ACADEMIC ACHIEVEMENT IN BIOMEDICAL SCIENCES AND ITS CORRELATES AMONG STUDENTS OF BACHELOR OF NURSING SCIENCE PROGRAM IN UGANDA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF MEDICINE, DEPARTMENT OF FAMILY MEDICINE, COMMUNITY HEALTH AND MEDICAL EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY DEGREE IN MEDICAL EDUCATION OF MOI UNIVERSITY

DECLARATION

I declare that this thesis is my original work and has not been presented for a degree in any other university. No part of this thesis shall be reproduced without the prior written permission of author and Moi university.

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DEDICATION

This dissertation is dedicated to my dear father, the late Mr. Sebastian Kalenzi, whose unwavering commitment to education laid the foundation for my academic journey. Though he is no longer with us, his values and sacrifices continue to inspire me. I also dedicate this work to my beloved mother, Ms. Ozebia Tigatorwa, whose love, strength, and unwavering support have been my pillar since birth.

To my dear wife, Ms. Alice Nandutu, and my sons, Kamukama Emmanuel, Karuhanga Bruno, and Kamugisha Shadrack, I am deeply grateful for your patience, understanding, and sacrifices. Your unwavering love sustained me through this long and demanding journey.

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ABSTRACT

Background: Biomedical science courses such as anatomy, physiology, and biochemistry are critical components of nursing education, providing the foundational knowledge necessary for effective clinical practice. Despite their importance, academic achievement in these courses among nursing students remains low globally, with failure rates ranging from 20% to 50%. However, in Uganda, the extent of this problem and the factors associated with it remain poorly understood.

Objectives: This study aimed to examine the level of academic achievement and sociodemographic, student educational and institutional factors influencing it among students in Bachelor of Nursing Science (BNS) program in Uganda.

Methods: This mixed-methods study, guided by Critical Realism philosophy and Constructivist learning theory, was conducted at four purposively selected Ugandan public universities between March and July 2024. It employed cross-sectional and descriptive qualitative design for the quantitative and qualitative study aspects respectively. The qualitative study included 12 purposively sampled teaching staff, while the quantitative study used a census approach to enroll 208 students. Data were collected through key informant interviews and a self-administered questionnaire. Quantitative analysis involved Welch's analysis of variance, Pearson correlation, and a linear mixed-effects model, while qualitative data were analyzed thematically.

Results: The study found that academic achievement in biomedical sciences among nursing students had improved over time but remained context-dependent, with an overall failure rate of 8.41%. Physiology had the highest mean GPA (2.86 ± 0.768), while anatomy had the lowest (2.62 ± 0.825), leading to an overall GPA of 2.80 ± 0.788. Most students scored C (37%) and D (33.7%) letter grades. Similarly, one teaching staff stated: *"There is a little bit of improvement in performance now". O*lder age (e.g**.,** 35+, $\beta = -0.70$, 95% CI: -1.25--0.16**)** and coming from a region outside central Uganda (e.g., Northern region, $\beta = -0.43$, 95% CI: -0.74--0.12**)** were sociodemographic factors associated with lower GPAs. Selecting nursing as a lower-choice career option (e.g., fourth choice, $\beta = 0.62$, 95% CI: 0.30-0.93**)** and using uncollaborative learning methods (e.g**.**, rarely participating in group discussion, $\beta = -0.61$, 95% CI: -1.21- -0.12) were student educational factors associated with higher and lower GPAs respectively. Previous secondary education performance did not significantly influence academic achievement in biomedical sciences, despite its role in admission decisions **(**$r = 0.1163$**).** Not receiving feedback (e.g., lecturers not giving feedback on progressive test, $\beta = -0.54$, 95% CI: -0.93 --0.14) and using problem-based teaching method ($\beta = 0.48$, 95% CI: -0.05 --1.91) were some of the institutional factors associated with GPA.

Conclusion: Academic achievement in biomedical sciences among BNS students in Uganda is reported to have improved but remains suboptimal, with overall failure rate of 8.41%. Key factors that influence academic achievement include socio-demographics (age, region of origin), student educational choices and learning approaches (career preference, collaborative learning), and institutional practices (feedback to students, competence-based teaching methods). Notably, prior academic performance at high school did not significantly predict success in biomedical science courses at university, despite its use as a criterion for university admission.

Recommendations: To improve academic achievement, universities should provide targeted academic support to older students and those from regions outside central Uganda, strengthen career guidance at secondary level to align students' interests with nursing education, encourage group discussions and peer-led learning strategies to enhance student engagement and comprehension, ensure regular and timely feedback on assessments to support learning progress, and promote the contextually appropriate use of problem based learning. Universities and government could also consider reviewing the current admission criteria of students into the BNS program.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AR: Academic Registrar

AT: Anatomage table

AA: Academic Achievement

BNS: Bachelor of Nursing Science

CGPA: Cumulative Grade Point Average

CHS: College of Health Sciences

COVID: Corona Virus Disease

CR: Critical Realism

Dr. Doctor

GMAT: Graduate Management Admission Test

GPA: Grade Point Average

ICN: International Confederation of Nurses

ITO: Input Transformation Output

LoC: Locus of Control

PBL: Problem Based Learning

PhD: Doctor of Philosophy

PI: Principal Investigator

REC: Research and Ethics Committee

SDL: Self Directed Learning

SPSS: Statistical Package for Social Sciences

TDL: Traditional Didactic Learning

UNCST: Uganda National Council of Science and Technology

VARK: Visual, Aural or Audial, Reading or Writing, Kinesthetic

SAAS Subjective Academic Achievement Score

UNCHE: Uganda National Council of Higher Education

TASO: The Aids Support Organization

MUST: Mbarara University of Science and Technology

IIP: Inductive Interpretive Phenomenology

OPERATIONAL DEFINITION OF TERMS

1. **Bachelor Nursing Science (BNS) students:** Are undergraduate students pursuing a bachelor’s degree in nursing science.
2. **Academic Achievement:** According to York, Gibson, and Rankin (2015), Academic Achievement (AA) is defined as the ability of students to meet the set performance criteria, attain learning objectives and outcomes, acquire desired competencies, get satisfied with the learning experience, progress and complete the course on time, and apply competences to solve problems after the course. However, in this study, the term will be used to refer to the level to which BNS students achieve the learning objectives and satisfaction with the learning experience in biomedical sciences.
3. **Biomedical Sciences:** Is an interdisciplinary field that combines the areas of biology, medicine and health sciences (Liberty University, 2022). In this study, the term ‘biomedical sciences’ is used to mean the three core medical science courses that BNS students undertake in their first two years of study, namely, Anatomy, Physiology and Biochemistry.
4. **Correlates:** Are independent variables that have significant statistical relationship with the dependent variable and can be used to forecast or estimate the nature of the latter. In this study, the term is used to refer to the variables that can influence the level of academic achievement in biomedical sciences among BNS students.
5. **Lecturer:** The term "lecturer" referred to university staff responsible for teaching biomedical sciences. It included faculty members at a minimum rank of Assistant Lecturer up to full Professors. A sample of these lecturers constituted the study population for the qualitative aspect of the study

ACKNOWLEDGEMENT

I extend my deepest appreciation to the Almighty God for the gift of life granted to me, my family, my siblings, and my dear mother. I am grateful for His wisdom, which has guided me in making the right decision to embark on this challenging yet deeply rewarding academic journey.

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Finally, my heartfelt gratitude extends to Dr. Sylivia Nalubegga and Mr. Joseph Atukwatse for their mentorship and steadfast encouragement, especially during moments when the path seemed insurmountable.

To all of you, I am profoundly grateful. This work stands as a testament to your love, sacrifice, and support.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Overview

This chapter presents the study background, problem statement, study objectives, research questions, hypotheses, study justification and significance, philosophical underpinnings as well as conceptual framework that guided this study.

1.2 Study Background

According to the International Council of Nurses (1987), nursing care encompasses independent, interdependent, and cooperative care of individuals of all ages, families, groups and communities, sick or well and in all settings (ICN, 2002). It includes the promotion of health, prevention of disease and the care of the sick, disabled and the dying people, advocacy, promotion of a safe environment, research, participation in shaping health policy, health systems management and education. Given their wide scope of practice, nurses constitute more than 50 percent of the global health workforce and play a critical role in caring for millions of people, work across almost all health care points and contribute greatly towards realization of universal hegalth coverage and sustainable development goals (Nigel Crisp et al., 2018).

With the right knowledge, skills and attitudes coupled with adequate numbers and high level of motivation, nurses can greatly transform health care system. It has been found that better educated nurse workforce adds value to hospitals, and therefore, upgrading nurse education level has been reported to immensely improve patient care (Lasater et al., 2021; Liu et al., 2019).

As many countries work towards realizing universal health coverage, there is equally growing evidence showing that degree prepared nurses, also referred to as BNS graduates, bring unique skills to their work as nurse clinicians and contribute greatly towards high quality nursing care. For instance, Wieczorek-Wójcik et al. (2022) conducted a study to determine influence of nurse education level on hospital admissions. From this study, it was found that increasing number of nurses with BNS qualification was associated with significant reduction in patient readmissions and economic benefit. Johua Porat-Dahlerbursh et al. (2022) also revealed that higher hospital proportions of BNS nurses was associated with lower odds of congestive heart failure and inpatient surgical mortality.

In many developing and developed countries, nursing education is offered at certificate, diploma, bachelor's, master's, and, rarely, doctoral levels. The majority of nurses hold certificate qualifications, while those with doctorates in nursing are extremely few. Certificate nursing students are typically admitted after completing the ordinary level of secondary education, whereas diploma and bachelor's students are mainly admitted after completing the advanced level of secondary education. Additionally, there is an alternative admission pathway that allows certificate holders to progress to diploma programs and diploma holders to enter bachelor's programs.

In all cases, admission criteria are determined by previous academic performance and the choice of a nursing career. Undergraduate nurses typically undertake a four-year BNS program, with the first one or two years dedicated primarily to biomedical sciences and the remaining years focusing on social sciences and clinical science courses.

BNS program relies on biological or life science. Accordingly, biomedical science has been described as the foundation of nursing because its scope of knowledge is based on scientific principles, facts, concepts, theories and laws (WHO, 2016). Biomedical sciences encompass courses such as anatomy, physiology, and biochemistry which nursing students undertake during the first one or two years of their academic program (Grønlien et al., 2025). These courses are commonly referred to as preclinical, initial or gateway courses because they provide a strong foundation for clinical courses such as medical-surgical nursing, midwifery, child health nursing, community health nursing, and mental health nursing, which are typically taught in the later stages of the program (E. Royse et al., 2024; Syed Abd Halim et al., 2023). One of the previous studies found that students who perform well in preclinical courses also tend to excel in clinical courses. It further recommends that academic scores in biomedical courses can serve as a reliable predictor of future academic success (Horiuchi-Hirose et al., 2023).

The need for knowledge of biomedical sciences among undergraduate nursing students is anchored in many educational theories and concepts such as constructivist learning theory, self-determination theory, and cognitive load theory. Constructivist learning theory posits that learning is a progressive process. As such, foundational knowledge in biomedical sciences serves as a basis for mastering more complex clinical skills, which are taught on incremental basis (Lamina, 2024). Self-determination theory emphasizes the role of intrinsic motivation in teaching and learning in the three psychological domains namely, autonomy, competence and relatedness (Guay, 2021). In reference to self-determination theory, biomedical courses such as anatomy, physiology, and biochemistry serve as prerequisite courses for many clinical and non-clinical subjects, providing a strong foundation that fosters a sense of autonomy and competence among nursing students. In addition, acquiring knowledge in these courses enhances students' appreciation of learning and motivation to learn, as they can relate this foundational understanding to clinical disciplines (Guay, 2021). From Cognitive Load Theory, which explains how the human cognitive system receives, processes, and retains knowledge, having prior knowledge in biomedical sciences such as anatomy, physiology, and biochemistry reduces intrinsic and extraneous cognitive load. This reduction allows nursing students to receive, process, and retain clinical knowledge more efficiently (Gorbunova et al., 2025).

Therefore, academic achievement in biomedical sciences, defined as the extent to which students achieve pre-determined learning objectives and intended learning outcomes is a key determinant of competency in nursing education. Academic achievement indicates the extent at which students are able to achieve the carefully set level of academic and educational outcomes. This implies that the level of achievement of the students is context dependent and fluctuates depending on the prevailing factors.

Accordingly, biomedical science courses have been shown to predict the quality of nursing care that nurses ultimately provide (Nuuyoma et al., 2025). For example, S. Bakon et al. (2016) highlighted that greater knowledge of biomedical sciences among nursing students is associated with improved patient care outcomes. Similarly, Wood et al. (2020) noted that insufficient knowledge of biomedical sciences among nursing students raises concerns about patient safety.

Therefore, given the critical role biomedical sciences play in nursing education and clinical care practice, all student nurses at every level of education and training are expected to demonstrate adequate knowledge and competence in courses such as anatomy, physiology, and biochemistry. Their understanding of these courses should be comprehensive enough in both the breadth and depth. It should be concerning and scaring to some extent to find a practicing nurse who is largely inadequate in content and depth in these courses.

However, biomedical sciences are widely recognized as challenging courses for nursing students and other healthcare trainees, with poor academic achievement among nursing students remaining a persistent issue in many countries. For instance, a descriptive study in Iraq found that 45.5% of university nursing students failed anatomy and physiology, with the majority exhibiting a significant knowledge gap in the integumentary system (Mahfoudh Falih Hasan, 2022). A study in South Africa found that 30.0% to 46.0% of nursing students registered fail scores in biomedical science courses (Mhlongo & Masango, 2020). In Ethiopia, a similar study also found that about half of the medical students scored below a B grade in anatomy examination (Tiruneh et al., 2020).

In developed countries, poor academic achievement in biomedical sciences among nursing students may arise due to their abstract nature, content overload, low student motivation, or lack of appreciation for their relevance to nursing practice. While in developing countries, the poor academic achievement may be further exacerbated by high student-to-teacher ratios, inadequate teaching and learning resources, and variations in academic preparedness of students at the point of entry into the professional training (Pholphirul et al., 2023). Factors influencing academic achievement can be categorized into students' sociodemographic characteristics, student educational factors, and institutional factors. These factors may be modifiable or non-modifiable and can also be classified as input and transformative variables. Input factors include those introduced into the education system, such as sociodemographic and student educational characteristics like age and prior knowledge. Transformative factors, on the other hand, are institution-related, including the quality of teachers and the availability of learning resources. Among these, student educational factors, largely within the student's control, have been found to play the most significant role in academic success (Suleiman, 2023).

Poor academic achievement not only affects the quality of graduates but also reduces labor force density, limits future career opportunities, and demotivates teachers, students, caretakers, and universities. Moreover, it reflects the poor quality of the country's education system (M. Shahjahan, 2021). The impact of poor academic achievement is even more pronounced in developing countries, where a severe shortage of nurses coincides with a high disease burden, financial constraints on training, and limited educational opportunities.

In many countries, there is scanty and inconsistent literature on the level of academic achievement in biomedical sciences among BNS students and its correlates. For instance, in Kenya, a related study found that BNS students who were aged 30 years or more were more likely to excel in examinations compared to those who were less than 30 years old (Asiko et al., 2017).

However, this study did not specifically examine academic achievement of BNS in biomedical sciences. Similarly, findings from related study among graduate students of business studies at Makerere University in Uganda discovered that Graduate Management Admission Test (GMAT) scores of program applicants were significantly associated with their high academic achievement in the program (Wamala et al., 2012). Surprisingly, after a year later, a comparable study revealed contradicting findings that instead the students who were not admitted using GMAT had better educational outcomes (Wamala Robert & Mukadasi, 2013). As a result of insufficient and contradictory information, students, teachers and institutions remain unaware of the accurate level of academic achievement in biomedical sciences and its correlates among BNS students.

This is further evidenced by results from the integrative review study by Kari Toverud Jensen et al. (2018) which shed light on the deficient research studies about the problem of biomedical sciences in nurse education. Extra substantiation on the need for the study to determine correlates of academic achievement in biomedical sciences was articulated by Malik et al. (2018). Lack of this information makes it practically difficult to precisely predict which students are most likely to have difficulties in biomedical sciences.

Therefore, accurate understanding of the level of academic achievement in biomedical science courses such as anatomy, physiology and biochemistry and its correlates among BNS students provide credible evidence that can guide the design and implementation of effective and efficient interventions to tackle poor academic achievement in these courses in Uganda and beyond (Amy Gultice et al., 2015a).

1.3 Statement of the Problem

Academic achievement in biomedical sciences is vital in nursing education, yet it remains poor among BNS students in many countries across the globe (Manchester & Roberts, 2025). For instance, in South Africa, one study revealed that about 30% to 46% of the nursing students registered at least one fail grade in biomedical sciences (Mhlongo & Masango, 2020). Similarly, in Uganda, unpublished institutional records from several universities indicate that about 20-50% of the students register at least one failing score in these causes.

Such poor performance contributes to student attrition, delayed progression, and persistent academic difficulties in clinical courses for which biomedical sciences form a strong foundation (Sheikoleslami et al., 2025). It compromises the quality of graduates, reduces workforce density, limits career opportunities, and demotivates both students and educators (Sharda & Nowell, 2025).

Despite the magnitude of the problem in Uganda, limited context-specific evidence exists to guide universities in predicting or improving academic achievement (Shannon Bakon et al., 2016). Uncertainty remains regarding appropriate entry-level science score thresholds and the predictive value of prior performance in biology, chemistry, mathematics, or physics, resulting in continued but largely ineffective intervention efforts such as raising points for admission and recruiting more qualified academic staff among others. Therefore, credible research evidence is needed to inform targeted strategies aimed at improving and sustaining academic achievement in biomedical sciences among BNS students.

1.4 Study Objectives

1.4.1 General Objective

The overall objective of the study was to explore the level of academic achievement in biomedical sciences and factors that influence it in order to design effective interventions to improve and sustain it.

1.4.2 Specific learning objectives

The specific objectives of this study were to:

1. Explore the level of academic achievement in biomedical sciences among BNS students in Uganda.
2. Examine socio-demographic factors that influence academic achievement in biomedical sciences among BNS students in Uganda.

3. Investigate individual educational factors that influence academic achievement in biomedical sciences among BNS students in Uganda.
4. Analyze institutional factors that influence academic achievement in biomedical sciences among BNS students in Uganda.

1.5 Research Questions

We set out to do this study to answer the following questions:

1. What is the level of academic achievement in biomedical sciences among BNS students in Uganda?

2. What are the socio-demographic factors that influence academic achievement in biomedical sciences among BNS students in Uganda?

3. What are the individual educational factors that influence academic achievement in biomedical sciences among BNS students in Uganda?

4. What are the institutional related factors that influence academic achievement in biomedical sciences among BNS students in Uganda?

1.6 Study hypothesis

1.6.1 Null hypotheses

At 95 percent significant level and error margin of 5 percent, the following null hypotheses (Ho) were drawn to be tested in this study (Anupama, 2018):

1. The mean GPA in biomedical sciences among BNS students in Uganda is greater than or equal to 3.00 ($\mu \geq 3.00$).
2. There is no significant relationship between sociodemographic, individual educational, and institutional factors and academic achievement in biomedical sciences among BNS students in Uganda.

1.6.2 Alternative hypotheses

At 95 percent significant level and error margin of 5 percent, the following alternative hypotheses (Ha) were drawn (Anupama, 2018):

1. The mean GPA in biomedical sciences among BNS students in Uganda is less than 3.00 ($\mu < 3.00$).
2. There is a significant relationship between sociodemographic, individual educational, and institutional factors and academic achievement in biomedical sciences among BNS students in Uganda.

1.7 Justification of the study

Nursing students in Uganda continue to struggle with core biomedical science courses, namely anatomy, physiology, and biochemistry. Accordingly, unpublished reports from several universities in Uganda indicate that 20-50% of the students register at least one failing score in these causes. Therefore, there is a growing concern about the significant proportion of BNS students in Uganda who obtain failing or marginal pass scores in biomedical sciences; however, knowledge about the magnitude and determinants of this problem remains scanty and inconsistent.

The available literature on the level of academic achievement in biomedical sciences among BNS students and its correlates is insufficient to inform decisions on how best to improve performance. Many attempts to reduce the high failure rate in biomedical sciences such as hiking entry points and recruiting more academic staff have been largely less effective, as most of the interventions end up focusing on examination coaching to help students overcome assessment hurdles rather than addressing the underlying causes of the problem (Patel et al., 2015).

Therefore, this study was conducted to provide a credible understanding of the level of academic achievement in biomedical sciences and its correlates among BNS students in Uganda. The findings may inform evidence-based decisions on how to improve and sustain academic achievement in biomedical sciences. Enhancing performance in this field will, in turn, boost the motivation of both students and teachers in learning and teaching, respectively.

Additionally, improved academic achievement will increase career opportunities and employability for graduates while facilitating a smooth transition from the biomedical sciences phase to the clinical phase, enabling students to have satisfying learning experience. Furthermore, higher academic achievement will contribute to improved patient care, as BNS graduates will possess stronger competencies in patient assessment, clinical judgment, and decision-making.

By strengthening academic achievement in biomedical sciences, among nursing students, the study contributes to the realization of Sustainable Development Goal (SDG) 4 which emphasizes the need to improve the quality and relevance of tertiary education and enhancing the competencies required for safe, evidence-based practice. Similarly, the study also supports Uganda’s National Development Plan IV particularly under Human Capital Development programme which prioritizes improving quality and relevance of education and training and strengthening the health workforce to deliver efficient and effective health services. Specifically, it aligns with targets focused on increasing the stock of appropriately skilled health professionals through enhancing training quality in higher education institutions.

If this study was not conducted, the persistent problem of poor academic achievement in biomedical sciences among nursing students in Uganda would remain inadequately understood, leading to continued high failure and marginal pass rates without evidence-based interventions. Consequently, universities and policymakers would lack context-specific data to guide curriculum improvement, teaching strategies, and student support mechanisms, which could compromise the competence of nursing graduates and ultimately affect the quality and safety of nursing care in Uganda's health system.

1.8 Significance of the study

The findings from this study will be highly valuable in nursing education, nursing leadership and management, nursing care and nursing research. They will provide an in-depth understanding of the magnitude of the challenges in biomedical sciences and their correlates among BNS students in Uganda. This knowledge will be instrumental in designing strategies to improve the teaching of biomedical sciences, ultimately contributing to high-quality clinical care.

In nursing education, these findings will be particularly useful for BNS nurse educators, enabling them to identify students at risk of poor performance in biomedical sciences and develop targeted interventions to support their improvement. The study also highlights effective teaching and learning practices that can enhance and sustain academic achievement among BNS students in Uganda and beyond.

Policy experts in education will find the study's conclusions and recommendations valuable, as they outline key actions needed to improve academic achievement in biomedical sciences, ultimately leading to the production of high-quality BNS graduates. Additionally, the findings provide a clear understanding of the minimum requirements BNS students should meet to succeed.

Moreover, these findings can inform the design, implementation, and review of the BNS curriculum, shaping policy decisions on admission requirements, assessment methods, quality assurance, support supervision, and the overall learning environment. This, in turn, will contribute to improved nursing care quality in both the medium and long term.

Since previous studies have demonstrated a strong relationship between the quality of nursing care and knowledge of biomedical sciences, improving academic achievement in biomedical sciences will ultimately contribute positively towards having well prepared BNS nurses enhance nursing care quality.

Regarding research contributions, the findings from this study will be published in peer-reviewed journals to help fill the existing knowledge gap on this subject. The results will also refine current perspectives on factors influencing academic achievement in biomedical sciences among BNS students. Future researchers exploring similar areas will find this information highly valuable.

1.9 Research Philosophy

Philosophical assumptions refer to a system of beliefs about the development, search, and communication of knowledge. These assumptions are ontological, epistemological, axiological, and methodological. According to Saunders et al. (2009), ontological assumptions are about realities being encountered and can be categorized as realist, critical realist, or nominalist. Epistemological assumptions are those a researcher holds about nature of knowledge and how it is acquired, axiology is about beliefs and values of researcher and how these influence the study while methodological assumptions are conventions about research process.

This study was guided by Critical Realism (CR) philosophy. CR is one of the divisions of ontological assumptions which postulates that there is a reality that exists independent of our thoughts about it. It further states that while observing what happens may make us more confident about what exists, existence itself is not dependent on our observations (Sayer, 2000).

According to Haigh et al. (2019), CR defines knowledge as transitive and being open to change. CR axiology also acknowledges that society is not rigid, and improvement of society is therefore possible. According to Heeks et al. (2019), CR is commensurate with Pragmatism which favors an interactive combination of both inductive and deductive reasoning. This further implies that CR philosophy lies between positivism and interpretivism continuum, the main reason it has been preferred in this mixed methods study.

From CR philosophy, researcher is therefore convinced that significant proportion of BNS students perform poorly in biomedical sciences in Uganda though the extent of this problem is not clearly known. Researcher also strongly believe that factors associated with this poor academic achievement in biomedical sciences among BNS students exist irrespective of our limited knowledge of them. Therefore, there is a need to conduct a study to explore them. Secondly, since knowledge is not static according to CR philosophy, a researcher believes that knowledge from previous studies about this phenomenon could have changed and therefore cannot be inferred to the current time and more so to the different setting. Hence the need to conduct another study.

Thirdly, since CR philosophy confirms that improvement of society is possible, indeed there is need to conduct a study such that findings can guide on how academic achievement of BNS students can be improved and sustained.

1.10 Conceptual Framework

This study was guided by the Input-Transformation-Output (ITO) framework. This framework was initiated in a factory setting to illustrate the role of operation in creating and delivering goods and services in an organization (Henri, 2004). According to Melan (2002), ITO framework epitomizes three components of operation: the Inputs, Transformation system, and Outputs.

In reference to ITO framework (Melan, 2002), inputs are the raw materials, variables or services fed into the transformation system from outside. The efficiency and effectiveness of the transformation system depends on the quality and quantity of the inputs. Consequently, the quality and quantity of outputs partly depend on the capacity and quality of the transformation system which is indirectly dependent on the inputs. Transformation system is described as the processing phase in which inputs are converted into outputs. Similarly, transformative system which literally refers to what a machine does to the inputs can also influence the quantity and quality of outputs. Therefore, outputs are the direct products of the transformation system. ITO framework is usually used in education to describe relationship between students, the school or institution, and academic performance.

In reference to this research study, this framework was preferred because it guided on the categorization of the factors that influence academic achievement in biomedical sciences according to their levels of operation and how they interact across different levels. Therefore, Inputs in this study represent variables such as socio-demographic and individual educational variables.

Social demographic factors include but not limited to age, gender, socio-economic background, birth order, education of parents and accommodation.

On the other hand, individual educational factors include but not limited to previous academic achievement of students, type of previous school attended, self - concept and motivation level, career choice, locus of control, perceived efficacy and studying time, sitting arrangement in class as well as learning styles. Transformation processes represent institutional factors such as physical facilities, student quality and numbers, entry criteria, curriculum, teachers' quality and numbers, assessment methods, student-teacher interaction, as well as teaching and learning strategies and methods.

The output in this study describes the academic achievement of BNS students in biomedical sciences. Increased academic achievement in biomedical sciences will further lead to amplified teacher and student's motivation to teach and to learn respectively, will increase labour force density and quality of clinical nursing care among others.

Therefore, as shown in the modified ITO model below, it is believed that BNS students' socio-demographic and personal educational variables are fed into an institution. An institution should have a favorable environment and ability to transform these inputs into expected outputs, in this case, very good academic achievement.

The quality of output, in this case the level of academic achievement will be determined by reviewing previous records on academic achievement and will be reflected in the form of Grade Point Average (GPA) scores in anatomy, physiology, and biochemistry examinations.

It will also be manifested in highly motivated teachers and learners, the increasing number of BNS students completing the course on time and high-quality nursing care being offered to patients or clients. High completion rate, also referred to as increased labour force density will go a long way in solving staff shortage which also remains a big challenge in Uganda and other developing countries. As previously stated, knowledge of biomedical sciences will improve the competencies of BNS graduates in the areas of patient assessment, disease diagnosis, making sound clinical decisions, evidence-based care, and ability to comprehend clinical constructs. Conceptually, it means that the feedback should target those learner's socio-demographic and educational variables as well as institutional factors that have been found to be associated with academic achievement in biomedical sciences among BNS students. *Figure 1.*

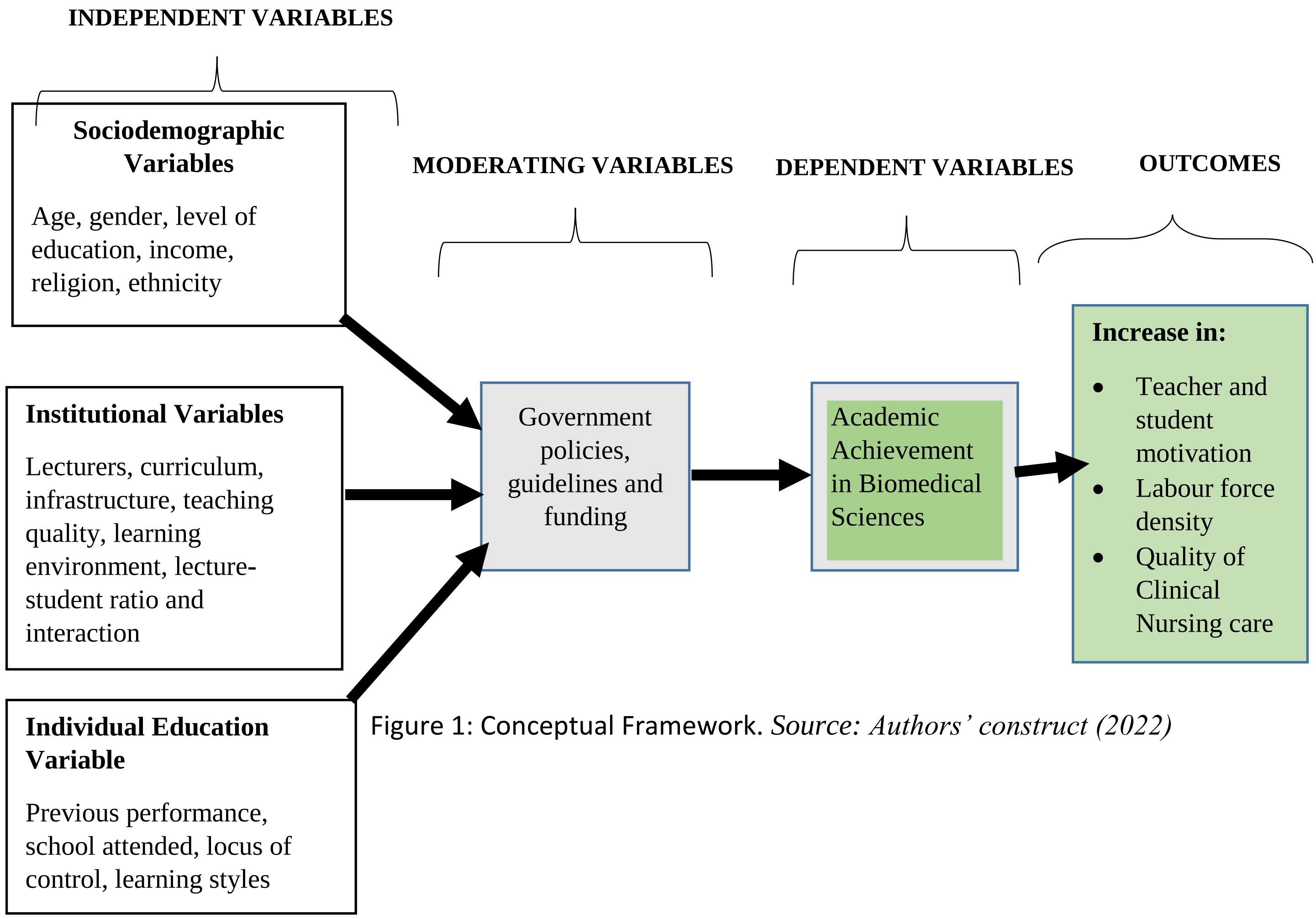


Figure 1: Conceptual Framework. *Source: Authors' construct (2022)*

ITO constructs in this study have been further described as independent, moderating, and dependent variables. In this study, sociodemographic (Input), individual education (Input) and institutional (Transformative) variables described earlier will be the independent variables while academic achievement in biomedical sciences among BNS students (Output) will be the dependent variable.

However, government policies, guidelines and funding will be the mediating variables. This conceptual framework is further borne on the strong assumption that there are interactions between teachers, students, learning environment, content or curriculum and biomedical courses namely anatomy, physiology, and biochemistry.

Although not fully understood, it is believed that curriculum prescribes the content, teaching methods, teaching resources and environment favorable to teach anatomy, physiology, and biochemistry. However, curriculum remains redundant until there are students who are motivated and ready to learn and teachers who are knowledgeable in the content, well-motivated and with appropriate pedagogical skills. It is further postulated that academic achievement in anatomy, physiology and biochemistry depends on the content and teaching methods dictated by the curriculum, the teachers' scope of knowledge, teaching skills and motivation of the teacher, the students' previous knowledge, motivation, and commitment to learning and lastly, the teaching and learning environment such as the university's resources inform of internet, library, accommodation, feeding, and other welfare support systems.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents literature of the previous studies according to the study objectives. It provides an overview of teaching and learning practices among BNS students, level of academic achievement in biomedical sciences, as well as sociodemographic, individual educational, and institutional factors that influence academic achievement in biomedical sciences among BNS students

2.1 Overview of teaching and learning practices among BNS students

The meaning of teaching and learning has been articulated by different authors with the common variables in the definition being a teacher, learner, content, communication, and environment. According to Edmund (1967), Davis et al (1962), Gagne et al (1974) and Gage (1978) as cited by Rajagopalan (2019), teaching is an interactive scientific and artistic activity between a teacher and a learner and involves effective communication, content and constructive feedback. Teaching has also been described as an intentional activity which is thought to bring about learning. Teaching therefore is regarded as an effective collaboration between teacher and learner, is both art and science and is controlled by the skill of communication. Teaching is a tripolar process because its success is hinged on the following three thematic areas: educational objectives, learning proficiencies and change in behavior. Educational objectives provide a guide for selecting content to be taught, help a teacher in allocating teaching time and define teaching and learning assessment criteria.

Learning proficiencies are competencies which a learner is expected to demonstrate after the completion of learning activities while change in behavior is what a learner portrays consistently as evidence to show that learning took place.

Teaching has also been described as a democratic, cooperative, kind, and sympathetic activity that stimulates learner's power of critical thinking. Teaching is further described as an activity that can be observed, analyzed and evaluated (Oxman et al., 2024). On the other hand, according to Sequeira (2012), learning is described as permanent change in behavior and attitude, usually not merely incidental but rather intentional. Therefore, the central purpose of teaching is to facilitate learning and the effective interplay between teaching and learning is determined by conducting assessment.

Assessment informs the teacher, the learner, and the institution whether learning objectives and intended learning outcomes have been achieved or if the learner is on track towards achieving such. According to Sumita and Pisano (2021), assessment enables a teacher to provide constructive feedback to the learner on what has been achieved and where a competence gap still exists.

BNS student nurses are usually equally assessed to determine their level of academic success and then make decisions on the next course of action. Academic achievement, usually indicated by the Grade Point Average (GPA) is an indicator of effectiveness of educational system and acquisition of required knowledge, skills, and attitudes by the students. GPA score shows the level of academic achievement of students and can be categorized as excellent, very good, good, fair, pass, or fail. Determining the level of academic achievement of student nurses helps educators to understand the extent at which the desired competencies have been achieved and guides on the decision about the next course of action to be taken by the student, teacher and institution.

The pride of any institution of higher learning squarely lies in the academic success of learners. Therefore, the focus of such institutions of higher learning is to prevent academic failures (Mannahan, 2017). Unfortunately, many institutions of higher learning that offer BNS academic program continue to register high failure rates in biomedical sciences among BNS nursing students.

However, the magnitude of failure rate in biomedical sciences among BNS students is poorly documented. In addition, factors that influence academic achievement among students are usually multifactorial in nature and are also poorly understood. These factors also interact with each other at various levels and appear to be context dependent.

These probable associates of academic achievement in biomedical sciences have been described as either modifiable or non-modifiable factors (Mannahan, 2017). These factors can also broadly be categorized as socio-demographic, institutional and learner educational factors.

For instance, from one of the studies by Tajabadi et al. (2021), it was found that individual and curriculum related aspects, teaching strategies and methods used by the faculty, failure to comply with lesson plans and large number of students in class were major correlates of high academic failure rate among nursing students. From this study, it can be concluded that each of the correlates of academic failure reported essentially belonged to either socio-demographic, individual academic or institutional category as earlier presented. Also, this study did not quantify the magnitude of academic failure. Therefore, there is a dare need for detailed literature about the level of academic achievement in biomedical sciences among BNS students and factors that correlate with it.

2.2 Academic achievement in biomedical sciences among students of Bachelor of Nursing Science

Flexner Report (1910) on medical education in United States of America and Canada opened a new era in the field of medical education. The report advocated for the transformational approach to the education of health professionals especially medical doctors and nurses.

In the report, it is well documented that Flexner emphasized the need for scientific knowledge that nurses needed to have in order to provide high quality and evidence-based care (Duffy, 2011). A hundred years later, in 2010, Carnegie report still reaffirmed Flexner's earlier position that indeed, nurses needed adequate knowledge of biomedical sciences such as anatomy, physiology, biochemistry and microbiology in order to practice safely and effectively (Benner, 2012).

Since then, it still stands that nurses need good understanding of biomedical sciences in order to make sound clinical decisions and provide quality nursing care. Accordingly, there is growing evidence showing that BNS nurses add tremendous value to the quality of patient care.

Accordingly, many countries and states are now encouraging professional bodies and councils of nurses and midwives to refocus on the transformation of nurse education approach so that more highly qualified, confident, knowledgeable, and specialized nurses and midwives are educated.

For instance, a study found that a 10% increase in the proportion of BNS nurses in the hospital units was associated with lowering odds of patient mortality by 10.9% (Manchester & Roberts, 2025).

Therefore, there is no doubt that BNS nurses can significantly improve the quality of patient care if they are well educated and employed in health facilities in sufficient quantities. BNS prepared nurses are able to provide high quality and respectful nursing care because they possess profound competences which are anchored on the good knowledge of biomedical sciences, clinical nursing, social sciences and humanities (Schnelli et al., 2024). The level of mastery of competencies required by BNS nurses can partly be demonstrated by their level of academic achievement in examinations and the final CGPA.

Academic achievement is a measure of educational success and provides an understanding of the level of knowledge and skills possessed by the student. However, ability of BNS nurses to learn and earn good examination scores in biomedical science courses as well as integrating this knowledge to their clinical practice still remains a big concern.

Previous studies about the level of academic achievement in biomedical sciences among nursing students in selected European countries revealed interesting contradictory findings. For instance, a study in Norway, Italy and England found that about 30% of BNS students registered at least one fail score in either anatomy, physiology or biochemistry (Bergen, 2010; Dante et al., 2013; Amy Gultice et al., 2015a; Knutstad et al., 2020; Lancia et al., 2013; Ryan Blackwell, 2016).

On contrary, a similar study in central Norway by Evensen et al. (2020) found that only nine percent of the students registered a fail-score in biomedical sciences and majority of students scored a letter B score grade which meant that a significant number of students had good academic scores. However, this study had a limitation of the small sample size and self-reported data which was not deeply independently verified. Other contradicting results were reported in a study in Rome which revealed that about 69% of nursing students generally registered fail scores and did not complete the course of study on time (Bulfone et al., 2021). Results from this study indicate that academic failure rate in biomedical sciences was much higher than that in Italy, England, and Norway.

In United States of America, the problem of poor academic achievement in biomedical sciences still remains a strong barrier to progress and retention among nursing students (E. A. Royse et al., 2024). For instance, a study at the community college in United States between the year 2014 and 2015 revealed that academic failure rate in bioscience courses among nursing students was high as 50% (Forgey et al., 2020). This study discovery was closely similar to that of Tartavoulle et al. (2018). Tartavoulle and colleagues conducted a study at one of the nursing schools in Southern United States. From this study, they also found that about 40% of nursing students did not graduate on time due to fail scores mainly in biomedical sciences. From this study, it can also be concluded that the academic failure rate in biomedical sciences reported by the studies in United States of America was within the global range but higher than that in some European countries.

Similarly, a study in Australia revealed that biomedical sciences were challenging and difficult to be understood by nursing students (Christopher Gordon et al., 2017). Similarly, according to Owens (2019), a significant proportion of nursing students in Australia still underperform in biomedical sciences and this significantly contributes to high attrition rate of students. However, both studies did not quantify the extent of this problem in Australia. But what these two research findings present is that failure rate in biomedical sciences remains one of the main challenges affecting nursing students in Australia.

In Africa, the problem of biomedical sciences among BNS students is poorly understood yet it continues to torment students. In Sudan, a study involving medical students revealed a mean score of 57.49% in basic sciences and failure rate of 19.5% in the same courses (Khalid et al., 2026). Roos et al. (2016) conducted a similar study in South Africa and found that about 64 percent of BNS students had dropped out of the program and fail score in human anatomy was the leading cause. Although this study reveals that fail score in biomedical sciences may be a leading cause of attrition among nursing students in South Africa, the researcher did not clearly state which proportion of students dropped out of school due to fail score in biomedical sciences.

Another study by Mhlongo and Masango (2020) in South Africa also reported that pass rate of biomedical sciences among student nurses fluctuated between 54% and 70%. This means about 30% – 46% of students failed biomedical courses. These study findings are similar to what Mahudi (2013) also reports in the research report. The author also stated that findings from the preview of summative results indicated that only about 50% of nursing students passed examinations of biomedical sciences. On contrary, another study by Desmond Oscar B. and Alan Kevir (2016) in South Africa on application of biomedical sciences to practice discovered that majority of nursing students had strong conviction that they had an in depth understanding of biosciences. However, this was self - reported information which was not independently investigated.

In Uganda, the problem of biomedical sciences among nursing students seems to be more even worse. A significant proportion of BNS students continue to find biomedical sciences more difficult to pass despite the amount of commitment and energy invested. This has been evidenced by findings from the study by Nantamu (2021). From this study, it was found that only 38.4% of BNS students passed all biomedical science courses on single sitting. The study also found that the mean score ranged between 63.06 and 77.19% with 60% being the pass mark (translated as D score) compared to the mean range for non-biomedical courses which was instead as high as 71.69 – 79.92% (C score). This suggests that majority of BNS students in Uganda indeed experienced difficulties in learning and succeeding in biomedical science courses. However, this study basically studied biomedical sciences in antibiotic resistance and therefore did not deeply explore level of academic achievement in biomedical sciences. The study also did not include faculty staff in the study to hear their views on this matter and particularly the challenges they face as they teach biomedical courses.

2.3 Socio-demographic factors associated with academic achievement in biomedical sciences among BNS students.

Academic achievement is usually an outcome of several interweaved factors some of which are social while others are demographic in nature. According to Spacey (2022), social factors are social aspects of life such as culture that affect the behavior and quality of life of an individual.

Whereas it is usually difficult to draw a thick line between the term social and demographic factors, demographic factors are mainly those factors such as age and gender that describe characteristics of the population (Writer, 2022). Therefore, sociodemographic factors are a combination of social and demographic variables that define people in a specific group or location. Description of sociodemographic variables allows a researcher to understand attributes that respondents have in common. These attributes include but not limited to age, gender, education, ethnicity, religious affiliation, marital status, household characteristics,]income, employment and location or address. There is body of literature available which indicates that some of the sociodemographic variables can influence the academic performance of students in schools (Alshammari et al., 2017; Thomas et al., 2021).

In research, sociodemographic factors are usually considered to be independent variables because they don't get manipulated in the study. They are usually explored in the study to determine if a relationship exists between them and the dependent variable and they can also be regarded as non-modifiable variables likely to influence academic achievement in biomedical sciences among BNS students. Sociodemographic variables can further be categorized as either categorical or continuous variables. Categorical sociodemographic variables are discrete variables that capture qualitative outcomes by placing observations in levels (Eric, 2021). Categorical variables can further be classified as ordinal, nominal or binary.

Ordinal variables are those in which the order of the groups is relevant. Nominal variables are ones in which the order of the groups is not relevant while binary variables have only two possible outcomes.

Income, education level and family size are good examples of sociodemographic ordinal variables. Common examples of sociodemographic nominal variables are ethnicity, religion and address while gender is the common example of binary sociodemographic variables.

Sociodemographic continuous variables on the other hand are variables which are measured but not counted because they pass from one value to the next by indefinitely small changes (Beltran & Tarwater, 2024). These include height, time, weight, and age. These variables are further categorized as ratio and interval variables. Ratio variables are those that are measured on a ratio scale in which zero number is an absolute or have true meaning while interval variables are variables with zero number which has no true meaning and the difference between given numbers can be meaningfully interpreted.

The age of students has been found to be one of the sociodemographic factors likely to influence academic achievement. For instance, a study in United States found that students who were of old age were more likely to pass anatomy, one of the core biomedical sciences compared to those who were young (Harmon et al., 2023). On contrary, another study in Nigeria found that young students passed examinations better than those who were old (Johnson et al., 2019). A study by Tartavoulle et al. (2018) on the predictors of academic success among BNS students found that students who were 22 years or older performed poorly in biomedical sciences and took extra semesters to complete the course. Surprisingly still, another study in South Korea found that nursing students who were aged 22 years or younger were more likely to pass examinations better than those who were older (Gu M, 2021). However, all the studies above did not measure the effect size between age and academic achievement in biomedical sciences. The possible explanation of the difference in academic achievement between young and old students could be variations in cognitive capacity, divided attention, and poor background of biological and physical sciences.

Gender of students has also been reported in few previous studies as a significant determinant of academic achievement. For instance, a study in Saudi Arabia found that being a male BNS student was positively correlated with academic achievement (Alshammari, 2019).

However, the study considered all the courses that students did, not biomedical sciences alone. Another study in Kenya also found that male BNS students indeed registered higher scores in examinations than female counter parts (Kamotho &

Mwenda, 2022). Whereas this study provides good comparative understanding of the relationship between gender and academic achievement, it considered all the courses that students had done, paying less attention to the possible unique aspect of the biomedical sciences. On contrary, Gu M (2021) revealed that instead the female students registered higher scores in examinations than their male counterparts. Conversely, researchers did not rule out the possibility that the number of female respondents outweighing that of males could have distorted the quality of findings. The difference in performance was possibly due to the small sample size of study participants.

Regarding place of residence, a study among Sri Lankan Universities found a strong correlation between satisfaction with the hostel facilities and academic achievement in examinations (Mansoor & Ali, 2015). A similar study in Tanzania found that students who were staying near the university were more likely to perform better in examinations compared to those who were living far, possibly because those who lived near were able to manage their time well and to access learning resources with ease (Shillingi & Kamugisha, 2025).

However, a similar study was carried out in Ethiopia and found no statistically significant difference between the living conditions of students in hostels and academic achievement (Abdulaziz Mussema. et al., 2019). However, this was a cross-sectional study which involved all randomly sampled students who were not nursing students.

BNS students in higher education institutions sometimes spend some time doing paid full time or part time work in order to boost their financial levels despite evidence that this may impact negatively on their academic performance. Indeed, there is growing evidence indicating that such students may perform poorly in their academics. For example, a study at the national university in Columbia found that nursing students who had paid jobs that demanded them to work for more than 20 hours in a week had a higher risk of failing examinations compared to those who were not working or had fewer hours of paid work (García-Vargas MC, 2016). A related study in New Zealand concluded that nursing students juggled work and studies so as solve financial constraints but the same study added that students felt that the work took most of the time for learning which negatively affected their academic performance (Mitchell, 2020). Another study in Australia on the type and amount of paid work while studying among nursing students indicated a significant association between spending 20 hours or more on the non-nursing paid work and academic performance (Salamonson et al., 2020). In summary, most empirical studies indicate that engagement in paid work during nursing education, particularly when students work long hours is associated with reduced study time, increased fatigue and stress, and a higher likelihood of lower academic achievement or examination failure, although the strength of this relationship varies across contexts.

Just like many other sociodemographic variables, race and ethnicity have been found to correlate with academic achievement of students in higher institutions of learning. Students usually come from different backgrounds and academic achievement has been found to vary greatly between people of different ethnic backgrounds (Kippenbrock T, 2022). This statement is further supported by findings from Mthimunye and Daniels (2020) in South Africa which indicated that certainly a significant difference existed between academic performance and ethnicity of students. This study concluded that South African students who were whites by race were more likely to pass nursing examinations compared to their black counterparts. Relatedly, Abrahamsen and Storvik (2019) from their study in Norway revealed that nursing students whom they regarded as immigrants were more motivated to study than native students. Since motivation has also been found to be one of the other influencers of academic achievement, this consequently implies that immigrants were more likely to register better scores in examinations than natives. What is not clearly understood though is whether ethnicity or race influences academic achievement in biomedical sciences among BNS students in Uganda.

Engagement into active sexual activities by students has also been found to be a silent act practiced by a large proportion of students high schools and institutions of higher learning including universities. For instance, a study revealed that more than half of the students in Brazil were actively engaged in sexual relationships (da Silva Nascimento et al., 2018). (Budeba & Neema, 2014). In Uganda, a similar study at one of the universities also revealed that about half of the university students had had sexual relationships with the prevalence being twice higher in males (Kaggwa et al., 2022).

There is common knowledge among many education stakeholders which postulates that involvement of parents or guardians in educational matters influences the level of academic achievement of the children. Involvement of parents or guardians in academic matters takes various forms.

It can be regarded as a school-based or home-based involvement. It can also be in the form of either direct or indirect control of students or both. In practical terms, parents or guardians provide material and financial support, psychosocial support, they help students to plan education and guide students on how and why to choose the next school or institution. Some previous studies show contradicting information about the relationship between academic performance and involvement of parents or guardians in educational matters.

Similarly, some previous studies also linked parental involvement in learning with academic achievement. For instance, a meta-analytical synthesis study revealed that parent involvement in learning of their children had a positive effect on academic achievement although the effect size was relatively small (Erdem & Kaya, 2020). A similar study among 120 randomly selected pupils in Ghana revealed that parental involvement was statistically significantly associated with academic achievement. However, although this study provides very good comparative study findings, the same study considered pupils not nursing students (Darko-Asumadu & Sika-Bright, 2021). On contrary though, Linda (2020) conducted a similar study at Asia-Pacific international university and instead found no correlation between academic performance and parent or guardian involvement in students' academic affairs. Therefore, parental involvement generally appears to be associated with academic achievement although the effect varies by involvement type and context.

Whereas economic and education levels of parents or caretakers are non-modifiable variables on the part of students and institution, it is still important to understand these concepts such that if possible, indirect interventions such as government policy on poverty alleviation can be strengthened. For instance, a study reported that students whose parents were well educated and had well-paying jobs were more likely to register better academic performance than those whose parents were not educated and consequently poverty stricken For instance, a study in Uganda reported that students whose parents were well educated and had well-paying jobs were more likely to register better academic performance than those whose parents were not educated and consequently poverty stricken (Dube & Mlotshwa, 2018). Similarly, Eknath et al. (2021) also conducted a study and concluded that a positive correlation existed between parents' level of education and academic performance. However, this study used a small sample size of only 120 participants. On contrary, another study by Adzido et al. (2016) at Ho polytechnic in Ghana found that low financial status of parents or guardians did not necessarily translate into poor academic performance of their children at the college.

The presence of inconsistent and sometimes contradictory findings in literature makes it difficult to draw a firm conclusion about whether a positive correlation exists between academic performance in biomedical sciences among BNS students and the income level or educational attainment of their parents or guardians.

2.4 Individual educational factors that correlate with academic achievement in biomedical sciences among BNS students

Learning involves acquiring new knowledge, skills and developing new behavior. Regardless of the efforts of other stakeholders, learning still remains an active process in which a student is solely responsible (McNamara, 2022). Therefore, learning cannot be successful unless a student feels a strong sense of ownership of the whole learning process. Students play a central role in the teaching and learning process by being available for class, asking and answering questions, attempting assignments and examinations, participating in practical sessions, doing private learning, actively participating in group discussion and sharing knowledge with others, obeying and cooperating with teachers and as well as applying the knowledge and skills to solve societal challenges among others (staff, 2022).

It is the responsibility of students to justify what is learned and to account for the learning outcomes. In reference to the teaching and learning process and from available literature, studies indicate that student related variables such as their previous academic achievement in particular courses or subjects, type of previous schools attended, self - concept and motivation level, career choice, locus of control, perceived efficacy and studying time, sitting arrangement in class as well as learning styles among others could be associated with academic achievement in biomedical sciences among BNS students. Fortunately, most of the variables mentioned above are modifiable at individual or institutional level and therefore there is need to clearly understand how each of these including others not mentioned, might be predictors of academic achievement in biomedical sciences among BNS students. This subsection of literature review presents a detailed account of these student related factors.

Learning is regarded as an active process that requires a significant amount of energy and time input. The demand for time investment in studying biomedical courses is enormous given the large volume of content of biomedical courses to cover in short given time (Zilundu et al., 2021). Indeed, some studies have been done to find out whether allocating more time to biomedical courses can contribute towards improved academic achievement. A related study also revealed that BNS students who spent more than 15 hours a week studying anatomy and physiology were more likely to succeed in examinations of these courses compared to those who spent less study time (Mannahan, 2017). Similarly, another study discovered that the more the time learners spent actively learning biosciences particularly on the online platform, the more their mark scores improved (Owens, 2019). However, none of the studies measured the strength of association between time spent studying biomedical sciences and academic achievement. Therefore, there is need to conduct a multisite study in another locality and on BNS students with different backgrounds to verify the impact of time on academic achievement and more so to quantify the magnitude of such effect.

As mentioned earlier, it is the role of students to take responsibility of their learning. However, this is only possible if students feel confident that they can take charge of their academic destiny. Therefore, it has been found that students’ self-determination, self-esteem and self-concept were positively correlated with academic achievement (Andrew et al., 2015). This implies that the way students perceive their abilities and the confidence they have that they can excel in their studies coupled with their capability to decide on their next course of action without any form of compulsion can determine their level of academic achievement.

For example, in Sri Lanka and United States, studies found that students' self-determination was significantly associated with their academic performance (Fernando, 2017; Jennifer P. Gray. & Mannahan, 2017). A similar study by Albert and Dahling (2016) concluded that students' academic self-concept was strongly associated with their academic achievement. Another study was carried out in Israel by Khalaila (2015) to determine effect of academic self-concept on academic achievement. Findings from this study indicated that higher self-concept was found to be directly related to greater academic achievement while intrinsic motivation and test anxiety were found to be mediators in the association between academic self-concept and academic achievement among nursing students.

Above findings are further strengthened by other interesting findings by (Blackmore et al., 2021). From their study, Blackmore et al. (2021) also concluded that ability of students to self-regulate their emotions in academic endeavor correlated positively with improved academic achievement.

Locus of Control (LoC) has also been found to correlate with academic achievement in biomedical sciences among BNS students. LoC can be described as a person's belief that his or her actions affect the special upcoming outcome (Mohamed et al., 2019). It is a person's inner conviction that he or she has powers to change or influence an event occurring or affecting his or personal life. Therefore, students with high internal LoC will accept that their academic success or failure is because of the effort and hard work they invested in their education. While those with high external LoC will believe that their success or failure was because of external factors beyond their control. Such students often attribute their academic success or failure to flimsy excuses such as luck, fate, injustice, or prejudice.

