

*Full Length Research Paper*

# Student nurses' competence in applying bioscience to practice in South Africa

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Student nurses' competence in applying bioscience to practice is under-researched in South Africa. This paper reports on two objectives of a longer study: (1) to describe final year nursing students' self-reported depth of understanding of six bioscience subjects; and (2) their perceptions of relevance of the bioscience subjects to their practice using descriptions of personal critical incidents and picture interpretations of three nursing activities. A descriptive observational survey was employed using a self-administered questionnaire at one time point in a classroom in a nursing college in Cape Town, South Africa in 2013. A sample of 76/236 (32.2%) fourth year students participated. Results showed that the majority of responses (n=252/456, 55.3%) across six subjects indicated self-reported adequate understanding of bioscience, but deep understanding for anatomy (n=35, 46.1%), physiology (n=32, 42.1%) and pharmacology (n=30, 39.5%). Respondents self-rated their understanding of biophysics, biochemistry and microbiology as superficial (n=31, 40.8%; n=32, 42.1%; n=16, 21.1%) respectively. Most respondents considered anatomy, physiology and pharmacology to be relevant for practice and microbiology to some extent but not biophysics and biochemistry. Most respondents' (23/56, 41.1%) descriptions of their interventions in clinical situations aligned with Akinsanya's Bionursing Model level two (task specific) and none at task level four (personal and professional development). The mismatch between self-reported adequate knowledge and a task approach to practice may be ameliorated by a practice model to guide an undergraduate biosciences curriculum.

**Key words:** Bioscience, nursing, bionursing model, student nurse.

## INTRODUCTION

Historically and globally, bioscience subjects have underpinned curricula for the health professions. To ensure patient safety (Andrew and Mansour, 2014) nurses need a good foundational knowledge of

bioscience. Consequently, the South African Nursing Council (SANC) has legislated for the inclusion of biological and natural sciences (anatomy, physiology, chemistry, biophysics, microbiology and parasitology)

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and pharmacology in the 4-year undergraduate pre-registration nursing programme (SANC, Regulation 425 of 1985). The regulation stipulates integration of bioscience with major nursing subjects across the lifespan but the method of integration is not specified. Fewer periods are allocated to bioscience than to major nursing science subjects, relegating bioscience to the status of an ancillary subject (Mohudi, 2013). This paper reports on two objectives of a longer study: (1) to describe final year nursing students' self-reported depth of understanding of six bioscience subjects; and (2) their perceptions of relevance of the bioscience subjects to their practice.

If nursing students disregard the importance and relevance of bioscience to their professional role, it might have implications for the standard of their practice. Nursing is a practice discipline and nurses have a responsibility to develop clinical scholarship (Mannix et al., 2013) ultimately to improve patient outcomes. Clinical scholarship implies evidence-based practice that, in a modern world, requires access to current and preferably online resources, the latter requiring internet connectivity. South Africa (SA) is a middle income country and in Cape Town where the study was undertaken, pre-registration nursing students undertaking a 4-year degree at a university or a diploma of the same duration at a nursing college, are educated within relatively well-resourced institutions. However, immediately after successfully completing their studies graduates are required to provide compulsory community service for one year in underserved, preferably rural settings. Underdeveloped rural SA comprises the greater part of the country and is characterized by limited communication networks and a maldistribution of nurses and other health professionals who prefer urban settlements (Wildschut and Mqolozana, 2008). In a study of 377 final year SA student nurses only 33.2% indicated that they would work in a rural area, even in the absence of any incentives (Erasmus and Blaauw, 2011). To improve health outcomes for the SA population, particularly in rural areas that are challenged by limited access to medical doctors, the pre-registration nursing programme leads to a comprehensively trained nurse (General, Community and Psychiatric) and midwife. For this expanded role, it is imperative that final year nursing students apply bioscience knowledge confidently in their practice.

In SA undergraduate student nurses spend 4000 h in clinical placements encompassing general, community and psychiatric nursing as well as midwifery under the supervision of clinical mentors for a proportion of the time. Mentors facilitate students' clinical learning and assess their clinical competence. Students have difficulty in learning bioscience subjects (Jordan et al., 1999); therefore, the clinical environment provides a rich laboratory for integration of bioscience knowledge and practice. Yet a small study undertaken in the United Kingdom by McVicar et al. (2010) showed that the clinical

learning environment presented challenges for pre-qualifying students such as practitioners having poor knowledge or lacking confidence in their knowledge. There is published literature on Registered Nurses' knowledge and application of the physical sciences in their practice (Choi-Kwon et al., 2002; Prowse, 2003; Van Wissen and McBride-Henry, 2010), but there is a gap in the research on objective measures of impact on students' actual learning (McVicar et al., 2014). Only two SA studies on biosciences in undergraduate nursing programmes were located (Mohudi, 2013; Scrooby, 2012).

