
	Total	188	89.1	100.0	
Missing	System	23	10.9		
Total		211	100.0		

Pharmacology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not relevant	51	24.2	26.0	26.0
	Relevant	145	68.7	74.0	100.0
	Total	196	92.9	100.0	
Missing	System	15	7.1		
Total		211	100.0		

APPENDIX 16: Professional editing statement

Brenda Burgess, Editor.

Searching for just the right words – writing what is upright and true.

Brenda Burgess
Durbanville
South Africa
082 7799389
bibburgess7@gmail.com

05/11/2021

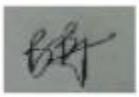
Professional Editing Statement

I confirm that I, Brenda Burgess, am a professional editor with fourteen years' experience in the field of editing.

During the period 18 October to 4 November 2021, I edited Bronwynne Rafferty's thesis, **Nursing students' self-reported knowledge of bioscience and its relevance to clinical practice**, submitted in partial fulfilment of the requirements for the Degree of Master in Nursing (Education) in the School of Nursing, Faculty of Community and Health Sciences, University of the Western Cape.

Although this thesis has been edited to improve grammar, typographical errors and formatting, it remains the work of Bronwynne Rafferty and she has approved the changes.

Kind regards



Brenda Burgess

BA Creative Writing, UNISA

Post-graduate editing course, University of Stellenbosch

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