They at times attribute their learning outcomes to the commitment, quality, discipline, or behavior of the teacher. Therefore, some studies indicate that there is a correlation between academic achievement and LoC. For instance, Pardede (2020) conducted a study on the association between LoC and learning achievement. The study found a correlation between the two variables. However, the correlation was weak with the effect of 0.22. From another study at Dananhour university in Egypt on the relationship between LoC and academic achievement of nursing students and found a strong relationship. Nursing students who had high internal LoC were more likely to succeed in examinations compared to those who had high external LoC (Mohamed et al., 2018).

Motivation is another concept among BNS students that might be correlated with their academic accomplishment in biomedical sciences (Saeedi M et al., 2021). Motivation can be described as a condition that activates and sustains behavior toward a goal. It is that force that keeps students on an academic task even when they face challenges. Edgar et al. (2019) further described the motivation concept in education as that energy that drives students to learn, work effectively on their academic tasks and achieve their potential. Therefore, motivated students are usually filled with vitality and commitment to learn no matter what. For example, a study was conducted by Sturges et al. (2016) and Meghna (2020) to determine the correlation between motivation and academic success. Findings from this study revealed that students who reported to be more motivated to succeed indeed performed better than those whose motivation to learn and excel in examinations was poor. However, the study above by Sturges et al heavily relied on the self-reported level of motivation and therefore did not independently measure the level of motivation among students.

Similarly, another study was carried out to determine the impact of motivation on students' academic performance at the University of Sultan. Form this study, it was found that there was a strong correlation between motivation and students' academic performance (Shuaibu Muhammad et al., 2021). However, this study's respondents were students of social sciences and business management. Therefore, whereas this study presents very credible findings, these findings may not be generalized to BNS students. Specifically, to BNS students, Yilmaz et al. (2017) and Stacy (2011) studied the effect of motivation on their academic success and concluded that truly a correlation existed between students' motivation to learn and their academic performance.

Critical thinking among students has also been found to have a strong correlation with academic achievement (Lee et al., 2016). Critical thinking can be described as student's ability to analyze, process and evaluate information for the purpose of constructing sound and insightful knowledge, understanding, hypotheses and beliefs (Heard et al., 2020). According to Fitriani et al. (2020) and Setiawati and Corebima Aloysius (2017), students who think critically are usually successful in their academics while students whose critical thinking ability is low usually straggle to succeed in their academic fields. This has been further supported by many studies. For instance, a study was undertaken at one of the universities in Australia to determine the relationship between critical thinking skills and academic performance. From this study, it was found that critical thinking scores positively correlated with academic performance and completion of nursing study program on time. Another study by Fitriani et al. (2020) equally concluded that a significant correlation existed between student's critical thinking skills and academic achievement in biological sciences. The same study revealed that academic achievement of students improved as the student's critical thinking increased and further recommended that teachers should promote critical thinking in classroom to improve student's academic achievement.

Learning in teams or groups has also been found to be associated positively with the academic performance of nursing students. Team Based Learning (TBL) is a small group instructional strategy that stimulates students to create and apply conceptual knowledge by performing academic activities in a team (Burgess et al., 2020). Another study also concluded that TBL strategy was found to enhance understanding of the learning content, teamwork (Hebles et al., 2019). However, literature search revealed very scanty literature on the effect of TBL on academic achievement in biomedical sciences among degree nursing students.

Accordingly, many institutions of higher learning that offer BNS program usually regulate entry into the study program by putting in place minimum weights or Cumulative Grade Point Average (CGPA) score for diploma holders as an entry requirement. This assertion is further supported by discovery learning theory by Jerome Bruner and study findings by (Dong et al., 2020) who emphasized that prior knowledge was strong determinant of students' success in the subsequent learning. In Italy, study findings revealed a strong relationship between academic achievement and prior scores in upper secondary diploma program (Caponnetto V et al., 2021). Many study findings in Africa on the same subject matter seem to hold similar findings. For instance, in South Africa, Farkas et al. (2015) indeed also found that BNS students who entered the course with poor background of sciences were more likely to fail anatomy. However, the majority of the studies did not clearly state the expected level of previous knowledge below which fail score in biomedical sciences is expected. Similarly, there is overwhelming research evidence which indicates that students who pass pre-entry BNS exams are equally more likely to pass biomedical sciences exams. However, pre-entry exams are given by some institutions while others do not give any exam. Another study by (Bulfone et al., 2021) and Alyahyan and Dustegor (2020) about variables that predict academic success of nursing students reported that preadmission test grade and overall examination scores in second and third year of study correlated positively with academic success. Another interesting study finding in Uganda by Umar et al. (2020) was that students who had good scores in their previous academic programs were more likely to succeed in their next new academic programs and therefore recommended for an admission criteria basing on such requirement since it was cost free as compared to administering a pre-entry test. However, contradicting findings were reported by (Andrew et al., 2015). Andrew revealed that prediction of academic achievement in biomedical sciences among BNS students using pre-admission academic scores was not reliable because it required a multivariable approach. Another contradicting finding was revealed from the study in Uganda by Wamala et al. (2012). These Ugandan researchers conducted a study from which it was concluded that students who were not admitted using pre-entry exam outperformed those who did and passed such exam. Similarly, one of the multisite studies also revealed that there was no significant correlation between entry (high school) grades and academic performance for students in the Bachelor of Medicine and Bachelor of Surgery program, meaning that high school academic success did not reliably predict medical students' academic outcomes at university (Aciro et al., 2023). However, this was a cross-sectional study and therefore cannot claim causal relationship between prior academic achievement and academic achievement. In addition, students admitted to medicine and surgery have high points and therefore, the limited range of scores could have influenced study findings.

Another variable likely to influence the level of academic achievement in biomedical sciences among BNS students is the type of schools or institutions which they attended before enrolling for the BNS program. Schools or institutions can be categorized as either private or public, rural or urban, single or mixed, faith based or non-faith-based schools. Previous studies reveal contradictory findings. For instance, Vitali et al. (2020) conducted a study titled tertiary anatomy and physiology and found that students who had their education from government schools outperformed their counterparts whose educational background was from private and catholic schools. On contrary, another study in Turkey found that being in a private school increased one's likelihood of academic performance by 29.6 percent (Cansız et al., 2019). Findings in Trinidad were not different from that in Turkey (Ndiku Makewa et al., 2011).

Also, some studies report that students who lack time management skills occasionally find difficulties in concentrating on their academics and risk failing examinations. For example, in Sri Lanka a study found that time management on the part of student significantly influenced their academic performance (Fernando, 2017). Findings from this study concurred with findings from other studies by Basak et al. (2008), Ashrafi et al (2020), Asikainen et al. (2011) and Temizkan Sekizler et al. (2022). These studies concluded that truly a significant correlation existed between time management and academic achievement.

Temizkan Sekizler et al. (2022) recommended that students should be trained in time management skills to enhance their academic achievement although this study used convenience sampling technique to enroll respondents into the study and therefore findings cannot simply be generalized. In addition, these studies made conclusions based on the overall academic achievement. Therefore, there is need for an independent study to verify whether time management also correlates with academic achievement in biomedical sciences among BNS students.

Class attendance is yet another important aspect in the teaching and learning process. Educationists informally believe that students who miss class usually perform poorly in their exams. To prevent failures, many institutions of higher learning have policies on class attendance while others do not have such policies. Reviewed literature indicates overwhelming evidence that truly, there is a correlation between academic achievement and class attendance. For instance, Ancheta et al. (2021) conducted a study in Omani and concluded that there was a significant relationship between class attendance and academic performance. The same study realized that as absence increased, academic achievement decreased by one mark score. These findings seem to also agree with those that S. Jafar and Sitther (2021), Branson et al. (2016) and Alshenawi et al. (2021) found from their studies. A similar study by Mackintosh-Franklin (2018) on the impact of class attendance onto academic achievement among undergraduate nursing students also found that leaners who attended all lessons were more likely to score an A in examinations.

To have a deeper understanding of the individual student related factors, the use of the library by the student is another important aspect That has been reported in many studies. Library is considered to be one of the core resources of an institution of higher learning because it provides access to teaching and learning materials with up-to-date information Mondal (2021). Biomedical science courses being huge in content and given that students need to spend many hours doing private reading, then a library appears to be more useful to students. Although there is a very scanty literature on the correlation between use of library and academic performance in biomedical sciences among BNS students, available prose on the same phenomenon can still provide leading and reliable guidance. For instance, a study on the relationship between academic achievement in terms of CGPA of medical students and use of library indeed stated that an association existed between the two variables(Alhassan et al., 2020). This means that the more students used library services for their private learning, the more likely they were to register good scores in examinations. On the contrary, some previous studies had silent views on the association between library use and academic achievement. For example, Leung et al. (2020) critically analyzed the resources that medical and nursing students needed to succeed in anatomy class and from the analysis, researchers concluded that use of anatomy website was the most useful resource for the students to pass anatomy and library was not mentioned at all. This implies that whereas institutions of higher learning continue to invest financial resources in the library services, there is need for an independent multisite study to determine the effect of library resources on the academic achievement in biomedical sciences among BNS students.

Relatedly, some studies have been done to determine whether academic achievement among students can be influenced by the quality of sleep. These studies have been influenced by the scientific discovery about the relationship between sleep and cognitive function. Accordingly, Mantua and Simonelli (2019) stated that when sleep is poor, cognitive performance also gets affected which consequently impairs memory, attention, and processing speed. Some previous studies indicated that students who had high quality sleep were more likely to perform better in examinations than those who had poor quality sleep (Elfaki et al., 2018; Stormark et al., 2019; Topal, 2019). However, it is important to note that some of the studies above used nonprobability sampling methods to enroll respondents into the study while others used a small sample size and therefore their findings cannot be generalized to the whole study population of students. Similarly, contrasting study findings were also reported by (Alotaibi et al., 2020). Alotaibi et al. (2020) conducted a study on the relationship between sleep quality, stress and academic performance among medical students and found no relationship between two variables.

2.5 Institutional factors associated with academic achievement in biomedical sciences among BNS students

Institutional factors are the internal variables that are under the control of universities where BNS students pursue their course. These factors can be broadly categorized as infrastructural, governance, environment, relational, students' welfare, type of curriculum, assessment methods and grading, quality of teachers, and teaching methods used, institutions' philosophy and other support systems. Most times, these factors are beyond the control of students though students need to be aware of them as potential influencers of their academic success. As discussed earlier, institutional factors are also referred to as independent variables because some of them are thought to correlate positively with academic achievement of students.

With their limitations notwithstanding, various studies have been conducted to understand the impact of institutional factors on academic achievement among students. This study therefore will be guided by the knowledge which is already available about the phenomenon of interest.

Alshammari (2019) found that a teacher who had great mastery of subject content, had good relationship with students and explained teaching objectives clearly before onset of the teaching sessions greatly influenced academic achievement of student nurses. Other general study involving non nurses in Nigeria established that institutional factors such as student – teacher ratio, teaching method and teachers' interest correlated positively with academic achievement while school leadership and library facilities had no association with academic achievement of students (Adeyemi & Adeyemi, 2014). Reinke (2019) conducted a study to determine predictors of academic achievement in anatomy, one of the core biomedical courses and discovered that teacher’s experience in teaching anatomy was a strong predictor of academic success of students in that course. A similar study was conducted by Podolsky et al. (2019) and established that teachers’ teaching experience was associated with students’ academic achievement. The same study observed that as teachers gained more teaching experience, their students also tended to perform better in examinations. However, the limitation of this study was that it used a single site and enrolled small sample size. Other studies also revealed that some teachers of human anatomy did not know teaching and learning styles that students preferred and therefore they were not promoting such, other teachers found challenges in creating favorable learning environment for human anatomy (Hadush et al., 2020; Leppink et al., 2014; Smith & Mathias, 2009).

The welfare of students such as accommodation, medical care, security, transport, and feeding were also found to correlate with academic achievement in biomedical sciences of BNS students. This is possibly true because a hungry student, living far away from the institution, sick with no medical attention and insecure with no one concerned may not settle and put all his or her energy to the learning biomedical sciences. Accordingly, many studies have been done about this phenomenon. For instance, Denys (2021) and Zotorvie (2017) indeed confirmed that students’ welfare such as accommodation and their academic performance were positively correlated. Another example is found in the study findings by Mohsen Adibu et al (2021) and Mthimunye and Daniels (2020) who revealed that student nurses who lived on campus dormitories were more likely to perform better in examinations than those who lived off campus. Although these study findings provide a fair understanding of the possible relationship between the welfare of students and their academic achievement, most of the studies did not focus specifically on BNS and biomedical sciences.

Studies about institutional learning resources and academic performance of BNS in biosciences revealed a strong correlation between the two variables. For the students to concentrate on their learning, they need resources such as library, internet connectivity, online resources and videos that are accessible, technologically viable, flexible, and engaging (Barton, 2016). A study in southwest Nigeria indeed found that nursing students believed that using library services enabled them to succeed in their examinations (Ajibona et al., 2019). However, this was self-reported information by students.

Related to institutional resources that enable teaching and learning is the dissection or prosection of cadavers. Cadaver or corpse is a dead human body which can be used by anatomist or physician to teach anatomy (one of the biomedical science courses), identify disease sites, or determine cause of death. Dissection can be described as dismembering of cadaver by the students for the purpose of deepening the learning of anatomy of the body while prosection is the dissection of the cadaver performed by the anatomist to display body structures for students to easily learn about them. Therefore, dissection has been known for a long time as one of the student-centered methods of teaching and learning anatomy. Accordingly, many studies indicate that teaching anatomy using dissection of cadavers is a gold standard method of teaching anatomy while other research findings argue that it is the practice of the past. For instance, Sneha G. et al. (2022) from their study concluded that dissection hall teaching was the best method of teaching anatomy because it deepens understanding of the subject matter. Previous study by Sneha G. et al. (2022) observed that cadaveric dissection a timeconsuming study approach compared to prosection but enabled students to acquire knowledge faster. Similarly, another contrary finding emerged from the study by Ghazanfar et al. (2018) who conducted a study to understand views of doctors regarding the benefits reported that only 27.9% of doctors believed that cadaveric dissection was the best method of teaching anatomy.

Another study about the impact of cadaver dissection onto academic performance of BNS students revealed that using Anatomage Table (AT), an automated virtual human cadaver was found to improve achievement in anatomy examinations (Narnaware & Neumeier, 2021). However, a similar study instead revealed that prosection alone was less effective in learning of anatomy (Thompson & Marshall, 2019).

Some previous studies indicate that the type of teaching strategies, approaches and methods influence academic achievement in biomedical sciences. Teaching approach can be described as a way one views teaching and learning. Teaching approach gives rise to teaching methods. Teaching methods refer to the general principles, pedagogy and management strategies used for classroom instruction (Aguilar-Moya et al., 2025). Selection of the teaching methods depends on the learning objectives, learning outcomes expected and content to be delivered, resources available, teachers' philosophy, suitability of environment and readiness of students. Teaching methods can broadly be categorized as teacher centered, student centered, content focused and participatory method. There is evidence to the fact that the type of teaching methods used squarely influences academic achievement of students. For instance, Evensen et al. (2020) discovered that use of student-centered methods such as small tutorial groups contributed towards improved academic achievement in biomedical sciences among BNS students. Similar study findings show that team based teaching and other innovative student-centered teaching methods influenced academic performance of biomedical sciences (Judy Craft et al., 2017). This study also revealed that the lecture method of teaching which is teacher-centered method is entirely not effective and never correlated with academic achievement of students. A study by Mata et al. (2022) also found that using of cinema and concept maps while teaching students in small groups were found to enhance understanding of biosciences among nursing students.

Similarly, another study by Gronlien et al. (2021) found that blended teaching method, which is also a student-centered method improved academic achievement in biomedical sciences among BNS students compared to single spine physical or online method.

Therefore, these findings indicate that students' centered teaching methods, which can also be referred to as modern methods of teaching have been found to improve understanding of biomedical sciences among BNS students (Durai et al., 2012). However, the effect size of each of these methods has not been well documented.

Educationists also argue that different courses and topics require multiple teaching styles to address all learning opportunities and facilitate learning of all learners. It is also a known fact that different students learn differently. One of the common multiple learning models is Visual, Aural, Reading or Writing, and Kinesthetic (VARK). According to Munazza A. Mirza and Khurshid (2007), visual learners prefer learning by use of graphics, videos, figures, maps and charts. Aural or audial learners indeed learn better if lectures and group discussions are used. Some students also prefer learning through reading lecture notes, journals while kinesthetic learners prefer demonstrations, practice, simulations, and case studies. Accordingly, studies found that teaching biomedical science courses such as anatomy using multiple teaching styles that students preferred improved their academic achievement (Alkhasawneh et al., 2008; Berman, 2015; Dobson, 2009; Katsioloudis & Fantz, 2012). For instance, a study by Md. Zain et al. (2019) found that some students learnt better with kinesthetic and visual learning styles while others learnt better when audial teaching strategy were used. The same author concluded that academic achievement of students would improve if teachers identified various learning styles and consequently matched them with the predominant learning styles of students. However, the author acknowledged that the sample size of respondents was small and therefore findings were limited to the context. Another study looked at the impact of integrating videos into human anatomy classes followed by the quiz and then discussion between the teacher and students. This study revealed that such form of multiple sequentially integrated approach to teaching helped to solidify basic knowledge of biomedical sciences such as anatomy into the mind of students and consequently contributed towards academic achievement (Ortega et al., 2025). Surprisingly, findings from other studies discredit the role of multiple teaching strategies on the quality of learning and academic achievement. For instance, Mozaffari et al. (2020) conducted a study on the relationship between VARK learning styles and academic achievement in dental students and found no significant relationship.

As the world strives to improve quality and access to education amidst other variables such as the availability of robust technology, many institutions of higher learning have been shifting from exclusive traditional face to face learning to innovative blended learning or purely online learning approach. However, some studies indicate that the type of instructional media used by the teacher also influences the level of academic achievement of learners. For instance, William (2018) found that nursing students who had traditional face to face teaching lessons in East Tennessee were three times more likely to pass human anatomy exam compared to those who had online classes. Another study on the impact of online education on the learning process among nursing students showed that there was a positive impact of online education system on the learning process. However, students were reluctant to recommend the replacement of the traditional face to face with an online learning approach. In addition, authors admit that this was a single site study and sample size was small (Abdel et al., 2020).

Similarly, another study applied systematic review design and found that online learning improved academic achievement of students. Though, it was also revealed by the same study that data gained was insufficient to conclude that online learning approach was more beneficial compared to other approaches (Mutalib et al., 2022). Inversely, Oducado and Estoque (2021) carried out a study on the online learning in nursing education during Corona Virus Disease (COVID) pandemic in Philippines and found that this approach to teaching was negatively correlated with academic achievement.

Like teaching and learning strategies and methods, recent studies also show that active learning or simply stated as learning by doing has more significant positive learning outcomes than learning by reading or observing (Mutawa, 2023). For instance, Stetzik et al. (2015) compared traditional lectures which promote rote learning with puzzle-based teaching which promotes active learning and found that students who actively learnt anatomy using puzzles perfumed in examinations better than students who were taught using traditional lecture method.

Similarly, one of the innovative teaching and learning methods known as Problem Based teaching and Learning (PBL) method has also been found to improve biomedical science teaching outcomes because it promotes active learning through tutorials, Self-Directed Learning (SDL). PBL is a student-centered teaching method whereby students are given study problems and work in groups to come up with series of learning objectives and study aims (Lauram, 2018).

PBL method of teaching and learning encourages students to find solutions to the presented problem or answers to the set learning objectives thus developing inherent skills such as self - directed learning, communication, teamwork, critical thinking, problem solving and time management (Trullàs et al., 2022). This has been evidenced by Nyemb (2017) who found that about 92 percent of the students of anatomy, one of the biomedical science courses who were taught through PBL had high level of motivation to learn the course compared to those who were taught using lecture method. Another study conducted by Mayner et al. (2013) also discovered that nursing students who were taught human physiology by using PBL learnt better, retained enough knowledge and were able to relate theory with clinical practice.

The type of curriculum being implemented was also found to be closely associated with the level of academic performance in biomedical sciences among BNS students. Similarly, Posner G. (2005) defined curriculum as a plan or design that guides the teacher on what and how to teach as well as how to solve the problems faced in learning and teaching environment. Even though there are many definitions of curriculum, many scholars seem to agree on the two core defining terms. The first term is 'prescriptive' while the other term is 'descriptive'. Curriculum is referred to as a prescriptive document because it prescribes what is supposed to be taught by the teacher. The second term is descriptive which means that a curriculum usually goes beyond what is taught to describe what happens outside the class. In other words, curriculum describes how knowledge, skills and behavior acquired by learners are applied outside the class to solve problems.

Curriculum can also be described as the crux of an educational process (Quintero, 2014) and a blueprint which is systematically planned and developed to bring about changes in the lives of learners (Remesh, 2017). Curriculum can be categorized as either student centered, teacher centered, problem based, competence based, or content based. Some studies have been found to implicate the type of curricula as among variables that influence the level of academic achievement among BNS students. A case in point is a study which revealed that factors related to curriculum including its implementation challenges were likely to be associated with poor academic achievement among BNS students (Abbasi et al., 2015). However, this study did not specify which type of curriculum, and the number of students correlated with the academic achievement. A similar study by Manee (2018) on the effect of using Competence Based Curriculum in teaching on acquiring competencies in sciences among middle school going students in Kuwait found no significant statistical difference in the acquisition of such competencies in science subjects. Therefore, this study partly investigated the type of curricula being implanted while teaching BNS students and whether the type of curriculum influences the level of academic achievement in biomedical sciences. Some recent studies discovered that integrating nursing practice within biomedical sciences improved learning experience and consequently correlated positively with academic achievement in biomedical sciences among BNS students (Hadush et al., 2020; Mortimer-Jones & Fetherston, 2018). An integrated curriculum is one in which the delivery of content is interweaved.

It is referred to as intertwined content because various aspects and experiences are brought together to cause deeper understanding of the content. Therefore, a curriculum can be vertically or horizontally integrated or both.

Therefore, a vertically integrated curriculum is one in which biomedical sciences and clinical sciences are progressively taught together while a horizontally integrated curriculum is one in which the content within either biomedical or clinical sciences is interrelated to create wider scope of understanding of student (Allouch et al., 2024).

Rafique (2014) conducted a study on the importance of vertical integration in teaching and assessment of physiological concepts and concluded that examination passing rate was higher in vertically integrated physiology content compared to none the integrated content. A similar study found that integrating biomedical sciences with clinical nursing practice enhanced contextual links between biological constructs and patient care and enabled students to appreciate the two phases and consequently earned better scores in examinations (Judy Craft et al., 2017). However, both studies did not provide the effect size of the integration onto the academic achievement.

Studies have also been done to understand whether giving advance organizers to BNS students indeed caused an improvement in academic achievement in biomedical sciences. An advance organizer can be described as a conceptual bridge between the old and new information (Nofriansyah et al., 2026). An advance organizer has been found to direct students' attention to what is going to be taught in the next lesson, highlights the relationship between ideas that will be presented and reminds students the background knowledge they already have.

Advance organizers can be presented in the form of analogy, expository, skimming, narrative or graphs. Advance organizers therefore enable learners to transition from what they already know to what they need to know.

Advance organizers have been found to increase student's interest of biomedical sciences (M. A & E, 2022). Indeed, a previous study in Kilifi County in Kenya confirmed that there was a strong statistical difference in the examination performance between students who were taught using advance organizers and those who were taught using traditional methods of teaching (Omondi et al., 2018).

Another study provided a five-day pre- nursing bioscience intervention to one group of nursing students who did not have a good background of biological sciences and compared examination scores with another group of students who had good background of biology. Findings showed that both groups registered similar examination scores in biomedical sciences, meaning that a five-day advance organizer as an intervention had a significant impact on the final scores (Owens, 2019).

Use of flipped class was also found to be an effective method of teaching biomedical sciences. A flipped class is a form of blended teaching approach where content is introduced to students while at home and practice working through it while at school (Malto et al., 2018). Malto et al. (2018) conducted a study and found that students who belonged to flipped class group had both lower and higher cognitive skills and interest in biological sciences than students who belonged to the traditional group. Similarly, another study found that nursing students who had on campus flipped classes were more likely to be supported to master the content of physiology, one of the core biomedical sciences(Bingen et al., 2020).

On contrary, another study compared the effects of flipped classroom and traditional lectures on nursing students' examination results in biomedical sciences and did not find any significant difference (Knutstad et al., 2020). Scaffolding and use of structured materials were other methods that have been found to correlate with academic achievement in biomedical sciences.

Scaffolding is a method of teaching where a more knowledgeable person provides a framework to enable the less knowledgeable individual learn a higher-level concept that he or she would have not afforded to do alone (Spadafora & Downes, 2020). Scaffolding can also be described as a structural bridge built upon what students already know to arrive at what they do not know. As discovered by Eissa and Al-Bargi (2017), applying scaffolding approach to teaching and learning was found to increase motivation of learners and consequently led to increased academic achievement. Accordingly, a study by Reynolds et al. (2022) disclosed that using scaffolding teaching strategy and contextually relevant biomedical science learning resources such as laboratory and teaching manual significantly resulted in increased engagement and decline in fail scores.

Teaching is an activity that is dominated by the act of communication and feedback between the teacher and the learner. Effective communication between teacher and students has been found to motivate students to learn, it inculcates confidence among students and consequently contributes to improved academic achievement (Sword, 2020). Accordingly, effective communication between teacher and students has been found to correlate with academic achievement (Kathare, 2021). However, this study did not specifically determine the extent to which effective communication between teacher and students influenced academic achievement in biomedical sciences among BNS students. Similarly, constructive feedback is an essential element in the teaching and learning process because it provides framework for the teachers to appraise the performance of students and to correct errors such that students learn how to perfect their knowledge and skills (Weidlich et al., 2025). Effective feedback has been found to enable students identify gaps in their learning, promotes responsive learning, sharpens teaching strategies of a teacher, provides constructive information to both the student and a teacher, motivates students to learn and consequently contributes positively to academic performance of students (Obilor, 2019). However, for this feedback to be effective, it should be given to the student during progressive assessment to enable him/her use it to improve performance.

Mathew and Faculty (2020) equates feedback to instruction since both aim at providing new information which fills the academic gap and sequentially learning and academic achievement. While constructive feedback has been found by previous studies to correlate with academic performance of students, there is barely any documented data specifically about whether providing feedback to BNS students can improve their academic achievement in biomedical sciences.

The teaching and learning process is incomplete until there is a stock taking of what has been achieved so far and what else needs to be done, just like what happens in the implementation of projects. Therefore, assessment of teaching and learning is critical. Assessment is the process of gathering and discussing information from multiple and diverse sources to develop deep understanding of what students know, understand and can do with their knowledge as a result of their educational experiences (Zhou, 2023). Authors add that assessment is more useful when its findings are used to improve subsequent learning and if the program it seeks to improve has explicitly stated purpose and key stakeholders are involved. Therefore, assessment in teaching and learning should be continuous and focus on teaching and learning outcomes. Surprisingly, available literature shows that the environment in which assessment is conducted, the type of assessment tools and formats used, the formatting of questions and time allocated to the assessment test can squarely influence the quality of assessment outcomes. Accordingly, some studies indicate that the way institutions conduct assessment of biomedical sciences among BNS students could be associated with their level of academic achievement therein.

From one of the studies, it was found that students scored highly on examination questions that had illustrative images compared to the questions that did not have images (Sagoo et al., 2020). Another study compared academic performance of anatomy between end of semester and end of year examinations. Findings from this study revealed that students who sat for end of semester anatomy examinations scored highly compared to those who sat for the same examination but at the end of year (Akhund, 2021). Nevertheless, authors expressed lack of understanding whether timing of assessment also influenced the outcome of other biomedical courses and therefore recommended for the extension of study onto other courses of interest. Varying findings arose from other studies as well. For instance, Coartzee and Heyns (2014) also conducted a study on factors that influenced academic performance in biological sciences among nursing students in Eastern Cape Province and found that giving frequent formative assessments to students coupled with constructive feedback certainly contributed positively towards their academic performance in biomedical sciences.

Regarding course load and time allocated to biomedical science courses on the teaching schedule, some studies have been found to conclude that biomedical science courses have too much content to learn in a short time and this negatively influences academic performance of students in these courses due to lack of enough time to comprehend the content. This claim has been verified as true by many studies such as that of Blackmore et al. (2021) and Mhlongo and Masango (2020) who found that heavier course load of biomedical science courses coupled with less time to comprehend the content were negatively correlated with students' academic performance. However, these studies did not specify how much time was adequate to study and comprehend the content of biomedical science courses.

As demand for BNS nurses increases in Uganda following revised scheme of service for nurses and midwives, coupled with proliferated desire of the public to access high quality care, many men and women are now enrolling for the course, and this has raised the number of BNS students in majority of universities and other BNS degree awarding institutions. However, there is credible emerging literature stating that large BNS classes could also be linked to poor academic achievement in biomedical science courses. For instance, Blackmore et al. (2021) documented that small class size of averagely fifteen students was positively correlated with academic achievement in biomedical sciences. This is further evidenced by findings from another study by Koc and Çelik (2015) who conducted a study on the impact of number of students per teacher on student achievement and established that undeniably a student teacher ratio negatively correlated with academic performance. By keeping the number of teachers constant, the higher number of students was correlated with low academic performance of students. Conversely, none of the studies that were specifically conducted study on the effect of class size on the academic achievement in biomedical sciences among BNS students.

2.6 Chapter summary

A review of the literature reveals studies that both support and contradict the findings, with variations often attributable to differences in study design, sample size, sampling techniques, and contextual factors. This underscores notable gaps in the existing literature. These gaps highlight the need for a multisite, context-specific study in diverse settings, such as Uganda, to generate a clearer understanding of the issue and inform the development of effective interventions. In addition, the literature indicates that most of the previous studies carried out single spine quasi-experimental studies hence leaving out other vital factors. Therefore, this study employed appropriate study designs to allow in-depth understanding of the level and factors associated with academic achievement in biomedical sciences among BNS students.

CHAPTER THREE

RESEARCH METHODS

3.0 Introduction

This chapter describes the study site, design, population, eligibility criteria, sample size determination, sampling techniques, data collection tools, study variables, data collection process, data management and analysis, ethical considerations, and dissemination of study findings.

3.1 Study site and setting

The study was conducted at four public universities in Uganda: Makerere University (Central Uganda), Mbarara University of Science and Technology (Southwestern Uganda), Busitema University (Eastern Uganda), and Soroti University (Northeastern Uganda).

Makerere University was founded in 1922 as a technical school. It later became a technical college affiliated with the University of London before attaining independent university status in 1970. In 1993, the Faculty of Medicine introduced the Bachelor of Nursing Science (BNS) program to train nurses at the bachelor's level. The Department of Nursing currently falls under the School of Health Sciences and offers a four-year BNS program primarily to students from the advanced level of education. The department also offers a master's degree in Midwifery and Women's Health and, as of 2023, when the proposal for this study was developed, the university had over fifteen academic staff members and a student population of approximately 150.

BNS students at Makerere University study biomedical science courses namely, Anatomy, Physiology, Biochemistry, Pharmacology, and Microbiology alongside students pursuing the Bachelor of Medicine and Surgery, Bachelor of Pharmacy, and

Bachelor of Dentistry, among others. Academic staff use both traditional and contemporary teaching approaches and methods such as lectures, practical demonstrations, problem-based learning, small group assignments and tutorials. The Departments of Biochemistry, Anatomy, and Physiology fall under the School of Biomedical Sciences and are responsible for teaching their respective subjects. These departments are staffed by academic personnel of various ranks, from professors to junior faculty members, with the majority being senior lecturers, lecturers, and assistant lecturers. Makerere university is considered as the oldest and most prestigious university in Uganda and East Africa at large.

Mbarara University of Science and Technology was officially established by the Government of Uganda in 1989 to address the shortage of scientists in the country. Its aim was also to instill a sense of community service among its students. In 2001, the university introduced the BNS program for students from the advanced level of education. In 2002, another nursing degree program, known as the extension program, was introduced for holders of diplomas in nursing, midwifery, and mental health nursing. This program is usually very intensive and takes only two years to complete. By 2023, the time the proposal of this study was developed, the university had a total of approximately 220 BNS students, with about 140 enrolled in the four-year BNS program. BNS students at this university study biomedical sciences, particularly anatomy, physiology, and biochemistry, during their first year alongside students of pharmaceutical sciences, physiotherapy sciences, and medical laboratory sciences. Academic staff primarily use traditional teaching methods such as lectures and practical demonstrations for biomedical science courses. This university is ranked as the second-best public university in Uganda for health science academic programs.

Busitema University was established by an Act of Parliament of Uganda in 2007. It is a multi-campus university, with its main campus located in Busitema, Tororo District. The Busitema campus was originally a college of agricultural engineering. Other campuses include Arapai, Nagongera, Namasagali, Pallisa, Mbale, and Kaliro. Mbale campus hosts the Faculty of Health Sciences, where the Bachelor of Nursing Science (BNS) program is offered. The BNS program at Busitema University is a four-year program that started in 2014 and primarily admits students from the advanced level of education. BNS students study biomedical sciences, such as anatomy, physiology, and biochemistry, alongside students pursuing a Bachelor of Medicine and Surgery and a Bachelor of Anesthesia. Busitema University primarily employs the problem-based learning method for teaching biomedical sciences, similar to other courses. The university embraces the principle of content integration and takes a holistic approach to teaching and learning. By 2023, when the proposal for this study was developed, the university had approximately 80 BNS students.

Similarly, Soroti University was established by the Government of Uganda in 2015 to address the shortage of medical doctors, engineers, nurses, and science teachers. It admitted its first Bachelor of Nursing Science (BNS) students in 2019, and by 2023, the university had a population of approximately 80 BNS students. The BNS program at Soroti University is a four-year program that primarily admits students from the advanced level of education. BNS students study biomedical science courses alongside Bachelor of Medicine and Surgery students during their first two years. The academic staff at Soroti University employs a combination of traditional and innovative methods to teach biomedical sciences.

These public universities were purposively selected due to their shared characteristics, which align with the focus of this study. In these institutions, biomedical courses are integrated and taught to both Bachelor of Nursing Science (BNS) students and those pursuing other medical programs such as Bachelor of Medicine and Surgery, Bachelor of Pharmacy, Bachelor of Medical Laboratory Science, and Bachelor of Physiotherapy. Additionally, these universities follow closely similar curricula and admit students with high academic grades from the advanced level of education. Furthermore, they are all funded by the Government of Uganda, ensuring standardized resources and institutional support. Private universities were excluded because they may have different curricular structures, admission criteria, and funding models, which could introduce inconsistencies in the study.

In Uganda, there are fifty-four (54) universities, seventeen (17) other degree awarding institutions and one hundred seventy-five (175) other tertiary institutions (NCHE, 2022). Of the 54 universities, twelve (12) are public while the rest are private universities. The public universities in Uganda are Kabale University, Mbarara University of Science and Technology, Makerere University, Kyambogo University, Busitema University, Soroti University, Lira University, Gulu University, Muni University, Uganda Management Institute, Makerere University Business School, and Mountains of the Moon University. These universities are fairly distributed in the country in all four regions.

For instance, Kabale, Mbarara and Mountains of the Moon Universities are in the Western part of the country, Gulu, Lira and Muni universities are in the Northern part of the country, Soroti and Busitema are in Northeast and Mid-East respectively while Makerere, Kyambogo, Uganda Management Institute and Makerere University Business School are in the central region of the country.

Of the twelve (12) public universities in Uganda, seven (7) offer the Bachelor of Nursing Science (BNS) program: Kabale University, Mbarara University of Science and Technology, Makerere University, Busitema University, Soroti University, Mountains of the Moon University, and Muni University. The BNS program in Uganda has two tracks. The first track is that of students directly from an advanced level of secondary education and the second one is for students who hold a diploma in either Nursing, Midwifery, Mental health, Comprehensive nursing or equivalent.

As of 2023, when the proposal for this study was developed, there were approximately one thousand five hundred (1,500) Bachelor of Nursing Science (BNS) students in Uganda, spanning all four academic years across seven (7) public and ten (10) private universities offering the BNS program. It was estimated that about eight hundred (800) of these students were enrolled in public universities, while the remaining seven hundred (700) were in private universities.

Since four out of the seven public universities participated in the study, it was estimated that approximately four hundred fifty (450) BNS students in public universities were studying at these four institutions. Additionally, based on crude information from the sampled universities, it was further estimated that about 225 students in these universities were in the post-biomedical sciences phase of the curriculum, meaning they were in years 2, 3, or 4. Figures 3 and 4 below illustrate a map of Uganda indicating the study sites and the estimation of the study population.

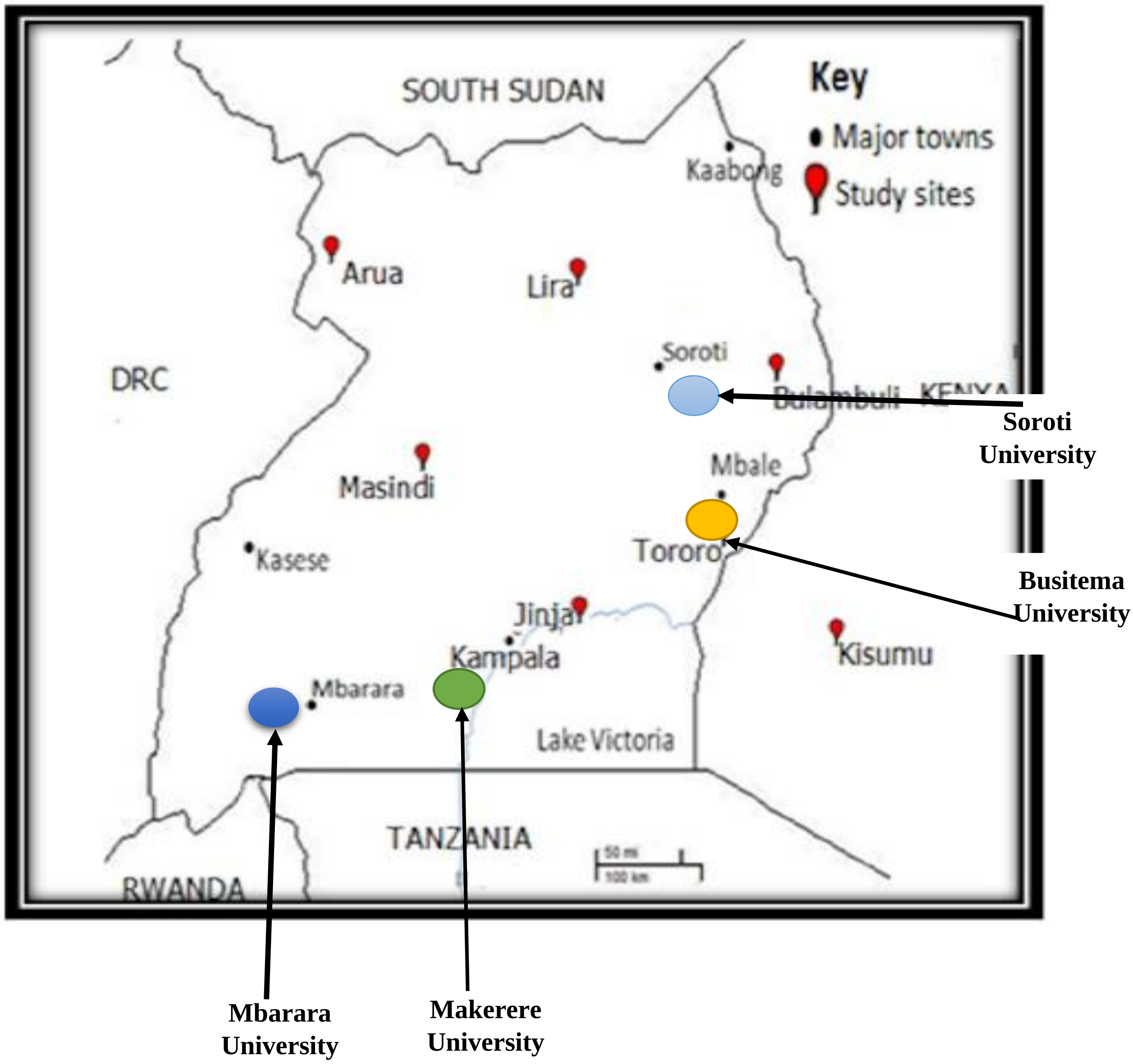


Figure 2: Map of Uganda showing study sites.

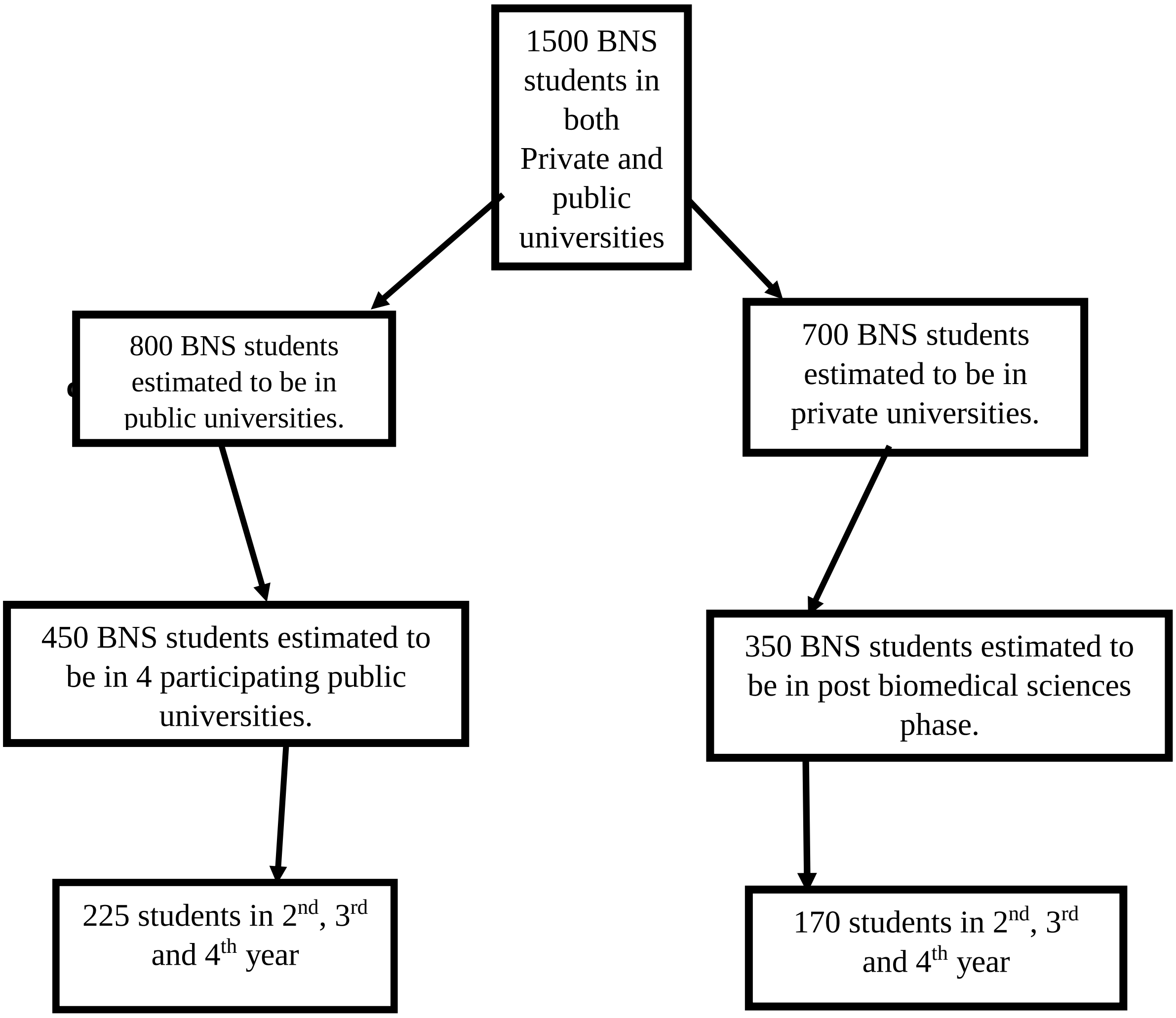


Figure 3: Population of BNS students in Uganda as of September 2023

Source: Preliminary data collected from some universities: September 2023

3.2 Study Design

A research design is a structured plan that guides how data are collected and analyzed to answer a research question. It ensures coherence in the study process, clarifies how variables relate to each other, and determines how far findings can be generalized.

This study used a mixed-methods approach to obtain comprehensive and credible data. Academic achievement is a complex and multidimensional concept that cannot be fully understood using only quantitative or qualitative methods. The quantitative component provided numerical data on the level of academic achievement and its related factors, while the qualitative component explored lecturers' opinions about the same issue. Combining both types of data strengthened the study by identifying statistical relationships and explaining the reasons behind them. It also allowed deeper exploration of contextual factors such as curriculum type, staffing levels, teaching skills, qualifications, experience, and availability of learning resources. The mixed-methods approach was consistent Critical Realism, which recognize both measurable outcomes and underlying contextual influences.

For the quantitative strand, a cross-sectional design was used. Data were collected at one point in time to assess the current level of academic achievement and its associated factors. This design was efficient and suitable for examining existing relationships without long-term follow-up. By involving a relatively large sample of students, it enhanced the representativeness and generalizability of the findings. It also provided observable evidence that could be further explained through qualitative inquiry.

For the qualitative strand, a descriptive qualitative design was applied. This design allowed in-depth exploration of lecturers' opinions about academic achievement in biomedical sciences within the Ugandan university context. It helped uncover student, sociodemographic, and institutional factors influencing achievement and supported open-ended data collection methods such as key informant interviews. The design complemented the quantitative findings by offering explanations for the observed relationships.

A phenomenological design was not used because the study focused on lecturers' views rather than their lived experiences.

The study followed a convergent parallel mixed-methods approach. Quantitative and qualitative data were collected and analyzed separately, then integrated during discussion. Both strands were given equal importance, enabling each to address the limitations of the other and providing a more complete understanding of academic achievement among nursing students. Figure 5 below summarizes how qualitative and quantitative data were collected, analyzed and later integrated at the level of data discussion, conclusion and recommendations.

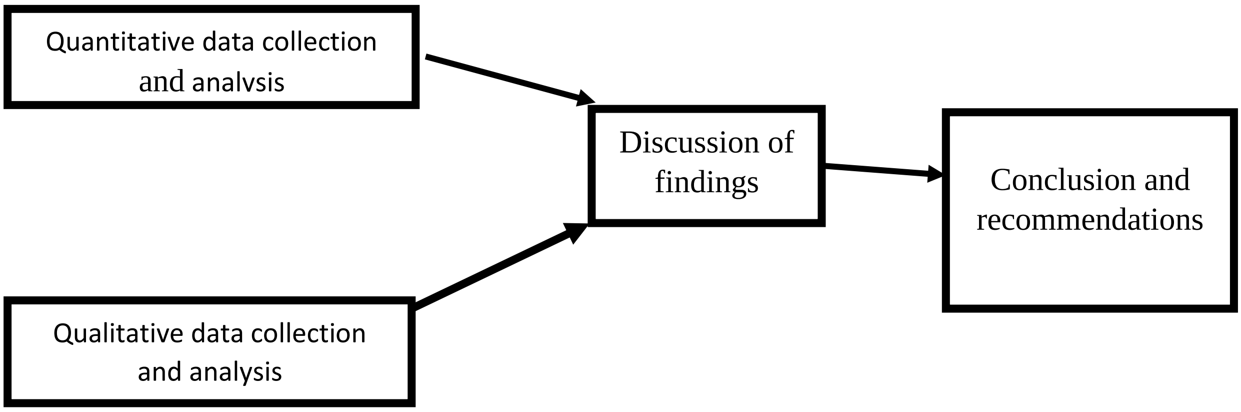


Figure 4: Schematic view of convergent parallel mixed methods study approach

Taken together, the study designs employed were considered appropriate, given that many previous studies had adopted quasi-experimental approaches that primarily measured the influence of a single factor on academic achievement. Such studies did not provide a comprehensive understanding of the magnitude of the problem in biomedical sciences or the range of factors influencing it. For instance, some prior research focused on quasi-experimental studies examining the effect of problem-based learning (PBL) on academic achievement, thereby overlooking other potential determinants. Therefore, the present study sought to conduct an in-depth investigation of the various influencing factors to ensure that subsequent interventions can be more comprehensive and contextually relevant.

3.3 Target population and the study population

In research, the target population is the entire group of individuals or elements, sharing common characteristics from which a sample is drawn to make interferences while study population is defined as a specific subset of the target population which is the primary focus of the study (Willie, 2023). Specifying both ensures that the study includes a representative sample that aligns with the study objectives.

3.3.1 Target population and study population for quantitative study

The target population for the quantitative study was the BNS students in public universities in Uganda while the study population were the BNS students at the study sites who were doing full time four-year BNS program, who were either in year 2, 3 or 4, and had studied all courses of anatomy, physiology and biochemistry. At Mbarara University of Science and Technology, students studied biomedical sciences and completed them in the first semester of year two while at other universities, the same courses were spread through the first two years of study.

As earlier elaborated, entrants into BNS program mainly come from advanced level of education with at least a principal pass in biology and chemistry plus either mathematics or physics or nutrition and home economics. However, it is also common to admit some students who hold diploma in nursing, midwifery, mental health nursing or public health nursing. At times, some universities also admit a very small proportion of students through mature age entry scheme or through Higher Education Certificate (HEC) scheme.

For the diploma entry scheme, applicants should have a good Cumulative Grade Point Average (CGPA) and for some universities, these diploma students do sit for pre-entry exams which they must pass well before they are admitted.

3.3.2 Target population and study population for qualitative study

The target population for the qualitative study comprised lecturers from universities that participated in the study and taught BNS students. Similarly, the study population for the qualitative study were the lecturers of biomedical sciences namely, anatomy, physiology, and biochemistry. The term "lecturer" was used to mean an academic staff responsible for teaching biomedical sciences. It included faculty members at a minimum rank of Assistant Lecturer up to full Professors. A sample of these lecturers constituted the study population for the qualitative aspect of the study.

3.4 Eligibility criteria

Eligibility criteria state the predetermined conditions that were followed to either qualify or disqualify participants into or from the study respectively. Therefore, inclusion criteria are characteristics that potential study participants must have if they are to be included in the study. On the other hand, exclusion criteria can be described as features possessed by the potential participants who meet the inclusion criteria but present with additional characteristics that could compromise the success of the study. Exclusion criteria can also be those features that might increase the risk of getting poor study outcomes. Ensuring adherence to the eligibility criteria enhances research rigor. It strengthens study validity, reliability and replicability. It ensures that the study remains aligned with its objectives by selecting participants who best provide the much-needed data.

3.4.1 Inclusion and exclusion criteria used to enroll participants

Quantitative study

The study enrolled BNS students who met the two conditions below:

i. BNS students pursuing a four-year BNS program at the selected universities
ii. BNS students in either year 2, 3 or 4 who attempted all examinations of anatomy, physiology, and biochemistry as prescribed by the curriculum and

had all the results of the examinations for the named courses on the results portal.

Similarly, BNS students who were in any of the following circumstances were excluded from the study:

i. Had transferred in their academic credits from other universities.

ii. Declined to consent to participate in the study.

Students who had transferred their academic credits in anatomy, physiology, and biochemistry were not eligible to participate in the study because they lacked sufficient experience with how these courses were taught at the current university.

Qualitative study

Lecturers of biomedical science courses who met all conditions below were enrolled into the qualitative aspect of the study.

i. Teaching either anatomy, physiology, or biochemistry.

ii. Appointed as full-time academic staff of the university participating in the study

iii. Had worked at the participating university for at least six months.

iv. Were at the level of an Assistant Lecturer or above.

Similarly, lecturers of biomedical sciences who were in any of the following circumstances were excluded from the study:

i. Holding full-time administrative position without active teaching duties.

ii. Declined to consent to participate in the study.

Only full-time appointed lecturers were eligible to participate in the study, as it was assumed that they had sufficient time to teach, assess, mentor, and guide students in the courses being investigated. To be included in the study, a lecturer was required to have taught anatomy, physiology, or biochemistry at the same university for at least six months, ensuring they had adequate time to understand the factors influencing their students' academic achievement. Similarly, any academic position below that of an Assistant Lecturer in Uganda was considered junior. Therefore, lecturers below this level were not included in the study due to presumed inadequate knowledge of the prevailing factors under investigation.

Enrolling participants who meet inclusion criteria greatly minimized sampling error and also increased the degree of statistical confidence in the study results (Guest, 2019).

3.5 Sample size determination

3.5.1 Sample size determination of study participants

It is important to reiterate that sample size research is very critical because it influences the confidence interval of the findings. From biostatistics, it is known that a large sample size causes the narrowing of the confidence interval, thus increasing precision of the findings. However, this relationship is not linear because further increase in sample size does not always translate into an equal decrease in confidence interval (Siegle, 2021). Therefore, this implies that a sufficient sample size should always be considered in research studies to produce high quality findings that provide a true picture of the same phenomenon in the population from which it was drawn. In some cases, if the study population is small, then the whole population is included in the study.

3.5.1.1 Sample size determination for quantitative study

In 2023, it was estimated that approximately 450 Bachelor of Nursing Science (BNS) students were enrolled in the four-year program across the four public universities that participated in this study. Of these, an estimated 225 students were in the post-biomedical science phase, meaning they were in either year 2, 3, or 4. Due to the small study population of 225 BNS students, the researcher considered a census approach and included the entire population in the study. Therefore, it was not necessary to calculate the sample size using statistical formulae. However, to ensure equal representation of BNS students from each participating university, the number of participants was estimated as shown in Table 1.

Table I: Initial estimation of BNS students from each participating university for quantitative study

SN	Name of University	Estimated number of BNS	Sample population
1	Busitema_University	65	33
2	Makerere University of Scie. Tech	120	63
3	Mbarara University of Science and Technology	170	79
4	Soroti University	95	50
	Total	**450**	**225**

3.5.1.2 Sample size determination for qualitative study

The sample size of expected participants for qualitative study depended on the amount of information power that study participants had, also previously known as saturation level. According to Malterud et al. (2015), the more information participants hold about the phenomenon of interest, the lower the number of participants needed.

Similarly, during the proposal development, the researcher estimated that at least one lecturer in anatomy, physiology, or biochemistry would be included from each participating university. This was expected to yield a minimum of four lecturers, with one from each university. However, the maximum number of lecturers ultimately depended on the saturation level, as explained above.

3.6 Sampling of participating universities

A sample can be defined as a small manageable subset of the study population (Singh & Masuku, 2014). The quantity and quality of the sample in research is extremely paramount as it determines the precision of the findings and therefore, it should be carefully determined. Therefore, sample size determination is the process of selecting a sample from the entire study population to draw conclusions on the whole population (Kaur, 2021).

In this study, four public universities offering the Bachelor of Nursing Science (BNS) program were selected as study sites using a homogeneous purposive sampling technique. The selected universities were Makerere University in central Uganda, Busitema University in eastern Uganda, Soroti University in northeastern Uganda, and Mbarara University of Science and Technology in southwestern Uganda. At least one university was chosen from each region to ensure regional representation.

Muni University, which would have represented Northern Uganda, was not included because it follows a different approach to teaching biomedical sciences. Specifically, its BNS students do not study these courses in combined classes with students from other academic programs. Additionally, Gulu University, also located in Northern Uganda, does not offer a BNS program. As a result, Soroti University, situated in Northeastern Uganda, was purposively selected to represent Northern Uganda in the study.