In our study, Akinsanya's Classic Bionursing Model (1987) was used to analyse and categorize the respondents' level of performance during interventions for a specific critical incident from their clinical experience that required the application of bioscience, gleaned from their descriptions. The bionursing model proposes four levels of task performance, reflecting the depth of knowledge and understanding of bioscience on which nursing care depends. The four levels are (1) task operational (lowest level), (2) task specific, (3) task contextual and (4) personal and professional development (highest level).

At a public nursing college in Cape Town, offering a 4-year pre-registration diploma programme, Mathematics or Mathematics literacy, Life Sciences and Physical science are compulsory entry subjects, yet the failure rate is approximately 50% in the bioscience primary examination. English is the language of instruction, but is a second language for the majority of approximately 350 first year students. Students gain clinical experience in a variety of health facilities from their first to the fourth year, but due to staff shortages in clinical settings, they are exposed to complex clinical situations beyond their competence.

The aim of this study was to describe fourth year student nurses' self-reported knowledge and understanding of the biosciences and perceptions of its relevance to practice. This paper presents only a selected part of the full study.

The primary objective of this study was to establish fourth year student nurses' self-reported knowledge and depth of understanding of the biosciences (deep, adequate, superficial). Selected sub-objectives of the primary objective are reported in this paper: to describe (1) respondents' demographic characteristics (age and previous work experience/qualifications); and (2) perceptions of the application of bioscience knowledge to practice (very poor, poor, adequate, good, and very good). A secondary objective was to establish respondents' rating of the relevance of bioscience to practice by: (1) describing a specific critical incident from practice requiring the application of knowledge and understanding of the biosciences to ensure quality patient care; (2) describing how knowledge of the biosciences may have influenced these actions; and (3) when shown

three illustrations of nursing activities (a nurse monitoring a patient's heart rate, blood pressure, temperature) to rate the relevance of the six bioscience subjects (relevant/not relevant) for performing each of the nursing activities and to give reasons for these choices.

## METHODOLOGY

A descriptive observational survey was employed using a self-administered questionnaire at one time point in a classroom to achieve the study aim. The study design was guided by Grimes and Schulz's algorithm for classification of types of clinical research methods (2002) in which the authors report that in observational research, the investigator does not assign an exposure and a descriptive observational study does not have a comparison (control) group. All the students in the fourth year programme present on the day of data collection were invited to participate voluntarily in the study; there was no assignment of exposure and no control group.

Ethics approval was granted by the University of Cape Town, Faculty of Health Sciences' Human Research Ethics Committee (HREC 631/2012) and relevant authorities. Principles of the Helsinki Declaration (WMA, 2013) were upheld. Respondents were assured of confidentiality and anonymity by coding. Respondents signed two consent forms endorsing voluntary participation: they retained one copy and deposited the other in a sealed box in the classroom.

Suboptimal reporting of published studies limits the use of a study in further research and as a result, the Enhancing the QUALITY and Transparency of Health Research (EQUATOR) Network (2013) has published a number of reporting guidelines to increase the ease of use and value of health research for many different study designs. Strengthening the Reporting of Observational Studies in Epidemiology Statement (STROBE) guidelines for reporting observational studies (von Elm et al., 2007) were used as appropriate for reporting aspects of our study (Appendix 1).

## Sampling and setting

This study was undertaken at a public nursing college offering a 4-year pre-registration diploma programme towards registration as a nurse (General, Psychiatric, Community) and midwife (SANC, 1985). The initial estimation was based on reports from previous years indicating that the total number of students who pass the primary examination and those who pass a second opportunity (supplementary) examination in bioscience in the first year of study usually comprises 70% of the cohort. The population size of final year students was 124 in the year of study, so 70% would have yielded a sample size of 87 respondents. To determine the actual sample size required, the following parameters were entered into StatCalc/Epi-Info version 7.1.0.6: population size = 214; incidence of satisfactory level of knowledge (set at 50%); design effect = 1.0; Confidence Level = 95%. A sample of 136 was needed. In the absence of previous studies on depth of understanding of bioscience, one of our objectives, on which to base sample size calculation, we used satisfactory level of knowledge. Convenience, nonprobability sampling was used by asking for volunteers amongst students who met inclusion criteria.

## Inclusion and exclusion criteria

The cohort of students in their final year of study in 2013 who had been registered for the R425 programme (SANC, 1985) for no

longer than four years, having passed the bioscience examination after one and no more than two attempts in the first year of study was included. Final year students who met inclusion criteria, but were not willing to participate voluntarily in the study were excluded.