Only public universities participated in this study because they are more homogeneous in nature. They receive relatively similar funding support from the central government, have comparable student admission criteria, implement nearly identical training curricula, and operate under the same government policies and guidelines. Additionally, public universities share closely aligned missions, aims, and objectives.

Private universities were not included in this study due to variations in their resource capacities, including academic staff. They also differ in academic policies related to admission, teaching, and assessment. Furthermore, private universities have diverse visions, missions, aims, and objectives. For instance, religious-founded universities emphasize faith and service to humanity, whereas non-religious institutions often prioritize profit-making. However, the findings from this study strongly justify conducting a similar study in private universities to understand the state of biomedical sciences education in those institutions.

The four public universities that participated in this study are considered fairly representative of the three other public universities offering the Bachelor of Nursing Science (BNS) program. Statistically, this means that about two-thirds of the public universities in Uganda that offer the BNS program were included. Given the relatively small number of BNS students in each university, selecting four universities ensured a sufficient sample size, providing high statistical power and precise findings.

Therefore, the findings from this study offer insights into academic achievement in biomedical sciences among BNS students in other public universities in Uganda.

3.7 Sampling of study participants

For a researcher to answer research questions, many times he or she does not have to collect data from all subjects of the study population. Researcher uses appropriate robust techniques to select a small group of subjects whose characters will represent those of the entire study population. Thus, sampling technique is a procedure used to identify individuals from the study population and enrolling them into the study without compromising on the credibility of the study (Verma et al., 2017). Sampling techniques employed in the study are very important and should be carefully chosen since they do determine the quality of data to be collected (Singh & Masuku, 2014). Many times, when the target population is small, every individual in the study population who meets the inclusion criteria is included in the study. This approach to sampling is known as census sampling.

3.7.1 Sampling of participants for quantitative study

Due to the small study population of BNS students, a census sampling technique was used to enroll participants in the quantitative aspect of the study. In this approach, all BNS students at each study site who met the inclusion criteria were enrolled considering the year of study until the entire eligible population was enrolled. The use of census sampling eliminated the risk of sampling error, thereby increasing the precision of the study findings.

Before approaching eligible students, the researcher first obtained a list of BNS students for year 2, 3 and 4 who met the inclusion criteria from the head of the department or course coordinator. The researcher then verified the list to confirm that the students indeed met the inclusion criteria

The head of the department introduced the researcher to the students through their leaders. The researcher then approached the students with a predetermined list of those selected to participate in the study. Together with the students, the researcher agreed on the most convenient time to meet, which was preferably immediately after the lecture.

At the scheduled time, the researcher addressed all the students, explaining the study's objectives, benefits, and the expected participants. The students were informed that their participation in the study was voluntary. Following this, the researcher took them through the consent process. Students were then asked to sign the two consent forms voluntarily. The first consent form was a generic form, while the second was specific to the request for access to their examination results in anatomy, biochemistry, and physiology.

After completing the consent process, all students who met the inclusion criteria were enrolled in the quantitative study. Table II below shows how participants for quantitative study were recruited from each study site.

Table II: Initial estimation of BNS students from each participating university for quantitative study

University	**Estimation prior data collection**		**Actual number of participants during data collection**		
	Estimated No. of BNS students expected to meet inclusion criteria	*Estimated No. of BNS students to be recruited*	*Actual No. of BNS students who met inclusion criteria*	*Actual No. of BNS students who were excluded*	*Actual No. of BNS students who were enrolled*
Mbarara University of Science and Technology	*79*	*75*	*70*	*03 (Absent)*	*67*
Makerere university	*63*	*60*	*59*	*00*	*59*
Busitema university	*33*	*30*	*33*	*04 (Absent)*	*29*
Soroti university	*50*	*45*	*56*	*03 (1bsent, 2 declined consent)*	*53*
Totals	***225***	***210***	***218***	***10***	***208***

3.7.2 Sampling of participants for qualitative study

Similarly, expert purposive sampling technique was used to sample lecturers of biomedical sciences to participate in qualitative aspect of the study. Purposive sampling is a method used by the researcher to identify subjects to participate in qualitative studies according his or her judgment (Nikolopoulou, 2022). According to this author, there are six purposive sampling methods. These methods are maximum variation or heterogenous sampling, homogeneous sampling, typical case sampling, extreme case sampling and expert sampling.

According to this author, there are six purposive sampling methods: maximum variation or heterogeneous sampling, homogeneous sampling, typical case sampling, extreme case sampling, and expert sampling.

The maximum variation purposive sampling method is used when there is a need to ensure maximum representation of various participants, including those from extremes. Homogeneous purposive sampling is employed when the focus is on a population with similar characteristics.

Typical case sampling is used when participants are selected based on their likelihood of behaving like others who share the same characteristics or experiences. Extreme case sampling, also known as deviant purposive sampling, is used when participants from extremes are needed, especially when the study aims to develop standard operating procedures that clearly indicate what should "not be practiced."

Similarly, critical case purposive sampling is used when a small sample of cases can explain broader trends or phenomena. Lastly, expert purposive sampling is used when participants with a high level of knowledge about the subject under study are required.

In this study, expert purposive sampling was used to select teachers of biomedical sciences specifically anatomy, physiology, and biochemistry to participate in qualitative study. This method was chosen because the teachers were considered experts in their fields and were assumed to possess rich insights into academic achievement in these courses among BNS students in Uganda.

To ensure fair representation of all participating universities and courses, efforts were made to enroll at least one lecturer from each university and at least one lecturer to represent each biomedical science course. Following the principle of information power, also known as the saturation point, Soroti University, where the data collection began, had the highest number of study participants.

The number of participants gradually decreased as the saturation point was reached, until no new data were collected at Mbarara University of Science and Technology, the last university from which data were collected. See Table III below. See table III below.

Table III: Table showing how teachers of biomedical sciences were recruited into the qualitative study

Course	**Participating university**				**Total**
	Mbarara university of Science and Technology	Makerere university	Busitema university	Soroti university	04
Anatomy	00	00	01	02	03
Physiology	00	02	01	02	05
Biochemistry	02	00	01	02	04
Total	02	02	03	05	**12**

3.8 Data collection instruments

According to Simplilearn (2023), data collection is the process of collecting, measuring, and analyzing different categories of information using validated and standardized techniques in order to find answers to research questions, test hypothesis, evaluate outcomes or forecast future trends. Bhandari (2020) also adds that before a researcher embarks on data collection, he or she must know the type of data to be collected and the tools to be used. The type of data to be collected determines methods and tools that should be used. Therefore, methods and tools to be used to collect data must be those that indeed will collect the data which is needed to answer the study objectives. Data collection is an important milestone in the life of research and therefore it must be handled carefully.

3.8.1 Data collection instruments for quantitative study

Structured questionnaire was used to collect data for quantitative study. The questionnaire used in this study was primarily developed by the researcher. However, one section incorporated selected parameters derived from the Subjective Academic Achievement Scale (SAAS). These parameters were not adopted in their original form; rather, they were adapted to suit the context and objectives of the present study. The adaptation involved refining the wording, improving clarity of English expression, and adjusting the formatting to align with the structure of the overall questionnaire.

These modifications were necessary to enhance contextual relevance and ensure that the items were easily understood by the study population. The underlying construct measured by the SAAS parameters was retained, but the presentation was modified to fit the specific data requirements of this study.

Nigel (2017) defines a questionnaire as a data collection tool which contains questions that are usually completed by either a respondent or a researcher. For the questionnaire to collect high quality data and excellent return rate, Gill (2005) recommends that it should be very carefully designed with structured questions and these questions should be systematically organized. Therefore, more important questions were placed midway through the questionnaire, well knowing that at that point, the participant was at the peak of providing very genuine responses to such very critical questions. The questionnaire also had some filter and matrix questions to provide more information.

An electronic version of the questionnaire was developed and administered using Kobo collect software to reduce data entry errors and to quicken data collection and analysis tasks. It was also preferred over hard copies because it minimizes the cost of printing hard copies, ensures security of the data since a password is used to protect data and prevents data loss due to the presence of an automatic backup system. The questionnaire was self-administered and therefore, quantitative data about the level of academic achievement as well as sociodemographic, individual educational and institutional factors that predict academic achievement in biomedical sciences among BNS students were filled in by the study participants individually.

The questionnaire had four main sections. The first section collected data on the sociodemographic characteristics of the participants. The second section collected data on the level of academic achievement, third section collected data on the participants' own educational related factors while the fourth section dealt with the data on the institutional or university related factors that could correlate with academic achievement in biomedical sciences among participants.

Questionnaire was preferred because the tool is known to collect high quality data due to its high propensity to achieve anonymity and response rate. Questionnaire is one of the recommended and commonly used tools to collect quantitative data because such data is usually easy to analyze compared to the data collected using other methods such as interview or focus group discussion. The other advantage of a questionnaire is that it is cheap and easy to administer (Abawi, 2017).

3.8.2 Data collection instrument for qualitative study

Key Informant Interview (KII) guide tool was used to guide data collection exercise for qualitative study. KII guide was used by the researcher while conducting interview with study participants.

In research, KII is a qualitative in-depth interview between key informant and the researcher. Meyer et al. (2015) define key informants as the people who have rich insider knowledge about the phenomenon being investigated and are willing to participate and provide such information to the researcher with an impartial mind.

In this study, lecturers of biomedical sciences namely anatomy, biochemistry and physiology participated in the study as key informants because they were believed to have rich information about teaching and assessment of learning of the named courses.

A Key Informant Interview (KII) guide was used to ensure that all key questions were addressed during the interview sessions. The guide contained a list of carefully designed open-ended questions to remind the interviewer of the core questions to be answered by the study participants. The guide was divided into major sections, including participants' sociodemographic and work experience backgrounds, their opinions on the level of academic achievement, sociodemographic, student educational, and institutional factors contributing to academic achievement, and finally, the concluding section of the interview.

3.9 Study Variables

According to Bhandari (2020), variables are any physiognomies that have the potential to take on different values such as age, income, test scores, height, weight, or temperature.

Bhandari (2020) further states that there are two main types of variables, and these are dependent and independent variables.

3.9.1 Independent Variables

The author describes independent variables as variables which a researcher manipulates to explore their effects. They are called independent variables because they are not swayed by other variables in the study. Independent variables can also be referred to as explanatory, predictor, or right-hand side variables. Phibbs (2021) describes independent variables as right-hand side variables because they appear on the right-hand side of a regression equation.

In this study, independent variables were precisely referred to as correlates of academic achievement and included socio-demographic and individual educational characteristics of BNS students as well as factors at the institutions where they studied from.

Socio-demographic variables comprised of the age, gender, level of education and income of parents or caretakers of students, religion, ethnicity, birth order, social support systems, self-efficacy, peer influence, and marital status among others.

Individual educational factors included previous academic performance, study time, study approaches and styles, attendance to lectures, attendance and participation in practical study sessions, ownership of study resources, sitting arrangement in lecture room, locus of control and utilization of available study resources.

Similarly, institutional variables were the factors that fell under the direct control of universities that offered BNS program. These factors included the quality of biomedical science lecturers, lecturer-student ratio, time allocation to biomedical sciences, teaching strategies and methods, availability and access to study resources, curriculum, available student supportive systems, teaching-learning environment and assessment approaches and practices among others.

3.9.2 Dependent variables

Dependent variables are variables that change because of manipulation of independent variables. Dependent variables are also referred to as outcome, response, or left-hand side variables. Likewise, dependent variables usually appear on the left side of the regression equation model. The dependent variable in this study was the level of academic achievement in biomedical sciences among BNS students.

Academic achievement was measured using objective and subjective approaches. Objective measurement of academic achievement was performed by considering Grade Point Average (GPA) of each set of courses while a modified Subjective Academic Achievement Scale (SAAS) was used to measure subjective aspects (Stadler et al, 2021). According to Stadler et al, many scholars use objective measurement in form of GPA to measure academic achievement of students in universities but recommend that subjective measurement should also be done to complement GPA measurement.

3.10 Objective measurement of academic achievement using Grade Point Average

Objective assessment of academic achievement was done by collecting data on the performance of students in examinations of biomedical science courses namely anatomy, physiology and biochemistry. The performance was mainly interpreted using Grade Point Average and Letter grading system.

a) Interpretation of academic achievement using Grade Point Average (GPA)

Accordingly, the Grade Point Average (GPA) of each set of courses namely anatomy, physiology and biochemistry were calculated. Table IV below shows how the GPA of each set of courses was calculated.

Table IV: Table showing how Grade Point Average (GPA) was calculated

Course	**Letter grade**	**Credit Unit (CU)**	**GP value (GP)**	**GP for the course (CU*GP)**	**GPA**
Anatomy I					
Anatomy II					
Anatomy III					
Anatomy IV					
Total		Total CU		Total Course GP	Total course GP/Total CU
Physiology I					
Physiology II					
Physiology III					
Physiology IV					
Total		Total CU		Total GP	Total GP/Total CU
Biochemistry I					
Biochemistry II					
Biochemistry III					
Biochemistry IV					
Total		Total CU		Total GP	Total GP/Total CU

To calculate GPA, each student was asked to write his or her raw marks scores in a questionnaire. These scores were objectively verified by researcher or research assistant during data collection before departure of study participant.

Each student was requested to display his or her results on the online portal and results on the portal were compared with those that the participant had filled in the questionnaire. Where a disparity was found, it was then corrected immediately. Letter grade and grade point was then assigned to each score. This was followed by obtaining information about the Credit Unit (CU) of each course. Grade Point (GP) value corresponding to the letter grade scored was obtained as shown in table III (subsection b) below. All CUs for each set of courses such as anatomy I, II, III, IV, Physiology I, II, III, IV and biochemistry I, II, III, IV were added together and the total value of all CUs was obtained. Grade Point (GP) for the course was then obtained by multiplying GP value with the total CUs (GP value × Total CUs).

GPs for each course were summed up. Then GPA was calculated as shown in this formula:

GPA=∑ (GPs for each course)/∑ (Credit Units).

b) Interpretation of academic achievement using Letter Grade (LG) system

To enhance the understanding of academic achievement among BNS students, performance in biomedical sciences was also interpreted using letter grades based on the Uganda National Council for Higher Education (UNCHE) guidelines. Academic achievement was categorized as follows: A (80% and above) for excellent performance, B+ (75%–79%) for very good performance, B (70%–74%) for good performance, C+ (65%–69%) for fairly good performance, C (60%–64%) for fair performance, D+

(55%–59%) for pass, D (50%–54%) for marginal performance, and F (below 50%) for failure, indicating performance below the minimum standards. See Table V below.

Table V: Table showing the grading system in Ugandan universities and key data that was collected to calculate GPA

SN	Score	Letter Award	Grade Point	Comment
1	80-100	A	5.0	Excellent
2	75-79	B+	4.5	Very good
3	70-74	B	4.0	Good
4	65-69	C+	3.5	Fairly good
5	60-64	C	3.0	Fair
6	55-59	D+	2.5	Pass
7	50 – 54	D	2.0	Marginal pass
8	0-49.9 Fail	F	0.0	Fail

c) Subjective measurement of academic achievement

Subjective Academic Achievement Scale (SAAS) was used to collect data about views of participants regarding their academic achievement in biomedical sciences. SAAS is an open access tool which was developed by Mathias Stadler, Samuel Greiff and Christoph Kemper in 2021. So far, the tool has been cited by eight researchers. According to the developers, it has five parameters, and each is measured on a 5- point Likert scale. The tool has a good internal consistency and factorial validity with Cronbach's alfa of 0.82. It measures the subjective view of students in relation to their goals, aspirations, invested effort and peers' achievement.

The five SAAS parameters were: the level of student satisfaction with their academic achievement in biomedical sciences; whether their achievement reflected their effort; their perceived knowledge in biomedical sciences; their self-efficacy to improve; and the extent to which they applied biomedical knowledge in patient care.

Students rated their satisfaction with their academic performance to determine whether they felt their achievements met their expectations, which could influence motivation and engagement. The comparison between effort and academic performance was examined to assess whether students felt fairly rewarded for their work, revealing potential disparities in study strategies or external challenges. Since some students may feel knowledgeable despite limited understanding, while others may have strong knowledge but low confidence, self-perceived knowledge was assessed to identify discrepancies and their influence on academic performance. Similarly, students estimated how much they applied biomedical knowledge in patient care to evaluate whether academic learning translated into practical competence, a key factor in curriculum development and student preparedness for professional practice. Participants measured each item on a five-point Likert scale where score one was the lowest while five was the highest. Stadler and colleagues state that SAAS scores about academic achievement are always closely related but far from being equal to GPA and therefore recommend that SAAS findings should always compliment those of the GPA.

Therefore, in this study, SAAS findings complimented those of the GPA to provide broad understanding of the level of academic achievement in biomedical sciences among BNS students and its predictors.

3.11 Data collection process

Initial ethical approval for the study proposal was obtained from the Institutional Research and Ethics Committee (IREC) of the College of Health Sciences (CHS), Moi University. As a requirement, the researcher also obtained ethical clearance from another local REC in the names of TASO-REC. This was followed by obtaining a permit from the Uganda National Council for Science and Technology (UNCST).

With the permit secured, permission was obtained from either the Vice Chancellor or the University Secretary of each participating university namely Makerere, Mbarara University of Sciences and Technology, Busitema, and Soroti University. This was followed by administrative clearance from the office of the School or Faculty Dean, where the study was to be conducted. After clearance from the Dean’s office, the researcher was directed to the department of Anatomy, Physiology, and Biochemistry. The heads of these departments also granted permission for the researcher to proceed and approach eligible study participants. Eligible participants were then contacted, and suitable dates and times for data collection were arranged.

To assist with data collection, one research assistant was recruited from Kampala, the capital city of Uganda. The assistant held a master’s degree in health research and had extensive experience in data collection and analysis. She received one day of training on administering data collection tools, screening participants based on inclusion criteria, obtaining valid ethical consent, ensuring confidentiality, and maintaining data quality. Additionally, a class representative or another suitable individual was identified to assist with mobilizing eligible students for participation.

Both assistants were remunerated accordingly. Regarding data collection of quantitative data, the head of department or course coordinator was requested to help researcher to provide a list of the BNS students who met the inclusion criteria. Then the researcher or his assistant gave a brief talk about the study. The talk mainly focused on the purpose of the study, the role of participants, their contribution, and rights as well as their benefits. In the talk, a request to access and verify examination results recorded on the questionnaire was also highlighted. All students who accepted to participate in the study were then taken through the consent process and the few who opted out of the study or did not meet inclusion criteria were still appreciated for listening to the talk.

After consenting, the guidance on how to fill out the questionnaire was also provided and then an electronic questionnaire on Kobo collect software tool was sent to the telephone number of each study participant to fill. Each participant was given only one day to fill the tool and submit. After submitting, each participant was requested to open and display his/her online examination result and then the portal was opened to view and compare the results submitted with those on the participant's results portal. In very rare cases where a disparity was found, it was corrected immediately. This opportunity was also used to peruse through the whole filled and submitted questionnaire to check if there were questions that were either wrongly filled or not filled at all. In rare cases where such an error was found, it was then fixed immediately before the departure of the participant. The participant was then thanked and compensated with ten thousand (10,000) Uganda shillings as indicated on the consent form.

The researcher or his assistant collected data during the most convenient time for both participants and leadership of the university, preferably during break time to avoid interrupting the planned activities of the day. In many cases, data collection of quantitative data took place from the lecture room before or immediately after the lecture. A lecture room was preferred to ensure comfort of participants and to also to adhere to confidentiality.

Although it was an online tool, still there was a need to provide a quiet comfortable environment for the participants to fill the questionnaire without interruption. A sufficient space of about 1.5 meters between each participant was ensured to minimize the possibility of participants discussing and sharing possible responses among themselves to obtain harmonized responses. Once a participant embarked on filling the questionnaire, it took him or her about 30 minutes to complete. Census sampling technique was used, meaning that all the BNS students who met inclusion criteria were enrolled into the quantitative aspect of the study. Both the researcher and trained research assistant actively participated in the collection of qualitative data.

Regarding the collection of qualitative data, teachers of either anatomy, physiology or biochemistry were approached and a brief talk about the purpose of the study as well as its benefits was given.

Teachers who voluntarily accepted to participate in the study were then taken through the consent process. After consenting, then an interview session followed. However, before each interview, special consent was obtained from each participant to allow the researcher to record the interview session. Teachers who were willing but were not ready at that time were requested to provide an alternative day and time. They were then softly approached again and again until most of them finally found time and finally participated in the study. The few who later declined were excused but were still appreciated for their prior interest in participating in the study. Since an expert purposive sampling method was used to sample study participants, an attempt was made to ensure that only teachers who had rich information about biomedical sciences were enrolled. Also, a researcher tried to enroll participants from each study site and from each department namely, anatomy, physiology and biochemistry.

An interview guide was used to guide the interview, and six thematic areas were discussed namely, self-introduction and ground setting, the BNS curriculum and level of academic achievement, biomedical sciences, BNS students, the university and the exploration of the university, individual and sociodemographic factors that predict academic achievement in biomedical sciences among BNS students in Uganda.

All interviews were conducted at the convenience of the study participants and were either by zoom or physical interface. Most of the interviews were done through physical interaction between participants and the researcher. Where a zoom interview was conducted, both the interviewer and the participant were switched on for the researcher to view the non-verbal communication clues of the participant. A zoom recording was also done and was listened to repetitively during data transcription. For the physical interviews, a tape recorder was used to record conversation. Interviews took a range of about 30 minutes to one hour and were personally done by the researcher.

All interviews were conducted from convenient spaces, mainly in the offices of teachers and in the absence of other people to maintain confidentiality. All recorded data including audiotape recorder were kept by the researcher himself. After completing data collection exercises at each study site, all interview notes were kept in a lockable cupboard and were only accessible by the researcher. Where a researcher required further clarity, he reached out to the participants on the phone to provide more information about a specific point.

3.12 Data analysis and presentation

3.12.1 Analysis and presentation of quantitative study findings

Data was exported from kobo collect software to excel and was then cleaned by checking for missing, redundant, repeated and outlying values. In addition, variable transformation was also done by recording (re-grouping) and coding. Where verification of data was needed, it was done with the help of class representatives. In some cases, some data was transformed by scaling and normalizing it.

Data cleaning exercise was done by the principal investigator himself with the help of another senior colleague who had extensive knowledge in data analysis.

Descriptive analysis was done to characterize the sample and to measure the level of academic achievement. Welch's Analysis of Variance (ANOVA) and Linear Mixed Effect Model (LMM) were used to perform bivariate and multivariate analyses respectively. Pearson correlation coefficient was used to assess the relation between academic performance at the advanced level of secondary education and academic achievement in biomedical sciences at the university. All analyzes were performed using R software version 4.4.1 with statistical significance defined as $p<0.05$.

Welch's ANOVA was preferred over the traditional ANOVA because the data violated assumption of homogeneity of variance required for the standard one-way ANOVA. Traditional ANOVA assumes that the variances across the groups being compared are equal (homoscedasticity).

When variance assumptions are violated, traditional ANOVA can lead to inflated Type 1 error rates, implying that it might falsely detect differences when actually they do not exist. Welch's ANOVA is specifically designed to handle situations where the groups have different variances. It modifies the degrees of freedom in the F-test to provide more accurate results when variance homogeneity is not met. Therefore, Welch's ANOVA corrects such abnormally and provides more accurate p-values.

Similarly, the Linear Mixed Effects Model (LMM) was preferred for multivariate analysis because it accounts for both fixed and random effects, making it appropriate for analyzing hierarchical or clustered data while addressing violations of standard regression assumptions. In this study, the data were nested within universities. Therefore, LMM accounted for this dependency, unlike traditional regression analysis, which assumes the independence of observations. Unlike standard regression, LMM includes random effects to model individual differences or variability across clusters (e.g., differences between universities), helping to capture the influence of unmeasured factors that may affect academic achievement.

After bivariate analysis, multivariate analysis was conducted to eliminate the effect of confounders on the findings. A stepwise method was used, where variables were iteratively removed and added to stabilize the model. Model fit was assessed by comparing the null model (a baseline model without any variables) with the final model (which included all significant variables from the bivariate analysis). When testing statistical assumptions, it was found that the data was nonhomogeneous due to clustering by university.

This also indicated a likelihood of dependence between observations within the same group (university). Consequently, a linear mixed-effects (LME) model was used. The mixed-effects model accounts for both fixed and random effects. By fitting an LME model, universities were treated as random effect, which accounted for within-group correlation by allowing each group to have its own intercept, representing how each university differed from the overall average.

The Akaike Information Criterion (AIC) was used to assess the model fit. AIC evaluates both the good fitness of the model and its complexity such as the number of parameters. Therefore, our aim was to have a lower AIC value because it suggests that the model fits the data better. The null model had an AIC of 457.5667.

Model 1 had an AIC of 579.6729 after all the suspected variables that influenced the outcome were added into the model. The stepwise regression method was used to select predictors by adding or removing them based on statistical significance. It identified collinear predictors by eliminating redundant variables. These included gender, mothers' occupation, sponsorship, distance from residence to university, people staying at home other than yourself extra. Therefore, the final model had an AIC of 444.6199 after the elimination of redundant variables. Model assumptions of linearity, normality of residuals, homoscedasticity, and independence of Random effects were also tested before using the model.

Confounders were tested using the stepwise command in R software, which identified problematic variables, eliminated them, and produced a refined model. However, potential confounders were also suspected at the bivariate stage by examining their distribution in percentages (e.g., variables with large percentage differences such as 60%, 47%, and 3% were identified through visual inspection).

The first step involved running a full model that included all suspected variables believed to influence the outcome variable. The stepwise command was then applied to this model, identifying and eliminating problematic variables to produce a refined model. However, because a Linear Mixed Effects Model (LMM) which primarily accounted for clustering was used, these measures required specific adjustments due to the nested structure of the data.

The risk of multiple confounding variables was a challenge, as their effects diminished with each computation, making them increasingly difficult to detect. For confounders to be identified, they needed to have a change of greater than 10%**,** which was not always apparent. This made the analytical method for identifying confounders crucial, as multivariate analysis simplified the process with a single command in R software.

For objective 4, academic achievement was analyzed with consideration of data variability and clustering within institutions. To address potential biases from institutional differences, analyses were conducted separately for each biomedical sciences course namely anatomy, physiology, and biochemistry. Findings for study objectives 2, 3, and 4 were then interpreted using intercepts, F-statistic, p-values, standard deviation, correlation coefficients, t-values, confidence intervals, and degrees of freedom**.** Similarly, data were presented using tables and scatterplots.

3.12.2 Analysis and presentation of qualitative study findings

The data were analyzed using thematic approach. The principal investigator transcribed the audio-recorded data and thoroughly familiarized himself with it by repeatedly reading the transcripts. Common responses were identified and coded through an iterative process. The codes were then reviewed and refined to identify patterns and relationships.

Related codes were grouped into categories, which were subsequently merged to form overarching themes that described the study findings. These themes were refined through multiple reviews to ensure they were comprehensive, coherent, and distinct. Subthemes were then developed from the refined themes. Finally, the themes and subthemes were named and interpreted by comparing them with existing knowledge on the topic. Findings were then presented descriptively using tables and narrative quotes of participants.

3.13 Quality Control

Ensuring quality is a crucial component of research. Quality control measures help maintain the viability and integrity of data, as the risk of errors arising at any stage from data collection to the dissemination of findings is always present. These measures ensure the validity, reliability, and accuracy of data throughout the processes of participant recruitment, data collection, analysis, interpretation, and discussion of findings.

3.13.1 Quality control for quantitative aspect of the study

The following measures were used to ensure the quality of quantitative aspect of the study.

3.13.1.1 Quality control during participant recruitment

A clear inclusion criterion was well established and strictly followed. The study population boundaries and participant characteristics were defined. People who fell into the target population category but were to be excluded were also well enumerated. Census sampling technique was used and as such, all members of the target population who met inclusion criteria were enrolled into the study and this eliminated sampling bias.

All participating universities had a fair representation of the study participants depending on the student numbers.

3.13.1.2 Quality control during data collection

The validity and reliability of the questionnaire, the instrument used to collect data, were ensured. Validity and reliability are key drivers of the integrity and quality of a measurement instrument (Kimberlin & Winterstein, 2008).

Validity of an instrument is the extent to which an instrument measures what it claims to measure (Blumberg & Cooper, 2005). Robson (2002) adds that validity of an instrument measures the degree to which the instrument measures what it is designed to measure and is an indicator of the level to which results of the study are truthful. There are several types of validity. These include face validity, content validity, construct validity and criterion validity.

Face validity is the extent at which the assessment tool looks valid by just carefully looking at it. This type of validity cannot be subjected to statistical measure and therefore provides weak information about validity of the assessment item. Content validity refers to the extent at which an assessment tool completely covers the content of the construct it is meant to measure. Construct validity denotes how well constructs covered by an assessment tool are measured by other related tools. Lastly, the criterion validity of a tool is done by comparing scores of an already existing assessment tool with those of one being tested.

Therefore, the following actions were taken to make sure that the tools being used are valid. First, the researcher was guided by the study objectives to develop questions to be included in the tools. Accordingly, each objective being addressed by the tool was clearly indicated in the tools. Secondly, tools were reviewed by the supervisors of the researcher and one other content expert, in this case a teaching staff of one of the biomedical sciences being studied.

The review of the questionnaire was followed by pretesting it at Mountains of the Moon University on 30 BNS students before its use. Pretesting was conducted to ensure the tool's reliability. A research assistant was trained, and the principal investigator (researcher) actively participated in and closely monitored the data collection process.

Additionally, during data collection, efforts were made to check the data for errors, consistency, and completeness before participants and the data collector left the site. Any inaccuracies found were corrected immediately.

On the other hand, reliability is a measure of consistency, precision, repeatability, and trustworthiness of a research (Chakrabartty, 2013). Reliability indicates the extent to which an instrument produces error free and consistent results. The reliability of an instrument indicates that an observed score of measure truly reflects the score of that measure. According to Kimberlin and Winterstein (2008), reliability is used to evaluate the stability of measures administered at different times to the same individuals and the equivalence of sets of items from the same test.

As guided by Taherdoost (2016), the researcher took several steps to ensure that the research tools were reliable and dependable. First, the data collection tools were written clearly to ensure participants could easily understand them.

Each tool included clear instructions guiding students on how to answer the questions. The researcher-maintained consistency in the questions asked during KII sessions. Additionally, the tools were administered under relatively similar environmental conditions and were of a reasonable length.

Finally, the split-half reliability of the questionnaire was calculated, yielding a correlation coefficient (Rho) of 0.9366, indicating a high internal consistency of the questionnaire (Revicki, 2024).

3.13.1.3 Quality control during data analysis

Data was checked for errors, inconsistencies, redundant and missing values. Values that were outliers were also detected and where necessary, some data were transformed.

Statistical assumptions were checked by performing normality tests, homogeneity and variance tests, independency tests and multicollinearity tests. The constructed model to be used for data analysis was also tested for stability under varying assumptions.

3.13.2 Quality control of qualitative aspect of the study

To ensure quality of the qualitative aspect of the study, the four criteria for ensuring rigor in qualitative studies namely credibility, dependability, confirmability, and transferability were adhered to.

i) **Credibility:** To ensure that the study findings are trustworthy and accurately represent the views of study participants, researcher did member checking by seeking clarifications from the study participants during data collection to verify whether the collected information was correctly interpreted.

ii) **Dependability:** To ensure consistent, transparent and reproducible research methodology, audit trail was done by documenting all the research decisions and procedures. Dependability was also achieved by clearly declaring all data collection and analysis procedures and by researcher acknowledging his own personal biases.

iii) **Confirmability:** To minimize the influence of study findings by personal biases, the researcher consistently held peer briefing meetings with fellow PhD students, with supervisors and other faculty researchers to discuss findings. In addition, a researcher involved an external person with a postdoc to independently review the whole research process.

iv) **Transferability:** To ensure that the study findings can be applied to similar contexts, researcher provided detail information about the study context and participants. In addition, expert purposive sampling technique was used to select study participants implying that only those who met the inclusion criteria participated in the study.

3.14 Ethical Standards

The study adhered to the fundamental ethical principles of respect for autonomy of persons, beneficence, non-maleficence, and justice**,** and was conducted in accordance with the Declaration of Helsinki (World Medical Association, 2013), which provides internationally recognized ethical guidelines for research involving human participants.

Initially, the study proposal was reviewed and approved by the supervisors. Thereafter, it was presented to Moi University College of Health Sciences, Department of Medical Education, Community Health and Family Medicine, for departmental approval before submission to research ethics committees. Ethical approval was subsequently obtained from the Institutional Research and Ethics Committee (IREC) of Moi University College of Health Sciences (Approval No: FAN-0004463).

As an international student conducting the study in Uganda, additional ethical approval was sought from a Ugandan-based Research Ethics Committee. An application was submitted to The AIDS Support Organization Research Ethics Committee (TASO-REC). The proposal was reviewed, and an oral presentation was made before the panel, after which approval was granted (Approval No: TASO-2023-261). Subsequently, the study was registered and approved by the Uganda National Council for Science and Technology (UNCST) (Approval No: HS3522ES), in compliance with national research regulatory requirements.

After obtaining all required ethical approvals, administrative permission to conduct the study was obtained from the leadership of each participating university. The Principal

Investigator (PI) obtained written informed consent from all participants prior to commencement of data collection.

Respect for persons (Autonomy) was upheld through a comprehensive informed consent process. Participants were provided with detailed information regarding the purpose of the study, procedures involved, potential risks and benefits, confidentiality safeguards, and their right to decline or withdraw at any time without penalty. Student participants were explicitly informed that participation or non-participation would not influence their academic grades, assessment outcomes, or relationship with lecturers and university administration.

Beneficence was ensured by designing the study to generate evidence intended to improve teaching and learning processes and academic achievement in biomedical sciences among Bachelor of Nursing Science students in Uganda. The study involved minimal risk, as data collection methods were limited to questionnaires and key informant interviews without invasive procedures. The anticipated benefit was the generation of knowledge that may inform institutional academic support strategies and policy improvements.

Non-maleficence was maintained by ensuring that participation did not expose respondents to physical, psychological, social, or academic harm. A research assistant was trained on research ethics principles and confidentiality procedures prior to data collection. Both the PI and the research assistant adhered strictly to ethical standards throughout the study. No names or registration numbers of participants were recorded or published.

Quantitative data collection from students was conducted at times when students were free to avoid academic disruption. During questionnaire administration, approximately 1.5 meters of space was maintained between participants to guarantee privacy and minimize peer influence. Completed questionnaires were collected immediately after completion and kept confidential. They were stored under lock and key, and electronic data were password-protected, accessible only to the PI and the research assistant.

Key Informant Interviews (KIIs) with lecturers of biomedical sciences were conducted in closed and private spaces such as offices or lecture rooms. The PI ensured that no other person was present within proximity during the interviews to safeguard confidentiality. Audio recorders and related data collection tools were handled exclusively by the PI. After each data collection session, all materials were secured in a lockable cupboard, with access restricted to the PI only.

Justice was upheld through fair and equitable selection of participants according to clearly defined inclusion and exclusion criteria. No discrimination was committed on the basis of gender, age, marital status, religion, or socioeconomic background. Sampling procedures were guided strictly by methodological considerations and study objectives to ensure fairness and representativeness.

Confidentiality and institutional integrity were further protected during dissemination of findings. Names of participating universities were not disclosed in publications to safeguard their institutional reputation, given that academic achievement outcomes may reflect the quality of teaching and learning processes within those institutions. Findings are presented in aggregate form without identifying individual participants or institutions.

3.15 Limitations of the Study

This study collected data at a single point in time and, therefore, does not account for potential changes in the level of academic success over time. However, the qualitative aspect of the study provided comprehensive understanding of how the level of academic achievement has been before and how it is today, implying that findings from this study could be used to somehow to foretell how the level of academic achievement will likely be in the future if current conditions are kept constant.

Quantitative study was guided by cross-sectional study design and therefore, does not allow for causal inferences about the observed relationships. However, the use of a mixed-methods approach enriched the quality of the findings and minimized the limitations that a purely cross-sectional design would have imposed. Although the study included four public universities, these purposively sampled institutions may not be fully representative of all nursing students in Ugandan universities. Nevertheless, including four out of the seven public universities provides substantial coverage of the public university system. Moreover, the universities were purposively selected to represent each region of Uganda.

Although an attempt was made to objectively verify academic scores in biomedical sciences of all study participants, the rest of the measures of learning characteristics were based on self-reports, which may be subject to biases. This was mitigated against by continuously emphasizing to the participants about the importance of providing honest responses. Also, during data analysis, effort was made to crosscheck quality of data.

Using census sampling approach posed a potential risk of non-response bias. However, this was minimized because study participants were found in one locality at each university and had ample time to participate and complete the questionnaire given. Similarly, purposive sampling technique used to enroll lecturers into qualitative study posed a potential risk of selection bias due to research judgement, excluding important but less visible subgroups, and over-representing certain characteristics. However, all these were mitigated by researcher through bracketing his personal views, assumptions, prior knowledge, opinions, and expectations, and being mindful of different subgroups of participants while conducting informant interviews. Using Linear mixed effect model posed a potential risk of invalid statistical inferences. However, this was mitigated by testing statistical assumptions before using the model.

3.16 Delimitation of the study

Study delimitation refers to the scope or boundaries of the study, specifying what is included and excluded. It helps to exclude unnecessary variables, establish geographical boundaries, clarify study objectives, and focus the research questions.

The scope of this study was the level of academic achievement in biomedical sciences and its correlates among BNS students in public universities in Uganda. This study did not extend to other academic health programs, such as medicine and surgery. It also did not investigate courses offered to BNS students beyond the three core biomedical sciences: anatomy, physiology, and biochemistry. Additionally, private universities were not included in this study.

3.17 Assumptions of the study

This study was based on the critical assumption that universities and students-maintained records of their examination results and were willing to present them for verification. Additionally, it was presumed that the participating universities would demonstrate a high level of cooperation, willingly providing any supplementary information needed to enrich the study. Furthermore, the study relied on the expectation that participants were mature, honest individuals who recognized the significance of their contributions and were committed to providing genuine information in the interest of advancing the nursing profession and enhancing patient care.

3.18 Chapter summary

This chapter provides a detailed account of the research design that guided the study. It explains the approaches and procedures used to select study sites and participants, ensuring a rigorous and systematic selection process. Additionally, it outlines the data collection tools employed and the measures taken to guarantee their validity and reliability.

Furthermore, the chapter clearly articulates the data collection process, and the strategies implemented to ensure strict adherence to research ethical standards. Finally, it presents a comprehensive discussion on how the Principal Investigator effectively managed the study to address the research objectives and test the proposed hypotheses, ensuring a robust and credible investigation.

CHAPTER FOUR

RESULTS

4.0 Overview

This chapter presents results organized into five main sections: a summary of participants' sociodemographic characteristics, followed by sections addressing the level of academic achievement, socio-demographic factors, individual educational factors, and institutional factors influencing academic achievement in biomedical sciences.

4.1 Sociodemographic characteristics of participants

This section presents sociodemographic characteristics of BNS students and lecturers of anatomy, physiology and biochemistry who participated in quantitative and qualitative study strands respectively.

4.1.1 Sociodemographic characteristics of BNS students

A total of 208 nursing students participated in the study between April and June 2025, representing response rate of 95.4%. The majority were males (58.7%, n = 122) and aged 20–24 years (71.6%, n = 149). Most participants were single (79.3%, n = 165), hailed from Eastern Uganda (37.5%, n = 78), and came from rural settings (35.6%, n = 74).

About half of the students (54.3%, n = 113) were on government sponsorship, while 75.5% (n = 157) had both parents alive. A significant proportion (63.5%, n = 132) resided in privately rented hostels that were typically located 1–3 km from the university.

Regarding university distribution, 25.5% (n = 53) were from Soroti University, 13.9% (n = 29) from Busitema University, 28.4% (n = 59) from Makerere University, and

32.2% (n = 67) from Mbarara University of Science and Technology. Table 6 below shows characteristics of study participants and university enrolment distribution.

Table VI: Characteristics of study participants and university enrollment distribution

Variable	Frequency	Percentage
Characteristics of study participants		
Gender		
Female	86	41.3
Male	122	58.7
Age category		
20 – 24	149	71.6
25 – 29	34	16.3
30 and above	25	12.0
Type of sponsorship		
Government	113	54.3
Private	85	40.9
Non-Governmental Organization	9	4.3
Marital status		
Single	165	79.3
In relationship or married	43	20.7
Region of home district		
Central	55	26.4
Eastern/northeastern	78	37.5
Northern	27	13
Western	48	23.1
Home location level of urbanization		
Peri urban (small town)	70	33.7
Rural	74	35.6
Urban	64	30.8
Entry scheme		
Advanced level secondary school	176	84.6
Diploma holder or any other	32	15.4
University enrollment distribution		
University A	53	25.3
University B	29	13.9
University C	59	28.4
University D	67	32.2

Regarding distribution of study participants by gender across universities, the number of males at Mbarara University of Science and Technology was about twice that of females while at Busitema university, there were slightly more females than males. Figure 6 below shows how the proportion of participants varied across universities by gender.

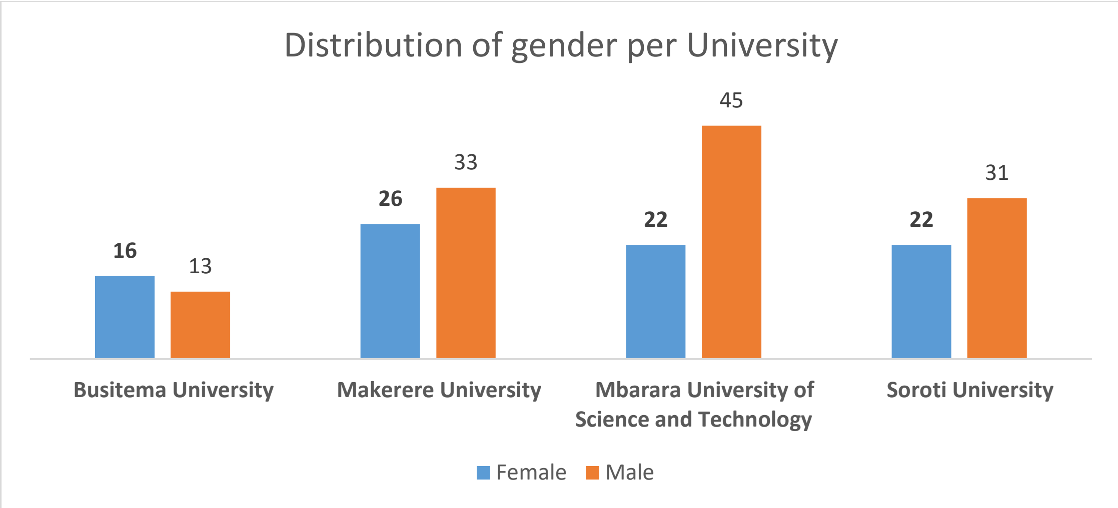


Figure 5: Bar graph showing distribution of gender of study participants in each university

4.1.2 Sociodemographic characteristics of lecturers of anatomy, physiology and biochemistry

Twelve (12) lecturers of anatomy (n=3), physiology (n=5) and biochemistry (n=4) at various levels of seniority from the four (4) public universities participated in the study as key informants between April and June 2024. Most of the participants were males by gender (n=10), aged 43 years (32-67) and with average teaching experience of 9.3 years. Half of the participants (50%) were at the level of lecturer while the rest were senior lecturers. See table VII below.

Table VII: Table showing vital characteristics of lecturers of biomedical sciences who participated in qualitative study

No	Gender	Age (years)	Experience	Highest qualification	Position	Course
1	M	49	15	Masters	Senior lecturer	Biochemistry
2	F	34	8	Masters	Lecturer	Physiology
3	M	45	5	Masters	Senior lecturer	Anatomy
4	M	34	5	Masters	Lecturer	Biochemistry
5	M	33	7	Masters	Lecturer	Biochemistry
6	M	32	4	Masters	Lecturer	Physiology
7	M	42	10	PhD	Senior lecturer	Physiology
8	M	54	18	PhD	Senior lecturer	Physiology
9	M	47	7	Masters	Senior lecturer	Physiology
10	F	41	7	Masters	Lecturer	Anatomy
11	M	67	18	Masters	Senior lecturer	Biochemistry
12	M	42	8	PhD student	Lecturer	Anatomy

4.2 Objective I: To explore the level of academic achievement in biomedical sciences among BNS students

The first objective of this study was to explore the level of academic achievement in biomedical sciences among students of Bachelor of Nursing Sciences in Uganda. Both quantitative and qualitative findings were presented separately and later integrated in the discussion section.

4.2.1 Findings from quantitative study

Academic achievement was measured both objectively and subjectively. The objective measurement focused on Grade Point Average (GPA) and Letter Grades (LG). The subjective measurement incorporated students' ranked opinions on their perceived academic achievement in biomedical sciences.

4.2.1.1 Objective measurement of academic achievement in biomedical sciences using GPA

Objective measurement of academic achievement in Anatomy (Anatomy 1, 2, 3, 4), Physiology (Physiology 1,2, 3, 4), and Biochemistry (biochemistry 1, 2, 3, 4) was determined by calculating and comparing mean marks scores and mean Grade Point Average (GPA). Overall, BNS students at Mbarara University of Science and Technology registered high academic achievement in all courses while those from Soroti university registered the least academic achievement.

Mean scores of the raw marks obtained by BNS students in biomedical sciences at all participating universities

When raw marks were considered to estimate the average score of each biomedical science at each participating university, it was found that at Busitema university, the mean score in anatomy was 60%, physiology 63.9%, and biochemistry 61.6%. At Makerere university, the mean score in anatomy was 56.3%, physiology 61.5%, and biochemistry 58.1%. At Mbarara University of Science and Technology, students registered a mean score of 65.9% in anatomy, 69.4% in physiology and 63.7% in biochemistry.

At Soroti university, students scored a mean of 54.8% in anatomy, 57.7% in physiology and 57.1% in biochemistry. See table VIII below.

Table VIII Table showing mean scores in biomedical sciences at all participating universities

	Course unit	Average Score
Busitema University	Anatomy	
	Anatomy1	59.8
	Anatomy2	60.0
	Physiology	
	Physiology1	64.7
	Physiology2	63.0
	Biochemistry	
	Biochemistry1	61.5
	Biochemistry2	61.7
Makerere University	Anatomy	
	Anatomy1	59.5
	Anatomy2	55.5
	Anatomy3	55.1
	Anatomy4	55.1
	Physiology	
	Physiology1	61.3
	Physiology2	62.0
	Physiology3	62.4
	Physiology4	60.2
	Biochemistry	
	Biochemistry1	57.1
	Biochemistry2	59.1
	Biochemistry3	57.4
	Biochemistry4	58.5
Mbarara University of Science and Technology	Anatomy	
	Anatomy1	68.0
	Anatomy2	63.9
	Physiology	
	Physiology1	70.6
	Physiology2	68.2
	Biochemistry	
	Biochemistry1	60.6
	Biochemistry2	66.8
Soroti University	Anatomy	
	Anatomy1	52.5
	Anatomy2	54.0
	Anatomy3	55.4
	Anatomy4	57.4
	Physiology	
	Physiology1	57.1
	Physiology2	55.9
	Physiology3	59.4
	Physiology4	58.4
	Biochemistry	
	Biochemistry1	53.4
	Biochemistry2	57.1
	Biochemistry3	58.9
	Biochemistry4	58.8

Table VIII shows that, in general, students had very poor academic achievement in the initial biomedical courses, such as Anatomy 1, Physiology 1, and Biochemistry 1. However, although academic achievement remained low in subsequent courses, there was a slight improvement in later courses, including Anatomy 2, 3, and 4; Physiology 2, 3, and 4; and Biochemistry 2, 3, 4. This was followed by a further analysis of academic achievement, considering the mean Grade Point Average (GPA) score for each biomedical science subject at each university.

However, when Intraclass Correlation Coefficient (ICC)) was calculated, the study found statistically significant difference in the academic achievement across universities with an ICC =0.37, implying that 37% of the variation in GPA was attributed to difference between universities. See figure 6 (b) below:

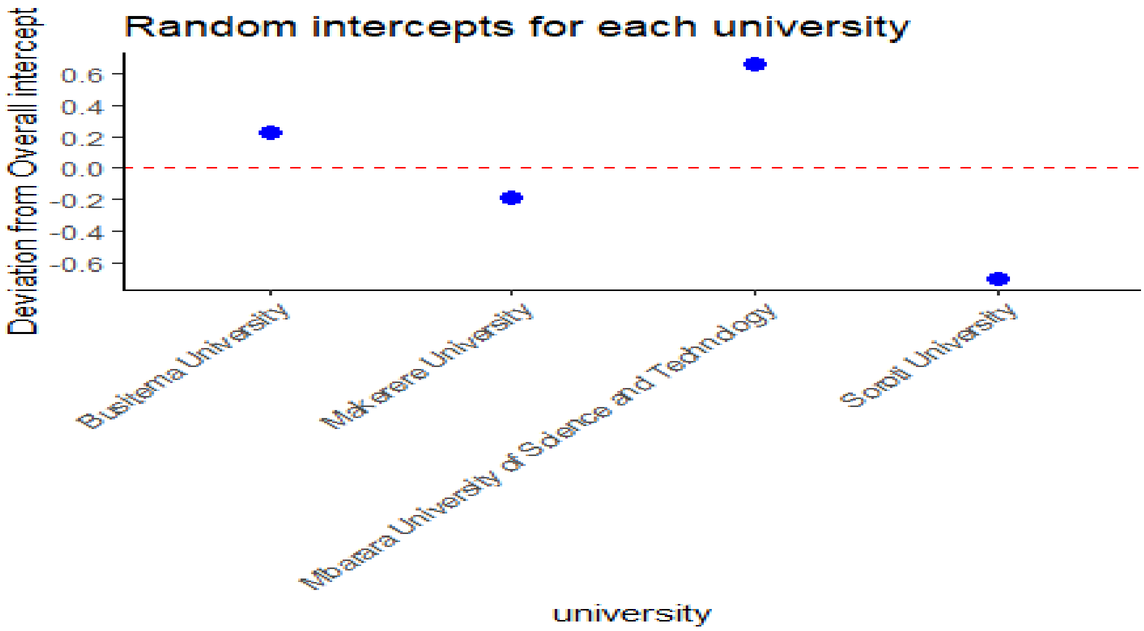


Figure 6 (b): Variance in academic achievement attributable to difference in universities

Mean GPA score in anatomy at all participating universities

In Anatomy, BNS students at Mbarara University of Science and Technology outperformed those from other universities, achieving the highest mean GPA of 3.36 with a relatively low standard deviation of 0.6265. This suggests that academic achievement among students at Mbarara University was relatively consistent, with minimal variation between the highest and lowest scores.

Academic achievement in anatomy at Busitema University was relatively better than at Makerere University and Soroti University, with a mean GPA of 2.75 compared to 2.35 at Makerere University and 2.04 at Soroti University. In contrast, Soroti University had the lowest performance, with a mean GPA of 2.04 and a slightly high standard deviation of 0.9821, indicating significant variability in academic achievement among students.

Additionally, there was a statistically significant difference in the mean Anatomy GPA scores across all universities ($p<0.001$). See table IX below.

Table IX: Table showing mean GPA scores in anatomy at all participating universities

University		Mean GPA	Median GPA	Sd	Sig
Busitema University		2.75	3.00	0.8530	0.00***
Makerere University		2.35	2.50	0.8368	
Mbarara University of Science and Technology		3.36	3.50	0.6265	
Soroti University		2.04	2.08	0.9821	

Mean GPA score in physiology at all participating universities

In Physiology, Mbarara University of Science and Technology outperformed all other universities, achieving the highest mean GPA of 3.70. However, the standard deviation of 0.7943 indicates moderate variability in academic performance. Similarly, Busitema University and Makerere University exhibited relatively high data variability, with standard deviations of 0.7547 and 0.8965, respectively.

Conversely, Soroti University recorded the lowest performance, with a mean GPA of 1.83 and a standard deviation of 0.6254, suggesting moderate consistency in academic achievement among students. Notably, the differences in mean GPA scores across all universities were statistically significant ($p<0.001$). See table X below.

Table X: Table showing mean GPA scores in physiology at all participating universities

University		**Mean GPA**	**Median GPA**	**Sd**	**Sig**
Busitema University		3.14	3.50	0.7547	0.00***
Makerere University		2.88	2.97	0.8965	
Mbarara University of Science and Technology		3.70	3.75	0.7943	
Soroti University		1.83	1.82	0.6254	

Mean GPA score in biochemistry at all participating universities

In Biochemistry, students at Mbarara University of Science and Technology still performed better than all other universities with the highest mean GPA score of 3.66 and standard deviation of 0.7305 implying moderate data variability. Mean GPA scores at Busitema University and Makerere University showed higher standard deviation of 0.8294 and 0.8182 respectively, implying moderate differences in academic achievement among students. Similarly, students at Soroti university had the lowest academic achievement with a mean GPA of 2.37 and standard deviation of 0.7060. There was a statistically significant mean difference in Biochemistry mean GPA score across all universities ($p<0.001$). See table XI below.

Table XI: Table showing mean GPA scores in biochemistry at all participating universities

University		Mean GPA	Median GPA	Sd	Sig
Busitema University		2.92	3.00	0.8294	0.00***
Makerere University		2.51	2.50	0.8182	
Mbarara University of Science and Technology		3.66	3.50	0.7305	
Soroti University		2.37	2.08	0.7060	

Mean GPA scores in biomedical courses across all participating universities

In Busitema university, Physiology was the most performed (GPA = 3.14), followed by Biochemistry (GPA = 2.92), then Anatomy (GPA = 2.75). At Makerere University, Physiology was the best performed biomedical science (GPA = 2.88), followed by Biochemistry (GPA = 2.51), then Anatomy (GPA = 2.35). Similarly, at Mbarara university of science and Technology, Physiology was the best performed (GPA = 3.7), followed by Biochemistry (GPA = 3.66), then Anatomy (GPA = 3.36). On contrary, at Soroti university, Biochemistry was the best performed (GPA = 2.37), followed by Anatomy (GPA = 2.04), then Physiology (GPA = 1.83). However, See figure VII below.

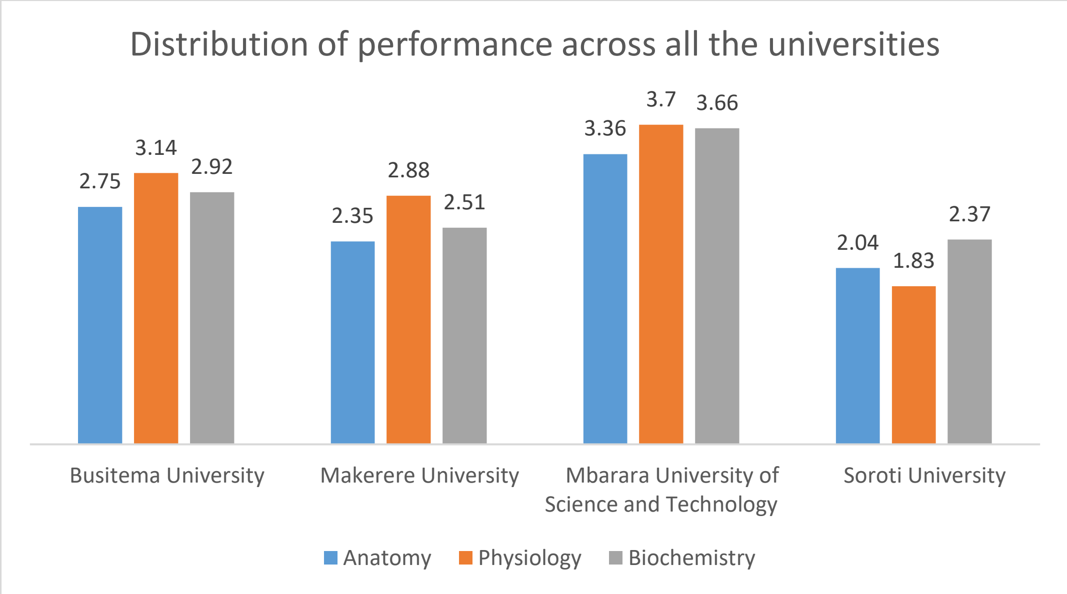


Figure 6: Graphical representation of the Grade Point Average scores of BNS students in biomedical courses across universities

Mean GPA scores showing variation in academic achievement across courses examined

In all universities under study, Physiology was the most performed biomedical course with a mean GPA score of 2.92, followed by Biochemistry with a mean GPA score 2.91, then Anatomy with a mean GPA score 2.65. The overall mean GPA for all biomedical courses was 2.80 (±0.788). Although GPA 2.80 is < 3.00 threshold, the difference was not statistically significant ($p = 0.067$) with a very small effect size (Cohen's d = -0.11). Analysis of variance demonstrated a significant difference in academic achievement across the three biomedical science courses (F= 7.9, $p<0.001$).See figure VIII below.