## Data collection

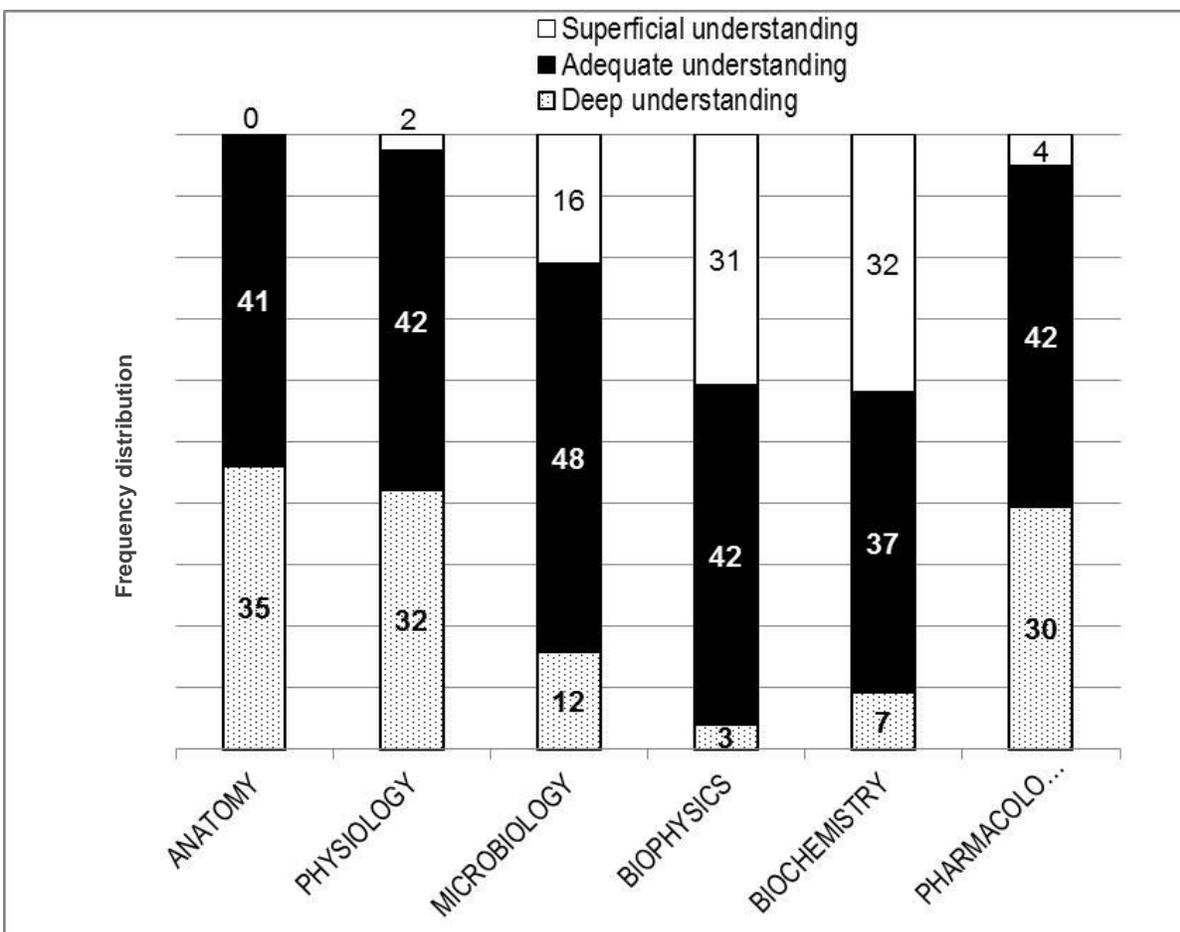
A three-part self-administered questionnaire for a study on Registered Nurses' knowledge and use of bioscience was adapted with permission (Kyriacos et al., 2005) guided by the research questions. Aspects of the questionnaire that are not reported on this paper deal with educational aspects of the curriculum and have been excluded. Part 1 of the questionnaire elicited respondents' self-reported demographic data, depth of understanding the biosciences (deep/adequate/superficial) and perceptions of relevance to their practice. For Part 2, respondents were required to describe a critical incident from personal experience, their interventions and an explanation of how their knowledge of bioscience might have ensured a good patient outcome.

In Part 3, a picture interpretation of three clinical scenarios (a nurse monitoring a patient's heart rate, blood pressure and temperature) required respondents to rate their perceptions of relevance of the biosciences for each scenario (relevant/not relevant) and an open-ended section required reasons for each rating. These activities and interpretation of vital signs data are considered basic nursing competencies required to provide safe quality care. This was the reason for using these examples as picture illustrations for respondents to indicate whether knowledge of any or all of the six bioscience subjects are relevant for these activities. We were of the opinion that the six subjects are relevant for each of these nursing activities. Knowledge of anatomy is needed to locate the radial pulse, brachial artery and an appropriate site for a temperature reading. Understanding physiology assists in interpreting an abnormal heart rate and rhythm, high or low blood pressure and temperature. An infection or sepsis can alter the heart rate, blood pressure and temperature, hence the relevance of microbiology. In each nursing activity portrayed in the pictures an item of equipment was used, requiring a basic understanding of the principles of biophysics. Knowledge of biochemistry, metabolic imbalance and pharmacokinetics helps with the interpretation of abnormal vital signs readings.

Adaptations were made to the existing questionnaire: gender was deleted from Part 1 and previous work experience and/or qualifications added. Part 2 remained unchanged. In Part 3 of the original questionnaire, respondents were interviewed and responses to three illustrations were audiotape recorded to capture their understanding of the relevance of bioscience for each clinical activity portrayed in the illustration. In the adapted Part 3 of the questionnaire, respondents were required to indicate in writing if each of the biosciences was relevant (1) or not (0) and they were requested to give a reason for their answer in each instance.