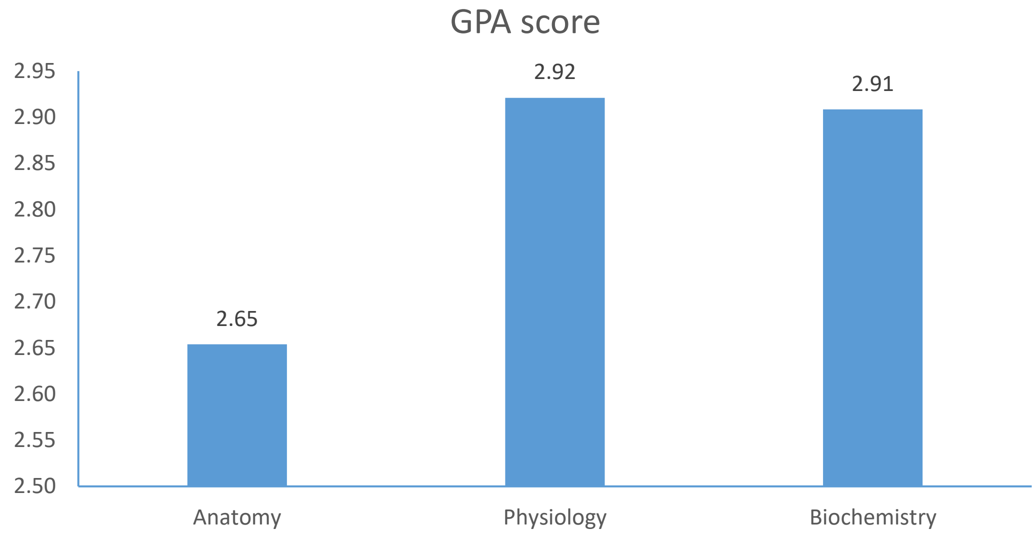


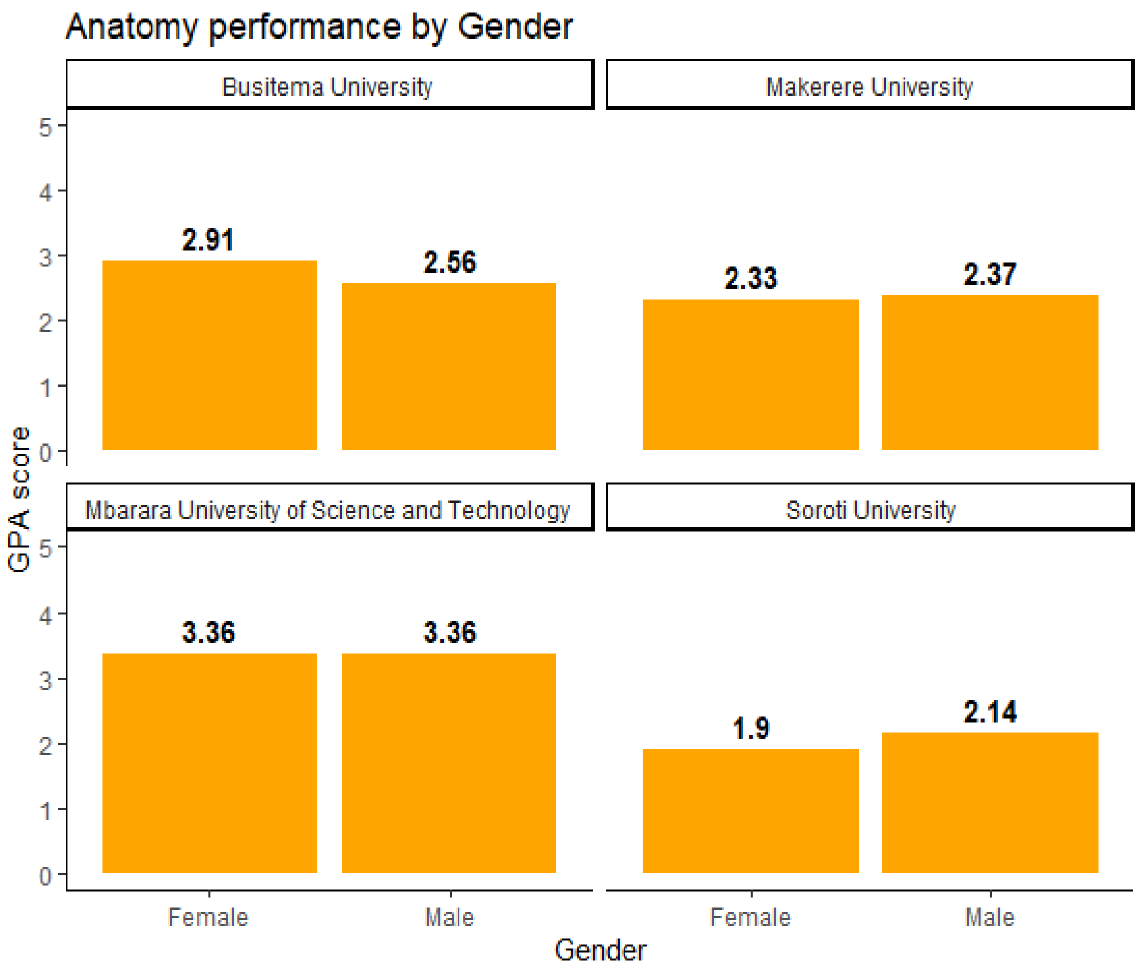
Figure 7: Graph showing the variation in GPA scores across courses examined

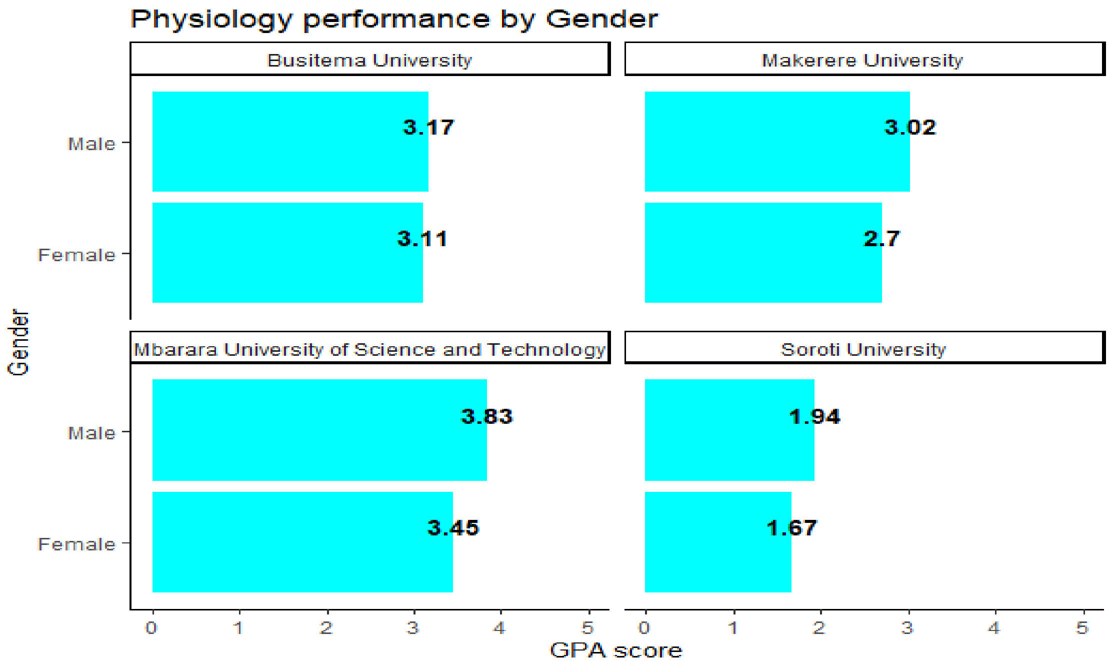
Variations in the mean GPA scores in biomedical by gender

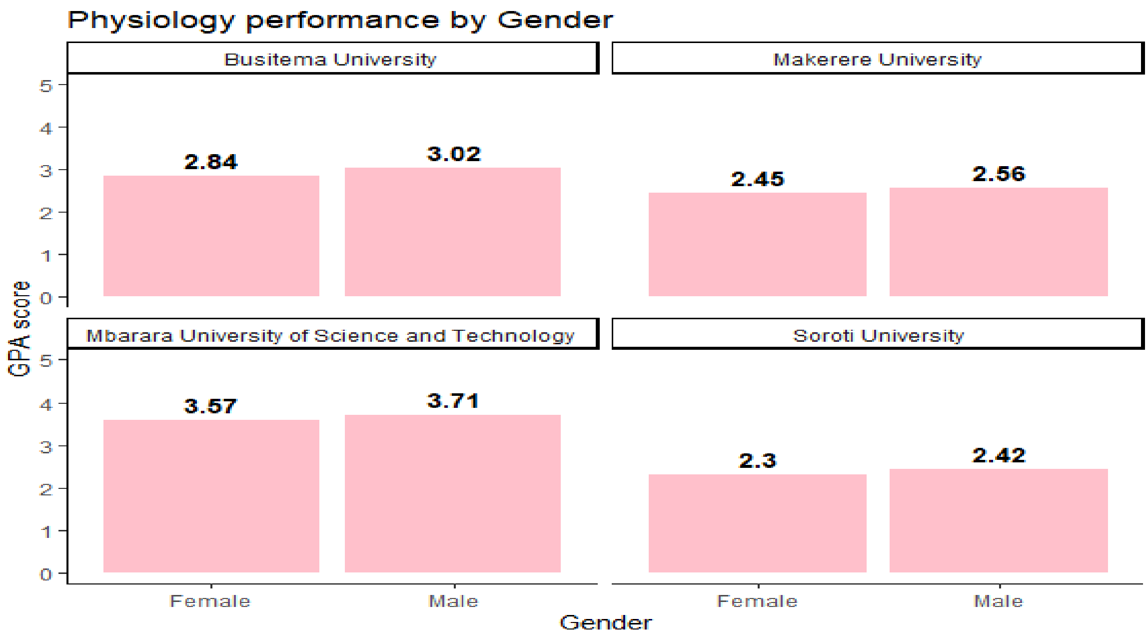
The study revealed that in Anatomy, female students at Busitema University outperformed their male counterparts, with a mean GPA of 2.91 compared to 2.56. At Mbarara University of Science and Technology, both male and female students achieved the same mean GPA of 3.36 in the same course. However, in the remaining biomedical sciences courses, male students generally performed better than females. Consequently, overall, male students recorded higher GPAs in biomedical sciences than their female counterparts. See table XII and bar graphs below.

Table XII: Table showing variation in mean Grade Point Average scores of BNS students in biomedical sciences by gender

University	Gender	Anatomy	Physiology	Biochemistry
Busitema University	Female	2.91	3.11	2.84
	Male	2.56	3.17	3.02
Makerere University	Female	2.33	2.70	2.45
	Male	2.37	3.02	2.56
Mbarara University of Science and Technology	Female	3.36	3.45	3.57
	Male	3.36	3.83	3.71
Soroti University	Female	1.90	1.67	2.30
	Male	2.14	1.94	2.42







4.2.1.2 Objective measurement of academic achievement in biomedical sciences by considering letter grade

As recommended by Uganda National Council of Higher Education (UNCHE), letter A, B+, B, C+, C, D+, D and F were also used to grade and interpret academic achievement in biomedical sciences among BNS students. This grading system was also used to estimate the failure rate.

a) Overview of the academic achievement at each university and the overall, by letter grade

At Busitema University, most BNS students scored either a C+ (fairly-good, 65%–69.9%) or a C plain (fair, 60%–64.9%) in physiology. In anatomy and biochemistry, they predominantly received a C plain (fair, 60%–64.9%) or a D+ (pass, 55.0%–59.9%).

At Makerere University, the majority scored a C plain (fair, 60%–64.9%) or a D+ (pass, 55.0%–59.9%) in physiology and biochemistry, while in anatomy, they mainly earned a D+ (pass, 55.0%–59.9%) or a D plain (marginal pass, 50.0%–54.9%).

At Mbarara University of Science and Technology, most students achieved either a B plain (good, 70%–74.9%) or a C+ (fair-good, 65%–69.9%) in physiology and biochemistry. In anatomy, they predominantly scored a C+ (fair-good, 65%–69.9%) or a C plain (fair, 60% –64.9%).

At Soroti University, the majority obtained either a D+ (pass, 55.0%–59.9%) or a D plain (marginal pass, 50.0%–54.9%) across all three biomedical sciences.

Overall, BNS students across all universities primarily scored within the C/C+ (fair-fair good, 37.0%) and D/D+ (pass-marginal pass, 33.7%) ranges in biomedical sciences. See figure 9(a), 9(b), 9(c), 9(d) below.

Figure 8(a)-9(d): Graphs showing variations in academic achievement (by letter grade) in biomedical sciences at the four participating universities

Figure 9(a)

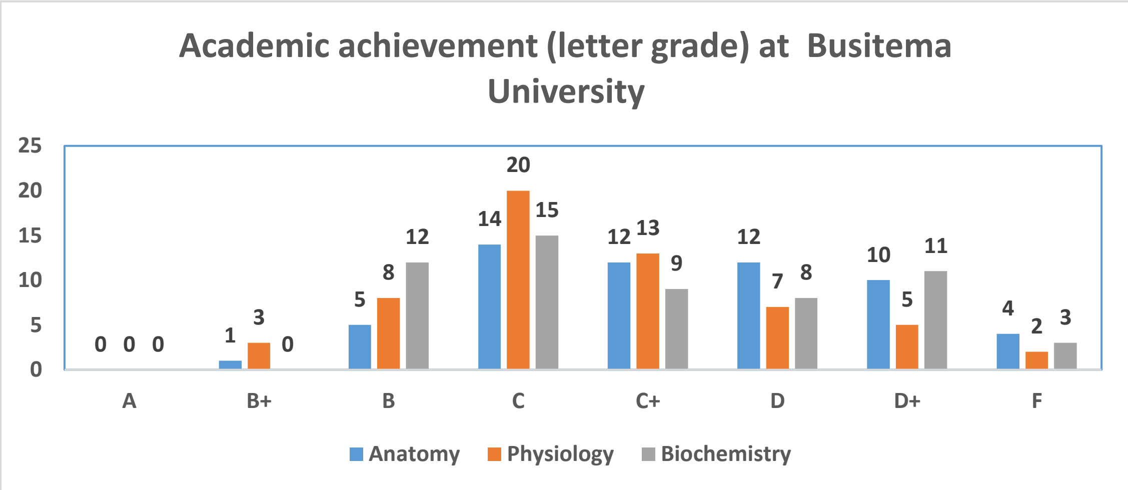


Figure 9(b)

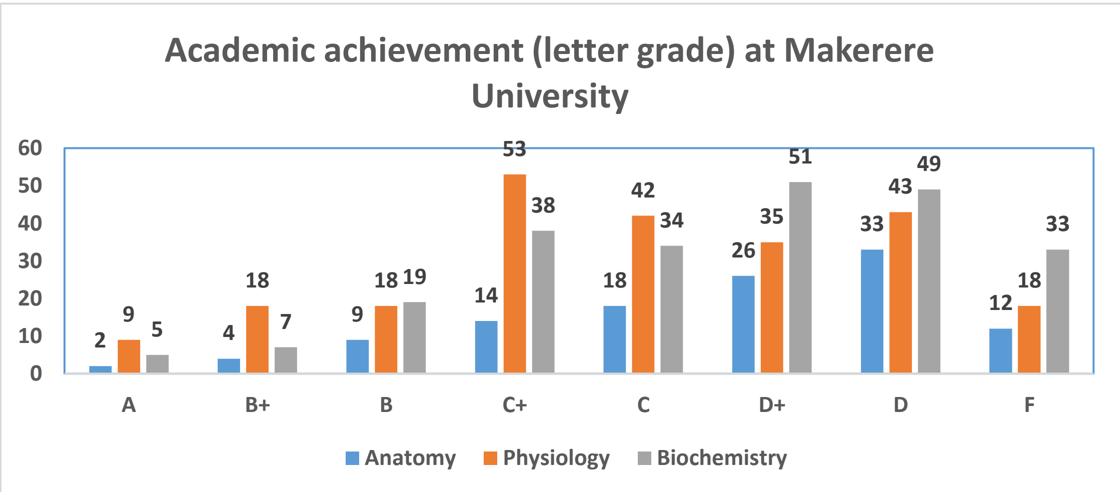


Figure 9(c)

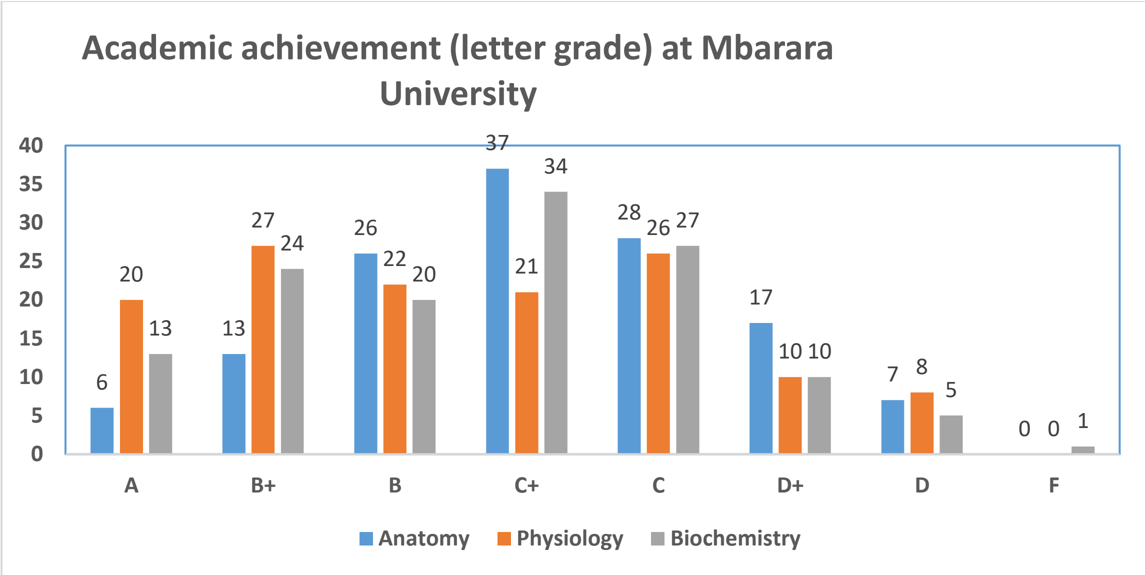
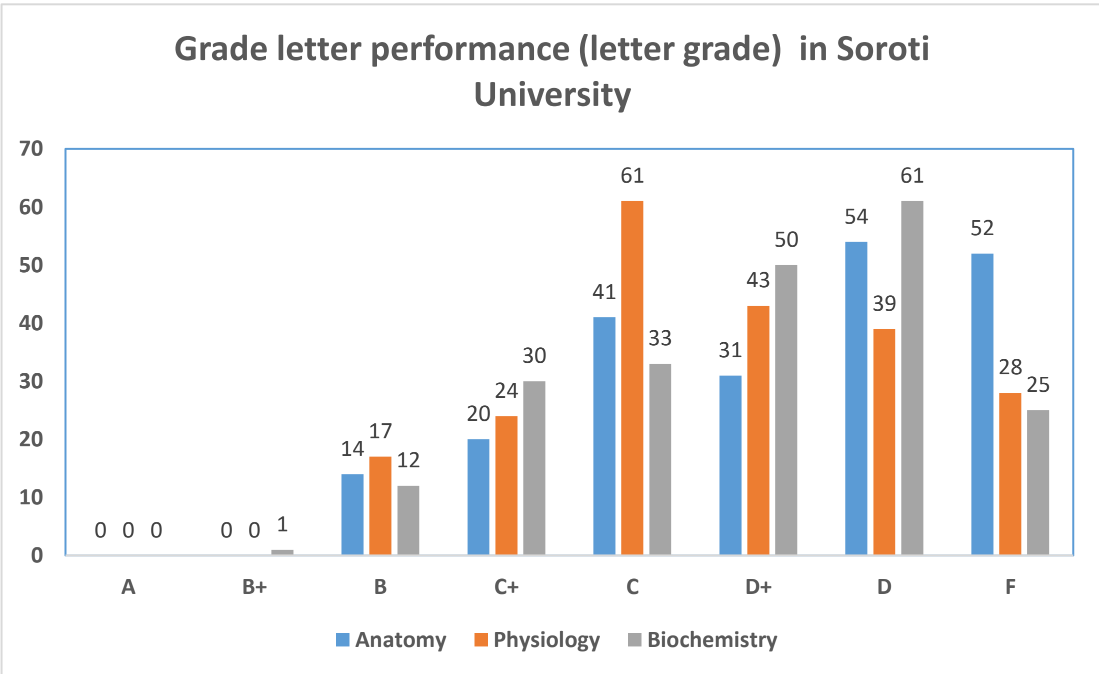

Academic achievement (letter grade) at Mbarara University
40
35
30
25
20
15
10
5
0
6 20 13
13 27 24
26 22 20
37 21 34
28 26 27
17 10 10
7 8 5
0 0 1
A B+ B C+ C D+ D F
Anatomy Physiology Biochemistry

Figure 9(d)


Grade letter performance (letter grade) in Soroti University
70
60
50
40
30
20
10
0
0 0 0
0 0 1
14 17 12
20 24 30
41 61 33
31 43 50
54 39 61
52 28 25
A B+ B C+ C D+ D F
Anatomy Physiology Biochemistry

b) Estimation of failure rate in biomedical sciences among BNS students

At Busitema University, most of the students who failed biomedical courses registered such fail score in anatomy (6.89%), followed by biochemistry (5.17%) and the least failed course was physiology (3.44%).

At Makerere University, the most failed course was biochemistry (13.98%), followed by anatomy (13.56%) and the least failed course was physiology (7.63%). At Mbarara University of science and technology, only one fail score in biochemistry was recorded accounting for 0.75%. At Soroti University, a significant proportion of students registered fail scores in anatomy (24.53%) followed by physiology (13.21%) and the least failed biomedical course was biochemistry (11.79%). Therefore, on further computing of the failure rate across all the four universities, it was found that anatomy had the highest failure scores (11.25%), followed by biochemistry (7.92%) and the least was physiology (6.07). However, the failure rate varied across universities and biomedical courses. See table XIII below.

Table XIII: Table showing objective measurement of academic achievement in anatomy, physiology and biochemistry, considering letter grade method

	Grade Letters								
University	**A (%)**	**B (%)**	**B+ (%)**	**C (%)**	**C+ (%)**	**D (%)**	**D+ (%)**	**F (%)**	**Total**
Busitema University									
Anatomy 1	0 (0)	2 (6.9)	0 (0)	6 (20.7)	7 (24.1)	7 (24.1)	6 (20.7)	1 (3.4)	29
Anatomy 2	0 (0)	3 (10.3)	1 (3.4)	6 (20.7)	7 (24.1)	3 (10.3)	6 (20.7)	3 (10.3)	
Physiology1	0 (0)	4 (13.8)	1 (3.4)	11 (37.9)	9 (31.0)	2 (6.9)	2 (6.9)	0 (0)	
Physiology 2	0 (0)	4 (13.8)	2 (6.9)	2 (6.9)	11 (37.9)	3 (10.3)	5 (17.2)	2 (6.8)	
Biochemistry 1	0 (0)	8 (27.6)	0 (0)	4 (13.8)	5 (17.2)	7 (24.1)	4 (13.8)	1 (3.4)	
Biochemistry 2	0 (0)	4 (13.8)	0 (0)	5 (17.2)	10 (34.5)	4 (13.8)	4 (13.8)	2 (6.9)	
Makerere University									
Anatomy 1	1 (1.7)	7 (11.9)	2 (3.4)	10 (16.9)	10 (16.9)	14 (23.7)	10 (16.9)	5 (8.5)	59
Anatomy 2	1 (1.7)	2 (3.4)	2 (3.4)	8 (13.6)	4 (6.8)	19 (32.2)	16 (27.1)	7 (11.9)	
Anatomy 3	0 (0)	3 (5.1)	0 (0)	8 (13.6)	7 (11.9)	21 (35.6)	12 (20.3)	8 (13.6)	
Anatomy 4	0 (0)	1 (1.7)	2 (3.4)	12 (20.2)	6 (10.2)	17 (28.8)	9 (15.3)	12 (20.3)	
Physiology1	1 (1.8)	4 (7.0)	0 (0)	12 (21.1)	17 (29.8)	9 (15.8)	12 (21.1)	2 (3.5)	
Physiology 2	2 (3.4)	6 (10.2)	5 (8.5)	16 (27.1)	9 (15.3)	5 (8.5)	12 (20.3)	4 (6.8)	
Physiology 3	4 (6.8)	6 (10.2)	3 (5.1)	14 (23.7)	11 (18.6)	6 (10.2)	9 (15.3)	6 (10.2)	
Physiology 4	2 (3.4)	5 (8.6)	6 (10.3)	6 (10.3)	10 (17.2)	11 (19.0)	12 (20.7)	6 (10.3)	
Biochemistry 1	0 (0)	4 (6.8)	0 (0)	5 (8.5)	11 (18.6)	20 (33.9)	14 (23.7)	5 (8.5)	
Biochemistry 2	1 (1.7)	3 (5.1)	3 (5.1)	13 (22.0)	9 (15.3)	10 (16.9)	14 (23.7)	6 (10.2)	
Biochemistry 3	3 (5.1)	4 (6.8)	1 (1.7)	10 (16.9)	9 (15.3)	8 (13.6)	13 (22.0)	11 (18.6)	
Biochemistry 4	1 (1.7)	8 (13.6)	3 (5.1)	6 (10.2)	9 (15.3)	11 (18.6)	10 (16.9)	11 (18.6)	
Mbarara University of Science and Technology									
Anatomy 1	5 (7.5)	11 (16.4)	10 (14.9)	11 (16.4)	23 (34.3)	0 (0)	7 (10.4)	0 (0)	67
Anatomy 2	1 (1.5)	15 (22.4)	3 (4.5)	17 (25.4)	14 (20.9)	7 (10.4)	10 (14.9)	0 (0)	

Physiology1	11 (16.4)	13 (19.4)	14 (20.9)	13 (19.4)	10 (14.9)	3 (4.5)	3 (4.5)	0 (0)	
Physiology 2	9 (13.4)	9 (13.4)	13 (19.4)	13 (19.4)	11 (16.4)	5 (7.5)	7 (10.4)	0 (0)	
Biochemistry 1	7 (10.4)	11 (16.4)	15 (22.4)	12 (17.9)	18 (26.9)	1 (1.5)	3 (4.5)	0 (0)	
Biochemistry 2	6 (9.0)	9 (13.4)	9 (13.4)	15 (22.4)	16 (23.9)	4 (6.0)	7 (10.4)	1 (1.5)	
Soroti University									
Anatomy 1	0 (0)	2 (3.8)	0 (0)	12 (22.6)	1 (1.9)	14 (26.4)	6 (11.3)	18 (34)	53 (100)
Anatomy 2	0 (0)	3 (5.7)	0 (0)	5 (9.4)	8 (15.1)	20 (37.7)	2 (3.8)	15 (28.3)	
Anatomy 3	0 (0)	3 (5.7)	0 (0)	10 (18.9)	7 (13.2)	8 (15.1)	12 (22.6)	13 (24.5)	
Anatomy 4	0 (0)	6 (11.3)	0 (0)	14 (26.4)	4 (7.5)	12 (22.6)	11 (20.8)	6 (11.3)	
Physiology1	0 (0)	4 (7.5)	0 (0)	15 (28.3)	5 (9.4)	11 (20.8)	9 (17.0)	9 (17.0)	
Physiology 2	0 (0)	3 (5.7)	0 (0)	16 (30.2)	4 (7.5)	11 (20.8)	12 (22.6)	7 (13.2)	
Physiology 3	0 (0)	4 (7.5)	0 (0)	16 (30.2)	10 (18.9)	9 (17.0)	9 (17.0)	5 (9.4)	
Physiology 4	0 (0)	6 (11.3)	0 (0)	14 (26.4)	5 (9.4)	8 (15.1)	13 (24.5)	7 (13.2)	
Biochemistry 1	0 (0)	1 (1.9)	0 (0)	6 (11.3)	3 (5.7)	22 (41.5)	9 (17.0)	12 (22.6)	
Biochemistry 2	0 (0)	1 (1.9)	0 (0)	5 (9.4)	12 (22.6)	12 (22.6)	18 (34.0)	5 (9.4)	
Biochemistry 3	0 (0)	4 (7.5)	0 (0)	13 (24.5)	9 (17.0)	13 (24.5)	10 (18.9)	4 (7.5)	
Biochemistry 4	0 (0)	6 (11.3)	1 (1.9)	9 (17.0)	6 (11.3)	14 (26.4)	13 (24.5)	4 (7.5)	

4.2.2 Subjective ranked opinions of BNS students regarding academic achievement in biomedical sciences

The majority of BNS students reported being dissatisfied with their academic achievement in anatomy, with 92 (44.2%) disagreeing or strongly disagreeing.

However, they expressed satisfaction with their academic achievement in physiology, with 92 (44.2%) agreeing or strongly agreeing, and in biochemistry, with 86 (41.4%) agreeing or strongly agreeing.

Most students agreed that their academic achievement was appropriate to their effort, with 81 (38.9%) agreeing or strongly agreeing. Additionally, 139 (66.8%) agreed or strongly agreed that they were knowledgeable in the three biomedical courses, namely, anatomy, physiology, and biochemistry. A significant majority, 187 (89.9%), believed they had the potential to perform better, while 184 (88.4%) agreed or strongly agreed that they were applying the knowledge and skills from these biomedical science courses in patient care.

Notably, a substantial proportion of students remained neutral regarding their level of satisfaction with academic achievement in all three courses and the appropriateness of their achievement, with 50 (24%) expressing neutrality. Similarly, 77 (36.9%) reported that their academic achievement was not appropriate and that their efforts were not being adequately rewarded.

Overall, the findings indicate that BNS students were satisfied with their academic achievement in other biomedical courses but not in anatomy. They acknowledged the importance of biomedical sciences in their clinical practice. Notably, two-thirds were knowledgeable in biomedical sciences, while the rest were not but remained confident that they could improve. However, perspectives on their academic achievement in biomedical sciences varied significantly. For instance, Students who strongly agreed or agreed that they were satisfied with their academic achievement in anatomy, physiology and biochemistry had significantly higher GPAs compared to those who disagreed or strongly disagreed ($p<0.01$). The strongest differences were observed in anatomy and physiology ($p<0.001$). Similarly, students who strongly believed that their academic achievement was appropriate for their efforts had the highest GPAs with significant differences across categories ($p<0.01$). Perception of being knowledgeable and applying knowledge in these courses in the care of patients did not show statistically significant associations with GPA ($p<0.316$ and $p<0.222$ respectively). Belief in the potential to do better was marginally associated with academic achievement ($p<0.051$). See table XIV below.

Table XIV: Table showing subjective opinions of BNS students regarding academic achievement in biomedical sciences

Variables category	n (%)	Mean GPA	Sd	Sig
Satisfied with performance in Anatomy				
Strongly agree	16 (7.7)	2.84	1.15	0.000***
Agree	49 (23.6)	3.37	0.81	
Neutral	51 (24.5)	2.80	0.86	
Disagree	61 (29.3)	2.63	0.77	
Strongly disagree	31 (14.9)	2.38	0.86	
Satisfied with performance in Biochemistry				
Strongly agree	22 (10.6)	3.14	0.99	0.007**
Agree	64 (30.8)	3.07	0.88	
Neutral	52 (25.0)	2.72	0.87	
Disagree	47 (22.6)	2.63	0.89	
Strongly disagree	23 (11.1)	2.47	0.77	
Satisfied with performance in Physiology				
Strongly agree	27 (13.0)	2.96	1.26	0.000***
Agree	65 (31.2)	3.14	0.78	
Neutral	47 (22.6)	2.90	0.70	
Disagree	50 (24.0)	2.49	0.82	
Strongly disagree	19 (9.1)	2.23	0.85	
My performance is appropriate for my effort				
Strongly agree	16 (7.7%)	3.49	1.13	0.000***
Agree	65 (31.2%)	2.98	0.92	
Neutral	50 (24.0%)	2.84	0.80	
Disagree	55 (26.4%)	2.58	0.82	
Strongly disagree	22 (10.6%)	2.44	0.80	
I feel knowledgeable in the three courses				
Strongly agree	25 (12.0%)	3.03	0.97	0.316
Agree	114 (54.8%)	2.88	0.89	
Neutral	52 (25.0%)	2.62	0.89	
Disagree	11 (5.3%)	2.77	0.94	
Strongly disagree	6 (2.9%)	2.72	0.95	
I believe I can do better				
Strongly agree	93 (44.7%)	2.94	0.85	0.051
Agree	94 (45.2%)	2.77	0.91	
Neutral	11 (5.3%)	2.77	0.92	
Disagree	3 (1.4%)	1.41	1.29	
Strongly disagree	7 (3.4%)	2.76	1.00	
I apply knowledge of courses in patient care				
Strongly agree	81 (38.9%)	2.88	0.82	0.222
Agree	103 (49.5%)	2.84	0.92	
Neutral	15 (7.2%)	2.56	0.92	
Disagree	4 (1.9%)	1.93	1.74	
Strongly disagree	5 (2.4%)	2.97	1.05	

4.2.3 Findings from the qualitative study to compliment quantitative findings to answer study objective I.

The first objective of the qualitative aspect of this study was to explore opinions of lecturers of biomedical sciences regarding the level of academic achievement in biomedical sciences among BNS students in Uganda.

Most of the lecturers held the view that academic achievement had improved lately. However, it was still not at the expected level and entirely depended on the contextual factors. Therefore, one theme emerged from three categories and fifteen codes that characterized academic performance as progressive, context-dependent, and marginal. See table XV.

Table XV: Table showing the views of lecturers regarding level of academic achievement in biomedical sciences among BNS students

Theme	Emerged categories	Emerged codes
Progressive, context dependent and marginal-moderate academic achievement	1. Progressive academic achievement	i) Academic achievement on a positive trend ii) Improving though still not good
	2. Contextualized academic achievement	i) Academic achievement depends on the course being taken ii) Comparative academic achievement iii) Achievement depends on the mode of admission iv) Varies between direct and extensor students v) Academic achievement is a struggle vi) Generally, MBChB outperform BNS students
	3. Marginal achievement	i) Marginal academic achievement ii) High failure rate in anatomy iii) About one eighth to a quarter of the students register fail scores in biochemistry while majority pass with marginal scores iv) Excellence performance comes as surprise v) Low failure rate in physiology vi) Low marks scored in physiology vii) BNS struggle to pass biomedical sciences

Theme: Progressive, context dependent and marginal-moderate academic achievement

Progressive, context-dependent and marginal academic achievement emerged as a central theme regarding the level of academic success in biomedical sciences among nursing students.

The theme presents opinions of lecturers on how academic achievement in biomedical sciences among degree nursing students has been improving over time. It highlights that academic success is never static and can be shaped by evolving and situational factors. This theme emerged from three (3) categories namely i) progressive academic achievement, ii) context-dependent academic achievement, and iii) marginal-moderate academic achievement. The three categories emerged from a total of fifteen (15) codes.

Progressive academic achievement

This component of the theme suggests that BNS students' academic achievement in biomedical sciences has not been deteriorating but rather improving over time. Accordingly, some lecturers described academic achievement in biomedical sciences as somewhat better compared to previous cohorts, noting that more students are now able to pass the specified courses, although their scores remain unsatisfactory. For example, one lecturer stated: '*There is a little bit of improvement now. Previously, about half of the class would fail'' (*Male, 15 years of experience, Bioch).

Context-dependent academic achievement

This dimension of the theme underscores the influence of various contextual factors on students' academic performance. Lecturers stated that the academic achievement of nursing students was not static and depended on various factors. The majority noted that while some students excelled in certain courses, they struggled with others. They also strongly believed that students admitted directly from advanced-level education performed significantly better than those admitted through the diploma scheme. For instance, one said: *''Academic performance depends on the course being taught. At times we don't register failure in biochemistry IV but up to 20% can be registered in biochemistry 1 and 2''* (Male, 7 years of experiences, Bioch). Another one said: ''*For direct students, it's very rare to fail. You find like only one or two with retakes. However, the problem is with the extensor students''* (Male, 18 years of experience, Bioch).

Marginal-moderate academic success

Equally, the majority of lecturers expressed their dismay at the performance of most nursing students in biomedical sciences examinations. They opined that the academic success of BNS students in biomedical sciences remains precarious, fragile, marginal-moderate, and unsatisfactory, with many students constantly navigating the boundary between success and failure and repeatedly at risk of falling off the path to success. Accordingly, some lecturers said: ''*What I can say is that most of the students pass physiology with marginal scores between 50 and 60%. There are extreme ends for instance A, B+ but these are very few'' (*Male, 7 years of experience, Phys). Similarly, another lecturer said: *'Overall, about 10-25% of the nursing students fail biochemistry and most of them who pass the course score between 50-60%* (Male, 18 years of experience, Bioch). Figure 10 below provides a summary of the findings.

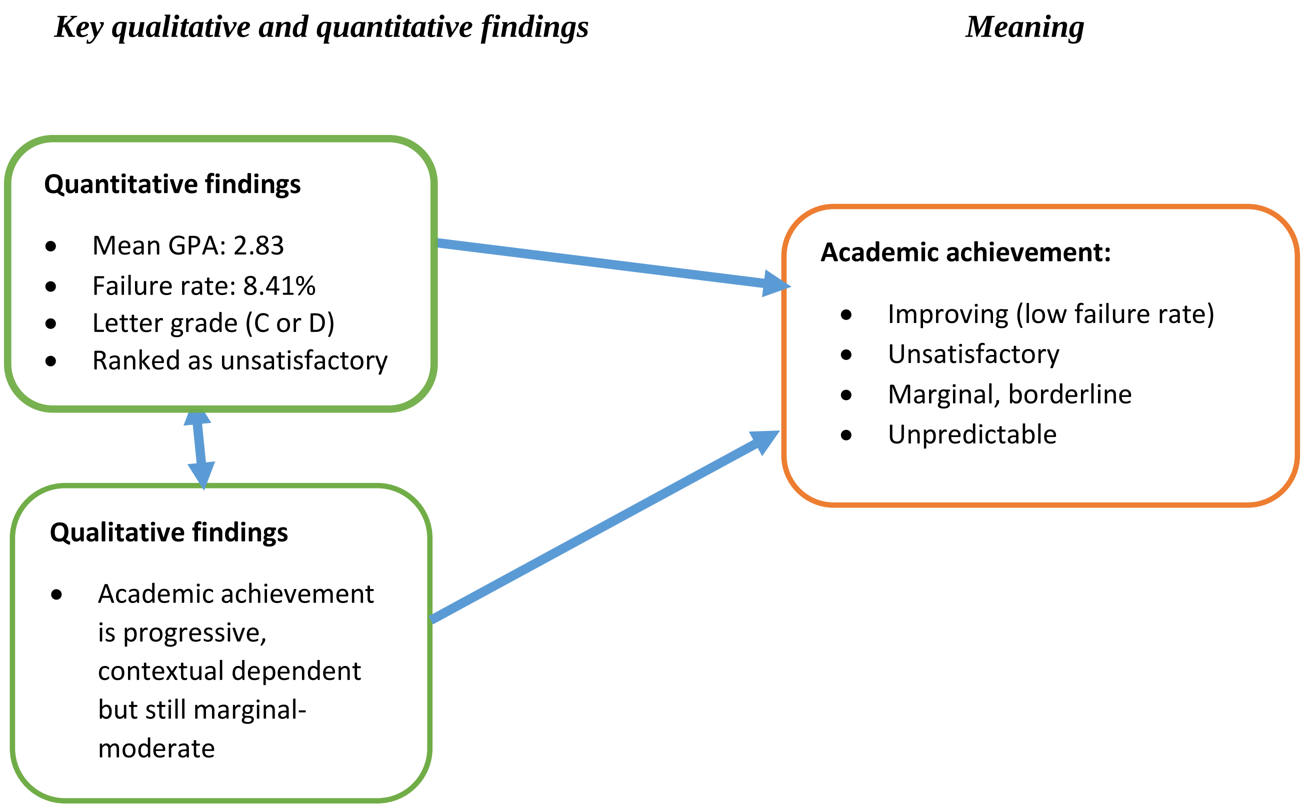


Figure 9: Summary of the quantitative and qualitative study findings on the level of achievement in biomedical sciences among BNS students

4.3 Objective II: To examine socio-demographic factors that influence academic achievement in biomedical sciences among BNS students in Uganda.

Quantitative and qualitative study findings were analyzed to gain in-depth understanding of the socio-demographic factors that influence academic achievement in biomedical sciences among BNS students in Uganda.

4.3.1 Findings from the quantitative study

a) Bivariate analysis of the socio-demographic factors that influence academic achievement in biomedical sciences among BNS students

Bivariate analysis was conducted using Welch's ANOVA in R software. The findings showed that younger students performed better than older ones ($F = 9.92$, $p \leq 0.001$). - Students on private sponsorship performed better than those who were government-sponsored ($F = 5.43$, $p \leq 0.001$). Those whose home districts were in the central region of Uganda performed better than those from other regions ($F = 5.12$, $p \leq 0.001$). Additionally, students who were in active sexual relationships, including marriage, performed poorly compared to those who were single ($F = 9.22$, $p \leq 0.001$).

Similarly, students who studied while multitasking with full-time paying jobs performed poorly compared to those without full-time jobs ($F = 12.17$, $p \leq 0.001$). Lastly, students who lived within one kilometer or less from the university performed better than those who lived farther than one kilometer ($F = 6.04$, $p \leq 0.001$).

Other sociodemographic factors, such as the occupation and education level of parents or caretakers, religion, gender, parental or caretaker guidance and counseling, level of urbanicity of the home location, family size, and type of residence (e.g., university hostels or privately owned hostels), did not show a significant influence on the academic achievement of BNS students in biomedical sciences. See table XVI.

Table XVI: Table showing sociodemographic variables that influence academic achievement in biomedical sciences among BNS students at bivariate analysis level

Parameter	Mean GPA	Sd	F statistic	Sig
Gender				
Female	2.69	0.89	3.25	0.07
Male	2.92	0.91		
Age Category				
20-24	2.97	0.85	9.92	0.00***
25-29	2.79	0.88		
30-34	2.03	0.74		
35 above	1.91	0.85		
Sponsorship				
Government	2.60	0.85	5.43	0.00***
Private	3.09	0.91		
Non-Government Organization	3.08	0.80		
Religion				
Born again including Protestants	2.82	0.97	1.41	0.23
Catholic	2.99	0.96		
Muslim	2.87	0.61		
Pentecostal	2.55	0.93		
Other	2.59	0.66		
Region of home district				
Central	3.11	0.88	5.12	0.00***
Eastern	2.58	0.98		
Northern	2.62	0.87		
Western	3.01	0.69		
Home location level of urbanization				
Peri urban (small town)	2.92	0.98	0.55	0.58
Rural	2.78	0.82		
Urban	2.78	0.92		
Parents living status				
Both alive	2.90	0.90	2.51	0.08
None of them alive	3.19	0.48		
Only one alive	2.58	0.91		
Fathers level of education				
Degree and above	2.96	0.82	0.46	0.79
Don't know	2.64	0.98		
Higher/Tertiary education	2.85	0.88		
Never went to school	2.98	0.88		
Primary level	2.83	0.94		
Secondary level	2.70	0.97		
Mothers level of education				
Degree and above	2.82	1.00	0.79	0.55
Don't know	2.77	0.99		
Higher/Tertiary education	2.78	0.96		
Never went to school	2.81	0.89		
Primary level	2.70	0.94		
Secondary level	3.02	0.77		
Fathers Occupation				
Informal employment	2.84	0.94	0.22	0.88
Formal employment	2.84	0.90		

No employment	2.53	0.90		
Business/Commercial farming	2.82	0.88		
Mothers Occupation				
Informal employment	2.77	0.94	0.62	0.60
Formal employment	2.80	0.98		
No employment	2.78	0.90		
Business/Commercial farming	2.98	0.77		
Marital status				
In sexual relationship	2.65	0.90	9.22	0.00***
Married/Cohabiting	2.23	0.91		
Single	2.95	0.86		
Paying Job while studying				
No	2.90	0.87	12.17	0.00***
Yes	2.19	0.98		
Residence while at school				
At home	2.55	0.86	0.95	0.38
University hostel	2.84	0.96		
Privately rented room	2.87	0.77		
Extent of parents guidance				
Great extent	2.87	0.87	0.85	0.46
Neutral	2.90	0.78		
Not at all	2.49	1.07		
Some extent	2.68	1.02		
Distance from Residence to university				
Less than a km	3.18	0.86	6.04	0.00***
1 – 3 km	2.85	0.86		
4 – 6 km	2.44	0.90		
7 km and above	2.35	0.92		
Family size (people at home)				
0 – 2	3.00	0.68	0.72	0.53
3 – 4	2.95	0.87		
5 – 6	2.82	0.90		
More than 6	2.75	0.95		
Signif. codes: 0 '' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1***				

b) Multivariate analysis of the socio-demographic factors that influence academic achievement in biomedical sciences among BNS students

Multivariate analysis was done using Linear Mixed Effect (LME) model to account for the effect of clustered data on universities (nonhomogeneous data). Model assumptions of linearity, normality of residuals, homoscedasticity, and independence of Random effects were tested before using the model. Confounders were tested using the stepwise command in R software.

After controlling for variation in clustered data on universities, confounders, interaction terms and covariates, age and region of the home district remained statistically significantly associated with academic achievement in biomedical sciences among BNS students.

Intercept: The mean GPA score of a student who was age 20 – 24 years and from central region of Uganda as their home district was 3.11.

Age: Younger students obtained higher GPAs than their older counterparts. For example, students aged 30–34 years had a GPA that was 0.65 points lower than those aged 20–24 years (β = -0.65, 95% CI: -1.12 - -0.18, $p = 0.009$). Similarly, students aged 35 years and above had a GPA that was 0.70 points lower than those aged 20–24 years (β = -0.70, 95% CI: -1.28 - -0.11, $p = 0.03$).

The region of a student's home district also influenced academic achievement in biomedical sciences. Students from Eastern Uganda had a GPA that was 0.30 points lower than those from the Central region (β = -0.30, 95% CI: -0.54 - -0.07, $p = 0.016$).

Likewise, students from Northern Uganda had a GPA that was 0.43 points lower than those from the Central region (β = -0.43, 95% CI: -0.74 - -0.12, p = 0.009). See XVII table below.

Table XVII: Table showing sociodemographic variables that influence academic achievement in biomedical sciences among BNS students at multivariate analysis level

Covariates	Coefficient (Estimates)	Std.Error	df	t-value	p-values
Intercept	3.11 [2.37-3.85]	0.37	7.00	8.37	0.000***
Age Category					
20 – 24	1				
25 – 29	0.04 [-0.22-0.30]	0.14	190.26	0.31	0.756
30 – 34	-0.65 [-1.12- -0.18]	0.25	190.25	-2.64	0.009 **
35 and above	-0.70 [-1.28- -0.11]	0.31	190.32	-2.26	0.03 *
Sponsorship					
Government	1				
Private	-0.05 [-0.27-0.18]	0.12	192.61	-0.41	0.68
Non-Government Organization	-0.14 [-0.60-0.34]	0.25	192.12	-0.56	0.576
Region of home district					
Central	1				
Eastern	-0.30 [-0.54- -0.07]	0.12	190.97	-2.429	0.016 *
Northern	-0.43 [-0.74- -0.12]	0.16	190.25	-2.64	0.009 **
Western	-0.19 [-0.44-0.07]	0.13	190.27	-1.34	0.164
Marital status					
In sexual relationship	1				
Married/Cohabiting	0.03 [-0.46-0.52]	0.26	190.17	0.13	0.899
Single	0.03 [-0.37-0.42]	0.21	190.26	0.13	0.896
Distance from residence to university					
1 – 3 km	1				
4 – 6 km	-0.14 [-0.42-0.14]	0.15	190.58	-0.92	0.360
Less than a km	0.07 [-0.16-0.31]	0.12	192.11	0.56	0.577
7 km and above	-0.00 [-0.39-0.38]	0.20	191.09	0.55	0.580.
Paying Job while studying					
No					
Yes	-0.01 [-0.44-0.41]	0.22	190.16	-0.066	0.95
Signif. codes: 0 '' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 AIC = 448.2594***					

4.3.2 Findings from the qualitative study to compliment quantitative findings to answer study objective II

Second objective of this study was to examine sociodemographic factors that influence academic achievement in biomedical sciences among BNS students in Uganda. From KIIs with lecturers, three themes emerged from six categories and ten codes to answer this objective: (i) variation in academic success by age and gender, (ii) divided attention of students, and (iii) Health and financial status of students. See table XVIII below.

Table XVIII: Summary of the views of lecturers regarding sociodemographic factors influencing academic achievement in biomedical sciences among BNS students

Theme	Emerged categories	Emerged codes
1. Variation in academic achievement by age and gender	i) Variation in academic achievement by age	i) Young students outperform old
	ii) Variation in academic achievement by gender	i) Unsure about which gender dominates ii) Males perform better than females
2. Divided attention of students	i) Balancing work and studies	i) Job demand ii) Study while working
	ii) Involvement in sexual relationships	i) Family responsibilities ii) Sexual intimacy iii) Missing tests and quiz
3.Student health, financial support and stability	i) Student health and wellbeing	i) Absenteeism due to illness ii) Pregnancy side effects
	ii) Financial support and stability	ii) Inadequate financial support

Theme 1: Variation in academic success by age and gender

Variation in academic success by age and gender emerged as a dominant theme in explaining the sociodemographic characteristics of nursing students that contributed to their performance in biomedical sciences. This theme suggests that academic achievement among degree nursing students in biomedical sciences is influenced by both age and gender. Age appears to act as a mediator of academic achievement, significantly shaping academic outcomes. This influence is likely due to factors such as life experience, level of maturity, family and work commitments, and cognitive abilities, which can fluctuate with age. Similarly, gender is highlighted as a potential social construct influencing academic success in biomedical sciences.

This may be attributed to societal expectations and stereotypes, variations in access to resources such as time, and the additional burden female students often face in balancing socially assigned extracurricular responsibilities with academic demands. These findings reflect the perspectives of biomedical sciences lecturers on disparities in academic achievement among male and female students of different age groups. The theme emerged from two categories namely i) variation in academic achievement by age ii) variation in academic achievement by gender. The two categories also emerged from two codes.

Variation in academic success by age

Nearly all lecturers strongly believed that younger nursing students performed better in biomedical sciences than older ones. They emphasized that younger students rarely received failing grades, although they did not explicitly state that younger students excelled.

In contrast, the majority of older students either failed the courses or achieved only marginal pass scores. For instance, one lecturer said: *‘’Regarding age, the more the* *age, the more likelihood of performing poorly in biomedical sciences''* (Female, 7 years of experience, Anat).

Variation in academic success by gender

In this regard, many lecturers mentioned that, over time, they had observed male students outperforming female students. However, they wondered why this was the case and were quick to add that they were unsure, as they had not conducted a study to ascertain the details of their observations. One lecturer said: ''*I have always seen that males tend to outperform females although I cannot explain why because I have never done a study on it''* (Male, 5 years of experience, Anat).

Theme 2: Divided attention of students

Dived attention also emerged as a vital theme in explaining sociodemographic characteristics of nursing students that contribute to their academic achievement in biomedical sciences. The theme reveals that students' attention is often divided across multiple aspects of their lives, fragmenting their academic focus. Divided focus creates an inner tension that is both emotional and existential, as students struggle to reconcile their personal and academic obligations.

Students grapple with questions of authenticity, feeling torn between their true interests and the expectations others place upon them, which can lead to feelings of inner conflict and crush. This theme emerged from two (2) categories namely i) balancing work and studies ii) involvement in sexual relationships. These categories also emerged from two codes.

Balancing work and studies

The majority of lecturers emphasized that most diploma-holding students attempted to balance work and studies. However, they noted that biomedical sciences are highly demanding courses that require total commitment. Lecturers expressed concern that many students admitted with diploma did not have official study leave from their employers. Consequently, they tried to manage their studies while remaining on full salary, which ultimately led to poor performance in examinations. For example, a lecturer stated: ‘’*Yes, some students who work as well as studying especially diploma holders tend to perform poorly because they don't get enough time to concentrate on the course’’* (Female, 8 years of experience, Phys).

Involvement in sexual relationships

Another factor explaining the diversion of attention among nursing students was their involvement in sexual relationships. This behavior was noted to impact their ability to concentrate on studying biomedical sciences, ultimately contributing to poor academic achievement in these courses. Lecturers observed that some students who had attended single-sex secondary schools, where interaction with the opposite sex was restricted, found freedom at university unsettling. This often led them to engage in sexual relationships, which caused distractions and, consequently, poor examination performance. For instance, a lecturer mentioned: *‘’Some students engage in sexual relationships especially those from single-sex secondary schools. So, they divert their attention to the relationships and finally end up performing poorly in exams’’* (Male, 5 years of experience, Bioch).

Theme 3: Student health, financial support and stability of students

Student health, financial support and stability of students emerged as another vital theme that explain why many degree nursing students struggled to succeed in examinations of biomedical sciences. Findings reveal a nuanced and interdependent relationship between students' well-being encompassing mental and physical health, financial stability, and academic performance in the context of biomedical sciences education. It emphasizes that students' physical and mental health are intricately tied to their academic achievements, often influencing each other in profound ways. The theme also highlights the existential challenges students face, particularly in the realms of health and financial security. The academic journey in biomedical sciences, marked by high demands and expectations, is further complicated when students experience sudden health issues or financial struggles.

These issues can arise at any time, adding a temporal dimension to the students' challenges, where acute poverty or illness can derail progress and shift their focus from learning to survival. The intentionality of students in managing these challenges is another key aspect. Faced with health or financial crises, many students must actively redirect their energy toward managing these aspects of their lives, sometimes at the expense of their studies. This shifting focus, although often necessary, can lead to diminished academic success.

Lecturers have observed these impacts, particularly noting that some nursing students perform below their potential due to these ongoing disruptions. Basic needs, such as food, transportation, housing, and other daily necessities, often go unmet due to inadequate financial support.