## Instrument validation

A checklist was designed to establish the Index of Content Validity (CVI) (Yaghmale, 2003) and face validity of the adapted questionnaire. Two experts (a lecturer with a Master's degree and a critical care nurse specialist) evaluated the CVI of each item using a 4-point ordinal rating scale. Pre-determined validity was taken as the proportion of items ( $\geq 70\%$ ) (Guttman et al., 2006) that received a rating of 3 (relevant but needs minor alteration) or 4 (extremely relevant). No changes were made to the content as the overall questionnaire had a high CVI agreement amongst all respondents ranging from 74.3 to 100%. For evaluation of face validity suggested changes to increase the spacing between questions



**Figure 1.** Frequency distribution of responses for self-reported depth of understanding bioscience (n=76).

and to use a uniform font were incorporated.

#### Data analysis

Data for 76 final year student nurses were analysed for descriptive statistics using the IBM Statistical Package for Social Sciences (SPSS version 21) for Windows. Microsoft Office Excel was used for graphic display of data.

## RESULTS

#### Demographic data

The questionnaire was completed by 76/214 (35.5%) final year nursing students on 7 February 2013. Data for age (Part 1) were not normally distributed ( $P < 0.001$ ). The median age of respondents was 25 years (interquartile range = 7) and the majority (42/75, 56%; 1 missing data) were in the 20 to 25 year age group. Of 75 respondents, 38 (50%) had a range of previous work experience and two (2.6%) respondents had previous nursing experience.

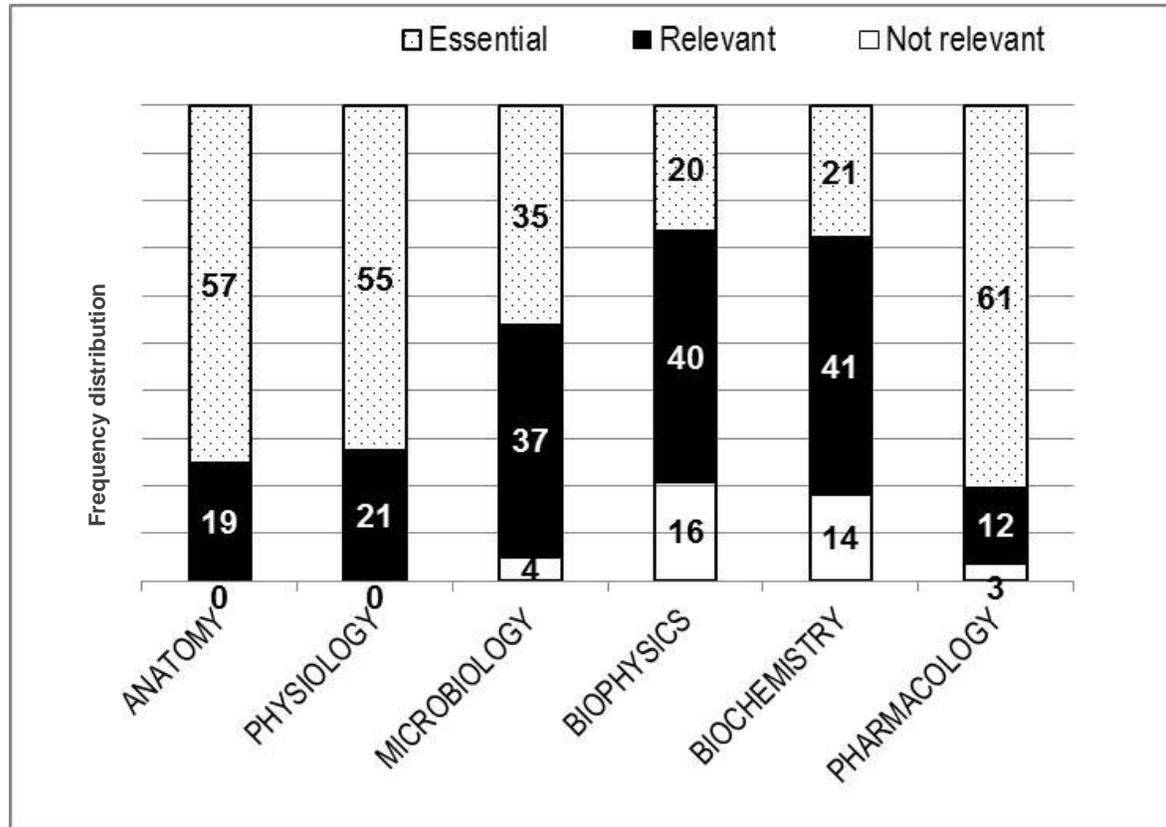
#### Respondents' self-reported depth of understanding of the biosciences

Respondents rated their understanding of the biosciences (Part 1) as deep, adequate or superficial (Figure 1).

The majority of responses (n=252/456, 55.3%) across six subjects indicated that respondents felt they had an adequate understanding of bioscience. Deep understanding was reported for anatomy (n=35, 46.1%), physiology (n=32, 42.1%) and pharmacology (n=30, 39.5%). For biophysics, biochemistry and microbiology understanding was rated as superficial (n=31, 40.8%; n=32, 42.1%; n=16, 21.1%), respectively.

#### Perceptions of understanding the application of bioscience knowledge to practice

Options for rating respondents' understanding of the application of bioscience to practice were: very poor, poor, adequate, good or very good (Part 1). The majority of responses (n=164/453, 36.2%, 3 missing data) across



**Figure 2.** Frequency distributions of responses for perceptions of relevance of bioscience to practice (n=76).

six subjects indicated good understanding of the application of bioscience knowledge to practice, n=139 (30.7%) indicated adequate understanding and n=19 (4.2%) indicated very poor understanding.

### Perceptions of relevance of bioscience to practice in general

Relevance of bioscience to practice (Part 1) was rated as essential, relevant or not relevant (Figure 2).

Pharmacology, anatomy and physiology were considered essential for practice (n=61, 80.3%; n=57, 75.0%; n=55, 72.4%, respectively) by most respondents, whereas most respondents considered microbiology, biophysics and biochemistry to be relevant (n=37, 48.7%; n=40, 52.6%; n=41, 53.9%, respectively), but not essential. Overall, n=34 (44.7%) respondents felt that microbiology, biophysics and biochemistry were not relevant to practice.

### Descriptions of critical incidents, student interventions and use of bioscience to improve patient outcomes

Of the 76 respondents, 20 (26.3%) did not answer the

question (Part 2) „Describe one incident where you had to draw on your knowledge and understanding of the biosciences (anatomy, physiology, microbiology, biophysics, biochemistry or pharmacology) to ensure a good outcome for one or more patients. Describe the incident and your actions.“ Akinsanya's (1987) Bionursing Model was used to categorize respondents' level of performance as (1) task operational (lowest level), (2) task specific, (3) task contextual and (4) personal and professional development (highest level). An extract of the data is presented in Table 1.

Data presented in Table 1 indicate that the majority of respondents (23/56, 41.1%) performed interventions at task level two, having insight of the basic concepts and principles of the biosciences. Thirty-two percent (n=18) of respondents performed at task level three, requiring deep understanding and application of the concepts and principles of the biosciences to a specific task, while 26.8% (n=15) performed at operational task level one, not requiring a specific depth of knowledge of the biosciences. Respondents giving limited descriptions of incidents or of the usefulness of the biosciences in these incidents were allocated to the level one performance category. Not one respondent provided evidence of personal and professional development by performing at task level four, requiring application of the knowledge of the biosciences for the development of a wide range of

**Table 1.** Categorization of level of performance described in critical incidents using Akinsanya’s Bionursing Model.

<b>Akinsanya’s (1987) Bionursing Model [N=56]</b>			
<b>Task level (Number of respondents)</b>	<b>Level descriptor</b>	<b>Example of incident</b>	<b>Perception of knowledge needed in example</b>
One: Task operational (15)	At this level of performance the activities done by nurses do not require a specific depth of knowledge of the biosciences	“I had to clean the wound and had to know Anatomy to guide me on the wounds.” [R40]	Anatomy Implied but not stated: Microbiology Aseptic technique
Two: Task specific (23)	In order to carry out tasks a nurse requires insight of the basic concepts and principles of the biosciences	“The patient had a reaction to blood transfusion, had hot flushes, vomiting, and rashes and couldn’t breathe. I had to report it to the Sister in the ward and removed the blankets the Sister gave him medication, stopped the blood transfusion and called the doctor.” [R30]	Implied but not stated: Anatomy: Cardio vascular system Physiology: Blood circulation Hb monitoring Pharmacology: Medication to be administered when anaphylaxis is observed
Three: Task contextual (18)	This level requires the nurse to have a deep understanding and is able to apply the concepts and principles of the biosciences to a specific task	“Patient was bleeding uncontrollably from an open wound. I took the blood pressure and knowing the patient would be dehydrated I hydrated the patient by giving fluids.” [R21]	Implied but not stated: Anatomy: Circulatory system Physiology: Homeostasis/dehydration Fluid balance
Four: Personal and Professional development (0)	The application of the knowledge of the biosciences allows for the development of a wide range of skills which is required for professional practice	No description	No description

R: Respondent. Framework reference (Kyriacos et al., 2005) with permission.

skills required for professional practice.

**Picture interpretation: Perceptions of relevance of biosciences for monitoring heart rate, blood pressure and temperature**

Part 3 of the questionnaire consisted of three colour pictures portraying nurses: (1) counting a patient’s radial pulse rate, (2) taking a blood

pressure reading and (3) oral temperature. Relevance of the biosciences for these three nursing activities was rated as relevant or not relevant (Figure 3).