Therefore, this theme emerged from two (2) categories namely i) student health and wellbeing ii) financial support and stability. These categories also emerged from three codes.

Student health and wellbeing

Some lecturers mentioned that nursing students sometimes fell ill due to various diseases, while others, particularly female students, experienced weakness as a result of pregnancy. Consequently, they struggled to focus on their biomedical science lessons and failed to submit graded assignments by the prescribed deadlines. As a result, their academic performance suffered. For instance, one lecturer mentioned: *''Some students miss submitting course work on time due to illness or side effects of pregnancies. As such, they ended up failing or getting very low marks''* (Male, 18 years of experience, Phys).

Financial support and stability

Many lecturers believed that some students who failed examinations in biomedical sciences were those who had financial constraints characterized by inadequate financial support from the government, parents, or caretakers. Some lecturers mentioned that certain parents had a misconception that students on government scholarships received all the financial support they needed, which led them to withdraw or reduce their own financial contributions. As a result, these students, whose parents or caretakers were less supportive, struggled financially, with some living in substandard housing and going for days without adequate three meals.

Similarly, students on government sponsorship took a long time to receive leave out allowance from the government and consequently struggled financially to make ends meet.

For instance, one lecturer mentioned: ‘’*I also had that some students sleep in lecture rooms because of lacking where to sleep after being expelled from their places of residence due to nonadherence to rental obligations. Of course, such students cannot concentrate on the academics and finally end up not doing well in examinations’’* (Female, 7 years of experience, Anat). *See figure 11 for the summary of the findings for study objective II.*

Quantitative and qualitative findings ***Academic ac***

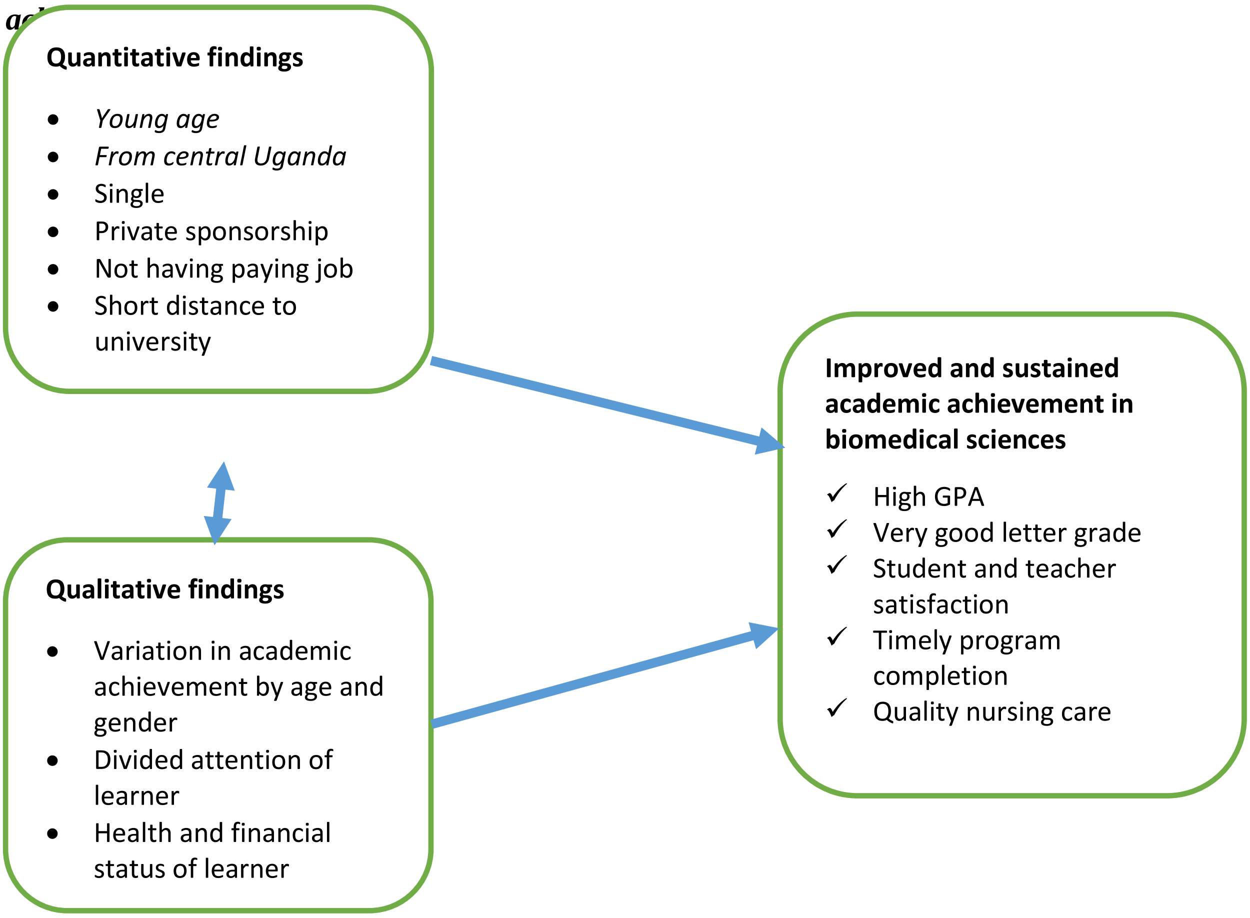


Figure 10: Summary of the quantitative and qualitative study findings on the sociodemographic factors influencing academic achievement in biomedical sciences among BNS students

4.4 Objective III: To Investigate individual educational factors that influence academic achievement in biomedical sciences among BNS students in Uganda.

The third objective of the study was to investigate individual educational factors that influence academic achievement in biomedical sciences among BNS students in Uganda. Both quantitative and qualitative studies were undertaken to deeply explore these factors.

4.4.1 Quantitative study findings

a) Bivariate analysis of the individual educational factors that influence academic achievement in biomedical sciences among BNS students

Bivariate analysis was performed using Welch's ANOVA in R software. Findings revealed several statistically significant differences in academic achievement. Students admitted from an advanced level of education performed better than those admitted with a diploma in nursing ($F = 6.616$, $p = 0.001$). Additionally, students who completed their advanced level secondary education at private, faith-based schools outperformed those who attended government-owned schools ($F = 3.207$, $p = 0.014$). Students who attended advanced level secondary school from urban based schools also performed better than those from rural based secondary schools ($F = 5.679$, $p = 0.003$). Interestingly, the study further revealed that students who selected nursing as their second, third, or fourth choice performed better than those who chose nursing as their first choice ($F = 3.581$, $p = 0.008$). Students who intended to remain in the nursing profession for long or forever showed better academic achievement than those who planned to leave the profession soon or any time ($F = 5.761$, $p = 0.003$). Additionally, students who actively participated in group discussions while studying biomedical sciences performed better in the same examinations than those who did not ($F = 2.534$, $p = 0.041$).

Other individual educational factors such as type of ordinary level secondary school attended, specialty preferred to specialize in later, type of resources used to study, attendance to lectures, hours spent on self-directed learning of biomedical sciences, participation in games and sports at the university, locus of control ownership of electronic learning devices such as laptop, and utilization of library to study biomedical sciences did not significantly influence academic achievement in biomedical sciences. See table XIX below.

Table XIX: Bivariate analysis of educational factors influencing academic achievement in biomedical sciences among students of Bachelor of Nursing Sciences

Factor	N (%)	Mean GPA	Sd	F-statistic	P-value
Entry scheme					
From secondary school	176 (84.6)	2.92	0.87	6.616	0.001**
With diploma	32 (15.4)	2.31	0.89		
Type of Ordinary Level secondary school attended					
Government, non-universal	41 (19.7)	2.68	0.97	0.827	0.481
Government, universal	47 (22.6)	2.84	0.93		
Private, faith-based	79 (38.0)	2.93	0.84		
Private, non-faith-based	41 (19.7)	2.74	0.92		
Type of Advanced Level secondary school attended					
Government, non-universal	46 (22.1)	2.90	0.90	3.207	0.014*
Government, universal	37 (17.8)	2.77	0.98		
Private, faith-based	66 (31.7)	2.97	0.87		
Private, non-faith-based	49 (23.6)	2.79	0.83		
Never went to A’ Level	10 (4.8)	1.92	0.84		
Location of Advanced Level secondary school attended					
Urban, city or municipality	131 (63.0)	2.91	0.88	5.679	0.003**

Peri urban	45 (21.6)	2.91	0.93		
Rural	32 (15.4)	2.34	0.84		
Choice of nursing profession					
First	36 (17.3)	2.40	1.01	3.581	0.008**
Second	76 (36.5)	2.99	0.82		
Third	45 (21.6)	2.99	0.91		
Fourth	29 (13.9)	2.84	0.82		
Fifth and Any other	22 (10.6)	2.59	0.89		
The extent of being proud of being a student of bachelor's in nursing					
Great extent	116 (55.8)	2.79	0.97	0.833	0.477
Neutral	30 (14.4)	2.99	0.85		
Less extent	52 (25.0)	2.87	0.80		
Not proud	10 (4.8)	2.51	0.74		
Intention to change from nursing profession					
Yes	52 (25.0)	2.58	0.83	5.761	0.003**
No	99 (47.6)	2.77	0.95		
Not sure	57 (27.4)	3.14	0.80		
Specialty preferred after qualifying with Bachelor of Nursing Science degree					
Critical care nursing	22 (10.6)	3.08	0.67	1.692	0.113
Medical-surgical nursing	30 (14.4)	2.52	1.02		
Mental health nursing	13 (6.2)	2.68	0.83		
Midwifery	15 (7.2)	3.12	0.83		
Nursing education	41 (19.7)	3.01	0.91		
Pediatric nursing	45 (21.6)	2.65	0.88		
Public health nursing	33 (15.9)	2.79	0.98		
Any other	9 (4.3)	3.09	0.67		
Resources used most to study biomedical sciences					
Internet, any other	13 (6.2)	3.06	1.06	1.112	0.345
Lecture notes	47 (22.6)	2.97	0.93		
Textbooks	96 (46.2)	2.72	0.88		
Videos	52 (25.0)	2.82	0.87		
Level of participation in group discussion					
Never	7 (3.4)	2.91	0.91	2.534	0.041*
Often	52 (25.0)	2.92	0.92		
Rarely	25 (12.0)	2.40	0.81		

Sometimes	65 (31.2)	2.73	0.92		
Very often	59 (28.4)	3.02	0.86		
Extent of missing class/lectures					
Great extent	3 (1.4)	2.78	0.79	2.481	0.086.
Never	90 (43.3)	2.98	0.85		
Some extent	115 (55.3)	2.70	0.93		
Hours spent on self-directed learning of biomedical sciences					
1 hour and less	8 (3.8)	2.86	0.36	0.097	0.962
2 – 3 hours	82 (39.4)	2.80	0.94		
4 – 5 hours	77 (37.0)	2.86	0.91		
6 hours and more	41 (19.7)	2.79	0.92		
Extent of participation in games and sports at the University					
Great extent	32 (15.4)	2.98	0.90	1.68	0.189
Less extent	115 (55.3)	2.87	0.88		
Never	61 (29.3)	2.66	0.94		
Person to blame for the good performance in biomedical sciences (locus of control)					
Myself	92 (44.2)	2.94	0.93	1.822	0.144
Teachers/Lecturers	35 (16.8)	2.58	0.81		
Classmates, friends	14 (6.7)	2.54	0.97		
The system	67 (32.2)	2.85	0.89		
Person responsible for the good performance in biomedical sciences (locus of control)					
Myself	129 (62.0)	2.88	0.91	1.17	0.322
Teachers/lecturers	25 (12.0)	2.85	0.93		
Classmates or friends	41 (19.7)	2.59	0.90		
Parents/guardian	13 (6.2)	2.91	0.71		
Most used electronic gadgets to study biomedical sciences					
Laptop/Desktop	54 (26.0)	2.67	0.94	2.233	0.11
Smart phone	149 (71.6)	2.90	0.88		
Tablet	5 (2.4)	2.27	0.74		
Extent of utilizing university library to study biomedical sciences					
Never	28 (13.5)	2.98	0.90	0.815	0.517
Often	34 (16.3)	2.72	1.15		
Rarely	66 (31.7)	2.91	0.89		
Sometimes	65 (31.2)	2.70	0.78		
Very often	15 (7.2)	2.94	0.85		

b) Multivariate analysis of the individual educational factors that influence academic achievement in biomedical sciences among BNS students

Further analysis of the data using a linear mixed-effects model in R software showed that nursing students who chose nursing as their second choice had GPAs higher by 0.31 points (β = 0.31, 95% CI: 0.04–0.58, p = 0.03), while those who chose nursing as their fourth choice had GPAs higher by 0.42 points compared to those who chose it as their first choice (β = 0.42, 95% CI: 0.08–0.76, p = 0.02). The study also found that students who rarely participated in group discussions had GPAs lower by 0.61 points compared to those who participated very often (β = -0.61, CI: -1.21 - -0.12, p < 0.001). Similarly, students who sometimes participated in group discussions had GPAs lower by 0.34 points compared to those who participated very often (β = -0.34, CI: -0.88 - -0.10, p = 0.01). See table XX below.

Table XX: Multivariate analysis of educational factors influencing academic achievement in biomedical sciences among students of Bachelor of Nursing Sciences

Covariates	Coefficient (Estimates)	Std. Error	Df	t-value	p-values
Intercept	2.93 [1.93 – 4.05]	0.57	35.13	5.15	0.00***
Entry Scheme1					
Diploma in health Science	1				
Mature entry	-0.00 [-0.44 – 0.43]	0.23	182.25	-0.01	0.99
UACE	0.20 [-0.17 – 0.57]	0.20	182.63	1.02	0.31
Type of school for A Level					
Government, non-U.S. E	1				
Government, U.S. E	-0.08 [-0.35 – 0.20]	0.15	182.14	-0.52	0.60
Private, faith-based school	-0.05 [-0.28 - 0.19]	0.13	182.12	-0.36	0.72
Private, non-faith-based \ School	-0.13 [-0.38 - 0.12]	0.13	182.21	-0.98	0.33
Never went to A Level	-0.23 [-0.77 – 0.31]	0.29	182.08	-0.78	0.43
Location of A Level school					
Peri urban	1				

Rural	-0.05 [-0.38 – 0.28]	0.18	182.21	-0.28	0.78
Urban, city or municipality	0.13 [-0.08 – 0.34]	0.11	182.07	1.20	0.23
Intention to change from nursing profession in future					
No	1				
Yes	-0.06 [-0.30 – 0.18]	0.13	182.31	-0.47	0.64
Not sure	0.10 [-0.12 – 0.33]	0.12	182.17	0.87	0.39
Participation in Group discussions					
Very often	1				
Often	-0.24 [-0.80 – 0.20]	0.13	182.44	-1.92	0.06
Rarely	-0.61 [-1.21 - -0.12]	0.17	182.38	-3.61	0.00 ***
Sometimes	-0.34 [-0.88 – 0.10]	0.12	182.43	-2.72	0.01 **
Never	0.06 [-0.56 – 0.44]	0.27	182.26	0.22	0.83
Extent of missing class/lectures					
Great extent	1				
Never	-0.18 [-0.96 – 0.60]	0.42	182.12	-0.43	0.67
Some extent	-0.36 [-1.14 – 0.42]	0.42	182.15	-0.86	0.39
Choice of nursing profession					
First	1				
Second	0.31 [0.04 – 0.58]	0.15	182.07	2.15	0.03 *
Third	0.18 [-0.13 – 0.49]	0.17	182.14	1.08	0.28
Fourth	0.42 [0.08 – 0.76]	0.18	182.24	2.27	0.02 *
Fifth and any other	0.22 [-0.18 – 0.62]	0.22	182.24	1.04	0.30
Extent of confidence to finish BNS on time					
Great extent	1				
Less extent	-0.31 [-0.71 – 0.08]	0.21	182.52	-1.48	0.14
Neutral, No hope	-0.34 [-0.70 – 0.02]	0.19	182.06	-1.77	0.08
Signif. codes: 0 ***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 ***AIC*** **= 485.169**					

When Pearson's correlation between previous performance at primary, ordinary, and advanced levels of education and academic achievement in biomedical sciences was examined, correlation coefficients (r) of -0.1673, -0.3205, and 0.1163, respectively, were found. This implies that there was a very weak or no relationship between previous performance in primary and secondary education and academic achievement in biomedical sciences at the university. See figure 12(a), 12(b), and 12(c).

Figure 11(a)-12(b): Relationship between academic performance at previous levels and university

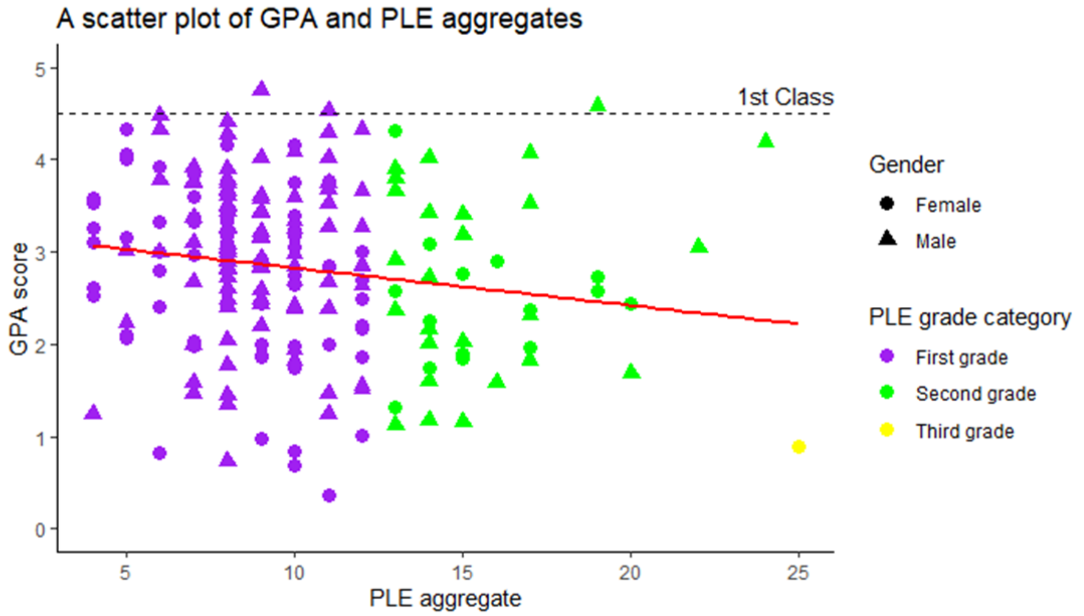


Figure 12(a): Scatter plot showing the relationship between examination scores at primary level of education and mean GPA in biomedical sciences among BNS students at the university

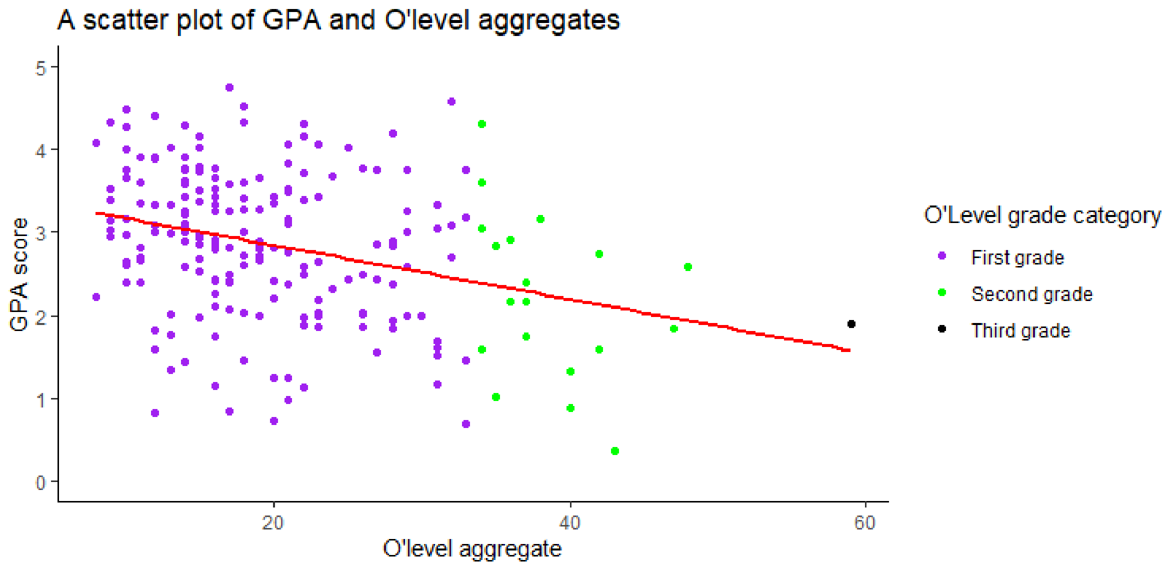


Figure 12(b): ***Scatter plot showing the relationship between performance at ordinary level of secondary education and mean GPA in biomedical sciences among BNS students at the university***

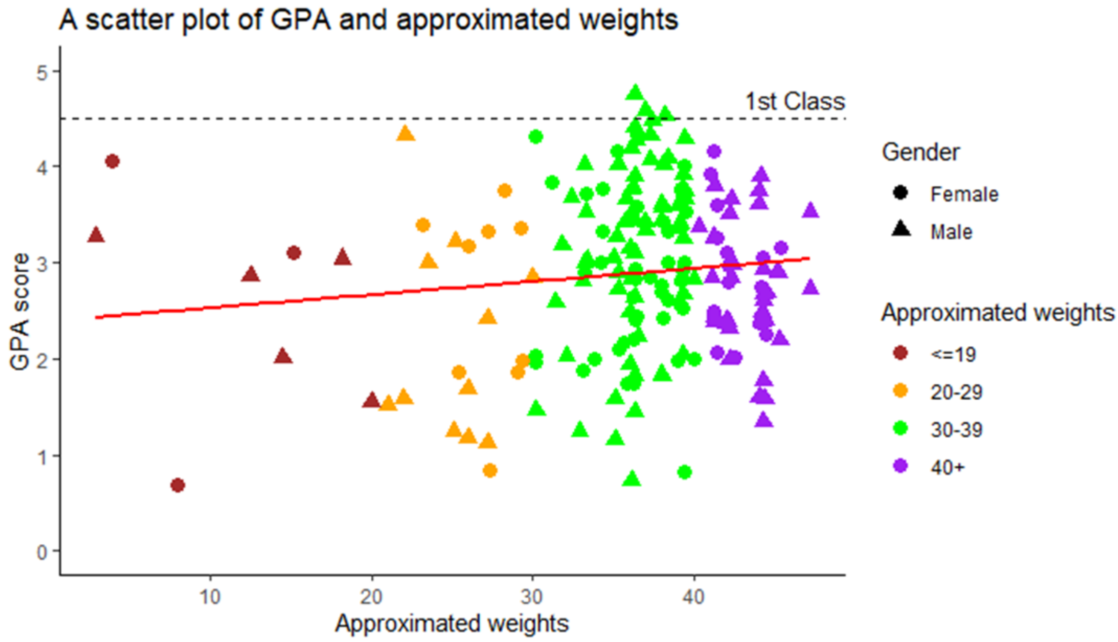


Figure 12(c): ***Scatter plot showing the relationship between performance at advanced level of secondary education and mean GPA in biomedical sciences among BNS students at the university***

4.4.2 Findings from the qualitative study to compliment quantitative findings to answer study objective III

The third objective of the qualitative aspect of the study was to examine the perspectives of biomedical sciences lecturers on BNS student-related factors such as prior knowledge and skills, learning habits and styles, motivation, and cognitive abilities that influence academic achievement in biomedical sciences in Uganda.

Therefore, three (3) themes emerged from seven (7) categories and twelve (12) codes. The themes are i) motivation of students to learn ii) foundational knowledge of biological sciences and capacity to recall it effectively and iii) use of diverse learning methods and styles. See table XXI.

Table XXI: Summary of the views of lecturers regarding student individual educational factors influencing academic achievement in biomedical sciences among BNS students

Theme	Merged category	Emerged code
1.Motivation of students to learn	i) Students low self esteem	i) Perceived self-incompetence ii) Inferiority complex
	ii) Family or peer influence on nursing career choice	ii) Nursing is not a priority course iii) Family/ peer influence on career choice
	iii) Relevance of knowledge of biomedical sciences	i) Learning what may not be applied in clinical practice ii) No realization of immediate application of content learnt
	iv) Unclear future prospectus for nurse graduates	i) Career goal ambiguity ii) Misguided career and educational goals
2.Foundational knowledge in biological sciences and capacity to recall it	i) Prior knowledge in biological sciences	i) Not studying sciences at an advanced level of education ii) Poor scores in science subjects at ordinary level of education
	ii) Capacity to recall prior knowledge in biosciences	i)Staying longer out of school ii) No prior learning at advanced level of education
3. Use of diverse learning methods and styles	Adoption of diverse learning styles, including contemporary approaches	Use of videos enhanced academic achievement

Theme 1: Motivation of students to learn

Motivation of students to learn emerged as central theme that explain why some BNS students performed better while others performed poorly or struggled to achieve predetermined educational objectives and learning outcomes in biomedical sciences.

This theme illustrates the complex, multifaceted factors that influence nursing students' motivation to study and succeed in biomedical sciences. It captures a range of perspectives from lecturers on the various motivations that drive nursing students to study and dedicate their energy to understanding and passing biomedical science courses. Many lecturers observed that nursing students' motivation to engage with biomedical sciences is shaped by a blend of career aspirations, personal interests, self-worth, and academic ambitions. The theme highlights the existential significance of motivation, which helps students navigate the demands of their academic journeys. Lecturers identified both intrinsic and extrinsic motivators: some students have an intrinsic curiosity, clear goals, and personal interest in biomedical sciences, while others are driven by external factors such as job availability, high salary potential, the prestige of being a healthcare worker, or the prospects of career advancement. These external motivators, however, may not be as sustainable as a genuine interest in nursing, and may wane when students encounter academic or practical challenges. Accordingly, four (4) categories namely i) students low self-esteem ii) family or peer influence on nursing career choice iii) unclear future prospectus for nurse graduates and vi) relevance of knowledge of biomedical sciences in nursing practice contributed to this overarching theme.

Student's low self esteem

Many lecturers mentioned that many BNS students struggled with self-doubt, a lack of confidence, and a negative self-image regarding their ability to excel in biomedical sciences. They explained that a significant proportion of BNS students compared themselves to medical students, who are often admitted with higher entry qualifications, which further compounded their feelings of inadequacy in performing well in biomedical sciences. This comparison, along with the rigorous course content, led to a diminished sense of self-efficacy, making it difficult for them to believe they were capable of excelling in biomedical sciences. For example, one lecturer said: '*Nursing students think that medical students are better than them and this makes them not to study hard, thinking that they are not capable of competing favorably and finally they end up performing poorly'* (Male, 7 years of experience, Phys).

Another lecturer mentioned this: *'At the beginning of the course, they (students) look very excited but later they get demoralized possibly after coming to terms with the demands of the course. This slows down their motivation to learn. But extensor students are usually not affected by this feeling of inferiority. What affects them is what I told you'* (Male, 9 years of experience, Anat).

Family or peer influence on nursing career choice

Many lecturers strongly believed that some BNS students had low motivation to study nursing and pursue it as a career because it was not their preferred academic program.

As a result, these students struggled to concentrate on biomedical science courses and performed poorly in examinations. Some lecturers added that certain BNS students were encouraged or even forced by their parents, caretakers, or funders to study nursing against their will, which further demotivated them. One lecturer stated*: 'We have some nursing students who are not interested in the nursing course, because they did not get the course they deserved, some are demotivated, they have been forced by their parents or their funders to do nursing. This demotivates them and they end up performing poorly'* (Male, 5 years of experience, Anat).

Unclear future prospectus for nurse graduates

It was noted by several lecturers that many BNS students did not have a clear understanding of their future career growth and opportunities. The lecturers expressed a strong belief that many nursing students who struggled with biomedical sciences did not recognize how their current academic performance would shape their future, leading them to feel that studying hard was not worthwhile. Additionally, some lecturers also appeared unsure about how degree-prepared nursing students would be addressed once they qualified. For example, one lecturer said: *'Nursing students seem not to know much about their future career. Just like me, they even do not know how they will be addressed when they finish the course. I think this demotivates them a lot and they end up not performing well in exams'* (Male, 7 years of experience, Phys).

Relevance of knowledge of biomedical sciences in nursing

Many lecturers strongly believed that some BNS students struggled academically in biomedical sciences due to a lack of motivation, which often stemmed from their inability to see the relevance of certain biomedical science content to their clinical work or from a perceived gap between theory and practice. Many lecturers emphasized that knowledge of biomedical sciences was very important to the nurses. However, they quickly added that much of what they learn in biomedical sciences is not what they actually do in clinical care. As a result, students found it challenging to connect the detailed biomedical sciences curriculum to practical applications in nursing care. Limited understanding of how the knowledge would be applied in their future roles caused frustration, which in turn led to low motivation and poor academic performance.

This issue was particularly pronounced among diploma-holding students upgrading to degree programs. Some lecturers explained that many of these students showed little interest in enhancing their knowledge and skills; instead, they were primarily focused on completing the degree to secure promotions on job. For example, some lecturers mentioned:

'*Well, whether medical physiology they learn is relevant to the nurses, I can say that physiology deals with how a normal body works. It's very important for them. The information they learn is really very important though it's not what they do. Imagine nurses are the ones who see patients first'* (Male, 17 years of experience, Phys).

'Attendance in class is usually good, but they dislike what they learn in biomedical sciences. What they learn is really very important though it's not what they do, and this demotivates them to concentrate (Male, 9 years of experience, Phys).

'There is also poor perception among some nursing students on extension, some believe that they have only come to get a paper to be promoted, and such students end up performing poorly' (Female, 7 years of experience, Anat).

Theme: Foundational knowledge in biological sciences and capacity to recall it effectively

Foundational knowledge in biological sciences and the ability to recall it effectively was another overarching theme explaining why some nursing students failed while others achieved marginal to moderate pass scores in biomedical sciences. This theme highlights the crucial role of bioscience foundations in determining academic success for BNS students.

It underscores the importance of a strong background in subjects like biology as a critical basis for understanding and excelling in advanced biomedical content at the degree level.

Conversely, students who lack this foundational knowledge often struggle academically, a situation that lecturers noted significantly hampers their progress in the rigorous biomedical sciences curriculum. The theme also captures the existential implications of this foundational knowledge as students navigate the demands of their academic journey. Lecturers see prior knowledge in biosciences as a temporal, evolving foundation. Students' previous exposure to biosciences serves as a reference point that interacts dynamically with current studies, while also supporting future practical applications. This temporal perspective suggests that students' knowledge builds gradually over time, informed by past experiences, reinforced through present studies, and projected toward future applications in clinical practice. In addition, the ability of students to recall this prior knowledge fast and effectively also plays a crucial role in shaping the current learning. Accordingly, the theme emerged from two (2) categories namely i) prior knowledge in biomedical sciences, and ii) capacity to recall prior knowledge in biomedical sciences.

Prior knowledge in biomedical sciences

Most of the lecturers believed that prior learning among nursing students played a big role in shaping academic success in biomedical sciences among nursing students. Lecturers widely agreed on the disadvantage faced by some students with inadequate backgrounds in biosciences, particularly those who entered the nursing program with a diploma rather than directly from an advanced level of education with a strong bioscience foundation. They noted that diploma entrants, often possessing limited exposure to essential bioscience concepts, appeared to struggle more with the degree-level biomedical curriculum. This gap, they felt, placed such students at higher risk of failing or underperforming compared to peers with stronger backgrounds in biosciences. For instance, a lecturer stated: *'Directs usually have no issues. You find maybe one or two challenges. However, extensors with diploma in nursing, midwifery, comprehensive nursing find biochemistry course hard due to limited prior knowledge in biological sciences''* (Male, 15 years of experience, Bioch).

Capacity to recall prior knowledge in biomedical sciences

Some lecturers shared views that BNS students who were admitted on diploma scheme but had delayed returning to school to pursue a degree often struggled to recall fundamental knowledge in biological and biomedical sciences they learnt in secondary school and nursing school, respectively. As a result, they tended to perform poorly in biomedical sciences at the university level. Consequently, some lecturers recommended that diploma-holding nurses who wished to upgrade to a degree would do so promptly to retain their foundational knowledge in biomedical sciences.

Relatedly, one lecturer stated: *' It is worse if diploma-holders return to study a degree long after their diploma courses. They usually find difficulties in recalling the previous biomedical sciences at diploma and end up performing poorly'* (Female, 7 years of experience, Anat).

Another lecturer stated: *'You know nurses do things which do not have science and for that reason, the longer they take before coming back to school, the more they are likely to perform poorly in biomedical sciences. This is because the longer they take, the more they tend to forget. Staying longer than 3 years out of school, when they come back to* *study, it's like they are coming in a fresh because they will have forgotten everything'* (Male, 9 years of experience, Phys).

Theme 3. Use of diverse learning methods and styles

This theme presents the opinions of lecturers about use of various learning methods and styles and how they contribute to academic achievement in biomedical sciences among BNS students in Uganda. The theme highlights the diverse approaches that nursing students employ to engage with biomedical sciences content. This theme underscores the idea that students who adopt a mix of learning methods, ranging from traditional approaches like reading textbooks and lecture notes to contemporary strategies like small group discussions and watching videos tend to achieve better academic outcomes. This theme reflects the adaptability and strategic learning behaviours of students who actively seek out different ways to understand complex biomedical concepts. The integration of multiple learning styles seems to enable deeper comprehension and retention of knowledge.

Accordingly, the theme emerged from one category namely, adoption of diverse learning styles, including contemporary approaches. This category evolved from one code.

Adoption of diverse learning styles, including contemporary approaches

Some lecturers who were interviewed mentioned that they had observed that BNS students who applied various learning methods and approaches, such as actively participating in small group discussions and watching YouTube videos, tended to improve their academic achievement in biomedical sciences. They further added that the content in biomedical sciences was extensive and contained complex concepts, requiring students to engage in self-directed learning approaches to deeply analyze and understand the material, rather than attempting to memorize everything.

For instance, one lecturer mentioned: '*Lately, I have also learnt that students love to study biochemistry using YouTube videos. I therefore strongly believe that such students tend to perform better in biochemistry examinations because such videos complement our other teaching methods'* (Male, 8 years of experience, Bioch).

Quantitative and qualitative findings Academic achievement

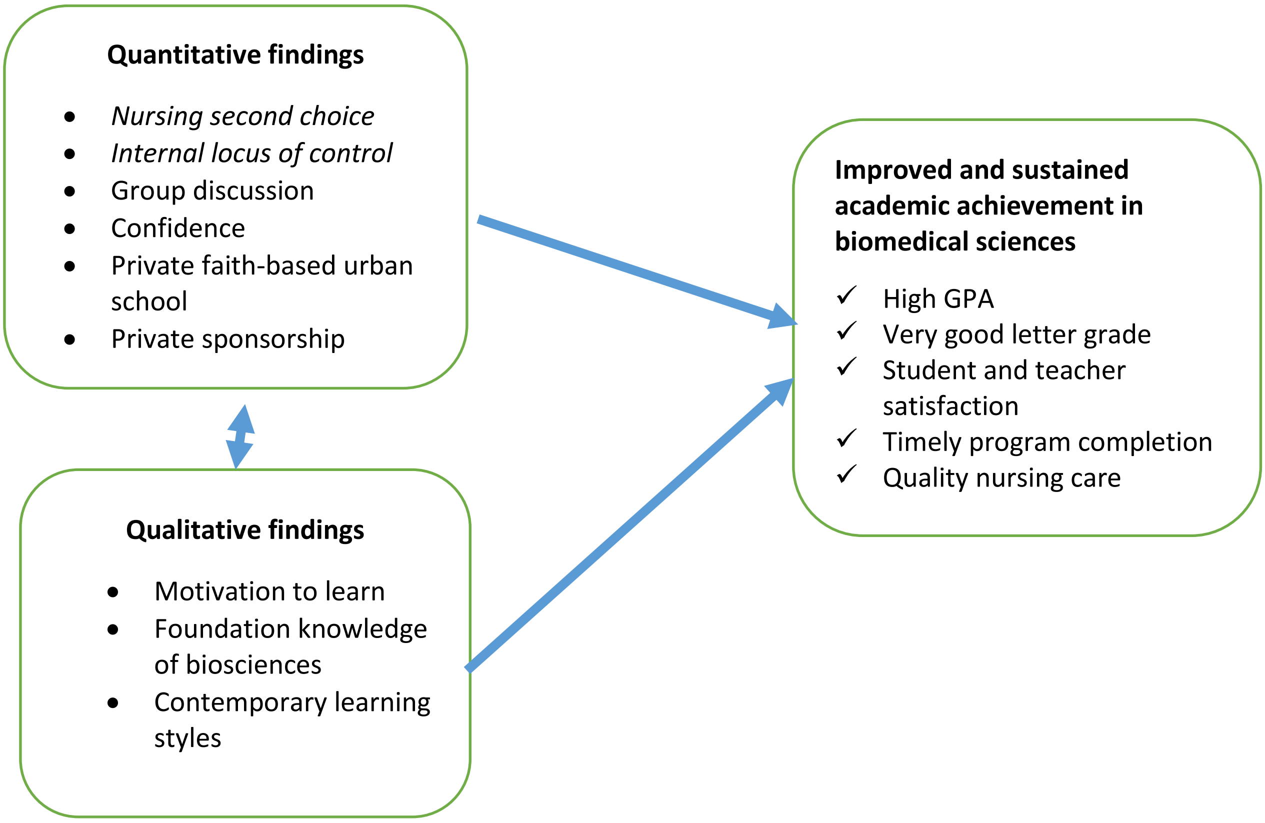


Figure 12: Figure showing a summary of quantitative and qualitative findings for the individual educational factors influencing academic achievement in biomedical sciences among BNS students

4.5 Objective IV: To explore institutional factors that influence academic achievement in biomedical sciences among BNS students.

The last objective of this study was to explore institutional factors that influence academic achievement in biomedical sciences among BNS students in Uganda. Quantitative and qualitative study findings were analyzed to gain in-depth understanding of these factors.

4.5.1 Findings from quantitative study

Academic achievement was analyzed with consideration of data variability and clustering within institutions. To address potential biases from institutional differences, analyses were conducted separately for each biomedical sciences course namely anatomy, physiology, and biochemistry. Descriptive statistics were used to summarize the sample and academic performance. For bivariate analyses, Welch's ANOVA was applied to accommodate unequal variances among groups. For multivariate analyses, a Linear Mixed-Effects Model was employed, treating university as a random effect to account for institutional clustering. These analytical approaches were selected to ensure robust inference despite variability in the data. All analyses were conducted in R (version 4.4.1), with statistical significance set at $p < 0.05$.

Institutional factors influencing academic achievement in Anatomy

a) **Bivariate analysis findings**

Bivariate analysis findings revealed that students who were aware that anatomy lecturers occasionally missed lectures performed better than those who were unaware or unsure ($F = 5.23$, $p = 0.001$). Students who had a very poor relationship with their anatomy lecturers performed better than those who had a good friendship with them ($F = 6.08$, $p \leq 0.001$). Additionally, students who reported not having access to online learning resources, such as e-notes, performed better than those who had them ($F = 5.463$, $p = 0.004$).

Those who participated in practical sessions, such as cadaver dissection, performed worse than those who did not ($F = 17.03$, $p \leq 0.001$). The study further revealed that students taught anatomy using a problem-based learning approach performed better than those taught using other methods ($F = 3.31$, $p = 0.012$). Similarly, students who received face-to-face instruction performed better than those taught using other approaches, such as blended learning. However, students who preferred learning anatomy through a blended approach performed better than those who favoured other teaching methods ($F = 3.81$, $p = 0.023$).

Furthermore, students who were assessed using both practical and theory examinations at the end of the semester performed worse than those assessed only through theory exams ($F = 15.43$, $p \leq 0.001$).

Other factors such as well stocked and accessible university library, exhibition of pedagogical skills by the lecturers, involvement of lecturers in student discussion groups, allocation of self-directed learning time on the master teaching timetable, taking students to the hospital to integrate theory with clinical cases, and providing feedback on the progressive tests did not significantly influence academic achievement in anatomy. See table XXII.

Table XXII: Bivariate analysis of institutional factors influencing academic achievement in anatomy among students of Bachelor of Nursing Sciences

Variable Category	N (%)	Mean GPA	Sd	F-value	Sig
Rate of Biomedical teachers missing teaching anatomy					
At times	90 (43.3)	3.02	0.93	5.23	0.001**
No	56 (26.9)	2.50	0.79		
Not sure	7 (3.4)	2.26	1.41		
Yes	55 (26.4)	2.91	0.78		
Accessibility to the library					
Great extent	172 (82.7)	2.85	0.92	078	0.507
Neutral	8 (3.8)	2.41	1.04		
Not at all	3 (1.4)	3.08	0.35		
Small extent	25 (12.0)	2.73	0.81		
Availability of very good book in the library					
Great extent	139 (66.8)	2.89	0.87	2.07	0.105
Neutral	23 (11.1)	2.45	0.92		
Not at all	5 (2.4)	3.23	0.63		
Small extent	41 (19.7)	2.75	0.98		
Lecturer's knowledge in anatomy					
Great extent	168 (80.0)	2.86	0.88	1.12	0.327
Neutral	16 (7.7)	2.53	1.08		
Some extent	24 (11.5)	2.73	0.96		
Whether lecturers possess good teaching skills					
To some extent	100 (48.1)	2.75	0.91	0.93	0.428
Great extent	90 (43.3)	2.94	0.90		
Not sure	12 (5.8)	2.63	1.01		
Not at all knowledgeable	6 (2.9)	2.73	0.48		
Teacher student relation in Anatomy					
Fair	67 (32.2)	2.54	0.94	6.08	0.000***
Good	81 (38.9)	3.00	0.92		
Poor	30 (14.4)	2.50	0.61		
Very bad	3 (1.4)	3.59	0.66		
Very good	27 (13.0)	3.27	0.73		
University has online resources such as e-books, magazines					
Great extent	81 (38.9)	2.81	0.89	5.463	0.004**
Not at all available	28 (13.5)	3.32	0.80		
To some extent	99 (47.6)	2.70	0.90		
Students doing practical as a way of learning anatomy **course**					
Never	22 (10.6)	3.67	0.60	17.03	0.000***
Always	101 (48.6)	2.56	0.77		
Most times	45 (21.6)	2.48	0.89		
Rarely	19 (9.1)	3.57	0.92		
Sometimes	21 (10.1)	3.25	0.67		
Encouragement from lecturers to students to learn in student groups					

Great extent	123 (59.1)	2.74	0.92	2.00	0.116
Neutral	23 (11.1)	3.01	0.96		
Table XXII continuation					
Not at all	6 (2.9)	3.55	0.82		
Small extent	56 (26.9)	2.85	0.83		
Lecturers involved in students discussion groups to guide them					
Great extent	37 (17.8)	2.93	0.86	0.75	0.523
Neutral	32 (15.4)	2.93	0.98		
Not at all	85 (40.9)	2.83	0.89		
Small extent	54 (26.0)	2.68	0.91		
Teaching method used most by teachers in class					
Group presentation	12 (5.8)	2.04	0.89	3.31	0.012*
Lecture	148 (71.2)	2.91	0.93		
Problem based	10 (4.8)	3.07	0.71		
Tutorials	31 (14.9)	2.62	0.65		
Demonstrations	7 (3.4)	2.85	0.92		
Teaching methods that students liked					
Demonstrations	37 (17.8)	2.63	0.88	2.15	0.076
Group presentation	18 (8.7)	2.92	0.81		
Lecture	76 (36.5)	2.74	0.99		
Problem based	16 (7.7)	3.36	0.80		
Tutorials	61 (29.3)	2.87	0.81		
Teaching methods that students dislike					
Demonstration	12 (5.8)	2.79	0.86	2.26	0.063
Group presentation	57 (27.4)	2.95	0.98		
Lecture	78 (37.5)	2.96	0.85		
Problem based	21 (10.1)	2.56	0.82		
Tutorials	40 (19.2)	2.53	0.87		
Teaching/Learning approach by the teachers					
Face2face/physical	105 (50.5)	3.06	0.88	9.63	0.000***
Blended/mixture	51 (24.5)	2.73	0.85		
Online	52 (25.0)	2.43	0.86		
Teaching/Learning approach is most liked by students					
Blended/mixture	34 (16.3)	3.03	0.67	3.81	0.023*
Face2face/physical	143 (68.8)	2.86	0.94		
Online	31 (14.9)	2.45	0.89		
Do teachers allocate some hours from the timetable for Self-Directed Learning (SDL)					
Sometimes	70 (33.7)	2.83	0.91	0.5	0.736
Always	41 (19.7)	2.72	0.89		
Most times	37 (17.8)	2.82	0.87		
Never	14 (6.7)	3.11	0.75		
Rarely	46 (22.1)	2.82	0.98		
Taking students to the hospitals to comprehend learning from patients					
No	171 (82.2)	2.77	0.95	2.84	0.093
Yes	37 (17.8)	3.05	0.64		
Lecturers giving back answer sheets to the students for the progressive tests					

No	147 (70.7)	2.88	0.86	1.76	0.156
Not sure	2 (1.0)	3.65	0.34		
Rarely	38 (18.3)	2.57	0.96		
Yes	21 (10.1)	2.79	1.03		
Lecturers use the returned progressive test to make corrections					
Anatomy					
Sometimes	41 (19.7)	2.71	0.82	1.81	0.128
Always	17 (8.2)	3.24	0.89		
Most times	15 (7.2)	3.09	0.87		
Never	95 (45.7)	2.72	0.90		
Rarely	40 (19.2)	2.90	0.97		
University giving free week for preparation for the end of semester exams					
Great extent	57 (27.4)	2.74	0.98	1.94	0.124
Neutral	15 (7.2)	3.15	0.71		
Not at all	77 (37.0)	2.70	0.86		
Small extent	59 (28.4)	2.98	0.90		
Examinations come from the content that has been taught/studied /from the notes					
Great extent	133 (63.9)	2.86	0.90	0.954	0.415
Neutral	19 (9.1)	2.99	0.98		
Not at all	9 (4.3)	2.95	0.78		
Small extent	47 (22.6)	2.64	0.89		
University giving end of semester practical examination					
At times	18 (8.7)	3.25	0.80	15.43	0.000***
No	23 (11.1)	3.62	0.63		
Yes	167 (80.3)	2.67	0.88		
	*Signif. codes: 0 ***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*				

b) Multivariate analysis findings

Multivariate analysis revealed that students who were not sure if their lecturers missed teaching some scheduled anatomy lessons scored GPA less by 0.59 points compared to those who knew that lecturers missed some scheduled anatomy lessons (β = -0.59, 95% CI: -1.11 - -0.09, p = 0.03). Students who were taught anatomy using practical sessions such as cadaver dissection in addition to theory lessons scored GPA less by 0.36 points compared to those who were not (β = -0.36, 95% CI: -0.04 - -0.12, p = 0.006). The study also found that students who were taught anatomy using Problem Based Learning approach scored higher GPA by 0.48 points compared to those who were taught using lecture method (β = 0.48, 95% CI: -0.05 – 1.91, p = 0.04). Similarly, students who were taught using tutorials scored higher GPA by 0.33 points compared to those who were taught using lecture method (β = 0.33, 95% CI: -0.04 – 0.61, p = 0.03).

The study also found that students who were taught anatomy using an online approach scored GPA less by 0.32 points compared to those who were taught using blended approach (β = -0.32, 95% CI: -0.61 - -0.02, p = 0.04). See table XXIII below.

Table XXIII: Multivariate analysis of institutional factors influencing academic achievement in anatomy among students of Bachelor of Nursing Sciences

Variable category	**Coefficients (CI)**	**std.error**	**Df**	**t-value**	**P-value**
Intercept	3.11 [2.38-3.84]	0.38	10.28	8.12	0.000***
Lecturer missing teaching Anatomy					
Yes	1				
No	-0.11 [-0.33-0.11]	0.12	183.45	0.94	0.35
Not sure	-0.59 [-1.11- -0.09]	0.27	182.46	-2.18	0.03*
Lecturer-student relation in Anatomy					
Fair	1				
Good	-0.03 [-0.25-0.19]	0.12	183.05	-0.27	0.79
Very Bad	0.68 [-0.08-1.45]	0.41	182.36	1.66	0.10
Very Good	0.30 [-0.003-0.61]	0.17	183.13	1.82	0.07
University has online resources such as e-books, magazines					
Great extent	1				
Not at all available	0.09 [-0.21-0.39]	0.16	182.04	0.56	0.58
To some extent	-0.10 [-0.29-0.09]	0.10	182.14	-0.95	0.34
Students doing practical as a way of learning anatomy					
Always	1				
Never	-0.21 [-0.70-0.25]	0.25	184.51	0.84	0.40
Most times	-0.36 [-0.04- -0.12]	0.13	183.56	-2.80	0.006**
Sometimes	0.02 [-0.65-0.25]	0.19	184.99	0.09	0.93
Teaching method used most by lecturers in class					
Lecture	1				
Group presentation	-0.04 [-0.56-0.28]	0.23	183.14	-0.60	0.55
Demonstrations	-0.07 [-0.44-0.58]	0.27	183.14	-0.24	0.81
Problem based	0.48 [-0.05-1.91]	0.23	183.28	2.08	0.04 *
Tutorials	0.33 [-0.04-0.61]	0.15	184.45	2.19	0.03 *
Teaching/Learning approach used most by the lecturers					
Blended/mixture	1				
Face2face/physical	0.07 [-0.17-0.31]	0.13	183.81	0.54	0.59
Online	-0.32 [-0.61- -0.02]	0.16	183.99	-2.02	0.04 *
Teaching/Learning approach most liked by the students					
Blended/mixture	1				
Face2face/physical	-0.26 [-0.51- -0.002]	0.14	182.66	-1.87	0.06
Online	-0.28 [-0.62-0.04]	0.18	182.55	-1.60	0.11

University giving end of semester practical examination					
At times	1				
No	-0.11 [-0.55-0.33]	0.24	182.43	-0.48	0.63
Yes	-0.05 [-0.38-0.28]	0.18	182.84	-0.26	0.80
*Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*				*AIC*=490.9925	

Institutional factors influencing academic achievement in physiology

a) Bivariate analysis findings

Bivariate analysis revealed that students who were taught physiology by lecturers perceived to have good teaching skills performed better than those whose lecturers were not perceived as such (F = 3.33, p = 0.020). Students who perceived their relationship with their physiology lecturer as very bad performed better than those who did not hold this perception (F = 8.05, p ≤ 0.001).

Surprisingly, students whose institutions did not have online learning resources tended to achieve better academic performance in physiology than those who had access to them (F = 5.32, p = 0.005). Similarly, students who were not exposed to practical sessions to complement theoretical lessons registered a higher mean GPA than those whose universities integrated practical sessions with theoretical lessons (F = 2.12, p = 0.049).

Students who were taught physiology using a face-to-face approach performed better than those who were not taught using this method (F = 13.39, p ≤ 0.001). The analysis also revealed that students who preferred a blended teaching approach for physiology performed better than those who favoured other teaching and learning methods (F = 3.66, p = 0.027).

Institutions that took their students to hospitals to integrate theoretical lessons with clinical cases had students who performed better in physiology examinations than those that did not provide such clinical exposure ($F = 6.84$, $p = 0.009$).

Lastly, students who were unsure whether their lecturers returned answer sheets for progressive tests tended to perform better than those who were certain that the marked scripts were returned ($F = 6.73$, $p \leq 0.001$).

Factors such as subjecting students to end-of-semester practical examinations, providing a free week for revision, allocating time for self-directed learning in the master teaching timetable, the teaching methods used by physiology lecturers, and lecturers' level of expertise in physiology did not significantly influence academic achievement in physiology among BNS students at the bivariate analysis level. See table XXIV below.

Table XXIV: Bivariate analysis of institutional factors influencing academic achievement in physiology among students of Bachelor of Nursing Sciences

Variable Category	n (%)	Mean GPA	Sd	F-value	Sig
Rate of lecturers missing teaching some scheduled lessons					
At times	81 (38.9)	2.83	0.97	1.91	0.129
No	85 (40.9)	2.94	0.88		
Not sure	8 (3.8)	2.25	1.10		
Yes	34 (16.3)	2.66	0.66		
Lecturer's knowledge in Physiology					
Great extent	177 (85.1)	2.87	0.91	2.22	0.111
Neutral	14 (6.7)	2.36	0.91		
Some extent	17 (8.2)	2.72	0.76		
Whether lecturers possess good teaching skills					
Great extent	139 (66.8)	2.96	0.88	3.33	0.020*
Not knowledgeable	3 (1.4)	2.48	0.22		
Not sure	6 (2.9)	2.75	1.20		
To some extent	60 (28.8)	2.54	0.88		
Lecturer-student relationship					
Fair	45 (21.6)	2.38	0.90	8.05	0.000***
Good	94 (45.2)	2.83	0.89		
Poor	19 (9.1)	2.57	0.66		
Very bad	1 (0.5)	4.33	0		
Very good	49 (23.6)	3.29	0.77		
University has online resources such as e-books, magazines					
Great extent	91 (43.8)	2.86	0.87	5.32	0.005**
Not at all available	26 (12.5)	3.29	0.93		
To some extent	91 (43.8)	2.65	0.89		
Students do practical as a way of learning physiology					
Never	4 (1.9)	3.46	0.81	2.12	0.049*
Always	94 (45.2)	2.63	0.87		
Most times	61 (29.3)	2.93	0.92		
Rarely	5 (2.4)	3.09	0.87		
Sometimes	44 (21.2)	3.01	0.91		
Encouragement from teachers to students to learn in student groups					
Great extent	143 (68.8)	2.83	0.91	0.83	0.481
Neutral	17 (8.2)	2.76	0.98		
Not at all	4 (1.9)	3.49	0.61		
Small extent	44 (21.2)	2.76	0.86		
Lecturer involvement in students discussion groups to guide them					
Great extent	42 (20.2)	2.84	0.92	0.04	0.988
Neutral	33 (15.9)	2.79	0.94		
Not at all	77 (37.0)	2.81	0.90		
Small extent	56 (26.9)	2.85	0.89		
Teaching method used most by lecturers					
Group presentation	3 (1.4)	3.51	0.32	0.57	0.684
Lecture	141 (67.8)	2.83	0.97		
Table continuation					
Problem based	14 (6.7)	2.89	0.97		
Tutorials	48 (23.1)	2.75	0.74		

Demonstrations	2 (1.0)	2.56	1.37		
Teaching methods that students liked most					
Demonstrations	29 (13.9)	2.72	1.06	0.85	0.498
Group presentation	8 (3.8)	2.69	0.84		
Lecture	87 (41.8)	2.80	0.97		
Problem based	16 (7.7)	3.20	0.71		
Tutorials	68 (32.7)	2.82	0.78		
Teaching methods that students dislike most					
Demonstration	20 (9.6)	2.64	0.90	1.87	0.117
Group presentation	64 (30.8)	2.98	0.99		
Lecture	54 (26.0)	2.95	0.87		
Problem based	30 (14.4)	2.73	0.79		
Tutorials	40 (19.2)	2.57	0.85		
Teaching/Learning approach by the lecturers					
Blended/mixture	55 (26.4)	2.50	0.86	13.39	0.000***
Face2face/physical	99 (47.6)	3.14	0.85		
Online	54 (26.0)	2.56	0.85		
Teaching/Learning approach most liked by students					
Blended/mixture	37 (17.8)	2.95	0.80	3.66	0.027*
Face2face/physical	143 (68.8)	2.87	0.92		
Online	28 (13.5)	2.41	0.88		
Lecturers allocate some hours from the timetable for Self-Directed Learning (SDL)					
Sometimes	81 (38.9)	2.77	0.85	0.47	0.758
Always	37 (17.8)	2.82	0.84		
Most times	39 (18.8)	2.76	0.94		
Never	12 (5.8)	3.08	0.94		
Rarely	39 (18.8)	2.92	1.02		
Taking students to the hospitals to comprehend learning from patients					
No	158 (76.0)	2.73	0.93	6.84	0.009**
Yes	50 (24.0)	3.11	0.75		
Lecturer giving back answer sheets to the students for the progressive tests					
No	137 (83.2)	2.74	0.89	3.31	0.021*
Not sure	4 (1.9)	3.62	0.59		
Rarely	18 (8.7)	3.24	0.66		
Yes	13 (6.2)	3.10	1.15		
Lecturer use the returned progressive test to make corrections					
Sometimes	27 (13.0)	3.17	0.78	6.73	0.000***
Always	14 (6.7)	3.32	0.84		
Most times	18 (8.7)	3.48	0.49		
Never	107 (51.4)	2.63	0.90		
Rarely	42 (20.2)	2.66	0.91		
University giving free week for preparation for the end of semester exams					
Great extent	60 (28.8)	2.78	0.97	0.95	0.417
Neutral	15 (7.2)	3.20	0.71		
Not at all	75 (36.1)	2.79	0.89		
Small extent	58 (27.9)	2.81	0.89		
Table continuation					
Examinations come from the content that has been taught/studied /from the notes					
Great extent	153 (73.6)	2.85	0.92	0.35	0.791
Neutral	13 (6.2)	2.66	1.06		
Not at all	3 (1.4)	2.43	0.44		
Small extent	39 (18.8)	2.82	0.83		

University giving end of semester practical examination					
At times	30 (14.4)	2.92	0.82	0.32	0.725
No	50 (24.0)	2.86	0.95		
Yes	128 (61.5)	2.79	0.91		
	*Signif. codes: 0 ***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*				

b) Multivariate analysis findings

Multivariate analysis of institutional factors influencing academic achievement in physiology among BNS students revealed that those who perceived their physiology lecturers as having good teaching skills to some extent scored, on average, 0.25 GPA points lower than those who perceived their lecturers as having good teaching skills to a greater extent ($\beta = -0.25$, 95% CI: -0.46 to -0.03, $p = 0.03$). Students who reported having very good relationship with their lecturers of physiology scored 0.37 GPA points higher than those who described their relationship with their lecturers as simply a fair one. Similarly, students who preferred to be taught physiology using an online approach scored, on average, 0.41 GPA points lower than those who preferred a blended teaching approach ($\beta = -0.41$, 95% CI: -0.75 to -0.07, $p = 0.02$). See table XXV.