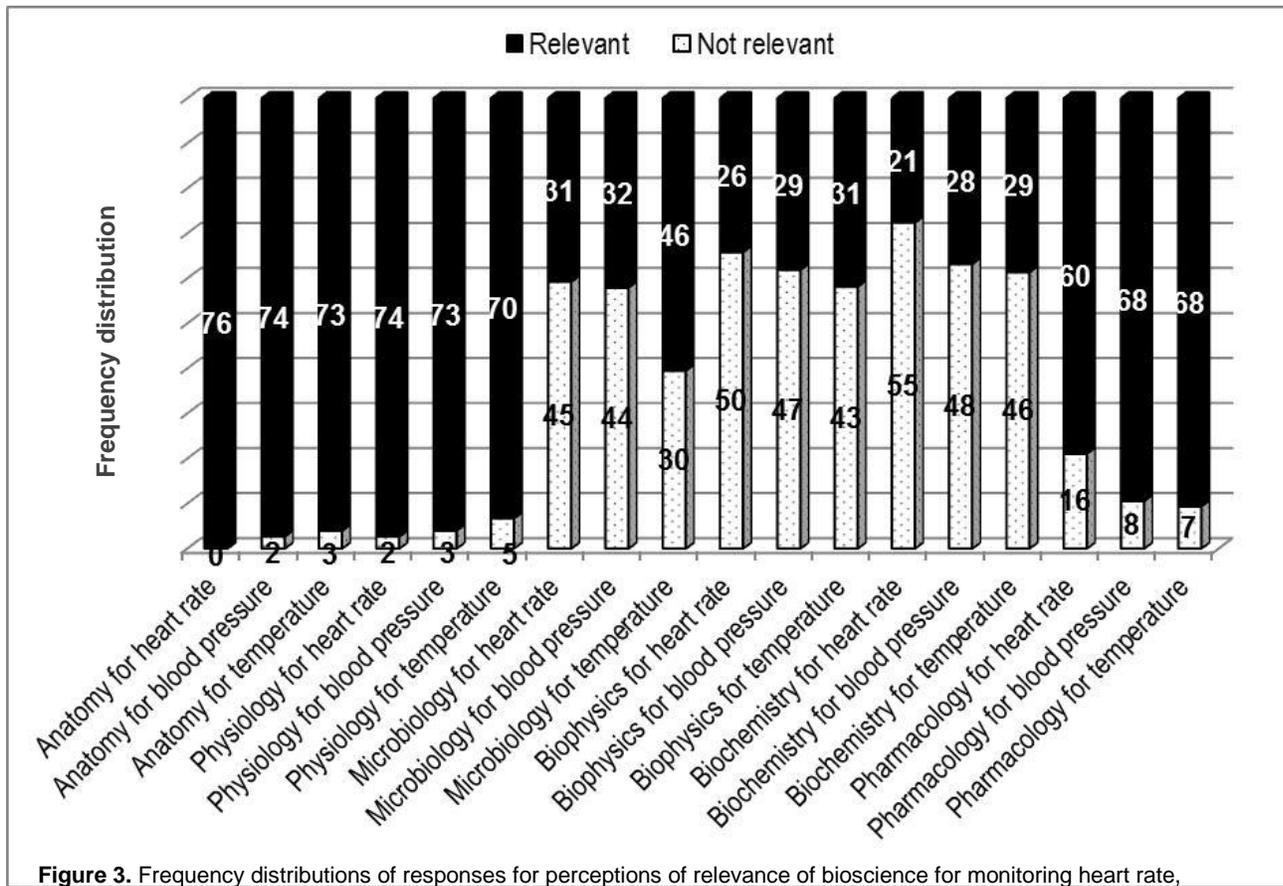
**Anatomy, physiology and pharmacology**

Anatomy, physiology and pharmacology were rated between 78.9 and 100% for relevance for

monitoring heart rate, blood pressure and temperature, while microbiology was also perceived to be relevant for temperature readings (60.5%).

**Microbiology, biophysics and biochemistry**

Microbiology, biophysics and biochemistry were considered less important for these activities



ranging from 27.6 to 42.1%. No reasons were provided for the relevance of the six bioscience subjects to the monitoring of a patient's heart rate, blood pressure and temperature.

### Summary of key results

Results for the primary objective of the study show that the majority of self-reported responses (n=252/456, 55.3%) across six subjects indicate an adequate understanding of bioscience and good understanding of the application of bioscience knowledge to practice (n=164/453, 36.2%).

Results for the secondary objective show that most respondents rated pharmacology, anatomy and physiology as essential for practice (n=61, 80.3%; n=57, 75.0%; n=55, 72.4%, respectively), and microbiology, biophysics and biochemistry as relevant, but not essential. With a non-response of 26.3%, there was a spread of evidence of task performance at levels one to three of Akinsanya's Bionursing Model, with the majority of respondents (23/56, 41.1%) showing evidence of task level two performance, that is, having insight of the basic concepts and principles of the biosciences. There was no

evidence of performance at level four. With the picture interpretations, anatomy, physiology and pharmacology were rated between 78.9 and 100% for relevance for monitoring heart rate, blood pressure and temperature, while microbiology was also perceived to be relevant for temperature readings. Microbiology, biophysics and biochemistry were considered less important for these activities ranging from 27.6 to 42.1%. No reasons were provided for the relevance of the six bioscience subjects to the monitoring of a patient's heart rate, blood pressure and temperature.