Table XXV: Multivariate analysis of institutional factors influencing academic achievement in physiology among students of Bachelor of Nursing Sciences

Variable category	Coefficient (CI)	std.error	df	t-value	P value
Intercept	2.62 [1.58-3.66]	0.57	60.13	4.59	0.000***
Whether lecturers possess good teaching skills					
Great extent	1				
Not at all knowledgeable	0.17 [-0.68-1.01]	0.46	180.19	0.36	0.72
Not sure	-0.53 [-1.14-0.07]	0.33	179.32	-1.62	0.11
To some extent	-0.25 [-0.46- -0.03]	0.11	179.28	-2.14	0.03 *
Lecturer- student relationship					
Fair	1				
Good	0.15 [-0.10-0.39]	0.13	179.18	1.12	0.26
Poor	0.18 [-0.20-0.56]	0.21	179.48	0.89	0.38
Very bad	1.62 [-0.02-3.26]	0.89	179.14	1.82	0.07
Very good	0.37 [0.07-0.67]	0.16	179.35	2.31	0.02*
University has online resources such as e-books, magazines					
Great extent	1				
Not at all available	0.34 [0.02-0.67]	0.17	179.81	1.97	0.05
To some extent	-0.06 [-0.26-0.14]	0.11	179.47	-0.57	0.57
Students doing practical as a way of learning physiology					
Never	1				
Always	0.46 [-0.32-1.25]	0.43	179.50	1.08	0.28
Most times	0.55 [-0.24-1.34]	0.43	179.34	1.29	0.20
Sometimes	0.71 [-0.09-1.50]	0.43	179.20	1.65	0.10
Teaching/Learning approach by the lecturers					
Blended/mixture	1				
Face2face/physical	0.01 [-0.25-0.27]	0.14	181.70	0.04	0.97
Online	-0.09 [-0.37-0.20]	0.16	181.77	-0.55	0.58
Teaching/Learning approach most liked by students					
Blended/mixture	1				
Face2face/physical	-0.22 [-0.48-0.03]	0.14	180.59	-1.64	0.10
Online	-0.41 [-0.75- -0.07]	0.18	180.20	-2.20	0.02 *
Taking students to the hospitals to comprehend learning from patients					
No	1				
Yes	-0.04 [-0.31-0.25]	0.15	178.29	-0.25	0.80
Lecturer giving back answer sheets to the students for the progressive tests					
No	1				
Not sure	0.43 [-0.23-1.08]	0.35	179.67	1.21	0.23
Rarely	0.15 [-0.19-0.49]	0.18	179.67	0.83	0.41
Yes	-0.04 [-0.46-0.38]	0.23	179.56	-0.17	0.86
Lecturer use the returned progressive test to make corrections					
Always	1				
Most times	0.11 [-0.38-0.60]	0.27	179.27	0.42	0.68
Never	-0.33 [-0.73-0.06]	0.21	179.38	-1.54	0.12

*Signif. codes: 0 ***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 AIC=504.0335*

Institutional factors influencing academic achievement in biochemistry

a) Bivariate analysis

From the bivariate analysis, the study revealed that students who had a very good relationship with their biochemistry lecturers performed better in exams than those who did not ($F = 3.15$, $p = 0.015$). Students from institutions that did not have online learning resources, such as magazines, performed better than those from institutions that had them ($F = 6.46$, $p = 0.001$). Those whose learning of biochemistry did not involve practical sessions tended to perform better in examinations than those whose institutions complemented theoretical lessons with practical sessions ($F = 2.82$, $p = 0.026$).

Students who were taught biochemistry using a face-to-face approach achieved better academic performance in biochemistry than those taught using other approaches ($F = 18.47$, $p \leq 0.001$). Similarly, students who were taken to the hospital to complement theoretical lessons in biochemistry with clinical presentations of patients tended to perform better than those who were not exposed to the clinical environment ($F = 4.61$, $p = 0.032$).

The study also found that students whose lecturers rarely returned marked scripts of progressive tests performed better than those who did not receive marked scripts or were uncertain about receiving them ($F = 4.13$, $p = 0.007$). Similarly, students who frequently received constructive feedback from their lecturers on their performance in progressive tests and ways to improve performed better than those who did not receive such feedback ($F = 6.87$, $p \leq 0.001$).

However, institutional factors such as attendance to scheduled sessions by the lecturers, teaching skills and methods used by the lecturers, allocation of some hours to self-directed learning, and giving students a free week for revision before beginning of end of semester examinations did not significantly influence academic achievement in biomedical sciences among BNS students at bivariate analysis level. See table XXVI.

Table XXVI: Bivariate analysis of institutional factors influencing academic achievement in biochemistry among students of Bachelor of Nursing Sciences

Variable Category	n (%)	Mean GPA	Sd	F-value	Sig
Rate of lecturers missing teaching some scheduled lessons					
Biochemistry					
At times	87 (41.8)	2.84	0.95	1.85	0.139
No	86 (41.3)	2.91	0.89		
Not sure	5 (2.4)	2.05	1.15		
Yes	30 (14.4)	2.66	0.67		
Lecturer's knowledge in biochemistry					
Great extent	168 (80.8)	2.87	0.89	2.11	0.124
Neutral	17 (8.2)	2.40	0.88		
Some extent	23 (11.1)	2.83	0.97		
Whether lecturers possess good teaching skills					
Great extent	127 (61.1)	2.90	0.92	0.89	0.448
Not knowledgeable	3 (1.4)	2.67	0.32		
Not sure	8 (3.8)	2.87	1.11		
To some extent	70 (33.7)	2.69	0.85		
Lecturer-student relationship					
Fair	56 (26.9)	2.63	0.93	3.15	0.015*
Good	85 (40.9)	2.85	0.89		
Poor	17 (8.2)	2.42	0.67		
Very bad	4 (1.9)	3.01	1.04		
Very good	46 (22.1)	3.15	0.88		
University has online resources such as e-books, magazines					
Great extent	82 (39.4)	2.87	0.86	6.46	0.001**
Not at all available	29 (13.9)	3.30	0.88		
To some extent	97 (46.6)	2.64	0.90		
Students doing practical as a way of learning					
Never	3 (1.4)	3.50	0.99	2.82	0.026*
Always	92 (44.2)	2.64	0.86		
Most times	63 (30.3)	2.82	0.96		
Rarely	6 (2.9)	3.23	0.83		
Sometimes	44 (21.2)	3.11	0.84		
Encouragement from lecturers to students to learn in student groups					
Table continuation					
Great extent	128 (61.5)	2.87	0.94	1.56	0.203
Neutral	19 (9.1)	2.81	0.92		

Not at all	3 (1.4)	3.67	0.58		
Small extent	58 (27.9)	2.67	0.81		
Lecturers involvement in students discussion groups					
Great extent	34 (16.3)	3.00	0.88	0.68	0.566
Neutral	38 (18.3)	2.77	0.93		
Not at all	88 (42.3)	2.83	0.87		
Small extent	48 (23.1)	2.72	0.97		
Teaching method used most by lecturers in class					
Group presentation	1 (0.5)	2.03	0	0.24	0.918
Lecture	166 (79.8)	2.82	0.96		
Problem based	8 (3.8)	2.91	0.75		
Tutorials	30 (14.4)	2.83	0.60		
Demonstrations	3 (1.4)	3.00	0.92		
Teaching methods that students liked most					
Demonstrations	30 (14.4)	2.72	0.99	0.32	0.865
Group presentation	8 (3.8)	2.84	0.83		
Lecture	100 (48.1)	2.83	0.95		
Problem based	17 (8.2)	3.02	0.97		
Tutorials	53 (25.5)	2.81	0.76		
Teaching methods that students dislike					
Demonstration	22 (10.6)	2.72	0.91	1.71	0.15
Group presentation	59 (28.4)	3.02	1.00		
Lecture	59 (28.4)	2.89	0.87		
Problem based	31 (14.9)	2.63	0.83		
Tutorials	37 (17.8)	2.62	0.77		
Teaching/Learning approach by the lecturers					
Blended/mixture	60 (28.8)	2.70	0.83	18.47	0.000***
Face2face/physical	82 (39.4)	3.24	0.87		
Online	66 (31.7)	2.42	0.80		
Teaching/Learning approach most liked by students					
Blended/mixture	38 (18.3)	3.03	0.76	2.06	0.13
Face2face/physical	138 (66.3)	2.82	0.94		
Online	32 (15.4)	2.59	0.87		
Allocation of some hours on the timetable for Self-Directed Learning (SDL)					
Sometimes	80 (38.5)	2.71	0.83	0.60	0.665
Always	40 (19.2)	2.87	0.89		
Most times	35 (16.8)	2.89	0.88		
Never	12 (5.8)	3.01	0.73		
Rarely	41 (19.7)	2.89	1.11		
Taking students to the hospitals to comprehend learning from patients					
No	176 (84.6)	2.77	0.94	4.61	0.032*
Yes	32 (15.4)	3.14	0.59		
Lecturer giving back answer scripts of the progressive tests to the students					
No	171 (82.2)	2.73	0.89	4.13	0.007**
Not sure	5 (2.4)	3.05	0.69		
Rarely	18 (8.7)	3.36	0.86		
Table continuation					
Yes	14 (6.7)	3.25	0.93		
Lecturer use the returned progressive test to make corrections					
Sometimes	28 (13.5)	3.02	0.75	6.87	0.000***
Always	14 (6.7)	3.34	0.85		
Most times	16 (7.7)	3.48	0.68		

Never	114 (54.8)	2.61	0.88		
Rarely	36 (17.3)	2.72	0.93		
University giving free week for preparation for the end of semester exams					
Great extent	56 (26.9)	2.87	1.04	1.09	0.356
Neutral	18 (8.7)	3.15	0.67		
Not at all	73 (35.1)	2.74	0.84		
Small extent	61 (29.3)	2.79	0.90		
Examinations come from the content that has been taught/studied /from the notes					
Great extent	136 (65.4)	2.86	0.91	1.03	0.38
Neutral	20 (9.6)	2.53	0.97		
Not at all	5 (2.4)	2.51	0.37		
Small extent	47 (22.6)	2.88	0.88		
University giving end of semester practical examination					
At times	19 (9.1)	2.90	0.93	8.64	0.000***
No	36 (17.3)	3.36	0.70		
Yes	153 (73.6)	2.69	0.90		
Signif. codes: 0 '' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1***					

b) Multivariate analysis

In the multivariate analysis of institutional factors influencing academic achievement in biochemistry, the study found that students who described their relationship with biochemistry lecturers as "very good" had a GPA that was 0.34 points higher than those who described their relationship as "fair" (β = 0.34, 95% CI: 0.06-0.62, p = 0.03).

Similarly, students whose lecturers never returned marked scripts for progressive tests scored a GPA that was 0.44 points lower than those whose lecturers always returned scripts for feedback and revision (β = -0.44, 95% CI: -0.84 - -0.04, p = 0.04). Additionally, students whose lecturers rarely returned marked scripts for progressive tests had a GPA that was 0.47 points lower than those whose lecturers consistently provided constructive feedback (β = -0.47, 95% CI: -0.90 to -0.03, p = 0.046). Although not statistically significant at the conventional threshold, the study suggests that students taught exclusively through an online platform scored, on average, 0.26 GPA points lower than those taught using a blended approach (β = -0.26, 95% CI: -0.52 - -0.20, *p* = 0.05). See table XXVII.

Table XXVII: Multivariate analysis of institutional factors influencing academic achievement in biochemistry among students of Bachelor of Nursing Sciences

Variable category	Estimate (CI)	std.error	Df	t-value	P value
Intercept	2.96 [2.20-3.72]	0.40	12.39	7.38	0.000***
Teacher student relation in Biochemistry					
Fair	1				
Good	0.09 [-0.14-0.32]	0.12	182.57	0.75	0.46
Poor	0.10 [-0.27-0.47]	0.20	182.07	0.52	0.61
Very bad	0.08 [-0.62-0.78]	0.38	182.41	0.22	0.83
Very good	0.34 [0.06-0.62]	0.15	182.45	2.25	0.03 *
University has online resources such as e-books, magazines					
Great extent	1				
Not at all available	0.19 [-0.12-0.50]	0.16	182.57	1.15	0.25
To some extent	-0.15 [-0.36-0.05]	0.11	182.52	-1.36	0.18
Students doing practical as a way of learning biochemistry					
Always	1				
Rarely	0.48 [-0.07-1.23]	0.30	182.41	1.61	0.11
Most times	0.02 [-0.20-0.24]	0.12	182.19	0.14	0.90
Never	0.07 [-0.74-0.89]	0.44	182.47	0.16	0.87
Sometimes	0.08 [-0.18-0.35]	0.14	184.22	0.58	0.57
Teaching/Learning approach by the lecturers					
Blended/mixture	1				
Face2face/physical	-0.24 [-0.52-0.05]	0.15	184.96	-1.60	0.11
Online	-0.26 [-0.52- -02]	0.13	183.74	-1.96	0.05
Taking students to the hospitals to comprehend learning from patients					
No	1				
Yes	0.05 [-0.26-0.36]	0.17	184.72	0.28	0.78
Lecturer giving back answer sheets to the students for the progressive tests					
No	1				
Not sure	0.39 [-0.23-1.02]	0.34	182.20	1.18	0.24
Rarely	0.14 [-0.21-0.50]	0.19	182.09	0.76	0.45
Yes	0.23 [-0.17-0.63]	0.21	182.39	1.10	0.27
Lecturer return marked scripts for progressive test for corrections and revision					
Always	1				
Sometimes	-0.25 [-0.70-0.20]	0.24	182.66	-1.06	0.29
Most times	-1.19 [-0.67-0.30]	0.26	182.22	-0.72	0.47
Never	-0.44 [-0.84- -0.04]	0.21	182.59	-2.05	0.04 *
Rarely	-0.47 [-0.90- -0.03]	0.23	182.20	-2.01	0.046 *
University giving end of semester practical examination, Biochemistry					
At times	1				
No	0.40 [0.01-0.80]	0.21	182.11	1.89	0.06
Yes	0.23 [-0.11-0.56]	0.18	183.01	1.27	0.21

*Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1*

AIC=505.4787

4.5.2 Findings from the qualitative study to compliment quantitative findings to answer study objective VI

The fourth objective of the qualitative aspect of the study was to examine views of lecturers of biomedical sciences about institutional factors that influence academic achievement in biomedical sciences among BNS students in Uganda.

Therefore, three (3) themes emerged from six (6) categories and nineteen (19) codes. The themes are i) mixed opinions about biomedical sciences curriculum content ii) suboptimal instructional capacity and ambivalent opinions regarding students admission criteria and iii) inadequate staffing and infrastructure to support teaching and learning. See table XXVIII below.

Table XXVIII: Summary of the views of lecturers regarding institutional factors influencing academic achievement in biomedical sciences among BNS students

Theme	Emerged category	Emerged code
1. Mixed opinions about biomedical sciences curriculum content	i) Appropriate biomedical sciences curriculum content	i) Curriculum content appropriate ii) Content relevant for degree nurses
	ii) Biomedical sciences curriculum content overload and inappropriate	i) Extra semester academic load for students ii)Limited time allocated to the large content iii) Inappropriate course content for BNS students iv) Inappropriate course content for diploma entry scheme students
2. Suboptimal instructional capacity and ambivalent opinions regarding students admission criteria	i) Suboptimal instructional capacity of lecturers	i) Ineffective tutorial teaching method ii) Inability to offer quality tutorials iii) Dominancy of the lecture method iv) Limited pedagogical training opportunities v) Mismatch between lecturer's qualifications and course being taught vi) Teaching experience of teachers
	ii) Ambivalent opinions regarding students admission criteria	i) Lenient admission criteria ii) Stringent admission criteria iii) Ineffective admission criteria
3. Inadequate staffing and infrastructure to support teaching and learning	i) High student-lecturer ratio	i) Understaffing ii) High number of students admitted
	ii) Inadequate teaching spaces at institutions	i) Inappropriate teaching space ii) Ineffective teaching strategies due to unmanageable student numbers

Theme 1: Mixed opinions about biomedical sciences curriculum content

This theme highlights the varied perspectives among lecturers on the quality and effectiveness of the biomedical sciences curriculum for degree nursing students.

It underscores the complexity of curriculum design and its significant impact on students' academic success.

While the curriculum aims to foster specific learning outcomes and support students' success, it can sometimes, according to lecturers, hinder those very outcomes due to several factors.

Lecturers had ambivalent opinions regarding the content of biomedical sciences in the BNS curriculum, with some describing it as appropriate while others considering it excessive and inappropriate. Accordingly, this theme emerged from two categories: appropriate biomedical sciences curriculum content and biomedical sciences curriculum content overload.

Appropriate biomedical sciences curriculum content

Some lecturers believed that the biomedical sciences content in the nursing degree curriculum was both adequate and appropriate. They argued that, as BNS students, nursing undergraduates needed a strong foundation in biomedical sciences to collaborate effectively with other health professionals, such as medical doctors. Additionally, they noted that this robust exposure could benefit students pursuing specialization in biomedical fields in the future. These lecturers dismissed content overload as the primary reason for poor student performance in biomedical sciences, attributing it to other factors instead. For instance, a lecturer stated: *'I feel curriculum content of anatomy in the nursing curriculum is appropriate. Degree nurses need this detailed content to increase their future career opportunities but also to prepare them to work better with other members of the caring team'* (Male, 18 years, Phys).

Biomedical sciences curriculum content overload

On the other hand, many lecturers believed that the content of some biomedical science courses in the BNS curriculum was excessive, given the scope of clinical practice and the limited time available to cover it. They argued that certain topics were unnecessary for degree nurses to provide effective nursing care, making them a burden with little or no benefit. Lecturers added that, as a result, many students struggled to understand these topics, questioned their relevance, became demotivated, and ultimately performed poorly. For instance, a lecturer said:'*I think that we give too much content of biochemistry to the nursing students, you know, things like biotechnology I think should not be taught to nursing students'*(Male, 7 years of experience, Bioch). Similarly, other lecturers mentioned:

'I think it's unfair to expose some diploma nurses to all the detailed biomedical sciences. There are some nurses who would like to update in the clinical area and only need a degree to practice clinical work better. So, I think it is better you split BNS. One for directs and other for diploma. Such that all biomedical science is taught to directs from senior six only' (Female, 7 years of experience, Anat).

'*There is also the issue of additional load for BNS students. At times, BNS have extra courses in semester than their colleagues, the medical students'* (Male, 9 years of experience, Phys).

'You know, there is a lot of information which should be taught within a short time, and this affects teaching and learning and is later reflected in the poor performance in exams' (Female, 7 years of experience, Anat).

'For us, at one time, BNS students used to study with medical students and the content was much and many students used to fail. Later, the mother department advised that some content be left out and now BNS study with BMLT, Physiotherapy and their performance in exams is now very good' (Male, 18 years of experience, Bioch).

Theme 2: Suboptimal instructional capacity and ambivalent opinions regarding students' admission criteria

This theme highlights the interconnected influences of lecturers' instructional capacities, student admission criteria, and the resulting academic success of BNS students in biomedical sciences. It emphasizes that enhancing lecturers' pedagogical skills and implementing stringent admission criteria can positively impact nursing students' academic achievement in biomedical sciences. The findings reveal perceived gaps in both areas: while a few lecturers felt the admission criteria were adequate, the majority saw room for improvement, as they believed the current admission standards sometimes admitted underprepared students. Therefore, this theme emerged from two categories: suboptimal instructional capacity of lecturers, and ambivalent opinions regarding students' admission criteria.

Suboptimal instructional capacity of lecturers

Many lecturers highlighted lack of ongoing pedagogical training opportunities, which they felt were essential for staying updated on effective advances in teaching and learning methods of biomedical sciences.

They noted that, as they were not formally trained as teachers, they needed regular updates on contemporary approaches to teaching and learning.

However, such training sessions were infrequent. Consequently, some lecturers remained largely outdated and continued to teach using traditional methods, which ultimately affected students' academic achievement in biomedical sciences. They, therefore, called for more frequent opportunities to enhance their pedagogical skills. For instance, a lecturer stated: ’*Pedagogical training is a bit lacking because in about 20 years, we have had only 2 trainings. Such trainings are a bit lacking, yet they are needed to improve the learning and academic achievement of students. I believe such trainings can enhance capacity of lecturers to teach biomedical sciences hence better academic performance of students’* (Male, 15 years of experience, Bioch).

Similarly, another lecturer said: ’*Of course we cannot only blame students. It may also be the way, we the teachers deliver the content’* (Male, five years of experience, Anat).

Ambivalent opinions regarding students’ admission criteria

Some lecturers expressed satisfaction with the admission criteria for students entering the BNS program, stating that the criteria were stringent and reliable. However, others questioned the quality of admitted students, suggesting the need for a more rigorous selection process. These lecturers believed that lenient admission standards allowed the entry of students who were not academically prepared to handle the demands of biomedical sciences, leading to poor performance.

Other lecturers questioned the authenticity of national examination results for students at the advanced level of education and called for a revision of the admission criteria.

For instance, some lecturers mentioned: *But I believe by the time one is admitted into the nursing program, that student is capable because our admission criteria is very tight’’* (Male, 10 years of experience, Phys). *‘I know that admission criterion has some* *challenges. It does not sieve these students very well. To improve academic performance, there is need for pre-entry exam. My university is slow to act but I know it will finally come'*(Male, 18 years of experience, Phys).

Theme 3: Inadequate resources and infrastructure to support teaching and learning

This theme underscores the intricate interplay between the physical and material aspects of the educational environment such as the availability of student hostels, lecture rooms, adequate staffing and the academic success of nursing students in biomedical sciences. It emphasizes the significance of a supportive educational environment, an optimal student-lecturer ratio, and considerations for student welfare as critical contributors to academic achievement. Therefore, this theme emerged from two categories: high student: lecturer ratio, and inadequate teaching spaces at universities.

High student: lecturer ratio

Most lecturers expressed concern about the high number of students admitted to nursing and other medical programs, while the number of lecturers remained unchanged. As a result, some found it impossible to implement student-centred teaching methods, such as tutorials and practical demonstrations, relying instead on lectures, which do not promote active learning. This led to passive learning among some students, contributing to poor academic achievement.

Additionally, the limited number of lecturers made it difficult to supervise and provide individual support to students. These factors collectively contributed to poor academic achievement in examinations. For instance, some lecturers stated: '*We have a staffing problem, and it is still a general problem in all public universities. Our staffing level is* *at 33% and this makes us to mainly teach using a lecture method which also has its limitations. As a result, some students do not perform better as probably they would have'* (Male, 7 years of experience, Phys). '*We teach both theory and practical but now, we don't do well because of student numbers. We no longer teach some practical skills in the good way we used to do before when the student population was manageable. This affects learning and is reflected in the low scores of students* (Male, 18 years of experience, Bioch). '*We cannot consistently give tutorials because of many students compared to few lecturers. You know you need to divide students into small groups but because of this, it becomes impossible. We give ineffective tutorials these days and this affects their academic performance in the long run* (Male, 5 years' experience, Anat).

Inadequate teaching spaces at universities

Similarly, nearly all lecturers noted that the available lecture rooms were insufficient in both number and size to accommodate the large cohort of nursing and other medical students. As a result, some lectures were missed, while those delivered often took place in overcrowded and uncomfortable spaces. Additionally, the existing practical rooms, originally designed for smaller groups, were unable to handle the increased student numbers. Consequently, many practical sessions were no longer conducted as they had been in the past, contributing to the poor academic performance of nursing students in biomedical sciences.

Accordingly, a lecturer stated: ''*These days, we do not teach practical sessions as we did before because of large student numbers which cannot fit into our small laboratories. I believe this also contributes to their poor performance''* (Male, 15 years of experience, Bioch).

Quantitative and qualitative finding Academic achievement

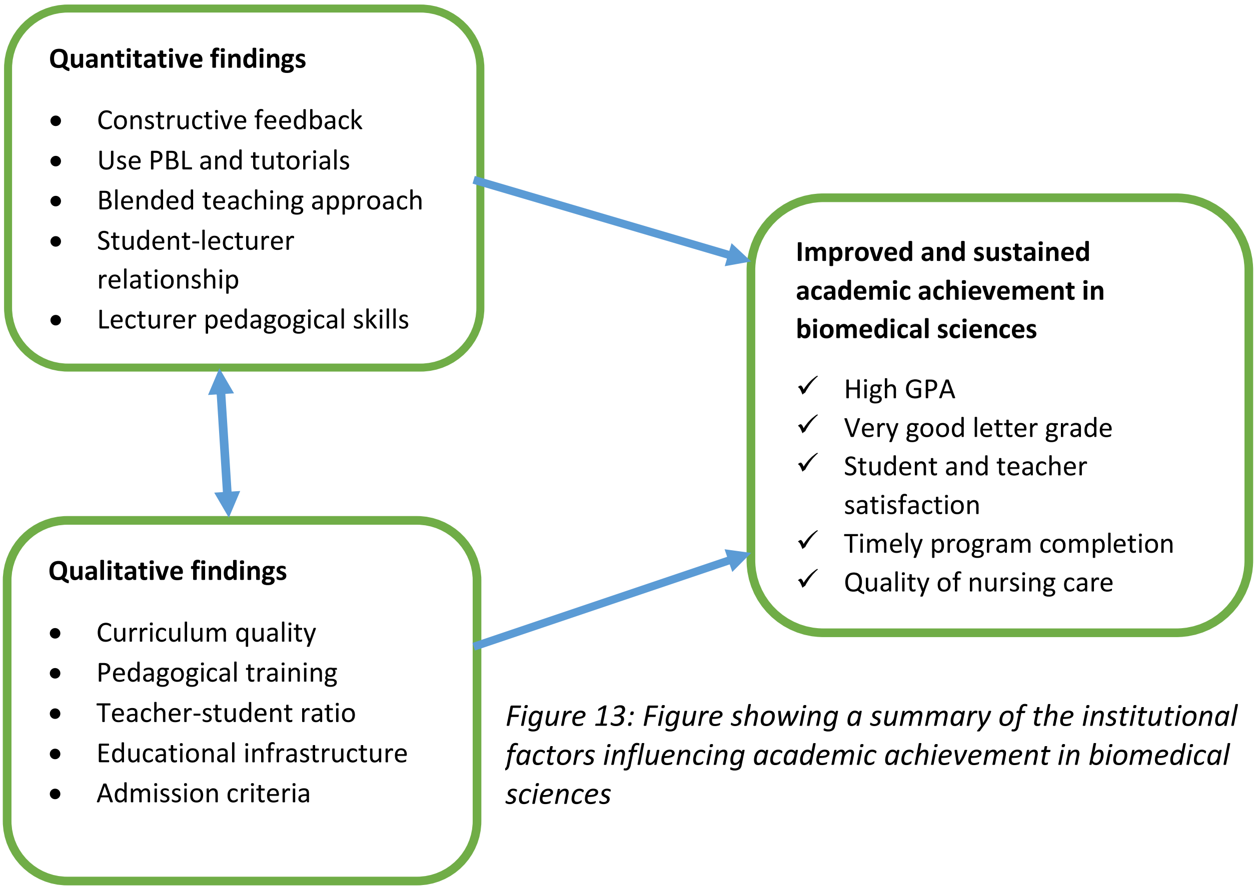


Figure 13: Figure showing a summary of the institutional factors influencing academic achievement in biomedical sciences

This chapter presents the findings of the study in alignment with the four research objectives, integrating both quantitative and qualitative data. Given the quantitative-qualitative mixed methods approach employed, quantitative findings are presented first, followed by qualitative findings.

To address the first objective, the level of academic achievement in biomedical sciences among BNS students was assessed using multiple indicators, including Grade Point Average (GPA), letter grades, and subjective evaluations based on a five-point Likert scale. These measures provided a comprehensive understanding of students' academic performance from both an objective and self-reported perspective.

Findings related to the second, third, and fourth objectives were analyzed using bivariate and multivariate statistical techniques. These results were initially summarized narratively, followed by detailed tables to enhance clarity and interpretation. The statistical analyses identified significant correlates of academic achievement in biomedical sciences, offering insights into the key factors influencing BNS students' academic achievement in biomedical sciences.

The qualitative findings were synthesized into overarching themes, further categorized for clarity. These were illustrated with tables summarizing key points and supported by direct quotations from study participants, ensuring that the opinions and perspectives of the participants were authentically captured.

Overall, the chapter provides a structured and comprehensive presentation of the study findings, integrating quantitative rigor with qualitative depth to address all four research objectives effectively.

CHAPTER FIVE

DISCUSSION

5.0 Overview

This chapter discusses the study findings in relation to existing literature and relevant theoretical and conceptual frameworks. It integrates results from both the quantitative and qualitative strands to provide a comprehensive interpretation of the factors influencing academic achievement in biomedical sciences among undergraduate nursing students. The chapter also shows how understanding of the findings was enhanced through lenses of various theories and conceptual frameworks. The chapter begins with the sociodemographic characteristics of the study participants and then addresses the findings according to each study objective.

5.1 Sociodemographic characteristics of study participants

The study found that the majority of degree nursing students were young (20–24 years), single, and male. This aligns with the typical profile of students entering a four-year BNS program directly from advanced-level education. Their youth and limited professional experience suggest a need for guidance and mentorship to develop professional values, and their likely financial dependence highlights the continued role of parental support.

Lecturers, on the other hand, were predominantly male, mid-career, and held positions of lecturer or senior lecturer. The convergence of male dominance among both students and lecturers suggests persistent gender imbalance in biomedical sciences education. This pattern may reflect broader systemic factors influencing gender representation in the field and has implications for mentorship, role modeling, and the cultivation of an inclusive learning environment.

This pattern may reflect broader trends in STEM education, where male participation has traditionally been higher. The consistency in these findings highlights the need for further exploration into gender-related influences on academic engagement and performance in biomedical sciences.

However, a notable divergence emerges in career stage and financial dependency. The quantitative findings show that most student participants were young and dependent on their parents or caretakers or government for financial support, whereas qualitative findings indicate that lecturers were mid-career professionals. This contrast underscores the transition from financial dependence during education to career stability later in life.

It also suggests potential disparities in perspectives regarding academic achievement, study habits, and resource accessibility, which may influence student performance and motivation.

The integration of both data sets provides a deeper understanding of mentorship and role modelling within biomedical sciences education. While students are largely young and financially dependent, they engage with mid-career lecturers who serve as potential mentors. This dynamic situation suggests that lecturers may play a crucial role in shaping students' professional aspirations, study habits, and academic success. Exploring how lecturers perceive their role in supporting students, alongside students' expectations of mentorship, could provide insights into strengthening academic support systems. Gender imbalance among lecturers revealed in this study also points to the potential challenge that a female student may face while seeking mentorship services from the male dominated academic staff. These findings highlight the importance of considering sociodemographic factors of key stakeholders when designing academic programs and supporting mechanisms in biomedical sciences.

By integrating quantitative and qualitative findings, this discussion provides a comprehensive interpretation of the study's results, identifying areas of convergence, divergence, and mutual reinforcement to offer a more holistic understanding of academic achievement in biomedical sciences.

The young age of the students who participated in quantitative study is similar to one for the nursing students that was reported in Italy and Kenya (Appiagyei et al., 2014; Canzan et al., 2022). Regarding the male students being the majority participants, this is rather surprising given that historically, nursing profession has been dominated by females. However, many studies now show an exponential influx of males into nursing profession. For instance, in Tanzania, one of the studies show that the number of male nurses increased from 23.6% to about 50% in a space of only seven years (Masibo et al., 2024). This could possibly be because more males do science combinations at advanced level of education than girls and then consequently, more of them qualify and are admitted for the course than females.

It could also be due to the recent improvement in the image of nursing, the availability of more career specialties in the profession, job stability and security, comparative remuneration and change in the admission requirements. However, the observed male dominancy among students in this study contrasts with the findings from another study which concluded that 76.9% of the global nurses were females (Kharazmi et al., 2023).

The mean age of 43 years observed among university lecturers and senior lecturers indicates the mid-career stage in which faculty staff have accumulated experience. The age of the lecturers observed in this study fairly concurs with that of the academic staff of higher institutions of education in India (Neelam et al., 2020).

Similarly, the midcareer stage of lecturers, evidenced by the mean teaching experience of 9 years as lecturers signifies established expertise in form of specialized knowledge and teaching skills, research, effective leadership and acquaintance with the curriculum. Findings from this study is similar to what was reported in Nigeria where majority of the lecturers were aged 39-45 years (Ojo et al., 2023). The positive role of teaching experience on the lecturer's productivity and contribution to the growth of the university has also been underscored in one of the studies (Murcahyanto et al., 2022).

5.2 Study objective I: Level of academic achievement in biomedical sciences among BNS students.

The study explored the level of academic achievement in biomedical sciences among BNS students in Uganda using a mixed-methods approach. Quantitative results indicated that academic achievement remained marginal to moderate, with a mean GPA of 2.80, which was not statistically significantly different from the benchmark of 3.00 as earlier set in the null hypothesis. Therefore, there was not enough evidence to reject the null hypothesis and concluded that: The mean GPA scores in biomedical sciences among BNS students was greater or equal to 3.00. The study also found that the overall failure rate was 8.41% which differed significantly between courses and universities.

Most of the students also held opinion that they worked harder for better performance but still scored less GPA. Similarly, one theme named; progressive, context dependent and marginal to moderate academic achievement emerged from the qualitative study.

Both the quantitative and qualitative findings converge in affirming that academic achievement in biomedical sciences is not at an ideal level. The mean GPA above confirms that students continue performing at a level that is neither failing nor excellent but remains in the lower moderate range. Similarly, qualitative data reinforce this by describing student achievement as marginal and unsatisfactory, indicating that both perspectives recognize a persistent struggle in attaining good academic outcomes. This agreement between the two datasets strengthens the validity of the conclusion that academic performance in biomedical sciences remains a challenge for nursing students.

Despite this convergence, a notable divergence emerges in how the findings characterize trends over time. While the quantitative results provide a static measure, offering a snapshot of students' GPA at the time of the study, the qualitative data suggest that achievement has slightly improved over time. This divergence highlights the limitations of purely quantitative approaches, as they may fail to detect subtle progress that qualitative insights can reveal.

Beyond convergence and divergence, the two datasets complement each other by providing both measurable academic outcomes and a nuanced understanding of the factors influencing these outcomes. While the quantitative findings objectively establish that achievement remains below the desirable threshold, the qualitative data add depth by contextualizing this performance. By integrating these perspectives, the study offers a richer interpretation of academic achievement beyond numerical data.

Therefore, the mixed-methods approach provides a robust understanding of the level of academic achievement in biomedical sciences among BNS students. The findings converge in identifying marginal academic performance, diverge in their depiction of trends over time, and complement each other by merging statistical evidence with qualitative insights. This triangulated understanding underscores the need for targeted interventions to ensure that students move beyond the current marginal achievement and attain higher levels of academic success.

Students from Mbarara university of science and technology performed best in all courses possibly because the university did not admit diploma holders into the four-year BNS program of interest and therefore all the study participants were directly from advanced level of education. The other possible explanation could be that BNS students at Mbarara university of science and technology studied biomedical science courses for only one year compared to other students at Makerere and Soroti who studied the same for two years, pointing to the possible influence of the content overload of biomedical sciences on the academic achievement.

Similarly, BNS students at Mbarara University of Science and Technology did not study biomedical sciences alongside students pursuing Medicine and Surgery (MBChB), as is the case in most other universities. Instead, they studied with students of Biomedical Laboratory Science, Pharmaceutical Science, and Physiotherapy, implying that they probably focused solely on biomedical science content that was highly relevant to their professional practice.

Reasons why students at Soroti university registered least performance may not be very well understood. However, factors could be individual student or institutional related such as content overload, teaching approaches, methods and styles used, pedagogical skills and experience of the lecturers or any other as explained in study objective two, three and four.

Findings from this study on the overall failure rate in biomedical sciences among BNS students are comparable with what was also reported in Norway. The study also reported that majority of the degree nursing students scored C in anatomy and physiology courses (Grønlien et al., 2021). The similarity in the academic achievement scores could be due to the comparable sample size and robust quasi-experimental study design that guided this study. Findings from this study also concur with what was reported in a study in Gambia (Gbenga E, 2020). This study also revealed that 6.1% of the medical students failed anatomy.

However, they differ from what a similar in Gambia also reported. On contrary, this study revealed that most of the medical and nursing students scored 72%, corresponding to B letter grade score in anatomy and physiology (Udeh et al., 2023). The difference in academic achievement could be due to the difference in data collection methods and approaches as well as analysis. Similarly, the failure rate reported in this study was lower than 34.2% reported in a pilot survey study in United States of America (A. Gultice et al., 2015) and also lower than 50% reported in a quasi-experimental study conducted in the southeastern part of the United States (Staci B. Forgey, 2020). This implies that although biomedical sciences remain a global challenge to BNS students, Uganda also shares on this challenge although the academic achievement among BNS students is somehow better compared to those in developed countries such as United States of America, thus casting rays of hope for better improvement in the near future.

Before collecting, analyzing, and interpreting data, it was not clearly known that academic achievement in biomedical sciences among BNS students at the four universities had improved over time, as evidenced by the low failure rate. However, in comparison with lecturers' views, achievement remained unsatisfactory, with most students still struggling to attain the pass mark of 50%. From the philosophical perspectives of Critical Realism (CR) and pragmatism, the observed improvement in academic achievement, previously unknown to us suggests that critical information usually exists independently of our perceptions (Lawani, 2020). This study, therefore, contributes new knowledge to this phenomenon. Similarly, improvement in the academic achievement observed in this study is not surprising and is also very well explained by the CR and pragmatism philosophical point of view.

From CR, we know that knowledge is transitive and open to change and improvement in society is always possible while from pragmatism, we know that study findings should be contextualized, implying that findings from this study overly describe academic achievement in biomedical sciences among BNS students at the universities that participated in the study and cautiously apply to other students and universities which have the same or similar characteristics.

Dissatisfaction with academic achievement among students can be explained by principles of constructive misalignment and negative washback. There appears to be a mismatch between learning objectives, teaching methods, and assessment.

Students often put effort into areas of the course that are either not examined or assessed differently, which negatively affects their motivation. As a result, they tend to focus on learning for examinations rather than developing actual competencies. Some may even resort to examination dishonesty, such as malpractice, after losing hope in the benefits of hard work.

Education is a strong change agent which determines the social, economic, political, and health status of the people (Spiel et al., 2018). Largely, strong educational system of the country determines quality of life of its citizens and entirely reflects its future growth and transformation (Kioupi & Voulvoulis, 2019). Success of education is reflected in many ways, one of which is the level at which students achieve predetermined educational goals. The level of academic achievement of students indicates the magnitude of mastery of learning objectives and outcomes, the competence levels and quality of future graduates (Steinmayr et al., 2014). It also shows the quality of the training institution (university) and educational system of the country.

Accordingly, although most of the students passed biomedical courses, they equally barely met the set performance criteria, attained the learning objectives and outcomes, acquired the desired competencies and got satisfied with the whole teaching and learning experience.

Findings from this study are particularly concerning because they suggest that students barely achieved the learning objectives and intended outcomes of these critical courses. Furthermore, they imply that BNS students transitioned from the first phase, dominated by biomedical sciences, to the second phase, focused on clinical courses, with limited knowledge of the former despite its necessity for understanding the latter. This also indicates that a significant proportion of BNS students struggled with the courses, were dissatisfied with the teaching and learning experience, and were at risk of either delaying their studies or dropping out of the program.

Given the well-documented linkage between mastery of biomedical sciences and clinical competence, these findings seem to question the readiness of Uganda's BNS graduates to fulfill the expanding and increasingly complex roles assigned to them under the revised scope of nursing and midwifery practice (MoPs, 2017). As these roles now encompass not only general nursing functions but also critical care, mental health, reproductive health, teaching, and management, they demand a level of scientific literacy and clinical reasoning that can only be achieved through solid biomedical training (UNMC, 2022). The situation is further complicated by the recent reforms in Uganda that formally integrated BNS graduates into public service, heightening expectations for their professional contributions in key institutions such as the National, regional, and general hospitals as well as local government-level health facilities.

This study also reflects the current crossroads at which the nursing profession in Uganda stands. There is a pressing need for BNS graduates to distinguish themselves through competent, science-driven clinical practice. Their performance in public service will either validate the ongoing national campaign to professionalize nursing through degree-level education or cast doubt on its effectiveness, potentially undermining hard-won progress in policy and perception. International evidence supports the assertion that degree-prepared nurses contribute to better patient outcomes, including lower mortality rates, reduced hospital stays, and fewer complications (Blegen et al., 2013).

Uganda's health sector must therefore prioritize and invest in improving biomedical science education as a strategic lever for elevating the quality of care.

Finally, the relevance of biomedical sciences extends beyond immediate clinical outcomes to the broader professional trajectories of BNS graduates. As global health trends increasingly favour specialization and advanced nursing roles, Uganda's nurses must be equipped not only for current demands but also for future opportunities that require a deep and functional understanding of biomedical sciences. For instance, nurses should equally specialize in biomedical sciences education and teach the same to the fellow nurses among others. Therefore, the need to improve academic achievement in biomedical sciences is not just an academic concern but also a foundational requirement for clinical excellence, professional credibility, and the long-term advancement of Uganda's nursing and midwifery profession. Achieving and sustaining excellence in biomedical sciences is a necessary condition for unlocking the full potential of BNS graduates and transforming the quality of healthcare delivery across the country.

5.3 Study objective II: Socio-demographic factors that influence academic achievement in biomedical sciences among BNS students

Findings from the study revealed that students who were young performed better than those who were older. Also, that students who hailed from central region of Uganda performed better than those who came from other regions of the country. From qualitative study aspect, lecturers reported that students who were young, male, had no other engagements to serve such as jobs, were in good health, and had adequate financial support were most likely to perform better in examinations of biomedical sciences than those who were older, female, had divided attention, were sick, and had financial challenges.

Therefore, regarding hypothesis testing, the study found enough evidence to reject the null hypothesis and therefore concluded that: There was a significant relationship between the age of students and the region of the country where their homes were located and academic achievement in biomedical sciences among BNS students in Uganda.

These findings highlight the complex interplay between sociodemographic factors and academic achievement in biomedical sciences among degree nursing students. Using a concurrent parallel design, the study integrated both quantitative and qualitative study findings mentioned above to identify factors that converge, diverge or complement each other. Integration of both qualitative and quantitative study findings provided a comprehensive understanding of the sociodemographic factors that influence academic achievement in biomedical sciences.

Findings from qualitative and quantitative aspects converge at age as a central sociodemographic factor that influence academic achievement in biomedical sciences. The quantitative data from students revealed that younger students performed better than older students, which aligns with lecturers' qualitative perspectives. Lecturers held strong opinion that younger students outperformed their counterparts in examinations of biomedical sciences, possibly due to their greater adaptability, fewer responsibilities, and ability to recall abundant prior knowledge. This convergence suggests that younger students may have an advantage in grasping biomedical science concepts, possibly due to better cognitive capability and recent exposure to biological or biomedical sciences at advanced level of education or diploma level respectively.

Another key point of convergence was the impact of socioeconomic status. Quantitative findings showed that students from central region of Uganda where socioeconomic status is generally higher, and schools are better equipped outperformed those from other regions. The qualitative data complemented this by indicating that financial hardships negatively affected students' performance. Lecturers observed that students struggling financially often had to balance academics with other casual work such as part time teaching in secondary schools as unlicensed part time teachers to get funds to meet their basic needs, which reduced their study time and concentration. This suggests that financial stability provides an advantage by allowing students to focus entirely on their studies without external pressures.

One notable divergence was in the role of gender. While the quantitative data did not explicitly highlight gender differences in academic performance, qualitative findings suggested that male students were perceived as performing better. This discrepancy may be due to the fact that lecturers’ perceptions are influenced by classroom interactions rather than objective performance measures. Alternatively, male students may exhibit confidence or active participation that creates an impression of academic strength, even if their performance does not significantly differ from that of females. This finding was mainly reported by the male lecturers which then can also be due to the stereotype held by the male lecturers about the academic ability oof female students.

Another divergence was in the regional influence. Quantitative findings emphasized regional disparities, with students from wealthier central Uganda performing better, suggesting that educational background and resources play a role in academic achievement. This finding indicates that access to better schools, well-trained teachers, and enhanced learning facilities in the central region may give students an academic edge over their counterparts from less privileged regions. This divergence suggests that while regional advantages provide a strong foundation for academic success, they do not guarantee high performance. Individual circumstances, such as financial instability and competing responsibilities, can override these benefits. Students from regions with better socioeconomic status may still struggle in academics if they face personal distractions, just as some students from regions with low socioeconomic status may excel if they have the right financial support and focus. This highlights the importance of addressing both systemic inequalities and individual challenges to improve academic achievement in biomedical sciences.

Academic achievement in biomedical sciences among BNS students is shaped by a complex interplay of sociodemographic factors, as revealed through both quantitative and qualitative findings. The Input-Transformation-Output (ITO) framework, Constructivist Learning Theory, Critical Realism philosophy, adult learning theory, and

Maslow's theory provide a logical lens through which these findings can be deeply understood.

From the ITO framework perspective, academic achievement in biomedical sciences is not a random occurrence but rather the result of specific inputs, a transformative learning process, and an eventual academic output. In this study, young age, male gender, sufficient financial support, coming from central region of Uganda, and avoidance of distractions emerged as key sociodemographic factors that promoted better academic achievement in biomedical sciences among BNS students. These factors serve as inputs that shape students' capacity to engage with biomedical sciences. The transformation process characterized by access to learning resources, time devoted to studies, and ability to focus without financial or social distractions determines how effectively students acquire knowledge and skills. Ultimately, the output, which is academic achievement, reflects the extent to which these factors interact to support or hinder learning of biomedical sciences.

Through the lens of Constructivist Learning Theory, academic achievement is influenced by how students actively construct knowledge based on their personal experiences, prior understanding, and the educational environment. Young students, with fewer external obligations, may have sufficient prior knowledge, greater cognitive capability and adaptability, hence allowing them to engage more deeply in biomedical sciences. Students from central Uganda may have benefited from stronger early education systems, giving them a solid foundation to build upon. Financially stable students can focus on their studies without the burden of economic stress, ensuring consistent class attendance and easy access to learning materials. Additionally, those who avoid distractions such as romantic relationships or part time jobs with studies may experience reduced cognitive overload, enabling them to allocate their mental and emotional energy more effectively toward academic pursuits. Meanwhile, male students, who were more academically successful, may have benefited from societal structures that afford them fewer domestic responsibilities, allowing more time for studies.

From a Critical Realism philosophical standpoint, these findings underscore the deeper structural realities that shape academic achievement. At the real level, sociodemographic conditions such as economic disparities, cultural norms, and regional educational differences exist silently and independently of any single individual but exert a profound influence on learning. At the actual level, these structures manifest in students lived experiences. For instance, those with sufficient financial support, favorable social expectations, and fewer external distractions navigate their studies with greater ease, whereas those facing financial struggles or competing responsibilities encounter barriers to success. Finally, at the empirical level, the study's findings capture observable patterns in academic achievement, revealing the influence of these underlying mechanisms. However, because knowledge is transitive and open to change, these barriers are not insurmountable.

From adult learning theory, the findings of this study confirm that although adult learners are usually wealthy in experience, which, when well-integrated with current learning, can make learning more meaningful, they can also become distracted by other engagements such as job and family demands, which negatively affect their academic achievement. Similarly, the importance of financial support in learning is better explained by Abraham Maslow’s motivational theory. The theory posits that students learn better when they are able to meet their basic needs, such as accommodation, food, security, and clothing.

Findings from this study concur with findings from other previous studies. For instance, cross-sectional study in Sudan found that medical students who were young and in high socioeconomic status performed better than those who were old and in low socioeconomic status (Jaber et al., 2024). In Ghana, the most recent study also revealed that nursing and midwifery students who were older were 0.6 times more likely to perform poorly in examinations compared to those were young (Usman et al., 2025). Equally in South Korea, a similar study found that nursing students who were young performed better in examinations than those who were old (Gu & Sok, 2021). However, findings from a cross sectional study in Ethiopia revealed contrary findings where students who were aged 20-24 years were less likely to register better academic achievement compared to those who were aged 25-29 years (Tadese et al., 2022). Similarly, findings from the study in United States (Ohio) also differed from our findings in which their study found that nursing students who had lower average age were more likely to fail biomedical sciences compared to those whose average age was higher (Amy Gultice et al., 2015b). Two studies in Australia also revealed that age alone was not always the predictor of academic achievement, and that some other personal factors such cognitive resources, metacognitive abilities and social-cognition were equally important predictors of academic achievement (Holzer et al., 2025; Imlach et al., 2017).

The observed differences in academic achievement reported in various studies could have been due to the variations in contextual factors, study design and methods including sample size, sampling techniques, data collection tools and methods, as well as data analysis and interpretation. More importantly, these findings reveal that while age and region of origin/socioeconomic status influence academic achievement, there are other factors such as metacognition, cognitive capacity, and socio-cognitive factors such as motivation that play along the structural equation pathway to influence academic achievement even when the age is favorable.

Regarding purported variation in academic achievement by gender, various study findings concurred with ours that male nursing students registered higher academic scores than females in many findings. For instance, a cross sectional study in Saudi Arabia also found a strong positive correlation between gender and academic achievement in which the study pointed out that male nursing students registered higher academic achievement than female nursing students (Alshammari et al., 2017). In addition, a correlational cross sectional study at two universities in Kenya revealed findings which also concurred with ours that male nursing students tended to perform better in the undergraduate course than their female counterparts (Kamotho et al., 2022). However, on contrary, Dante et al. (2016) conducted a study in Italy and instead found that female nursing students performed better than their male counterparts. However, in both cases, the cited studies considered various courses, not only biomedical sciences.

Financial support to nursing students continues to appear in many study findings as a strong factor that influences their academic achievement. Many previous studies concur with findings of this study on the aspect of financial support. For instance, a study in Nigeria found that nursing students whose parents had good and stable financial sources were by far most likely to perform well in the course compared to those whose parents struggled to rise some money to support the students (Umar, 2020). Related to financial support, there are studies that have reported the influence of ethnicity on academic achievement (University of Arkansas, 2023). In Norway, a study also found that migrant nurses were more motivated to pursue nursing career to higher levels than the native nurses, implying they were more likely to even outperform their fellow native nurses in examinations (Maurud et al., 2022). A similar study in South Africa found that nursing students of white ethnicity were more likely to pass using examinations compared to nursing students who were black (Mthimunye & Daniels, 2020).

Although the effect of the location of the hostel on the academic achievement lost its significance at multivariate analysis level, its relevance cannot be completely ignored. Therefore, some previous studies also concur with findings from this study on the distance students trek from campus to hostels. For instance, a longitudinal study in Italy found that BNS students who commuted more than 30 minutes from the university to their residences registered poorer academic scores than those who took less than 30 minutes (Dante et al., 2016). A similar study in Sri Lankan universities equally found that students who were satisfied with their hostel facilities passed examinations better than those who were dissatisfied (Mansoor & Ali, 2015).

Students who live closer to the university tend to perform better academically because they save commuting time, experience less fatigue and stress, and have greater access to academic resources such as libraries, laboratories, and faculty support. Proximity also facilitates participation in group discussions, tutorials, and mentorship programs, enhancing learning and retention. Additionally, nearby accommodation often provides a study-friendly environment and reduces transportation costs, allowing students to focus more on their studies and maintain a healthier lifestyle. In contrast, long commuting distances can lead to exhaustion, limited access to resources, reduced academic engagement, financial strain, and environmental distractions, all of which may negatively affect academic performance.

Divided attention among some nursing students due to engagement in paying jobs and sexual intimacy as extracurricular activities has been a concern among BNS students. In our study, this factor was highlighted by quantitative findings at the bivariate analysis level and reinforced by qualitative analysis, as emphasized by lecturers during interviews. Most biomedical sciences lecturers noted that the majority of BNS students who registered poor academic achievement in biomedical sciences were those who combined learning with work, as their jobs diverted their attention from academics. Our findings align with those of another mixed methods study in Columbia, which similarly concluded that nursing students who studied while working more than 20 hours per week were at a high risk of failing. Even among those who passed, their academic scores remained marginal (García-Vargas et al., 2016). Another study by Salamonson et al. (2011) also found that students who had paying jobs as extra engaging activity were more likely to register fail scores than those who committed all their time to the course. A similar survey study in Columbia also found that students who had full time jobs while studying scored low marks compared to those who had dedicated all their time to academic work (Osorio & Rodríguez, 2023). However, on contrary, a study at the university of Canberra in Australia concluded that having less demanding paid work while studying did not have a negative effect on the academic achievement of students, instead it promoted time management skills among them (Applegate & Anne, 2006).