### DISCUSSION

The results of this study showed that the typical final year student was 25 years of age and may have had previous work experience outside of the nursing profession. Interestingly, most of the respondents in our study reported having adequate understanding of bioscience, whereas practising nurses in a study by McVicar et al. (2010) self-reported having weak bioscience knowledge. Respondents in our study felt they had adequate bioscience knowledge despite having no experience as independent practitioners, whereas practising nurses in

the study by McVicar et al. (2010) indicated that experience is important for bioscience learning. It may be that for practising nurses, bioscience knowledge is lost along the way if they do not pursue continuing education or there is no perceived link to practice (Choi-Kwon et al., 2002). The provision of links between the biological sciences and clinical practice remains unresolved and might be attributed to the unstructured and haphazard application of biosciences knowledge in clinical situations (Johnston, 2010).

Bioscience in a nursing curriculum is intended to help students to relate their knowledge to patients with disease patterns in clinical settings (Durai et al., 2012). Understanding bioscience and its application to problem-solving skills are pivotally important in preparing student nurses for clinical competence. Less than half of the pre-qualifying respondents in our study reported having deep understanding of anatomy, physiology and pharmacology. What is puzzling about the somewhat inflated self-rated bioscience knowledge is that 26% of respondents did not provide a description of an intervention portraying not only application of their bioscience knowledge, but also the value that this knowledge added to their actions. Most respondents were therefore unable to substantiate the use of bioscience knowledge in their practice implying weak knowledge. This is in contradiction to these final year students' self-reported good understanding of the application of bioscience knowledge to practice. Of those who were willing to describe an intervention for a critical incident, the majority were found to function at Akinsanya's (1987) task level two (task specific). At this level of performance, nurses would be required to have insight of the basic concepts and principles of the biosciences, which is only one level above task operational (not requiring a specific depth of knowledge of the biosciences). While there was some evidence of performance at task level three (task contextual), requiring deep understanding and application of the concepts and principles of the biosciences to a specific task, it is of concern that not one respondent could confidently be placed at level four. At task level four, there is evidence of personal and professional development requiring application of bioscience knowledge for the development of a wide range of skills required for professional practice. In SA, the minimum requirement on registration after completing a 4-year programme is, among others, to demonstrate the ability to solve problems effectively in order to apply a scientific approach to nursing, from the initial assessment to the rehabilitation of a patient or group (SANC, 1994).

In our study 21 to 41% of the respondents felt they had a superficial understanding of biophysics, biochemistry and microbiology. Understanding content is influenced by its complexity. For decades, researchers have reported that students perceive bioscience subjects as the most difficult in a nursing programme (Nicoll and Butler, 1996;

Jordan et al., 1999; Gresty and Cotton, 2003), particularly biochemistry (Cheesman et al., 2007; Hassan et al., 2012; Silva and Batista, 2003) and removed from the field of nursing (McKee, 2002). Also, biophysics is reported to be the least relevant (Fenton, 2010). Conversely, Friedel and Treagust (2005) and Davis' (2010) findings indicated that 80% of students rated bioscience as relevant to practice. Understanding bioscience content is also influenced by anxiety. The application of biosciences knowledge in clinical situations is not only difficult, but reportedly also unstructured, haphazard and anxiety provoking (Johnston, 2010) which might account for nurses' difficulty in understanding the biosciences and applying this knowledge in practice. Perceived anxiety about studying bioscience may be linked to poor examination performance (Gresty and Cotton, 2003). In South Africa, high school biology is not a requirement for entry into the undergraduate nursing programme at many higher education institutions (Mohudi, 2013) and students might experience anxiety having to cope with certain bioscience courses for the first time.

In our study, 54.3% of respondents reported having adequate understanding of pharmacology. Focus group discussions with final year students in a study completed by Adhikari et al. (2014) revealed limited knowledge, insufficient understanding, lack of confidence and a need for more learning sessions on medication management and applied pharmacology. A lack of knowledge in pharmacology may be attributed to a lack of in-service training and integration of theory and practical (Lim and Honey, 2006; Ndosu and Newell, 2009; Davis, 2010) and has implications for patient safety (Andrew and Mansour, 2014). Whereas most respondents considered pharmacology, anatomy and physiology essential for practice and therefore relevant, this was not so for microbiology, biophysics and biochemistry. Biophysics and biochemistry were even considered to be irrelevant to practice. From the first year of training to the fourth year, respondents would have been assessed on their competence to monitor and interpret a patient's physiological vital signs such as heart rate, blood pressure and temperature in various clinical disciplines including midwifery. The respondents' self-rating of the relevance of bioscience knowledge to practice earlier in the questionnaire was tested by providing them with pictures of specific nursing tasks with which they were familiar and asking them to justify the relevance of bioscience knowledge for each activity. Most respondents considered knowledge of anatomy, physiology and pharmacology to be relevant for these nursing, substantiating their earlier ratings of the relevance of these three bioscience subjects. Microbiology was also considered relevant for interpreting temperature readings. This exercise confirmed respondents' views that biophysics and biochemistry are less relevant for practice than anatomy, physiology, pharmacology and microbiology.