In conclusion, it can be confidently stated that sociodemographic factors such as young age, being from the Central Region, divided attention, and the health and financial status of BNS students interact at various levels to influence their academic achievement in biomedical sciences in Uganda. Modifiable factors such as divided attention, financial status, and health status should be minimized or addressed, while non-modifiable factors such as age should be recognized and considered in planning interventions aimed at improving and sustaining academic achievement in biomedical sciences among BNS students in Uganda.

5.4 Study objective III: Individual educational factors that influence academic achievement in biomedical sciences among BNS students

Findings from this study revealed that students who gave nursing other choices other than the first one performed better than those who gave nursing first choice. Similarly, students who actively engaged in group discussions outperformed those who entirely depended on lecture sessions provided by the lecturer. The study found weak or no relationship between academic performance at primary, secondary and academic achievement in biomedical sciences at university. Three themes namely i) motivation of students to learn, ii) foundational knowledge in biological sciences and capacity to recall it and iii) use of diverse learning methods and styles emerged from the qualitative study.

Therefore, regarding hypothesis testing, the study found sufficient evidence to reject the null hypothesis and concluded that there was a significant relationship between the level of choice of the nursing programme and participation in small group discussions, and academic achievement in biomedical sciences among BNS students in Uganda.

Both quantitative and qualitative strands converged on the role of students' engagement in learning processes in shaping academic achievement. The quantitative analysis revealed that students who actively participated in group discussions outperformed those who relied solely on lecture-based instruction. This aligns with the qualitative insights from lecturers who suggested that students' lack of motivation, often stemming from low self-efficacy and external influences in career choice, negatively impacted their engagement and consequently, their academic achievement. Thus, both data sources converge to suggest that passive learning strategies, often influenced by external pressures, may hinder academic achievement, whereas active engagements which are usually characterized by strong internal motivation foster better academic achievement. Similarly, qualitative findings also emphasize the importance of using diverse learning methods and styles which concurs with the small group discussion method revealed by the qualitative study.

However, there is a point of divergence in the role of prior academic performance. Quantitative findings indicated weak or no correlation between previous academic performance at primary, ordinary level, and advanced level of education and academic achievement in biomedical sciences. This contradicts the qualitative insights from lecturers, who stated that students with prior exposure to biomedical sciences, particularly those who had done biology and chemistry at the advanced level of education, performed better than those without such background, such as diploma-entry students. This discrepancy suggests that while prior academic performance may not directly predict GPA cores in biomedical sciences, the specific content exposure at the advanced level of formal education may provide a foundational advantage, especially in mastering complex biomedical concepts.

Another compelling point of divergence is in students' motivation and its impact on performance. Quantitative data revealed that students who selected nursing as their second or fourth choice performed better than those who had it as their first choice. This contrasts with the qualitative findings, where lecturers attributed poor student motivation to external pressures, such as being forced into the nursing course by caretakers or peer influence. One possible explanation for this contradiction is that students who initially preferred other courses but later joined nursing may have developed a more pragmatic and goal-oriented approach to learning, realizing the importance of excelling in biomedical sciences while those who gave nursing the first choice might have become overly complacent. On the other hand, students who selected nursing as their first choice might have had unmet expectations regarding the course, leading to demotivation. Similarly, it could also be that students who gave nursing the first choice had to study much harder to excel and prove their capability. This underscores the complexity of motivation, which may be shaped by both initial career preferences and the realities encountered in the learning process.

A point of complementarity emerges in the discussion of students' self-efficacy and its impact on performance. While qualitative data emphasized that students' low confidence in competing with medical students contributed to their poor academic achievement, quantitative results indirectly support this by showing that group discussions-an active learning strategy that fosters confidence, were associated with better academic achievement. This suggests that enhancing self-efficacy through collaborative learning could mitigate some of the motivational challenges that lecturers identified.

Another complementary insight arises in relation to diploma-entry students. Qualitative findings indicated that students who took long to return to school after completing their diploma performed poorly due to difficulty in recalling previous biomedical knowledge. While the quantitative data did not explicitly highlight this, the weak correlation between prior academic performance and university-level achievement suggests that factors beyond grades such as the time elapsed since previous studies may play a role in academic success. This highlights the importance of academic refresher programs or bridging courses for diploma-entry students to reinforce their biomedical knowledge before transitioning into the BNS program.

From bivariate analysis, this study revealed that BNS students who had their advanced level of education from faith-based private secondary schools and also from the schools that were located in urban setting, performed better than those who studied from government owned and rural based secondary schools respectively. Although these findings lost their statistical significance at multivariate level, their relevance may not be completely ignored, especially where qualitative findings also revealed similar findings. For instance, qualitative findings revealed views of lectures who maintained that good prior exposure in biological or biomedical sciences was a good foundation for academic achievement in biomedical sciences. Private and urban schools often provide better access to science resources, experienced teachers, and well-equipped laboratories, which contribute to stronger foundational knowledge in biology and chemistry. In contrast, students from government or rural schools may have had limited access to quality science education, leading to weaker preparation and subsequently poorer performance in biomedical sciences at university. This seems to suggest that the educational environment before university significantly influences students’ readiness to handle complex biomedical concepts, reinforcing the importance of strengthening science education, particularly in rural and government schools.

The findings of this study can be comprehensively analyzed through the Input-Transformation-Output (ITO) framework, Constructivist Learning Theory, Self Determination Theory and Critical Realism philosophy, each providing a unique lens to understand the educational factors influencing academic achievement in biomedical sciences among BNS students in Uganda.

The study revealed that students who had prior exposure to biomedical sciences at the advanced level performed better than those without such a background, particularly diploma-entry students who had been away from formal education for an extended period. From an Input-Transformation-Output perspective, this suggests that prior academic exposure serves as an input that influences learning outcomes, although the quantitative findings showed weak or no correlation between previous performance and university academic achievement. This contradiction can be explained by Critical Realism, which acknowledges that while past academic performance exists as an objective reality, its effect is mediated by deeper underlying mechanisms, such as motivation, engagement, and learning strategies. The weak statistical relationship does not imply that previous academic exposure is irrelevant but rather that other interacting factors play a more significant role in shaping academic success. In the transformation process, the study found that students who actively engaged in group discussions performed better than those who relied entirely on lectures.

Constructivist Learning Theory explains this finding by emphasizing that learning is an active process where students construct knowledge through interaction rather than passively receiving information. Group discussions allow students to articulate ideas, clarify misconceptions, and reinforce their understanding of biomedical sciences, leading to better academic outcomes. This finding aligns with the Input-Transformation-Output framework, where engagement in group discussions represents a transformation factor that enhances learning, ultimately leading to higher academic achievement. The qualitative findings further highlighted that students' self-efficacy played a crucial role in their engagement.

Many students struggled with low confidence in their ability to compete with medical students, a perception that negatively affected their participation in learning activities. From a Critical Realist perspective, this lack of confidence is not merely an individual challenge but a reflection of deeper structural realities, including the positioning of nursing education within the broader health training system. The belief that nursing students are academically inferior to medical students shapes their engagement and performance, reinforcing the importance of addressing self-efficacy in learning interventions.

In addition, the finding on career choice suggests that motivation plays a significant role in shaping academic achievement. Constructivist Learning Theory supports this interpretation by emphasizing that learning is most effective when students see personal relevance in their studies. Students who initially aspired for other careers, but later pursued nursing may have developed a stronger intrinsic motivation to excel as a way to prove themselves that they were even capable of doing the higher course which they were denied doing, whereas those who selected nursing as their first choice may have had unmet expectations, leading to demotivation. It is also possible that these students might have become more complacent hence poor academic achievement. This finding also highlights a deeper structural issue captured by Critical Realism. Many students entered nursing due to external pressures from parents, caretakers, or peer influence, rather than personal interest. This lack of autonomy in career choice created motivational barriers that ultimately affected academic performance. Understanding these underlying mechanisms is crucial for designing educational interventions that foster student engagement and motivation.

Self Determination Theory also explain these interesting findings. This theory explains the importance of internal motivation in optimizing learning outcomes. The theory adds to the previous theories that learning outcomes among students improve if students are driven by curiosity, interest and personal goals to learn (Liu et al., 2022).

The study also found that diploma-entry students, particularly those who had taken long study breaks, struggled to perform well in biomedical sciences. While prior exposure to biology and chemistry at the advanced level provided an advantage, students who had been out of school for an extended period had difficulty recalling biomedical knowledge. The Input-Transformation-Output framework helps explain this by considering the time gap in formal learning as a factor that weakens the transformation process. Without continuous engagement in biomedical sciences, knowledge retention declines, making it harder for students to integrate new concepts. Constructivist Learning Theory further supports this interpretation by emphasizing that new knowledge builds upon prior knowledge. When prior knowledge is not well retained, students struggle to construct new understanding, leading to poor performance. From a Critical Realist standpoint, this finding highlights the importance of contextual factors, such as gaps in academic continuity, in shaping learning outcomes. Diploma-entry students often return to school after working in clinical practice, where their focus is primarily on applied nursing rather than biomedical sciences. This shift in focus weakens their foundational knowledge, reinforcing the need for academic refresher programs to support their transition back into biomedical learning.

Findings from this study can further be discussed in view of what other previous studies found. For instance, confidence among students to learn and perform better in examinations has also been found in previous studies to improve their academic achievement (Sarla et al., 2019). This is possibly because confidence increases motivation to learn and engage with academic material, enables the student to focus more effectively, strengthens memory and recall hence facilitating retention of content (Acosta-Gonzaga, 2023). Confidence among students has been reported to reduce anxiety, increases resilience, promote positive self-talk and emotional regulation.

Findings from this study concur with findings from a cross sectional study in Iran which equally found that medical students who had high self-confidence and efficacy performed better than those who lacked it (Hayat et al., 2020). Although this study involved medical students instead of nursing students, the similarity in findings could have been due to the comparable study design used and sample size. Other studies also showed a strong relationship between self-confidence and academic achievement (Telbis et al., 2014; Zhao et al., 2021). Although these studies had relatively smaller sample size of participants, they could have still reported similar findings possibly due to the comparable cross-sectional study design.

Similarly, motivation of the learners has been documented by other studies to be a strong determinant of their academic success. Motivation initiates and sustains interest in learning, it promotes engagement and participation, promotes persistence amidst challenges, fosters self- confidence, promotes development of positive study habits and encourages deep learning and understanding. Our findings agreed with findings from other studies by Blackmore et al. (2021); (Saeedi et al., 2021; Shuaibu Muhammad et al., 2021; Sturges et al., 2016) which also revealed that students whose motivation to learn was high, were more likely to register good academic achievement than those whose motivation to learn was comparatively low. Most of the studies indicated above were systematic reviews and observational and similarity in findings could have been due to the comparable quality of the designs that were used.

Foundational knowledge, also known as prior knowledge, has also been recognized in previous studies as a factor that contributes to academic achievement. For instance, a study in Finland by Nivala et al. (2016) found that medical students who had a strong foundation in biology were more likely to perform better in first year course examinations than students whose foundational knowledge in biology was largely inadequate. Similarly, other authors in Australia also, in their publication, emphasized the importance of biomedical sciences among nurses and indicated that prior knowledge was vital in understanding such biomedical sciences (Cox, 2013).

However, our findings, which indicate a weak or no relationship between prior academic performance at the primary and secondary school levels and academic achievement in the form of GPA for biomedical sciences at the university, are also consistent with previous study findings. For instance, a study at Gulu and Makerere university in Uganda which involved selected students from science, arts and medical specialties found that academic achievement of students at advanced level of education did not correlate with their academic achievement in medicine and surgery course at the two universities (Rosalba Aciro, 2023). Similarity in findings could have been due to the robust design, probability sampling technique and large sample size that were used in this study. A similar study at Moi university in Kenya also found that KCSE grade score did not predict academic achievement of medical students in preclinical and clinical courses at the university (Omenge, 2017).

The finding of mixed views on the role of prior knowledge in academic achievement highlights the complexity of learning in fields such as biomedical sciences. Although constructivist learning theory emphasizes the importance of prior knowledge, its influence is not always direct or consistent. For prior knowledge to meaningfully support new learning, it must align with current content and be actively stimulated by both lecturers and students. Variations in findings may be explained by contextual factors such as teaching approaches, assessment methods, curriculum alignment, and broader influences including motivation, socioeconomic support, quality of teaching, and the learning environment. These factors can either compensate for weak prior knowledge or diminish its potential impact. The results suggest that nursing students enter university with differing levels of prior knowledge, and relying solely on secondary school academic performance to predict university achievement in biomedical sciences may be inadequate. The findings also indicate the need for further research to determine which specific secondary school subjects most strongly influence academic success in biomedical sciences at university.

Findings from this study regarding the influence of group discussion on academic achievement in biomedical sciences are similar to the findings that were reported in previous studies. For instance, a cross sectional study in India involving medical students compared small group discussion with traditional lecture method and concluded that small group discussion as a method of teaching anatomy involves active participation with good communication skills and develops good retention of knowledge compared to the traditional lecture method (JAiSwAl, 2023). Although this study involved medical students instead of nursing students, the similarity in findings could have been due to comparable study contexts and study design. A similar study in the same country also revealed that teaching students using small group discussions produced better examination results compared to the lecture method (Shah, 2019).

Comparably, findings from a systematic review paper whose aim was to synthesize opinions and scores of students by comparing group discussion and lecture method concluded that group discussion seemed to result in better learning than lecture method and recommended that both methods be used to enhance student learning (Adib-Hajbaghery & Rafiee, 2016). Similarity in findings could have been due to the systematic review design that was used. A quasi-experimental study involving midwifery students in Iran also compared student-focused group discussions with the traditional lecture method and found that students who learned through group discussions performed better than those taught using lectures (Aghapour et al., 2015). Similarly, the agreement of the findings between the two studies could have been due to the precise study designs that were used.

However, a similar study in India which based on the self-reported opinions of the medical students, did not find a significant difference between small group discussion and lecture and recommended that both teaching methods be used to teach accordingly (Paul et al., 2019). The difference in the findings could have been due to the study participants being medical students instead of nursing students, small sample size of 97 students, and self-reported views from the study participants.

In summary, this study showed that discussion groups had a strong positive effect on academic achievement in biomedical sciences among BNS students, which agrees with past research. However, even though most students preferred group discussions, lecturers mainly used the lecture method to teach.

Motivation to learn was one of the main themes that emerged from qualitative study. This theme was used to explain the quantitative findings at the beginning of the discussion in response to the third study objective. Lecturers reported that some students felt disappointed after failing to gain admission to Medicine and Surgery, which had been their preferred course. Others felt inferior and unable to compete favorably with students of Medicine and Surgery, reflecting low self-efficacy. Additionally, some students perceived the career paths in nursing as ambiguous, and the relevance of biomedical sciences to nursing care was unclear to them. As a result, some students felt it was less important to concentrate on such content.

Motivation is a process in which goal directed activity is instigated and sustained (Urhahne & Wijnia, 2023). According to Urhahne and Wijnia (2023), there are two forms of orientation to motivation. Task oriented motivation and ego-oriented motivation. Task oriented motivation focuses on the goal of developing high abilities while ego-oriented motivation focusses deeply on proving high abilities to themselves and to others. Therefore, our earlier finding from the study where students who gave nursing the second choice were more likely to register good academic achievement better than others is well explained by ego-oriented motivation phenomenon. Indeed, it is most likely that such students had ego-motivation to prove to themselves and others that they were worth and able to excel in the course.

The role of motivation of students to learn has been well explained by some learning theories. These theories include Achievement Goal Theory, Expectancy-Value Theory, Social Cognitive Theory, Self Determination Theory, and Adult Learning Theory/Andragogy.

Achievement Goal Theory posits that students engage in learning tasks with different goal orientations**,** which influence how they approach learning, persist through challenges, and interpret success or failure. According to this theory, there are two types of goal orientations namely masterly goal orientation and performance goal orientation. Students with mastery goal orientation aim at developing competence, understanding content, and mastering a task and are motivated by the desire to learn and improve while students with performance goal orientation focus on demonstrating competence and outperforming others. Usually, students with performance goal are driven by competition and external validation. They may perform better but usually use surface learning strategies which may lead to anxiety, procrastination, or avoidance of some tasks (Canfield & Zastavker, 2010; Chazan et al., 2021).

Expectancy-Value Theory is a widely used motivation theory in education that explains why students choose to engage in certain tasks**,** how much effort they put in, and how persistent they are**,** based on two key factors: expectancy and value. Expectancy for success refers to the students' belief on how well they perform on the task. Expectancy is usually influenced by the students' self-efficacy, past experience of the same or similar task, perceived difficulty of the task and the support available. For instance, a nursing student who believes they are good at science may expect to perform well in biomedical sciences. Similarly, the value in this theory refers to the way students observe the task as worthwhile.

This is usually influenced by intrinsic value where students have an inherent interest in performing the task, utility value which relates to the usefulness of the task to the future goals as well as attainment and cost values.

Attainment value refers to the importance of doing well for one's identity. For instance, some students may hold a strong view that being good at science is part of who they are. Cost value relates to the perceived negatives of engaging in the task. For example, students may appreciate the fact that studying biomedical sciences takes too much time and effort (Wigfield et al., 2016).

The power of motivation in education, particularly in influencing learning outcomes, is further emphasized by Malcolm Knowles' adult learning theory. One of its key principles states that adults learn more effectively when they are self-regulated and self-directed both of which require a high level of motivation. The theory suggests that if adult learners are not motivated, they are unlikely to take charge of their own learning, which can ultimately lead to poor learning outcomes (Clawson, 2008; Jensen, 2009; Murtonen & Lehtinen, 2020; Yusuf, 2021).

According to the lecturers, one of the other serious issues that slowed down motivation of BNS students was studying a lot of content of biomedical sciences, yet they were not going to apply all of it in their clinical practice. Lecturers also believed that some students were worried about their future careers. This can well be explained by the principles of andragogy earlier advanced by Malcom Knowles. One of the principles of andragogy is that learners develop internal motivation to learn if they understand that what they are learning will be applied immediately to solve problems. According to this principle, learners loose interest and motivation to learn if they don’t see relevancy and application of what they are learning and if they don’t realize that what they are learning will help them to solve immediate problems and to better their lives (Purwati et al., 2022).

Findings from previous studies also reveal that motivation to learn among students contributes positively to the learning outcomes. For instance, a study in Australia which examined the influence of student motivation on academic achievement among medical students in anatomy reported that students who had intrinsic motivation to learn indeed performed better than those whose intrinsic motivation was low (Abdel, 2020). Although the study involved other allied health students, not nursing students, the similarity in findings could have been due to the comparable study design and sample size.

A similar study in North Carolina also found that teaching anatomy using cadaver dissection lead to student motivation to learn which itself contributed to improved academic achievement (Shell et al., 2020). In United States of America, findings from the study that correlated self-efficacy of medical students with academic outcomes reported that students who had high self-efficacy scores were most likely to perform better in examinations of anatomy (Burgoon et al., 2012; Shrestha, 2021). The similarity in study findings could be due to the cross-sectional and observational study designs that were also used.

In conclusion, this study revealed that individual educational factors such as nursing career choice, internal locus of control, motivation, foundational knowledge of biosciences, and contemporary learning styles significantly influence academic achievement in biomedical sciences among BNS students in Uganda. Therefore, to improve and sustain strong academic performance in biomedical sciences, interventions should address both modifiable and non-modifiable factors.

5.5 Study objective VI: Institutional factors that influence academic achievement in biomedical sciences among BNS students

This study aimed to explore institutional factors influencing academic achievement in biomedical sciences among BNS students in Uganda. As the findings were grouped by university, and the first study objective had shown slight variations in academic achievement across universities and biomedical science course units, the discussion for this objective was organized by course unit. This approach enabled a clearer understanding of course unit-specific institutional factors affecting academic achievement.

However, regarding hypothesis testing, the study found sufficient evidence to reject the null hypothesis and concluded that there was a significant relationship between teaching modality, learner epistemic agency, constructive pedagogy, relational pedagogy, teaching quality threshold, constructive feedback, and academic achievement in biomedical sciences among BNS students in Uganda.

A) Institutional factors influencing academic achievement in anatomy

Multivariate analysis revealed that students who were uncertain about whether their anatomy lecturers missed scheduled lessons had lower GPAs compared to those who were aware of the lecturers' attendance and any missed lessons. Additionally, students at universities where both theory and practical teaching methods were used had lower GPAs than those who were taught using theory alone. The study also found that students who were mainly taught using Problem-Based Learning (PBL), and tutorial methods performed better than those who were primarily taught through lectures. Similarly, students who were taught exclusively through online methods had lower academic performance compared to those who were taught using a blended approach combining both online and face-to-face instruction. Qualitative analysis revealed that lecturers had mixed views on the biomedical sciences curriculum. While some considered the content appropriate, others felt it was excessive in certain areas.

Lecturers also expressed concerns about their instructional capacity, with many citing limited trainings in pedagogical skills and this negatively contributed to the academic achievement of students. Lecturers’ opinions were similarly divided regarding the quality of admitted students and the admission criteria where some lecturers described the process as rigorous and effective, while others believed it had weaknesses that allowed underprepared students to enroll. Furthermore, lecturers emphasized that universities were significantly understaffed and lacked adequate infrastructure to support large student numbers. These challenges were seen as contributing factors to the low academic achievement observed among some students.

The integration of quantitative and qualitative findings from this study provides a more nuanced understanding of the institutional factors influencing academic achievement in biomedical sciences among BNS students in Uganda. Areas of convergence, divergence, and complementarity are evident in the interpretation of these findings.

A notable convergence between the two sets of findings is observed in the relationship between lecturer-related factors and student academic achievement. Quantitative results indicated that students who were uncertain about whether their anatomy lecturers missed scheduled lessons had lower GPAs. This aligns with qualitative insights in which lecturers themselves acknowledged concerns about instructional capacity, including limited training in pedagogical skills.

These findings collectively suggest that lecturer consistency, preparedness, and pedagogical competence to stimulate, motivate and actively engage students are critical to student success. It is very unlikely that the student who is motivated to learn, attends lessons, and is actively engaged by the lecturer will be unsure whether the lecturer missed attending to the scheduled lessons or not. Similarly, a student who attends lectures, and is passive in the lesson, will most likely learn less and can easily later forget whether the lesson was attended to or not.

Therefore, lack of pedagogical training, as noted in the qualitative findings, most likely contributes to inconsistencies in lesson delivery and reduced student engagement, which may explain the lower academic achievement among students who were unsure about their lecturers' reliability. This possibly implies that some of the lessons that the lecturer delivered were less impactful to the extent that the students did not have exciting new knowledge they acquired to remind them of such lessons.

A divergence emerges in the interpretation of teaching methods revealed in the study. Quantitative findings showed that students taught using both theory and practical methods had lower GPAs than those taught using theory alone. This appears counterintuitive and contrasts with the widely held belief that practical session compliments theory teaching to provide comprehensive and deep understanding of the biomedical sciences. However, this result may be explained by contextual qualitative findings, which revealed that universities were grossly understaffed and lacked adequate infrastructure. In such settings, the implementation of practical sessions may be suboptimal, possibly overwhelming both staff and students and reducing the intended effectiveness of these methods.

Hence, the negative quantitative outcome could reflect not the inherent limitations of practical teaching, but rather the institutional incapacity to implement it effectively.

In contrast, the effectiveness of interactive and student-centred teaching strategies such as Problem-Based Learning (PBL) and tutorials was confirmed by both data sources. Quantitative analysis showed that students taught mainly using PBL and tutorials performed better than those taught primarily through lectures. This is complemented by the finding from the qualitative study of the limited pedagogical skills among lecturers, suggesting that where more active methods are applied, likely by better-prepared lecturers, students benefit academically. This convergence reinforces the need for pedagogical training of lecturers to enhance instructional quality so as to diversify teaching approaches beyond traditional lectures.

Furthermore, both strands of data converge on the limitations of online-only teaching. Quantitative findings revealed that students who were taught exclusively through online methods had lower GPAs compared to those taught using a blended approach. Qualitative findings indirectly support this by highlighting limited institutional resources and infrastructure. The implication is that full online delivery, in poorly resourced settings, possibly with poor internet connectivity and limited capacity of lecturers to actively engage students, may not provide the necessary support for effective learning. Blended learning, on the other hand, offers flexibility while retaining the benefits of face-to-face engagement, thereby contributing to better academic outcomes.

Lastly, the qualitative concern about the quality of student admissions provides contextual insight into student preparedness, which was not directly measured in the quantitative analysis. While the quantitative data focused on teaching methods and lecturer behavior, qualitative findings introduced the issue of variability in student entry qualifications. Some lecturers expressed doubts about the rigor and effectiveness of admission criteria, suggesting that some students may lack the foundational competencies necessary for success in biomedical sciences. This perspective complements the quantitative findings by identifying a potential underlying factor influencing student performance, especially where instructional methods may not compensate for academic deficiencies.

The findings of this study highlight the multifaceted institutional factors that shape academic achievement in biomedical sciences among BNS students in Uganda. When interpreted through the Input-Transformation-Output (ITO) framework, Critical Realism, Learner Epistemic Agency principle, cognitive load theory, and Constructivist

Learning Theory, a more comprehensive understanding of the mechanisms and processes underlying academic performance emerges.

The ITO model provides a useful pragmatic structure to organize and interpret the interaction between various elements within the educational system. Within the input phase, the study identified a range of institutional characteristics that set the foundation for student learning experiences. Among these were concerns about lecturer attendance, adequacy of infrastructure, staffing levels, the quality of student admissions, and lecturer capacity in terms of pedagogical training. These factors are structural and contextual features of the institutions that serve as the initial conditions under which learning occurs.

From a Critical Realist perspective, these institutional arrangements exist as part of the true domains which are deep-seated generative mechanisms that may not be immediately observable but have significant implications for the outcomes of teaching and learning processes. The recognition of insufficient pedagogical preparation, the acknowledgement of infrastructural and staffing limitations by lecturers indicate that these structures may limit the effectiveness of teaching regardless of intent or even the content. Similarly, divergent opinions on the quality of admitted students reflect the operation of another mechanism about admissions policy and its execution which may produce different student cohorts in terms of preparedness and capability, thus introducing variations in learning outcomes even before the real instruction begins.

The transformation phase, which encompasses the teaching-learning process, reveals the complex interplay between pedagogical strategies, institutional practices, and learner engagement. Quantitative results revealed that students taught primarily through Problem-Based Learning (PBL) and tutorials outperformed those taught using traditional lecture methods. This supports the tenets of Constructivist Learning Theory, which views learning as an active, learner-centred process in which knowledge is constructed through experience, reflection, and interaction. PBL and tutorials naturally lend themselves to such engagement, allowing students to contextualize biomedical science content, develop problem-solving skills, and internalize knowledge more effectively. The preference for these methods, as reflected in academic achievement, illustrates that when transformation processes align with how learners best acquire and process information, the likelihood of positive academic outcomes increases.

Similarly, this study presents robust evidence that student centered, or contemporary teaching methods positively influence academic achievement in biomedical sciences among BNS students, yet lecture method is the dominant teaching method used to teach biomedical sciences (Baillie et al., 2022). This finding agrees with many other findings which have been presented in the earlier chapter. It can therefore be concluded that teachers of biomedical sciences commonly use the lecture teaching method which many students dislike and the one which promotes passive learning, recall and rote learning as opposed to the contemporary ones which improve critical thinking, problem-solving, long-life learning, self-directed learning, and student motivation (Izuagba, 2015).

The interesting finding about students who were not knowledgeable about the lessons of anatomy missed, performing poorly compared to ones who keenly followed the teaching schedules and knew which topics were taught, not taught, and those to be taught next can be explained by Learner Epistemic Agency principle. This principle refers to the ability and willingness of students to take responsibility for knowing what they are supposed to know, noticing when something is missing and acting on it to fix it.

From a constructivist perspective, combining theory with practical learning should strengthen comprehension through active engagement. However, Cognitive Load Theory explains why, in the context of Ugandan universities facing staff shortages and insufficient infrastructure, this integration may backfire. The poorly executed practical sessions increase extraneous cognitive load, distracting students from the core learning objectives and diminishing the potential benefits of experiential learning. Through a Critical Realist lens, this illustrates how structural realities, not the pedagogy itself, mediate the relationship between theoretically sound teaching methods and actual learning outcomes. Essentially, the negative effect is not due to practical learning per se, but to the contextual factors that overload students cognitively, making theory-only instruction more effective under these circumstances.

This misalignment between intended pedagogy and actual practice underscores the importance of considering underlying institutional capacities when evaluating the effectiveness of teaching methods. Recently, just like many other countries, Uganda undertook a radical policy decision to promote science education to help the country to develop rapidly and to be able to solve her own scientific technical challenges such as health, electricity, engineering, among others. Accordingly, the number of students pursuing science combinations at the advanced level of education has already skyrocketed and the performance of students in these science subjects has been improving steadily due to the heavy investment in science teaching at secondary school level. This means that all the qualifying students at the advanced level of education should be admitted to the universities to pursue different courses of their choice. Therefore, there is an overwhelming pressure to the already poorly facilitated universities to admit these students and as a result, the number of students per university science academic program has been equally increasing steadily yet the staffing level and teaching space among others have not been increasing at the equal measure. Therefore, to accommodate the current huge spillover of students to universities from advanced level of education, another radical decision needs to be made by the government.

Similarly, the observed lower academic achievement among students taught exclusively through online methods compared to those taught through blended approaches underscores the role of contextual factors in shaping the efficacy of instructional strategies. Constructivist learning principles emphasize interaction, dialogue, and active participation which are elements that may be difficult to achieve in purely online environments, especially where there are technological and infrastructural limitations. The qualitative data highlighted concerns about institutional readiness, digital infrastructure, and teaching staff capacity. These findings suggest that online instruction, in under-resourced settings, may limit opportunities for student engagement and feedback, resulting in reduced academic achievement. In contrast, blended learning provides a more balanced approach, combining the flexibility of online content delivery with the relational and interactive benefits of in-person engagement. Thus, the higher academic achievement associated with blended methods reflects a better alignment with constructivist pedagogical ideals in contexts where full online delivery is not feasible or effective. Another area where both data sources converge is the issue of lecturer reliability and consistency. Students who were unsure whether their anatomy lecturers missed scheduled lessons had significantly lower GPAs. This finding correlates with lecturers' own acknowledgements of capacity constraints and the lack of training in pedagogical methods.

The uncertainty around lecturer presence likely contributes to students' reduced engagement and trust in the learning process, which are factors that are central to the constructivist view of effective education. If learners perceive inconsistency in instructional delivery, their ability to meaningfully engage with content and construct knowledge is compromised. Furthermore, from a Critical Realist stance, such inconsistency is not merely an issue of individual behaviour but a reflection of deeper institutional mechanisms such as workload pressures, absence of monitoring, or weak organizational culture that shape and constrain lecturer practices.

Finally, the output stage of the ITO model is represented by academic achievement, captured quantitatively through GPA. While GPA is a surface-level empirical indicator, Critical Realism encourages probing beneath such outcomes to identify the structural and cultural mechanisms that produce them. The diversity in performance across institutions, teaching methods, and student backgrounds reflects the complex interdependence of multiple layers of reality and observable events, underlying causal mechanisms, and the structural context in which they are embedded. The constructivist emphasis on learner experience further enriches this interpretation, as it highlights how institutional conditions such as pedagogical strategy, mode of delivery, and teacher reliability shape the nature of knowledge construction and, ultimately, student success.

In summary, the integrated analysis of these findings demonstrates that academic achievement in biomedical sciences cannot be adequately explained by surface-level observations or linear cause-effect assumptions. Instead, it emerges from the interaction of input conditions, the nature and quality of teaching-learning transformations, and the structural and cultural environment within which students are embedded. The ITO framework facilitates a systematic understanding of this process, Critical Realism provides the philosophical depth to uncover hidden mechanisms and contextual constraints, and Constructivist Learning Theory offers a pedagogical lens through which to interpret how students engage with and make sense of their learning experiences.

Taken together, these perspectives underscore the importance of investing in institutional capacity, aligning pedagogy with learner needs, and critically examining the contextual realities of higher education delivery in order to enhance academic achievement in biomedical sciences.

Findings from the published articles retrieved on this matter concur with what this study found. For instance, a study in United Kingdom revealed that teaching students using PBL improved their learning experiences in biomedical and biological sciences (Hamdan et al., 2014). A correlational study by researchers in Philippines revealed a strong relationship between small group discussion and academic performance in medical physiology (Banal, 2022). The similarity in the findings could be due to the similarity in the study participants. The two studies also enrolled nursing students in year 3 and year 4.

Similarly, a survey study in Pakistan found that students who were taught using small group discussion exhibited high level of satisfaction with the teaching and learning process. The study further revealed that students who were studied using small group discussions found the course very lively and engaging and consequently improved critical thinking and retention of the content compared to non-collaborative approaches such as lectures (Waheed et al., 2019).

One of the learning strategies used in small group discussions is peer-assisted learning, where one or more group members are tasked with leading the discussion as facilitators.

A study on Peer-Assisted Learning (PAL) found a statistically significant difference in academic achievement in anatomy between group facilitators and participants.

This suggests that students who facilitated the small group discussions performed better than those who participated more passively (Li et al., 2025). Relatedly, a mixed-methods study in Australia comparing the lecture method with collaborative active learning strategies such as team teaching reported that students perceived the lecture method as ineffective for teaching biosciences. Instead, they found collaborative methods that engaged students in discussion and self-directed knowledge construction to be far more effective (Craft et al., 2017). Similar findings could be due to the similar characteristics of the study participants and also sequential explanatory mixed methods approach that was used.

Findings from the metanalysis study also showed that science students who were taught using problem-based learning approach performed better than those who were taught using traditional approaches (Uluçınar, 2023). A similar systematic review study about the most effective teaching strategies in medical education revealed that PBL, compared to lecture method was one on the most effective teaching strategy which contributed to enhanced learning outcomes and students satisfaction (Zhang et al., 2024). However, our findings contrasted with findings from a related study on the effect of problem based learning on academic achievement in science among secondary school students which found no relationship between the two variables (Almanea, 2018).

Broadly, when student-centered teaching strategies such as problem-based learning were compared with teacher-centered approaches like lectures, many studies found that teacher-centered methods were less effective for teaching biomedical sciences (Joseph et al., 2021). Á similar study also found that lecture method consequently left many students with knowledge gaps which were revealed by their examination scores (Craft et al., 2016). Another study in South Africa recommended that innovative teaching methods that actively engage learners should be used by the teachers of biomedical sciences to improve its performance (Mhlongo & Masango, 2020).

Although student-centered teaching methods such as Problem-Based Learning (PBL) are generally more effective than teacher-centered approaches, this study found that the lecture method remained the predominant teaching strategy used by instructors.

The similarities and differences in the study findings, when compared to what this study found can be due to differences or similarities in the study design, participant characteristics, sample size, sampling techniques and data analysis.

This reaffirms the importance of the global movement toward Competence-Based Education (CBE), a pedagogical approach being implemented in primary, secondary, and tertiary education systems in countries like Uganda, Tanzania and Kenya. However, many universities in Uganda have not yet fully embraced this new medical educational trend which grossly undermines the efforts of the government in promoting high quality and more meaningful education. The lack of alignment between CBE at lower education levels and university education is a serious issue of going concern implying that the universities that are still lagging behind should quickly transform themselves and equally embrace this new CBE approach.

In summary, the findings of this study reveal that academic achievement in biomedical sciences among BNS students is shaped by a complex interplay of instructional methods, lecturer engagement, and institutional capacity. Students demonstrated higher academic performance when exposed to problem-based and tutorial teaching approaches as opposed to lecture-based methods, and when taught through a blended learning model rather than purely online delivery. Interestingly, the use of practical sessions did not always translate to better GPA, suggesting possible issues in the integration or execution of these sessions.

Moreover, awareness of lecturer adherence to scheduled teaching appeared to correlate with better academic outcomes, underscoring the importance of consistency and transparency in teaching. From the lecturers' perspective, concerns were raised about the relevance and manageability of the curriculum, their own preparedness due to limited pedagogical training, and the strain caused by high student-lecturer ratios and inadequate infrastructure. These challenges point to deeper systemic issues within the educational environment that influence both teaching effectiveness and student outcomes. When interpreted through the lens of constructivist learning theory, critical realist philosophy, and the ITO framework, these findings underscore the value of learner-centered pedagogies, responsive institutional support, and strengthened teaching capacities in enhancing academic success if academic achievement in anatomy is to be improved and sustained.

B) Institutional factors influencing academic achievement in physiology

Quantitative findings revealed that students who felt that their lecturers possessed good teaching skills to some extent scored GPA less compared to those who felt their lecturers possessed good teaching skills to a greater extent. Students who were taught using online lecture method performed less compared to those who were taught using blended teaching method of teaching. From qualitative study, lecturers had mixed opinions about biomedical sciences curriculum, with some believing that it was appropriate while few others thought it was congested with content too much content which was not very necessary for undergraduate, and this created content overload and lowered the academic achievement of some students.

Lecturers also reported that they had suboptimal instructional capacity since they received fewer pedagogical trainings. Some also had ambivalent opinions regarding admission criteria with some believing that it was stringent while others thought it had loopholes. Lastly, most of the lecturers raised a concern of inadequate infrastructure to support teaching and learning.

Analysis of these findings presents a rich, multifaceted understanding of the factors influencing academic achievement in physiology among BNS students. Discussion integrates the quantitative and qualitative findings, highlighting the areas of convergence, divergence, and complementarity.

The quantitative findings revealed that students who perceived their lecturers to possess good teaching skills to a greater extent scored higher GPAs compared to those who rated their lecturers' teaching skills as only moderately good. This underscores the pivotal role of effective teaching in promoting academic success. This finding aligns with qualitative data, where lecturers acknowledged having suboptimal instructional capacity, primarily due to limited pedagogical training opportunities. The convergence of these findings suggests that investment in pedagogical development is crucial to enhancing lecturers' ability to effectively deliver complex content such as physiology, which in turn positively impacts student performance.

Similarly, the teaching method emerged as another influential factor. Students taught using blended methods performed better compared to those taught using online-only lectures. This observation was complemented by lecturers' opinion of inadequate infrastructure for teaching and learning, including unreliable internet connectivity and lack of teaching materials. These infrastructural challenges likely limit the effectiveness of fully online teaching and suggest that blended learning where in-person interaction can compensate for technical shortfalls offers a more conducive environment for student learning in the current context.

A point of divergence emerged in relation to admission criteria. Some lecturers considered the criteria to be stringent, while others believed there were loopholes that might allow underprepared students into the program. This inconsistency in opinion was not explored quantitatively, indicating a gap that could be addressed in future research to determine whether the mode of admission correlates with performance in physiology or other biomedical sciences.

Qualitative findings further revealed mixed opinions among lecturers regarding the suitability of the biomedical sciences curriculum. While some found it appropriate, others criticized it as being overly congested with content that was not entirely necessary at the undergraduate level. Although this aspect was not directly assessed in the quantitative strand, it offers complementary insight into the possible cause of cognitive overload, which could contribute to lower academic achievement. Streamlining the curriculum to focus on essential content could therefore support deeper learning and better academic outcomes.

Overall, the integration of both data strands suggests that student achievement in physiology is shaped by multiple interrelated factors. Good teaching skills, effective and well-supported teaching approaches, an appropriately structured curriculum, and adequate institutional resources all contribute to student success. Conversely, inadequacies in any of these areas be insufficient pedagogical training, over-reliance on poorly supported online methods, curriculum overload, or weak infrastructure can negatively impact learning outcomes.

The discussion of these findings is grounded in the Input–Transformation–Output (ITO) conceptual framework, Constructivist Learning Theory, teaching quality threshold principle, and the Critical Realist philosophical lens.

The Input stage of the ITO framework encompassed elements such as the teaching abilities of lecturers, instructional strategies, curriculum design, admission criteria, and institutional infrastructure. Quantitative findings indicated that students who perceived their lecturers as possessing strong teaching skills to a greater extent had higher GPAs in physiology compared to those who rated their lecturers' teaching skills as good to some extent. This finding affirms the importance of lecturer competence as a key educational input. In alignment with Constructivist Learning Theory, effective teaching enhances the learner's ability to actively construct knowledge through interaction, engagement, and reflection. Where students seemed to doubt the teaching skills of their lecturers, their learning may have been more passive, likely resulting in diminished performance.

The qualitative data deepened understanding of this finding. Some lecturers reported that they had suboptimal instructional capacity, largely due to limited exposure to pedagogical training. From a Critical Realist perspective, this points to deeper, often unobservable generative mechanisms such as institutional under investment in faculty development that shape observable outcomes like poor instructional delivery and ultimately, lower academic achievement. Similarly, the concern raised by majority of the lecturers regarding inadequate infrastructure to support teaching and learning further reflects contextual limitations that hinder the educational process.

These include limited access to modern teaching aids, overcrowded classrooms and laboratories, and poor internet connectivity, all of which compromise the learning environment and thus influence student performance.

Another key input was the admission criteria. Lecturers had mixed views: some considered the criteria stringent enough to select capable students, while others believed they had loopholes that allowed in students ill-prepared for the rigors of biomedical science. This duality exemplifies Critical Realism's assertion that reality is layered and that social phenomena are usually influenced by multiple, sometimes contradictory, mechanisms operating simultaneously.

The Transformation phase focused on how teaching strategies or approaches and curriculum delivery affected learning. Students who were taught using blended learning approach performed better in physiology than those who were taught solely online. This supports Constructivist Learning Theory, which holds that learning is most effective when students engage in active dialogue, collaboration, and immediate feedback elements more accessible in blended environments than in purely online instruction.

Within the Critical Realist paradigm, this finding signals the influence of real contextual limitations such as poor digital infrastructure, student unfamiliarity with online platforms, and lack of institutional support that undermine the effectiveness of online learning in the given context.

The qualitative findings also revealed that some lecturers believed the biomedical sciences curriculum was overloaded with content that was not essential at the undergraduate level. This content overload likely contributed to cognitive fatigue among students, limiting their ability to process and apply knowledge effectively. From a constructivist standpoint, this is problematic, as meaningful learning requires time for learners to engage deeply with content, connect it to prior knowledge, and reflect on its application. The overloaded curriculum undermines this process, reducing learning to surface-level memorization rather than deep understanding. Critical Realism further encourages the identification of such structural constraints, as they represent underlying causes that require attention for lasting change.

At the Output level, the primary outcome considered was the students' GPA in physiology. The findings showed that suboptimal teaching quality, use of less interactive teaching methods, an overloaded curriculum, and poor infrastructure contributed to lower academic achievement among students. The ITO framework effectively captures how each stage of the educational process from inputs and transformations to outputs contributes to the final performance outcomes.

Critical Realist philosophical lens challenges the notion that academic achievement is merely an observable trend. Instead, it posits that it is the result of complex, interrelated causal mechanisms such as policy gaps, institutional limitations, and socio-cultural factors that operate beneath the surface of observable GPA score.

Furthermore, it acknowledges that reality is not fixed; with improved policies, investment in teaching capacity, curriculum reform, and infrastructural development, it is possible that better academic outcomes can be attained.

Therefore, the integration of the ITO framework, Constructivist Learning Theory, and Critical Realist philosophy has enabled a comprehensive interpretation of the findings. Together, they emphasize that enhancing student academic achievement in physiology requires attention not only to visible elements such as teaching approaches, curriculum structure, and infrastructure but also to deeper institutional and systemic issues that influence how nursing education is designed and delivered in Uganda.

The finding from this study that nursing students who perceive their physiology lecturers' teaching skills more positively tend to achieve higher GPAs than those who perceive them less positively can also be explained by several other educational phenomena and theories such as Pygmalion effect and Self Determination Theory. This relationship is also supported by recent studies in nursing and medical education. Pygmalion effect (also known as self-fulfilling prophesy) is an educational phenomenon which suggests that higher expectation of better academic performance among students leads to better academic performance (Chang, 2011; Gayathri & Saranya, 2020; Gündüzalp & Özan, 2019; Jahan & Mehrafzoon, 2019).

Therefore, when students perceive their lecturers as very competent, they may internalize these expectations, leading to increased motivation and better academic achievement. According to Self-Determination Theory, students who perceive their instructors as competent and supportive are more likely to experience intrinsic motivation, leading to increased engagement and better academic outcomes. A study found that students with higher academic achievement had more positive perceptions regarding their education, suggesting a link between perception and performance (Ahmed et al., 2018).

This interesting finding can also be explained by teaching quality threshold principle. In teaching and learning, the teaching quality threshold principle refers to the idea that there is a minimum level of instructional quality below which student learning outcomes are significantly compromised**,** regardless of other factors such as student ability or effort. In other words, once teaching quality falls below this threshold, even highly motivated or capable students are unlikely to learn effectively, and improvements in student engagement or study behaviors will not compensate for poor instructional delivery. This principle highlights that certain baseline conditions such as clear explanations, alignment of assessments with learning objectives, classroom organization, and timely feedback must be met for effective learning to occur, especially in complex subjects such as biomedical sciences (Hattie & Zierer, 2024).

The finding from this study shows that nursing students who are taught mainly using online approach get lower GPAs in biomedical sciences compared to those who are taught using blended teaching methods or approaches. This finding can be further explained by other educational phenomenon, frameworks and theories such as Community of Inquiry (CoI) framework, cognitive load theory and transactional distance theory.

CoI framework emphasizes three essential elements for effective learning in online and blended environments namely, cognitive presence, social presence, and teaching presence. Cognitive presence is the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse. It involves the critical thinking process that helps students understand, apply, and integrate new knowledge. In blended or online learning, cognitive presence is demonstrated when students engage with content, ask questions, solve problems, and make connections across topics and real-world contexts. Social presence element is the ability of learners to project themselves socially and emotionally in a learning community. It includes building trust and creating a sense of belonging among learners. In online and blended settings, social presence is essential for fostering collaboration, engagement, and mutual support which are key factors in enhancing motivation and reducing feelings of isolation. Teaching presence involves the design, facilitation, and direction of cognitive and social processes to support meaningful learning. This includes instructional design (such as structuring content and activities), facilitating discussion, and providing timely feedback. In blended learning, teaching presence is often stronger due to in-person opportunities for guidance, whereas in fully online environments, its effectiveness depends heavily on the instructor's ability to engage students through digital platforms (Lim, 2007). Therefore, blended learning tends to support all three more effectively than online-only approaches. Online-only environments may suffer from reduced social and teaching presence, leading to lower student motivation, engagement, and ultimately, achievement (Garrison & Akyol, 2013). Blended learning approach which combines face-to-face interaction with online aspect provides richer opportunities for active student engagement such as dialogue and collaborative learning, Peer Assisted Learning, and immediate feedback which are vital in academic achievement. In contrast, online teaching and learning only limits students from the named learning opportunities hence reducing the depth of knowledge construction (Efgivia et al., 2021).

Findings from this study are also consistent with those of previous researchers in the same or similar areas. For instance, a quasi-experimental study in the United Arab Emirates compared both online and blended learning strategies and found that although both approaches were effective, the blended approach was superior to the online-only approach (Ali et al., 2023). A study in India revealed that the majority of anatomy students taught using a blended learning strategy, compared to those taught through face-to-face instruction, reported greater satisfaction with the learning experience. They also indicated an increased ability to develop independent learning skills, which the face-to-face approach did not adequately support. The study therefore recommended blended learning as a suitable approach for teaching anatomy to medical and nursing students (Khalil et al., 2018). The similarity in findings with this study could have been due to the robust quasi-experimental design that was also used to guide the study and the similar study participants who provided data. However, the study had smaller sample size of 120-150 compared to 208 of our study. In Australia and China the two studies concluded that blended strategy can be effective in teaching anatomy and biochemistry long as face-to-face sessions are maintained for practical sessions to complement theory taught online (Green & Whitburn, 2016; Yang et al., 2025). The comparison in findings could be due to similar sample size of 200 and 180 respectively that were considered during data collection. Similarly, a post test only randomized study in Ireland that compared online, face-to-face and blended learning strategies concluded that face-to-face and blended strategies were effective at leading to skill acquisition and were most preferred by the students when compared to online only strategy (Forde et al., 2024).

On contrary, a study in United States of America and Hong Kong which compared online, face to face and blended learning strategy concluded that there was no statistically significant difference between online alone blended teaching approaches (Ngan et al., 2018; Yen et al., 2018).

The difference in the findings could have been due to the difference in the focus of the study participants. While our study focused on biomedical sciences, instead, the previous study indicated above considered students who were doing a child development course, not biomedical sciences. However, this was still the only most appropriate study that was found whose findings to compare with.

In summary, this study highlights the significant influence of teaching quality, curriculum design, and institutional support on academic achievement in biomedical sciences among BNS students. Students who perceived their lecturers as having strong teaching skills and who were taught through blended learning approaches generally attained higher GPAs than those taught primarily through online methods or who viewed their lecturers as less competent. Lecturers expressed varying opinions about the appropriateness of the biomedical sciences curriculum, with some indicating that the content was overly demanding and not well aligned with students' academic levels. Many lecturers also cited challenges such as limited pedagogical training, high student-lecturer ratios, and constrained infrastructure including inadequate lecture halls and laboratory spaces which were seen to affect the effectiveness of teaching and, consequently, student performance.

These findings align with the Input-Transformation-Output (ITO) educational framework, which illustrates how institutional inputs and pedagogical processes influence learning outcomes. They also reflect key assumptions of Critical Realism, which recognize the existence of structural educational challenges while affirming the potential for /transformative change. Additionally, the results support Constructivist learning theory, emphasizing the value of interactive and context-rich learning environments.

Together, these insights draw attention to the potential advantages of blended teaching strategies over online-only approaches, the implications of lecturer preparedness on learning outcomes, and the possible role of adequate human and infrastructural resources in enhancing academic achievement in biomedical sciences if academic achievement in physiology is to be improved.

C) Institutional factors influencing academic achievement in biochemistry

Findings from the quantitative study strand revealed that students who had good learning relationship with their biochemistry lecturers performed better than those who felt that their relationship with their lecturers was simply fair, not good. Students who were not given constructive feedback on progressive tests for revision had lower GPAs compared to those who were given constructive feedback on their progressive examinations and were guided on how to improve going forward. From the qualitative study, it was found that lecturers had mixed opinions about the curriculum content of biomedical sciences. Some believed the content was appropriate, while others felt it was, to some extent, too advanced for the learners' level. For instance, they said that neuroanatomy was more advanced for the degree nursing students. Additionally, some lecturers expressed that they lacked adequate teaching skills due to limited opportunities for pedagogical training. The majority also raised concerns about the high student lecturer ratio and reported being overworked. Furthermore, they highlighted inadequate infrastructure, such as lecture rooms and laboratory spaces, as a challenge that negatively impacted the quality of teaching and contributed to marginal-to-moderate academic achievement.

The integration of quantitative and qualitative findings provides a deeper understanding of the academic achievement of the BNS students in biomedical sciences.

A key area of convergence between the two research strands is the role of the lecturer-student relationship in influencing academic achievement.

From quantitative study strand, the study revealed that students who reported having a good learning relationship with their biochemistry lecturers performed better in biochemistry than those who felt that their relationship with the lecturers was just fair. This finding aligns with the findings from the qualitative strand, where lecturers themselves reflected on pedagogical limitations, suggesting that the quality of interaction between lecturers and students could have been compromised by inadequate teaching skills and limited pedagogical training. The two data strands highlight that strong, supportive relationships and effective teaching approaches are crucial for enhancing academic achievement in biomedical sciences among BNS students.

Findings from the two study strands also converge on infrastructural and resource-related factors. From the qualitative study strand, lecturers pointed to inadequate lecture rooms and skills laboratory spaces as significant factors that negatively contributed to effective teaching. Although this challenge did not emerge directly in the quantitative study strand, it may underpin some of the observed academic achievement outcomes by affecting the overall learning environment. The lack of appropriate infrastructure may limit hands-on learning experiences and meaningful engagement, which are vital in biomedical sciences education.

Constructive feedback and high student-lecturer ratio as factors that contribute to marginal-moderate academic achievement in biomedical sciences among BNS students complement each other.

Findings from the quantitative study strand showed that students who received constructive feedback on their progressive tests performed better than those who did not receive feedback. While this was not outrightly mentioned in the qualitative findings, the lecturers expressed concerns about being overworked and handling large student numbers suggesting a context in which providing individualized, timely and impactful feedback might be difficult. Therefore, findings from the qualitative strand help to explain why some students might not be receiving constructive feedback, thereby complementing the quantitative data by offering underlying structural and systemic reasons.

However, a divergence in the findings can be observed in the opinions of the lecturers regarding content of biomedical sciences in the BNS curriculum. While this was not directly measured in the quantitative study strand, findings from the qualitative study strand reveal that lecturers had mixed opinions on the appropriateness of the content of biomedical sciences in the curriculum. Some lecturers felt the content was somehow more than what is expected of the BNS to know, which may suggest a potential misalignment between curriculum design and student readiness to learn. This divergence points to the need for curriculum review and adjustment to better match learners' needs and prior knowledge levels.

Overall, the integration of findings from both quantitative and qualitative study strands reinforces the idea that academic achievement in biomedical sciences among nursing students is influenced by a combination of relational, pedagogical, and structural factors.

The convergence of the findings strengthens the credibility of the results, while divergences and complementarity offer directions for further studies and nursing education improvement.

The findings from both study strands of this study can be meaningfully interpreted using the Input–Transformation–Output (ITO) framework, Constructivist learning theory, relational pedagogy, constructive feedback principle, and the assumptions of Critical Realism. These lenses are helpful in explaining more about the complex interplay of factors that influence academic achievement in biomedical sciences among BNS students.

From an Input–Transformation–Output viewpoint, several key inputs such as lecturer's experience in teaching, pedagogical skills, student lecturer relationships, learning resources, and curriculum design play a foundational role in shaping student academic outcomes. Findings from the quantitative strand that students with good relationships with their biochemistry lecturers registered better academic achievement in biomedical sciences suggest that the quality of interpersonal engagement is a critical input into nursing education that influences the learning process and consequently its outcomes. Similarly, the provision of constructive feedback emerges as another important input, as students who received it had higher GPAs than those who missed it. This is possible because constructive feedback not only supports academic growth but also facilitates cognitive engagement, allowing learners to reflect, adjust, and improve their academic abilities (Altmiller, 2016).

In the transformation stage, which involves the actual teaching and learning processes, the constructivist learning theory offers valuable insights. According to constructivist learning theory, learning is an active, student-centred process where learners build knowledge through experience, reflection, and interaction (Lima, 2016). A good student lecturer relationship enhances opportunities for active engagement and meaningful dialogue, fostering a collaborative learning environment (Cureton & Gravestock, 2018). When students are not given feedback, their capacity to reflect and build upon existing knowledge is undermined, thereby impeding the learning transformation process (Altmiller, 2016). The findings from the study that students without feedback had lower GPAs suggest a gap in the scaffolding that aims at supporting learners' progress (Frank et al., 2018). Besides, the findings from qualitative study strand that many lecturers felt inadequately prepared in pedagogy points to a weakness in the transformation phase. Without pedagogical skills, lecturers may struggle to facilitate constructivist learning experiences that are responsive to students' needs, thus limiting their ability to support learners’ construction of knowledge.

Curriculum content also plays a double role as both an input and part of the transformation process. Mixed opinions of lecturers about the appropriateness of the content of biomedical sciences in the curriculum, with some considering it as too much in depth and width in some cases, highlight a potential misalignment between what students are meant to learn as indicated in the curricula, how ready they are to learn it, how able they are to learn it and how relevant it is to their professional practice. From a constructivist viewpoint, curriculum content which is very complex and unnecessarily too wide may fail to connect with students' prior knowledge, thereby disrupting knowledge construction (Seyyedrezaie & Barani, 2017). This mismatch challenges the ability of students to engage meaningfully with the content and limits the achievement of intended learning outcomes.

The output, as reflected in the academic achievement of students in biomedical sciences, is shaped by the interaction between inputs and the transformation process.

The observed overall marginal-to-moderate levels of academic achievement and failure rate, especially among students who did not have supportive academic relationship with their lecturers and those who rarely received constructive feedback on their academic performance, indicate systemic gaps across both input and transformation stages.

Interpreting these findings through the lens of Critical Realism helps to uncover the deeper structures and mechanisms underlying observable academic outputs. Critical Realism suggests that reality exists independently of our perceptions, but our knowledge of it is mediated by social structures and contextual conditions (Zhang, 2023). The opinions of lecturers of being overworked and managing large class sizes point to structural constraints such as high student lecturer ratios and inadequate infrastructure that inhibit effective teaching and provision of constructive feedback. These structural factors are indeed real and are also regarded as causal, even though they may not always be directly visible in the metrics of academic achievement of students. Similarly, inadequate pedagogical training opportunities for lecturers reflect institutional-level mechanisms that constrain the development of effective teaching practices. Critical Realism further points to this silent challenge of inadequate pedagogical skills among lecturers. Lecturers in many cases continue to be perceived as competent to teach on account of being content experts, thereby ignoring the pedagogical skills which are equally needed to effectively teach the content to the students.

Critical Realism also acknowledges that improvement is possible by addressing these underlying mechanisms (Zhang, 2023). For instance, increasing opportunities for pedagogical training, improving infrastructure, and ensuring reasonable student–lecturer ratios could alter the context in ways that enhance both teaching quality and student achievement. These interventions, although they target the whole structure, can ultimately improve the capacity of both lecturers and students within the learning process.

In summary, the findings of this study reveal that academic achievement in biomedical sciences is shaped by a dynamic interplay of structural inputs, interactive learning processes, and contextual outcomes. Strengthening the quality of inputs such as feedback to students, academically engaging relationship between students and lecturers, infrastructure, curriculum alignment and supporting transformation processes through pedagogical training and constructivist teaching are critical for improving academic achievement. Furthermore, a Critical Realist approach reminds us that beneath these empirical findings lie deeper causal mechanisms that must be addressed to create sustainable educational improvements.

Constructive feedback to students by the lecturers as revealed in this study is one of the practices that has been recommended to improve learning outcomes. For instance, feedback enables students to bridge the gap between what they know and what they desire to know. Feedback promotes responsive learning because when students receive feedback, they learn that their lecturers want them to learn and are therefore most likely to trust the advice of their lecturers and use it to progress towards improvement. It also promotes teachers' teaching capabilities as it helps lecturers to modify teaching by reflecting upon feedback (McFadzien, 2015). Therefore, constructive feedback improves understanding, enhances student motivation, enables students to carry out self-reflection and evaluation (Obilor, 2019).

Feedback encourages critical thinking, problem solving skills, motivation to learn, self-regulated learning capabilities, self-efficacy and confidence among students(Aslam & Khan, 2020). Many studies support constructive feedback as an important tool to improve academic achievement of students. For instance, a study in Australia by Colthorpe and Zimbardi (2013), emphasized that for the feedback to produce positive impact, it should be timely, detailed, directed and specific. A study at Queensland university in Australia found that feedback to students by their lecturers was positively associated with academic performance (Zimbardi et al., 2016). A similar study about the effect of constructive feedback on the academic performance in Pakistan revealed that students who were low academic achievers registered better academic achievement in chemistry, a biochemistry closely related course after getting constructive feedback from their teachers (Aslam et al., 2023). Therefore, feedback, if appropriately implemented by the lecturers of biochemistry can improve its academic achievement among BNS students. The comparable findings are possibly due to the similar sample size and very appropriate study design. However, some studies had participants who were not nursing students and relatively smaller sample size.

The importance of constructive feedback to students in medical and nursing education that this study revealed strongly aligns with the international policies and practices. For instance, the World Federation of Medical Education (WFME) global standards for quality improvement in medical education emphasizes the role of constructive and timely feedback as a key strategy in improving learning outcomes and clinical competence development (WFME, 2012). Similarly, UNESCO guidelines on quality teaching and learning in higher education states that teaching is more effective if learners receive regular, actionable feedback from their educators (Rose, 2014).

However, despite the emphasis of the positive effects of constructive feedback to students, many times, teachers of medical sciences who are not trained teachers, not even exposed to any pedagogical training, find difficulties in giving constructive feedback due to the limitation in the skills of giving it (Ezati et al., 2014).

Good academic relationship between students and their lecturers was found to have positive statistically significant influence on academic achievement in biomedical sciences among BNS students. The positive and supportive relationship between students and their lecturers relates with the comparison between teacher-centered and student-centered approaches to teaching and learning. Teacher centered teaching approach is usually characterized by the authoritative teacher who controls all the activities of teaching and learning and considers the student as a passive participant who has little or nothing to contribute in terms of planning and decision making. On the contrary, the student-centered approach to teaching and learning recognizes the learner as an adult who is able to plan, drive self, and make appropriate decisions regarding his or her learning and the teacher respects and supports the student to exhibit his or capabilities. Similarly, students who have good academic relationship with their teachers usually find the learning environment very supportive and motivating to learn, easy to approach their teachers for consultation, and builds sense of confidence and self-efficacy among themselves (Nyadanu et al., 2015).

A study in India also reported that teachers who were more approachable by their students were more likely to cause positive feeling about the subject being taught hence students registering good academic achievement compared to the teachers whose character was poor (Dharmarajan et al., 2022). Two studies in Karachi and Finland also assessed the relationship between teacher-student relationship and academic achievement and found that indeed students who had cordial academic relationship with their teachers performed better in examinations than those who lacked it (Imran et al., 2023; Sointu et al., 2017). In Africa, a cross-sectional study in Nigeria concluded that a significant correlation existed between student-lecturer relationship and academic achievement (Leonard et al., 2024). However, all these studies examined the influence of the student–teacher relationship on academic achievement among students in non-medical disciplines. Even so, their findings still underscore the importance of this relationship in education broadly. The present study adds a new dimension by showing that the student–teacher relationship is just as crucial in nursing education.

Relatedly, from the qualitative study strand, it was reported that many lecturers had limitations regarding pedagogical skills due to rare in-service training opportunities. This finding emphasizes the vital role that a teacher plays regarding academic achievement of students. From one of the study, it was found that a teacher influenced academic achievement of a student by 20-30%, 50% by the student, and 5-10% by the school, the peers and the school (Hattie, 2003). Pedagogical skills among teachers of biomedical sciences guide them how to; set clear learning objectives and outcomes, plan and deliver the content logically, encourage students to participate, use available resources including teaching methods to cause meaningful learning, administer reliable and valid assessment, provide constructive feedback, and how to motivate learners to learn. Findings from our study concur with findings from a study by (Hafeez, 2021). Comparable findings could have been due to the quasi-experimental design which guided the study. This is an experimental design which usually produces high quality findings. In Indonesia, a study on the relationship between lecturer's pedagogical competence and academic achievement found that students who were taught by lecturers with pedagogical skills indeed performed better in examinations than those whose lecturers had limitations in pedagogical skills. Consequently, authors recommended that universities need to equip their lecturers with pedagogical skills (Astuty, 2015). Similarly, a study in Pakistan on the impact of teacher's training on interest and academic achievement of students by multiple methods found that training of teachers plays an important role for choosing the method for teaching and improves the academic achievement and interests of students (M. Hafeez, 2021). This study also found that high lecturer-student ratio coupled with inadequate infrastructure were reported by lecturers of biomedical sciences to influence the quality of teaching and learning and consequently contributing to poor academic achievement in biomedical sciences among BNS students. This study finding concurred with one in Turkey which also found that a strong negative correlation existed between high student-teacher ratio and academic achievement (Koc & Çelik, 2015).

Equally, in Ethiopia it was reported that dormitory crowdedness, large class size, inadequate classroom facilities, inadequate anatomy teaching models and low internet connection independently influenced academic achievement in anatomy among medical students in Ethiopia (Tiruneh et al., 2020). The similarity of the findings could be due to the same cross-sectional design which guided the study and the anatomy medical students who were not very much different from nursing students in various parameters. However, the study had a small sample size of 120 participants compared to 208 who participated in our study.

In summary, findings of this study reveal a multifaceted interplay of individual, pedagogical, and systemic factors that influence academic achievement in biochemistry among BNS students in Uganda. Findings from quantitative study underscore the importance of supportive student-lecturer relationships, and timely constructive feedback as critical factors that enhance academic achievement in biochemistry. These interpersonal dynamics are supplemented by qualitative insights which reveal the importance of appropriate curricular content, pedagogical preparedness of lecturers, stringent yet fair admission processes, and the provision of adequate physical and instructional resources by the universities.

Structured within the Input-Transformation-Output (ITO) conceptual framework, these findings suggest that when appropriate inputs such as students with adequate prior knowledge, lecturers with pedagogical skills, and conducive learning environments are in place, the transformation process is more likely to yield positive academic outcomes. The application of Critical Realist philosophy further enriches this understanding by affirming the layered nature of educational realities, where observable academic outcomes are underpinned by deeper generative mechanisms such as institutional policies, lecturer capabilities, and student readiness to learn.

Additionally, Constructivist learning theory affirms the role of interactive, student-centred teaching in fostering meaningful learning, thereby linking the quality of educational engagement to academic success.

Put together, these viewpoints offer a robust and coherent explanation of the factors influencing academic achievement in biochemistry, emphasizing the need for a holistic and intentional approach to improving and sustaining better academic achievement in biomedical sciences such as biochemistry in Uganda.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the conclusion about the study, recommendations arising from the conclusions, strength of the study, and contribution to the knowledge from this study.

6.1 Conclusion

This study examined the level of academic achievement in core biomedical sciences among Bachelor of Nursing Science students in Uganda and explored the sociodemographic, individual educational, and institutional factors associated with it. Overall, academic achievement in anatomy, physiology, and biochemistry demonstrates gradual progress but remains variable and shaped by contextual factors. Students' perceptions of their learning reflect both areas of confidence and areas of challenge, particularly within anatomy, underscoring the complex nature of biomedical sciences education in nursing education.

The study establishes that academic achievement in biomedical sciences is not determined by a single factor but emerges from the interaction of sociodemographic characteristics, student educational practices and background, career trajectories, and institutional practices.

Sociodemographic attributes such as age and region of origin function as structuring conditions that shape students' academic engagement and progression. Similarly, prior educational pathways and admission routes influence students' transition into degree-level biomedical sciences, highlighting the importance of alignment between foundational preparation and university expectations.

At the individual level, career choice patterns and learning approaches demonstrate that academic success in biomedical sciences extends beyond initial interest or motivation alone. Instead, academic outcomes reflect broader academic adaptation processes within the university environment. Prior academic performance at secondary level appears to have limited explanatory power for achievement at university level, suggesting that performance in biomedical sciences is shaped more strongly by experiences within the higher education context.

Institutionally, teaching approaches, relational dynamics between lecturers and students, and the nature of academic feedback form part of the structural environment within which learning occurs. Academic achievement in biomedical sciences is therefore embedded within pedagogical systems, instructional practices, and institutional conditions rather than being solely a product of student ability.

Taken together, the study concludes that academic achievement in biomedical sciences among BNS students in Uganda is multidimensional and context bound. It reflects the dynamic interaction between student characteristics, prior preparation, pedagogical approaches, and institutional environments.

Understanding academic achievement in biomedical sciences therefore requires an integrated perspective that recognizes both individual agency and structural influences within nursing education.

6.2 Recommendations

Based on the conclusions above, the following recommendations are made:

i) Universities should provide targeted academic support and mentorship to older students, those from regions outside central Uganda and those who select nursing as their first choice for university education. This will help these students at risk of performing poorly to adjust more effectively and improve their engagement with the biomedical sciences.

ii) Universities and the Ministry of Education and Sports should strengthen career guidance at secondary level to align students' interests with nursing education. This will help students to make better informed decisions about pursuing nursing, and what is expected in it especially the biomedical sciences. Career guidance will demystify nursing and its requirements, hence preparing students emotionally and mentally for the biomedical sciences component of the curriculum.

iii) Universities in conjunction with the Ministry of Education and Sports should revise current traditional curricula and adopt Competence Based Curricula (CBC) that encourage use of collaborative teaching and learning strategies such as group discussions, peer-assisted learning, problem-based learning to enhance student engagement and comprehension.

iv) Universities should provide pedagogical training for lecturers to strengthen their understanding and application of competence-based teaching strategies. This training should focus on effective competence-based teaching methods and strategies such as relational pedagogy, student-centered collaborative teaching and learning strategies and constructive feedback.

v) Universities should institutionalize standardized feedback practices that ensure students receive specific, timely, and actionable input aligned with course learning objectives.

vi) Universities and Ministry of Education and Sports should establish and promote flexible learning tracks such as part time and weekend studies or blended learning approaches that accommodate older students who may need to balance work, family and academic responsibilities.

vii) The Ministry of Education and Sports should review and harmonize the BNS curricula between diploma and degree programs to ensure smooth transition of diploma nurses and midwives to degree level.

viii) Universities and the Ministry of Education and Sports should revise the current criteria of considering academic performance at advanced level of secondary education to admit nursing students to universities.

It is hoped that implementation of these recommendations will enhance level of academic achievement in biomedical sciences among BNS students, thereby reducing course dropout rate, promoting timely completion of BNS program, and improving patient care outcomes.

6.3 Contribution to knowledge

This study presents fascinating findings. These findings contribute immensely to the current inadequate, inconsistent and scattered knowledge about the level of academic achievement in biomedical sciences and its correlates among BNS students in Uganda. To the best of my knowledge, there is not any previous study that has ever deeply explored the level of academic achievement in biomedical sciences and factors that correlate with it in Uganda.

For instance, for a long time, it has been held as gospel truth that students who perform very well at secondary school level do perform equally well at university, and this understanding has been informing Public Universities Joint Admission Board (PUJAB) to admit students to public universities. Whereas some people have been having a contrary view on this and have been advocating for pre-entry examinations, they have been lacking adequate scientific research evidence to support their contrary view. Our study now presents findings that can guide decision making on this matter. Again, no one knew that BNS students from central Uganda were most likely to perform better than those who came from other countries.

For a long time, it was known that students who had an initial interest and passion for nursing and gave it their first choice were more likely to be more motivated for the course and consequently perform better. As such, this is usually assessed in some pre-entry examinations for lower-level nursing courses. To the contrary, our study reveals that initial interest into the BNS course may not be enough internal drive to cause better academic achievement and possibly to become a better nurse. These are just a few examples of the seemingly simple but very impactful study findings presented by this study.

6.4 Strengths of the study

The first strength of this study is in its approach and design. This was a mixed methods study which utilized analytic cross-sectional design for quantitative and interpretive hermeneutic phenomenology for qualitative study. Being a mixed methods study provided an opportunity for the weaknesses of one approach to be offset by another approach. As such, findings from qualitative study provided deeper understanding of most of the quantitative study findings. The study was carried out at the four prominent universities namely Makerere University, Mbarara University of Science and Technology, Busitema University and Soroti University which represent all the regions of Uganda. In addition, census sampling technique was used to enroll participants for quantitative study which eliminated participant selection bias which contaminates many studies. Participants for qualitative study were senior academic staff who are believed to hold rich data on the phenomenon.

All the academic scores of students were verified to confirm their authenticity and inferential statistical data analysis was done using Linear Mixed Effect model (LME) which caters for the effect of non-homogeneous data. Inductive thematic analysis method was used which allowed study findings in form of themes to emerge from the data. Therefore, these studies can be generalized to other settings that are closely similar to the settings where this study was conducted.

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APPENDICES

Appendix I: Questionnaire

A5	What is your ethnic group?	1. Bantu ☐ 2. Hamites ☐ 3. Nilohamites ☐ 4. Nilotics ☐ 5. Other……………………………………..(specify)
A6	In which sub region in Uganda is your home district found?	1. Buganda ☐ 2. Bunyoro ☐ 3. Ankole ☐ 4. Tooro ☐ 5. West Nile ☐ 6. Lango ☐ 7. Teso ☐ 8. Bugisu ☐ 9. Bukedi ☐ 10. Acholi ☐ 11. Any other -----------------------------------(indicate)
A7	In which level of urbanization is your home located?	1. City ☐ 2. Municipality ☐ 3. Town ☐ 4. Rural village ☐
		5. Any other ------------------------------ (indicate)
A8	Are all your parents alive	1. Yes ☐ 2. No ☐
A9	If No in A8 above, is one of the parents a live or both died?	1. One parent is a live ☐ 2. Both parents died ☐
A10	What is/was the highest level of education of your father?	1. Never went to school ☐ 2. Primary level ☐ 3. Secondary level ☐ 4. Advanced level education ☐

		5. Certificate 6. Diploma 7. Degree 8. Masters 9. PhD 10. Not sure
A11	What is/was the highest level of education of your mother?	1. Never went to school 2. Primary level 3. Secondary level 4. Advanced level education 5. Certificate 6. Diploma 7. Degree 8. Masters 9. PhD 10. Not sure
A12	What is/was the occupation of your father?	1. Civil servant 2. Peasant 3. Self-employed: Business 4. Politics 5. Formal employment: N.G.O 6. Any other ---------------------------------- (specify)
A13	What is/was the occupation of your mother?	1. Civil servant 2. Peasant 3. Self-employed: Business 4. Politics 5. Housewife 6. Formal employment: N.G.O 7. Any other ---------------------------------- (specify)
A14	What is your marital status?	1. Officially married (in church, cultural,….) 2. Cohabiting/engaged (not official) 3. In sexual relationship 4. Single
A15	Do you have a paying job you do while studying?	1. Yes 2. No

A16	How many people do you stay with at home?	1. None 2. 1-2 people 3. 3-4 people 4. 5-6 people 5. More than 6 people	☐ ☐ ☐ ☐ ☐
A17	Where do you live while at school?	1. Privately rented room 2. University hostel 3. At home 4. Any other ……………………………….(Specify)	☐ ☐ ☐
A18	How many people do you stay with in the room while at university?	1. None 2. One person 3. Two people 4. Three people 5. More than 4 people	☐ ☐ ☐ ☐ ☐
A19	How far is it from where you live to the University?	1. Less than a km 2. Between 1 – 3 km 3. Between 4 - 6km 4. Between 7 -9 5. 10 km or more	☐ ☐ ☐ ☐ ☐ ☐
A20	To what extent does your parent(s) or guardian encourage, guide, or motivate you to concentrate on your studies?	1. Great extent 2. Some extent 3. Neutral 4. Not at all	☐ ☐ ☐ ☐

B: Academic achievement in anatomy, physiology and biochemistry

In this section, you are requested to write the marks (percentage score, letter award and grade point) you scored in the following courses: anatomy, physiology, biochemistry at first attempt (and subsequent attempts if the course was retaken).

B1	**Anatomy** 1 2 3 4	**Score** 1 ………………………………………………………………………. 2……………………………………………………………………….. 3………………………………………………………………………. 4………………………………………………………………………..
B2	**Physiology** 1 2 3 4	**Score** 1 ………………………………………………………………………. 2……………………………………………………………………….. 3………………………………………………………………………. 4………………………………………………………………………..
B3	**Biochemistry** 1 2 3 4	**Score** 1 ………………………………………………………………………. 2……………………………………………………………………….. 3………………………………………………………………………. 4………………………………………………………………………..
B4	For the questions below, express your views about the course units above by ticking in the space with the number and description that correspond with your most accurate response. For the last two statements, tick against the course chosen. *This is scored on a 5-point Likert scale with Strongly Disagree (SD) = 1, Disagree (D)= 2, Neutral (N)= 3, Agree (A)= 4, Strongly Agree (SA) = 5.* **Parameter** **Score** (SD) = 1, (D) = 2, (N) = 3, (A) = 4 (SA) =5 I feel satisfied with my performance in anatomy ……. …….. ……… ……….. ……… I feel satisfied with my performance in physiology ……. …….. ..……. ……….. ………. I feel satisfied with my performance in biochemistry ……. …….. …….. ……….. ………. My performance is appropriate for my effort ……. …….. ……. ……….. ……….	

	I feel knowledgeable in these three courses	…….	……..	…….	………..	……….
	I believe can perform better in these courses	…….	……..	…….	………..	……….
	I apply knowledge of these courses in patient care	…….	……..	…….	………..	……….
	This course was the most difficult of all (tick):	Anatomy	Physiology	Biochemistry		
	This course was the simpler of the three (tick):	Anatomy	Physiology	Biochemistry		

C: Individual educational factors associated with academic achievement in biomedical sciences among BNS students in Uganda

In this section, you are requested to answer questions about how you as an individual student contribute towards academic performance in biomedical science courses namely, anatomy, physiology, and biochemistry.

C1	Which type of entry scheme did you use to be admitted into this course	1. Advanced Level (UACE) results ☐ 2. Diploma in health science course ☐ 3. Mature age entry scheme ☐
C2	In which type of school did you complete your Ordinary Level (O-Level) of education?	1. Government, non U.S.E ☐ 2. Government, U.S.E ☐ 3. Private, Christian founded ☐ 4. Private, non-Christian founded ☐
C3	In which type of school did you complete your Advanced Level (A-Level) of education?	. Government, non-U.S.E ☐ 2. Government, U.S.E ☐ 3. Private, Christian founded ☐ 4. Private, non-Christian founded ☐ 5. Never went to A-Level ☐
C4	In which location was your Advanced Level school or Health Training Institution?	1. Urban, city or municipality ☐ 2. Semi- rural ☐ 3. Rural ☐ 4. Any other…………………………………….(specify

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C5	How many aggregates did you get at primary seven?	Write your agregates here……………………..
C6	How many aggregates did you get at O-Level?	Write your agregates here…………………….
C7	Indicate scores you got in Chemistry, biology, physics, Mathematics, and English at O level	Chemistry……………………………………….. Biology…………………………………………. Physics…………………………………………… Mathematics……………………………………… English…………………………………..……..
C8	How many A-Level points or/and CGPA at diploma did you get?	1. A-Level points ……………………………….. 2. CGPA at diploma (for diploma entry) ………….. 3. Not applicable ☐
C9	Indicate scores you got in Chemistry, biology, physics/Mathematics, and general paper at A level	Chemistry……………………………………………. Biology………………………………………………. Physics………………………………………………. Mathematics………………………………………… General paper……………………………………….. Not applicable……………………………………….
C10	Which choice was the nursing profession in your life	1. First ☐ 2. Second ☐ 3. Third ☐ 4. Any other choice…………………………….. (specify)
C11	To what extent are you proud to be a Bachelor nurse student?	1. Great extent ☐ 2. Less extent ☐ 3. Neutral ☐ 4. Not proud ☐ 5.

C12	Do you intend to change from nursing profession to another profession in future?	1. No ☐ 2. Yes ☐ 3. Not sure ☐
C13	If you were to choose, which nursing specialty would you prefer to practice after qualifying with BNS degree?	1. Midwifery ☐ 2. Medical-Surgical nursing ☐ 3. Public health nursing ☐ 4. Nursing education/teaching ☐ 5. Mental health nursing ☐ 6. Any other…………………………………......(specify)
C14	Do you have a job that requires you to dedicate some hours to it in a week?	1. Yes ☐ 2. No ☐ 3. At times ☐
C15	How many hours do you use to do private study or read on daily basis?	1. About an hour ☐ 2. 1-2 hours ☐ 3. 3-4 hours ☐ 4. 5-6 hours ☐ 5. Above 6 hours ☐ 6. Others ………………………………………(specify)
C16	During the time you studied biomedical science courses, how many hours did you use to do private study or read on daily basis?	1. About an hour ☐ 2. 1-2 hours ☐ 3. 3-4 hours ☐ 4. 5-6 hours ☐ 5. Above 6 hours ☐ 6. Others ……………………………………..(specify)
C17	Which electronic garget do you use for your studies?	1. Laptop ☐ 2. Smart phone ☐ 3. Tablet ☐ 4. Desktop ☐ 5. None ☐ 6. Any other…………………………………..(specify)
C18	To what extent are you engaged in games and sports at university?	1. Great extent ☐ 2. Less extent ☐ 3. Never ☐
C19	Do you sometimes miss classes/lectures	1. Yes ☐ 2. No ☐

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C20	If yes in C19 above, what is the commonest reason for missing lectures/classes?	1. Sickness ☐ 2. Financial constraints ☐ 3. Workplace ☐ 4. Other……………………………………..(specify)
C21	If you were to blame one person for your performance in exams of anatomy, physiology, and biochemistry; who would you blame?	1. Your self ☐ 2. Teachers/lecturers ☐ 3. Parents/guardian ☐ 4. Classmates or friends ☐ Any other…………………………………(specify)
C22	Who do you believe is responsible for your good performance in anatomy, physiology, and biochemistry?	1. Your self ☐ 2. Teachers/lecturers ☐ 3. Parents/guardian ☐ 4. Classmates or friends ☐ 5. Any other…………………………………..(specify)
C23	How often do you read from the university library?	1. Very often ☐ 2. Often ☐ 3. Sometimes ☐ 4. Rarely ☐ 5. Never ☐
C24	Choose only one resource you used most to study anatomy, physiology, and biochemistry	1. Lecture notes ☐ 2. Textbooks ☐ 3. Videos ☐ 4. Any other……………………………………(specify)
C25	While studying anatomy, physiology, and biochemistry, how often did you participate in group discussion or team learning?	1. Very often ☐ 2. Often ☐ 3. Sometimes ☐ 4. Rarely ☐ 5. Never ☐
C26	While studying anatomy, physiology, and biochemistry, on average, how many hours did you use to sleep/rest daily?	1. Less than 5 hours ☐ 2. 6-8 hours ☐ 3. 9-11 hours ☐ 4. Others………………………………………(specify)
C27	How adequate was the sleep stated in B26 above?	1. Adequate ☐ 2. Inadequate ☐ 3. Not sure ☐

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C28	To what extent are you confident that you will complete BNS course on time?	1. Great extent ☐ 2. Less extent ☐ 3. Neutral ☐ 4. No hope ☐

D: Institutional factors that influence academic achievement in biomedical sciences among BNS students in Uganda

In this section, you are requested to answer questions about how you believe the university contributes to your academic performance in biomedical science courses namely, anatomy, physiology, and biochemistry.

	Anatomy	*Physiology*	*Biochemistry*
D1: Are there times when teachers of the biomedical sciences named below missed teaching?			
	1. Yes ☐ 2. At times ☐ 3. No ☐ 4. Not sure ☐	1. Yes ☐ 2. At times ☐ 3. No ☐ 4. Not sure ☐	1. Yes ☐ 2. At times ☐ 3. No ☐ 4. Not sure ☐
D2: In your view, to what extent are the teachers of biomedical sciences named below knowledgeable in the course units they teach?			
	Anatomy 1. Great extent ☐ 2. Some extent ☐ 3. Neutral ☐	*Physiology* 1. Great extent ☐ 2. Some extent ☐ 3. Neutral ☐	*Biochemistry* 1. Great extent ☐ 2. Some extent ☐ 3. Neutral ☐
D3: In your view, do you think the teachers of biomedical sciences named below possess good teaching skills?			
	Anatomy 1. Yes ☐ 2. Some of them ☐ 3. No ☐ 4. Not sure ☐	*Physiology* 1. Yes ☐ 2. Some of them ☐ 3. No ☐ 4. Not sure ☐	*Biochemistry* 1. Yes ☐ 2. Some ☐ 3. No ☐ 4. Not sure ☐
D4: How good is your learning relationship with teachers of the biomedical sciences named below?			
	Anatomy 1. Very good ☐ 2. Good ☐ 3. Fair ☐ 4. Poor ☐ 5. Non-existent ☐	*Physiology* 1. Very good ☐ 2. Good ☐ 3. Fair ☐ 4. Poor ☐ 5. Non-existent ☐	*Biochemistry* 1. Very good ☐ 2. Good ☐ 3. Fair ☐ 4. Poor ☐ 5. Non-existent ☐
D5: To what extent do teachers of biomedical sciences named below create good environment for you to approach them and consult with ease?			
	Anatomy 1. Great extent ☐	*Physiology* 1. Great extent ☐	*Biochemistry* 1. Great extent ☐

<table>
<tr><td></td><td>2. Small extent
3. Neutral
4. Not at all</td><td>1. Small extent
2. Neutral
3. Not at all</td><td>2. Small extent
3. Neutral
4. Not at all</td></tr>
<tr><td colspan="4">D6: Does the university have online resources such as e-books, magazines, or videos for the courses named below?</td></tr>
<tr><td></td><td>Anatomy
1. Yes
2. At times
3. No
4. Not sure</td><td>Physiology
1. Yes
2. At times
3. No
4. Not sure</td><td>Biochemistry
1. Yes
2. At times
3. No
4. Not sure</td></tr>
<tr><td colspan="4">D7: Did you do practical as part of learning biomedical sciences named below?</td></tr>
<tr><td></td><td>Anatomy (cadaver dissection)
1. Yes
2. Rarely
3. No</td><td>Physiology
1. Yes
2. Rarely
3. No</td><td>Biochemistry
1. Yes
2. Rarely
3. No</td></tr>
<tr><td colspan="4">D8: To what extent do teachers of the biomedical sciences named below encourage you to learn in student groups?</td></tr>
<tr><td></td><td>Anatomy
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td><td>Physiology
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td><td>Biochemistry
1. Great extent
2. Small extent
3. Neutral
Not at all</td></tr>
<tr><td colspan="4">D9: To what extent do teachers of biomedical sciences named below sit in your discussion groups to guide you how to approach learning?</td></tr>
<tr><td></td><td>Anatomy
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td><td>Physiology
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td><td>Biochemistry
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td></tr>
<tr><td colspan="4">D10: To what extent did you watch videos to learn biomedical sciences named below?</td></tr>
<tr><td></td><td>Anatomy
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td><td>Physiology
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td><td>Biochemistry
1. Great extent
2. Small extent
3. Neutral
4. Not at all</td></tr>
<tr><td colspan="4">D11: Which most teaching method do teachers of biomedical sciences named below use in class to teach?</td></tr>
<tr><td></td><td>Anatomy
1. Lecture
2. Tutorials</td><td>Physiology
1. Lecture
2. Tutorials</td><td>Biochemistry
1. Lecture
2. Tutorials</td></tr>
</table>

	3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ 6. Any other………………..	3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other………………	3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other……………
D12: Which teaching method did you like most to learn biomedical sciences named below?			
	Anatomy 1. Lecture ☐ 2. Tutorials ☐ 3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other……………….	*Physiology* 1. Lecture ☐ 2. Tutorials ☐ 3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other……………….	*Biochemistry* 1. Lecture ☐ 2. Tutorials ☐ 3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other……………….
D13: Which teaching method did you dislike most to learn biomedical sciences named below?			
	Anatomy 1. Lecture ☐ 2. Tutorials ☐ 3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other………………...	*Physiology* 1. Lecture ☐ 2. Tutorials ☐ 3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other……………….	*Biochemistry* 1. Lecture ☐ 2. Tutorials ☐ 3. Demonstrations ☐ 4. Problem-based ☐ 5. Group presentation ☐ Any other……………
D14: Which teaching/learning approach do teachers of biomedical sciences named below use most?			
	Anatomy 1. Face to face/Physical ☐ 2. Online ☐ 3. Blended/mixture ☐ Any other…………………(specify)	*Physiology* 1. Face2face/Physical ☐ 2. Online ☐ 3. Blended/mixture ☐ Any other………(specify)	*Biochemistry* 1. Face2face/Physical ☐ 2. Online ☐ 3. Blended/mixture ☐ Any other…………..(specify)
D15: Which teaching/learning approach did you like most to learn biomedical sciences named below?			
	Anatomy 1. Face to face/Physical ☐ 2. Online ☐ 3. Blended/mixture ☐ Any other…………………(specify)	*Physiology* 1. Face2face/Physical ☐ 2. Online ☐ 3. Blended/mixture ☐ Any other………(specify)	*Biochemistry* 1.Face2face/Physical ☐ 2. Online ☐ 3. Blended/mixture ☐ Any other……………..(specify)

D16: Do teachers of biomedical sciences named below allocate you some hours on the teaching timetable for Self-Directed Learning (SDL)?			
	Anatomy 1. Yes ☐ 2. At times ☐	*Physiology* 1. Yes ☐ 2. At times ☐	*Biochemistry* 1. Yes ☐ 2. At times ☐

	3. No ☐ 4. Not sure ☐	3. No ☐ 4. Not sure ☐	3. No ☐ 4. Not sure ☐
D17: Do teachers of biomedical sciences named below take you to the hospital to learning from patients?			
	Anatomy 1. Yes ☐ 2. At times ☐ 3. No ☐ 4. Not sure ☐	*Physiology* 1. Yes ☐ 2. At times ☐ 3. No ☐ 4. Not sure ☐	*Biochemistry* 1. Yes ☐ 2. At times ☐ 3. No ☐ 4. Not sure ☐
D18: Do teachers of biomedical sciences named below give you back answer sheets of the progressive tests?			
	Anatomy 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Physiology* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Biochemistry* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐
D19: Do teachers of biomedical sciences named below use progressive test results to explain to you correct answers for the questions you failed?			
	Anatomy 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Physiology* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Biochemistry* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐
D20: While teaching, do teachers of biomedical sciences named below start from what you know and slowly progress to what you do not know?			
	Anatomy 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Physiology* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Biochemistry* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐
D21: While teaching biomedical sciences named below, do teachers give you written tutorial problems which require you to write your own learning objectives?			
	Anatomy 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Physiology* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐	*Biochemistry* 1. Yes ☐ 2. Rarely ☐ 3. Not sure ☐ 4. No ☐
D22: To what extent does your university give you a free week of revision to prepare for end of semester exams of the biomedical sciences named below?			
	Anatomy 1. Great extent ☐ 2. Small extent ☐	*Physiology* 1. Great extent ☐ 2. Small extent ☐	*Biochemistry* 1. Great extent ☐ 2. Small extent ☐

Appendix II: IREC LETTER

MTRH/MU-INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/398/2022
Approval Number: 0004463

29th June, 2023

Munguiko Clement,
Moi University,
School of Medicine,
Medical Education Department,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Mr. Munguiko,

ACADEMICS ACHIEVEMENT IN BIOMEDICAL SCIENCES AND ITS CORRELATES AMONG STUDENTS OF BACHELOR OF NURSING SCIENCE PROGRAM IN UGANDA

This is to inform you that ***MTRH/MU-IREC*** has reviewed and approved the above referenced research proposal. Your application approval number is ***FAN: 0004463.*** The approval period is **29th June, 2023- 28th June, 2024.**
This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, Material Transfer Agreements (MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***MTRH/MU-IREC***.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***MTRH/MU-IREC*** within 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***MTRH/MU-IREC*** within 72 hours.
v. Clearance for export of biological specimens must be obtained from ***MOH at the recommendation of NACOSTI*** for each batch of shipment.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***MTRH/ MU-IREC.***

Prior to commencing your study; you will be required to obtain a research license from the National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and other relevant clearances from study sites including a written approval from the CEO-MTRH which is mandatory for studies to be undertaken within the jurisdiction of Moi Teaching & Referral Hospital (MTRH) and its satellites sites.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
29 JUN 2023
APPROVED

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc	CEO	-	MTRH	Dean	-	SOP	Dean	- SOM
	Principal	-	CHS	Dean	-	SON	Dean	- SOD

Appendix III: Letter of transmittal and consent for quantitative data collection

Participant registration No................................

PART 1: INFORMATION SHEET

Introduction to the study

Greetings! My name is Munguiko Clement. I am a student of Doctor of Philosophy (PhD) at Moi University, Kenya. I am conducting a study on: *Academic Achievement in Biomedical Sciences and its Correlates among students of Bachelor of Nursing Sciences program in Uganda.*

You are being requested to participate in this research study. The information provided here is to inform you about the study. Please read this form carefully. You will be given a chance to ask questions.

Taking part in this research study is voluntary. Saying no will not affect your rights to health care or any other services. Your rights and privilege regarding learning at this university will not be affected in any way if you decide not to take part in this study. You are also free to withdraw from this study at any time. If after data collection you choose to quit, you will be at liberty to request that information provided by you be destroyed under supervision.

This would be before data is de-identified and aggregated. You will be notified if new information becomes available about the risks or benefits of this research. You will receive a copy of this form after it is signed.

Purpose of the study

The main purpose of this study is to collect data on the extent of academic achievement in biomedical science courses and its correlates among students of Bachelor of Nursing Sciences in Uganda. Findings from this study will be very helpful to the stakeholders who may need to re-design and implement evidence-based interventions that aim at improving and sustaining good academic achievement in biomedical science courses among students of Bachelor of Nursing Science program in Uganda and beyond.

Study site

This study will be carried out in four (4) public universities of Uganda. These universities are Makerere University, Soroti University, Mbarara University of Science and Technology, and Busitema University.

THE AIDS SUPPORT ORGANISATION RESEARCH COMMITTEE
27 OCT 2024
Approved Valid Until

Study population

This study will involve collection of data from students of Bachelor of Nursing Science program and teachers of biomedical science courses namely, anatomy, physiology, and biochemistry. Teachers and students involved in teaching and learning of biomedical sciences respectively have been selected to participate in this study because they will provide the much-needed information about biomedical sciences.

Study procedure

About 200 students pursuing a Bachelor of Nursing Science program will participate in this study. Also, teachers of biomedical science courses namely anatomy, physiology and biochemistry will participate in this study to provide information needed. Data on level of academic achievement in biomedical sciences, sociodemographic, educational, and institutional variables will be collected. To understand the extent you performed in exams, we will request you to allow us access your marks for anatomy, physiology, and biochemistry through your head of department, course coordinator or lecturer. This information will remain confidential with us and will only be used for the study purpose. Your examination results will not be published anywhere in a manner that will reveal your identity. Collected data will be analyzed and findings will be widely disseminated. However, your identity will be concealed, and no one will know that you are one of those who volunteered such information.

If you agree to participate in this study, you will do the following:

If you agree to participate in this study, you will be requested to provide your honest responses on the above topic by answering questions below. These questions have been written in a simplified English language and require very short answers. This will require only about 30 minutes of your time. Thank you very much!

Benefits

The information you provide today will help students, teachers, universities, and the government to design ways to improve acquisition of knowledge and skills in biomedical science courses. Increase in knowledge and skills will go a long way in decreasing the high failure rate in these courses which is currently a big concern. It will also contribute towards decreasing the student dropout rate because of high failure scores, which currently is also a big challenge.

In the long term, findings from this study will contribute significantly towards passing out of more bachelor nurses with biomedical science base which is needed to provide evidence based clinical care.

Risks

In this study, you will only respond to questions about factors that are likely to influence your level of achievement in the named biomedical science courses. However, while participating in this study, you may experience very minimal emotions.

When this happens, kindly I request you to immediately let me know. Otherwise, you will not be subjected to any form of physical harm.

Payments and reimbursements

You will not receive any payment for participating in this study. However, the time you dedicate to this study will be compensated with ten thousand (10,000/-) Uganda shillings. In addition, your participation will be highly appreciated.

Cost

You will not meet any cost while participating in this study.

Risk and compensation

This is a non-experimental study and therefore you will not suffer any form of physical injury because of participating in this study. Accordingly, no compensation for the physical harm will be paid.

Confidentiality

All reasonable efforts will be made to keep your information protected (private and confidential). Using or sharing ('disclosure') of such information will follow National Privacy Guidelines. By signing the consent document for this study, you are giving permission ('authorization') for the use and disclosure of your study information. We may need to share your protected information with National Council of Higher Education, Uganda Nurses and Midwives Council, Ministry of Education and Sports of Uganda and National Council of Science and Technology. However, while sharing the information, we shall not disclose your identity and that of your university.

We will retain your research records for at least six years after the study is completed. At that time, the research information will be destroyed by burning.

If you decide to withdraw your permission to use your personal data, contact the Principal Investigator in writing and let him know your decision.

At that time, we will stop further collection of any information about you. However, the health information collected before this withdrawal may continue to be used for the purposes of reporting and research quality.

Contacts

In case you need to contact any person for further information or reporting any occurrence regarding this study, please contact the following:

1. Mr. Clement Munguiko, the principal investigator: 0771436963
2. Dr. Adrian Jjuuko, chair TASO REC: 0782169505

PART II: CONSENT OF PARTICIPANT

I have read the description of the research study. The investigator or his representative has explained to me the study and has answered all the questions I have currently.

I have been told of the risks, discomfort, and possible benefits of the study. I freely volunteer to take part in this study.

………………………………….	…………………………	…………………………..
Registration number of participant	Signature of participant	Date and time
………………………………..	……………………………	…………………………….
Name of person obtaining consent	Signature of person obtaining consent	Date and time
……………………………....	……………………………	…………………………..
Name of the Principal Investigator	Signature of Investigator	Date and signature

THE AIDS SUPPORT ORGANISATION
27 OCT 2024
Approved, Valid Until:..........
RESEARCH ETHICS COMMITTEE

Munguiko Clement
Moi University
School of Medicine
P.O Box 4606-30100,
ELDORET, KENYA

To the Research Participant,

Dear sir/madam

RE: REQUEST FOR PERMISSION TO ACCESS YOUR EXAMINATION RESULTS

I thank you for volunteering to participate in this study. Your participation in this study will contribute immensely to the understanding of the level of academic achievement in biomedical science courses and what can be done to improve it in Uganda. Therefore, we will need a lot of credible data to document this information. To understand the extent you performed in exams, we will need to access your examination results of some biomedical science courses.

This is therefore to request you to allow us to access your marks for anatomy, physiology, and biochemistry through your head of department, course coordinator or lecturer. This information will remain very confidential with us and will only be used for the study purpose. Your examination results will not be published anywhere in a manner that will reveal your identity. Your name and registration number will not be documented anywhere in the publications. Therefore, this information will always remain anonymous. Should you need any further information, please contact me on 0771436963 or Dr. Adrian Jjuuko, chair TASO REC: 0782169505.

If you permit us to access your examination results, kindly sign in the space shown below.

Thank you,

THE AIDS SUPPORT ORGANISATION
27 OCT 2024
Approved, Valid Until:.........
RESEARCH ETHICS COMMITTEE

CLEMENT MUNGUIKO
PRINCIPAL INVESTIGATOR

....
SIGNATURE FOR PARTICIPANT

Appendix IV: Letter of transmittal and consent for qualitative data collection

University where participant works ……………………………………………………………..

Biomedical course(s) that participant teach…………………………………………………..

PART 1: INFORMATION SHEET

Introduction to the study

Greetings! My name is Munguiko Clement. I am a student of Doctor of Philosophy (PhD) at Moi University, Kenya. I am conducting a study on: *Academic Achievement in Biomedical Sciences and its Correlates among students of Bachelor of Nursing Sciences program in Uganda.*

You are being requested to participate in this research study. The information provided here is to inform you about the study. Please read this form carefully. You will be given a chance to ask questions.

Taking part in this research study is voluntary. Saying no will not affect your rights to health care or any other services. Your rights and privilege regarding learning at this university will not be affected in any way if you decide not to take part in this study. You are also free to withdraw from this study at any time. If after data collection you choose to quit, you will be at liberty to request that information provided by you be destroyed under supervision. This would be before data is de-identified and aggregated. You will be notified if new information becomes available about risks or benefits of this research. You will receive a copy of this form after it is signed.

Purpose of the study

The main purpose of this study is to collect data on the extent of academic achievement in biomedical science courses and its correlates among students of Bachelor of Nursing Sciences in Uganda. Findings from this study will be very helpful to the stakeholders to re-design and implement evidence-based interventions that aim at improving and sustaining good academic achievement in biomedical science courses among students of Bachelor of Nursing Science program in Uganda and beyond.

Study site

This study will be carried out in four (4) public universities of Uganda. These universities are Makerere University, Soroti University, Mbarara University of Science and Technology, and Busitema University. Thank you for being one of the participants!

Study population

This study will involve collection of data from students of Bachelor of Nursing Science program and teachers of biomedical science courses namely, anatomy, physiology, and biochemistry. Teachers and students involved in teaching and learning of biomedical sciences respectively have been selected to participate in this study because they will provide the much-needed information about biomedical sciences.

THE AIDS SUPPORT ORGANISATION
27 OCT 2024
Approved, Valid Until:...
RESEARCH ETHICS COMMITTEE

Study procedure

About 200 students pursuing a Bachelor of Nursing Science program will participate in this study. Also, at least four (4) teachers of biomedical science courses namely anatomy, physiology and biochemistry will participate in this study to provide information needed. Data on level of academic achievement in biomedical sciences, sociodemographic, educational, and institutional variables will be collected. Collected data will be analyzed and findings will be widely disseminated. However, your identity will be concealed, and no one will know that you are one of those who volunteered such information.

If you agree to participate in this study, you will do the following:

If you agree to participate in this study, you will be requested to provide your honest views on the above topic by having an in-depth conversation with the researcher. You will be free to answer questions posed to you by the researcher in any way you like. This conversation will require only about thirty (30) minutes to one (1) hour of your time. Thank you very much!

Benefits

The information you provide today will help students, teachers, universities, and the government to design ways how to improve acquisition of knowledge and skills in biomedical science courses. Increase in knowledge and skills will go a long way in decreasing high failure rate in these courses which is currently a big concern. It will also contribute towards decreasing the student dropout rate because of high failure scores which currently is also a big challenge. In the long term, findings from this study will contribute significantly towards passing out of more bachelor nurses with biomedical science base which is needed to provide evidence based clinical care.

Risks

In this study, you will only respond to questions about factors that are likely to influence your level of achievement in the named biomedical science courses. However, while participating in this study, you may experience very minimal emotions.

When this happens, kindly I request you to immediately let me know. Otherwise, you will not be subjected to any form of physical harm.

Payments and reimbursements

You will not receive any payment for participating in this study. However, the time you will spend on this study will be compensated with ten thousand Uganda shillings (10,000/=).

THE AIDS SUPPORT ORGANISATION
27 OCT 2024
Approved, Valid Until:...
RESEARCH ETHICS COMMITTEE

Cost

You will not meet any cost while participating in this study.

Compensation

You will not be compensated for participating in this study. This is because researcher does not expect any form of injury to you because of participating in this study. However, your participation in this study will be greatly appreciated.

Confidentiality

All reasonable efforts will be made to keep your information protected (private and confidential). Using or sharing ('disclosure') of such information will follow National Privacy Guidelines. By signing the consent document for this study, you are giving permission ('authorization') for the use and disclosure of your study information. We may need to share your protected information with National Council of Higher Education, Uganda Nurses and Midwives Council, Ministry of Education and Sports of Uganda and National Council of Science and Technology. We will retain your research records for at least six years after the study is completed. At that time, the research information will be destroyed by burning. If you decide to withdraw your permission to use your personal data, contact the Principal Investigator in writing and let them know your decision. At that time, we will stop further collection of any information about you. However, the health information collected before this withdrawal may continue to be used for the purposes of reporting and research quality.

Contacts

In case you wish to contact us, please reach out to us on the following lines.

1. Clement Munguiko, Principal Investigator: 0771436963
2. Dr. Adrian Jjuuko, Chair TASO REC: 0782169505

Appendix V: Clearance Letter from Busitema University

BUSITEMA UNIVERSITY
Pursuing Excellence

P.O. Box 236, Tororo, Uganda
Gen: +256 - 45 444 8834
Dir: +256 - 45 443 6517
Email: info@adm.busitema.ac.ug
www.busitema.ac.ug

DIRECTORATE OF GRADUATE STUDIES, RESEARCH AND INNOVATION

26th March 2024

To All Staff and Students

AUTHORIZATION FOR MR. CLEMENT MUNGUIKO TO COLLECT DATA

The Directorate of Graduate Studies Research and Innovations (DGSRI) is pleased to introduce to you the above-mentioned person who is interested in conducting data collection exercise at Busitema University Faculty of Health Sciences Mbale Campus.

Mr. CLEMENT MUNGUIKO is a staff of Soroti University who is to carry out data collection on the study title: **"Academic achievement in biomedical sciences and its correlates among students of Bachelor of Nursing Sciences program in Uganda."**

Mr. Clement Munguiko from Soroti University will collect data from Busitema University Faculty of Health Sciences Mbale Campus from staff and students to be used specifically for academic purpose, we therefore request you to accord him the necessary assistance and cooperation required.

Sincerely,

Samson Rwahwire, Ph.D., NEFF., FUNAS
Associate Professor
DIRECTOR

Appendix VII: TESO REC Final Approval Letter

The AIDS Support Organisation (TASO) Uganda Ltd.

TASO Headquarters
Mulago Hospital Complex
P.O. Box 10443, Kampala-Uganda
Tel: +256 414 532 580/1
Fax: +256 414 541 288
Email: mail@tasouganda.org
Website: www.tasouganda.org

27/10/2023

To: CLEMENT MUNGUIKO

Soroti university 0771436963

Type: Initial Review

Re: TASO-2023-261: ACADEMIC ACHIEVEMENT IN BIOMEDICAL SCIENCES AND ITS CORRELATES AMONG STUDENTS OF BACHELOR OF NURSING SCIENCE PROGRAM IN UGANDA

I am pleased to inform you that at the **112th** convened meeting on **27/10/2023**, the The AIDS Support Organization (TASO) REC meeting voted to approve the above referenced application.
Approval of the research is for the period of **27/10/2023** to **27/10/2024.**

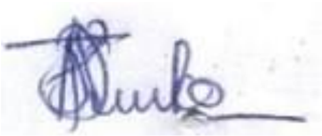
As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re- review and approval **prior** to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **eight weeks** prior to the expiration date of **27/10/2024** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by The AIDS Support Organization (TASO) REC:

No.	Document Title	Language	Version Number	Version Date
1	Third response to comments matrix	English	3	2023-10-27
2	Protocol	English	4	2023-10-27
3	Informed consent form for the recruitment of research participants	English	4	2023-10-27
4	Second response matrix to the comments	English	3	2023-10-01
5	Protocol	English	3	2023-10-01
6	Protocol	English	3	2023-10-01
7	Response matrix	English	1	--
8	Protocol	English	2 (Protocol with track changes)	2023-09-20
9	Protocol	English	2 (Clean Protocol)	2023-09-20
10	Protocol	English	1	2023-08-11
11	Proof of ethical approval if the protocol originates from outside Uganda/International researchers	English	1	2023-07-19
12	Informed consent form for the recruitment of research participants	English	1	2023-07-19
13	Informed consent form for the recruitment of research participants	English	1	2023-07-19
14	CVs of the investigators	English	1	2023-07-19
15	Prior Ethical Approval	English	1	2023-07-19
16	Data collection tools	English	1	2023-07-19
17	Data collection tools	English	1	2023-07-19

Yours Sincerely



Dr.Adrian Jjuuko
For: The AIDS Support Organization (TASO) REC

Appendix VII: Key Informant Interview Guide

1. **Self-introduction and ground setting**
   -Name
   -Qualifications, title
   -Specialty
   -Introduction of the study – transmittal letter and consent
2. **If you were asked to describe the current BNS curriculum, how would you describe it?**
   -Type
   -Delivery practices, strategies, and methods
   -Constructive alignment
   -Content integration
   -Assessment practices, feedback, quality assurance frameworks, performance level
3. **Let us talk about biomedical science courses namely, anatomy, physiology and biochemistry.**
   - Coverage in the curriculum, level of difficulty
   - Relevancy to BNS students
   -Teaching and learning strategies and methods
4. **If you were asked to describe BNS students, how would you describe them?**
   -Prior knowledge of biological sciences
   -Admission requirements
   -Pre-entry examinations
   -Interest, commitment, and motivation to study
   -Attendance to lectures, participation in tutorials/group work
5. **Let us talk about the university.**
   -Adherence to quality assurance standards including availability and functionality of curriculum implementation committee
   -Teacher: student ratio
   -Teachers' teaching experience, level, and qualifications
   -Pedagogical training of teachers including in service workshops/seminars
   -Teaching and learning environment
   -Internet connectivity
   -Availability and access to library, cadaver dissection, and practical laboratories
   -Availability and access to online educational resources such as e-books
   -Availability and access to internet connected computers, educational videos, charts and models
   -Availability and access to students' hostels (private or public)
   -Description of teaching-learning

THE AIDS SUPPORT ORGANISATION
27 OCT 2024
Approved, Valid Until:..........
RESEARCH ETHICS COMMITTEE

6. **In conclusion, if you were asked to summarize the academic achievement in biomedical science courses namely, anatomy, physiology, and biochemistry among BNS students, how would you describe it?**

   - The proportion of BNS students who excel, perform well, pass, and fail examinations of anatomy, physiology, and biochemistry

   -Sociodemographic factors likely to influence their academic achievement in biomedical sciences namely anatomy, physiology, and biochemistry

   -Individual students' related factors likely to influence their academic achievement in biomedical sciences namely anatomy, physiology, and biochemistry

   -Institutional related factors likely to influence their academic achievement in biomedical sciences namely anatomy, physiology, and biochemistry

END

Thank you very much for your time and honest answers. It has been a very fruitful discussion. You have made a significant contribution towards improving the teaching and learning of biomedical sciences in Uganda and beyond.

THE AIDS SUPPORT ORGANISATION
27 OCT 2024
Approved, Valid Until:.........
RESEARCH ETHICS COMMITTEE

Appendix VIII: UNCST Approval Letter

Uganda National Council for Science and Technology
(Established by Act of Parliament of the Republic of Uganda)

Our Ref: HS3522ES

CLEMENT MUNGUIKO SOROTI UNIVERSITY
Soroti

29 February 2024

Re: Research Approval: ACADEMIC ACHIEVEMENT IN BIOMEDICAL SCIENCES AND ITS CORRELATES AMONG STUDENTS OF BACHELOR OF NURSING SCIEN

CE PROGRAM IN UGANDA

I am pleased to inform you that on **29/02/2024**, the Uganda National Council for Science and Technology (UNCST) approved the above referenced research project. The Approval of the research project is for the period of **29/02/2024** to **01/03/2025**.

Your research registration number with the UNCST is **HS3522ES**. Please, cite this number in all your future correspondences with UNCST in respect of the above research project. As the Principal Investigator of the research project, you are responsible for fulfilling the following requirements of approval:

1. Keeping all co-investigators informed of the status of the research.

2. Submitting all changes, amendments, and addenda to the research protocol or the consent form (where applicable) to the designated Research Ethics Committee (REC) or Lead Agency for re-review and approval **prior** to the activation of the changes. UNCST must be notified of the approved changes within five working days.

3. For clinical trials, all serious adverse events must be reported promptly to the designated local REC for review with copies to the National Drug Authority and a notification to the UNCST.

4. Unanticipated problems involving risks to research participants or other must be reported promptly to the UNCST. New information that becomes available which could change the risk/benefit ratio must be submitted promptly for UNCST notification after review by the REC.

5. Only approved study procedures are to be implemented. The UNCST may conduct impromptu audits of all study records.

6. An annual progress report and approval letter of continuation from the REC must be

submitted electronically to UNCST. Failure to do so may result in termination of the research project.

Please note that this approval includes all study related tools submitted as part of the application as shown below:

No.	Document Title	Language	Version Number	Version Date
	Project Proposal	English	3	
1	Approval Letter	English		
2	Administrative Clearance	English		
2	Consent for quantitative study arm	English	3	11 February 2024
3	interview guide	English	3	11 February 2024

Yours sincerely,

Hellen Opolot
For: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

LOCATION/CORRESPONDENCE

Plot 6 Kimera Road, Ntinda
P.O. Box 6884
KAMPALA, UGANDA

COMMUNICATION

TEL: (256) 414 705500
FAX: (256) 414-234579
EMAIL: info@uncst.go.ug
WEBSITE: http://www.uncst.go.ug