Akinsanya (1987) reported a global paucity of research undertaken by nurses on bioscience advances or content taught which could suggest a reluctance to own bioscience as nursing content. Owning validated bioscience knowledge would empower practising nurses to use bioscience knowledge to support students in making links between theory and practice (McVicar et al., 2010). Since Akinsanya's expressed concern about a lack of research, the advent of early warning scoring (EWS) systems a decade later has resulted in a plethora of studies conducted by nurses (Odell et al., 2009). EWS research focuses particularly on vital signs monitoring for the recognition of and response to clinical and physiological deterioration in patients, requiring sound bioscience knowledge (McVicar et al., 2010; Kyriacos et al., 2015) to limit incidents of failure to rescue. The escalation of EWS studies by nurses does not support the views of Mostyn et al. (2013) of a total disinterest in biological sciences amongst nurse educators due to the move away from the medical model of care.

## Conclusion

The data from this study suggests that there is a mismatch between final year preregistration student nurses' self-reported adequate bioscience knowledge and their reported level of clinical practice. On analysis, respondents' clinical practice was characterised by low task specific performance. At a task specific level, performance lacks evidence of deep understanding and application of bioscience concepts and principles to a specific task, anticipated for final year students. Most respondents considered anatomy, physiology and pharmacology relevant for practice and microbiology to some extent, but not biophysics and biochemistry.

## RECOMMENDATIONS

Further research is needed to compare final year pre-registration nursing students' self-rated understanding of bioscience knowledge to lecturers' assessment of their knowledge. Student perceptions of the lack of relevance of the biosciences to practice particularly microbiology, biophysics and biochemistry may be ameliorated by a practice model such as Akinsanya's Bionursing Model to guide outcomes for an undergraduate nursing curriculum and specifically for ensuring integration of bioscience knowledge in clinical learning.

## STRENGTHS AND LIMITATIONS

This is the first reported study from SA on final year preregistration student nurses' self-reported depth of understanding of bioscience subjects and of their

perceptions of relevance of bioscience knowledge to their practice.

Despite the use of a self-reported anonymously completed questionnaire, we had no control over unanswered questions. The estimated sample size of 136 was not achieved as only 76 (55.9%) respondents participated in the study, thereby limiting generalization of results to other student populations. External validity is also jeopardised by missing data for 20 respondents that limited the interpretation of data and therefore the conclusions reached which has implications for implementation of the study findings. Although it was possible to describe demographic characteristics of non-respondents from available student records, this was not done thereby increasing the potential for volunteer bias (Jordan et al., 2013).

For a description of a critical incident a focus group rather than questions may have provided rich data. To analyse responses to certain questions, the framework of a previously published study was used to guide the coding of the data which may have limited the external validity of the study findings (Kawulich, 2004).

## Conflict of Interests

The authors have declared no conflict of interests.

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**Appendix 1.** STROBE Statement—checklist of items that should be included in reports of observational studies (von Elm et al., 2007).

Item No	Recommendation	Application to study, relevant sections
1	Title and abstract (a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 1. Abstract Yes
<b>Introduction</b>		
2	Background/rationale	Page 1
3	Objectives	Page 2 Objectives, no hypotheses
<b>Methods</b>		
4	Study design	Page 3
5	Setting	Page 3
6	Participants  (a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	N/A
		N/A
		N/A
6	(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	N/A
		N/A
7	Variables	Page 2 in objectives
8	Data sources/measurement	Page 4
9	Bias	Page 11 volunteer bias
10	Study size	Page 3 StatCalc/Epi-Info version 7.1.0.6
11	Quantitative variables	Page 4
12	(a) Describe all statistical methods, including those used to control for confounding	Page 4
	(b) Describe any methods used to examine subgroups and interactions	N/A
	(c) Explain how missing data were addressed	Page 5 reported
	(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
	(e) Describe any sensitivity analyses	N/A

## Appendix 1. Cont'd.

<b>Results</b>			
13	Participants	(a) Report numbers of individuals at each stage of study, e.g. numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	Page 4, 6 Not known Not done
14	Descriptive data	(a) Give characteristics of study participants (e.g. demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (e.g., average and total amount)	Page 4, 5 Page 5, 11 N/A
15	Outcome data	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	N/A N/A N/A
16	Main results	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g. 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Pages 4-8 as applicable N/A N/A
17	Other analyses	Report other analyses done, e.g. analyses of subgroups and interactions, and sensitivity analyses	N/A
<b>Discussion</b>			
18	Key results	Summarise key results with reference to study objectives	Page 8
19	Limitations	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 11
20	Interpretation	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Pages 9-10
21	Generalizability	Discuss the generalizability (external validity) of the study results	Page 11
<b>Other information</b>			
22	Funding	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 11

