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Educational factors influencing academic achievement in biomedical sciences among undergraduate nursing students in Uganda: analytical cross-sectional study

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Abstract

Introduction Biomedical science courses, including anatomy, physiology, and biochemistry, are challenging for many undergraduate nursing students. This study explored academic achievement in these subjects and the impact of student educational factors on performance among nursing students in Uganda.

Methods Analytical cross-sectional study of 208 nursing students from four Ugandan public universities examined academic achievement in biomedical sciences. Using Grade Point Average (GPA) and letter grades as measures, the study analysed the influence of student educational factors like prior academic performance, career choice, and learning methods through Welch's Analysis of Variance, Pearsons's correlation and Linear Mixed-Effects model.

Results Academic achievement varied slightly across universities, with physiology having the highest mean GPA of 2.89 (1.83–3.70) and anatomy the lowest at 2.63 (2.04–3.30), resulting in an overall GPA of 2.80 ± 0.747. Most students received C (37%) and D (33.7%) grades. Choosing nursing as a lower-priority career ($\beta = 0.42$, 95% CI 0.08–0.76, $p = 0.02$) and infrequent participation in group discussions ($\beta = -0.61$, CI −1.21 to −0.12, $p < 0.001$) influenced academic achievement in biomedical sciences. Secondary school performance showed negligible correlation with biomedical science GPA ($r = 0.1163$).

Conclusion Academic achievement in biomedical sciences among Ugandan nursing students is marginal to moderate, with most earning C and D grades. Universities should provide extra support to students who select nursing as their first choice while continuing to admit those who choose nursing as a later option. Encouraging small group discussions among students could also be beneficial.

Keywords Academic · Performance · Biomedical · Sciences · Nursing

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1 Introduction

Biomedical sciences encompass courses such as anatomy, physiology, and biochemistry which degree nursing students undertake during the first one or two years of their academic program [1, 2]. 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 [3, 4]. 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 [5].

The need for knowledge of biomedical sciences among undergraduate nursing students is anchored in 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 [6]. Self determination theory emphasizes the role of intrinsic motivation in teaching and learning in the three psychological domains namely, autonomy, competence and relatedness [7]. 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 [7]. 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 cognitive load. This reduction allows nursing students to receive, process, and retain clinical knowledge more efficiently [8].

Therefore, academic achievement in biomedical sciences, defined as the extent to which students achieve predetermined learning objectives and intended learning outcomes is a key determinant of competency in nursing education.

Accordingly, biomedical science courses have been shown to predict the quality of nursing care that nurses ultimately provide [9]. For example, Bakon, Craft [10] highlighted that greater knowledge of biomedical sciences among nursing students is associated with improved patient care outcomes. Similarly, Wood, Chandler [11] noted that insufficient knowledge of biomedical sciences among nursing students raises concerns about patient safety.

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 [12, 13]. Previous studies indicate that globally, between 20.0 and 50.0% of the nursing students perform poorly in biomedical sciences [14, 15]. 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 [16]. A study in South Africa found that 30.0% to 46.0% of nursing students registered fail scores in biomedical science courses [17]. In Ethiopia, a similar study also found that about half of the medical students scored below a B grade in anatomy examination [18].

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 [19]. 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 [20].

In Uganda, as in many other developing 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 4-year Bachelor of Nursing Science 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. Although the extent of academic achievement in biomedical sciences among nursing students is poorly documented, a significant proportion of degree nursing students often register failing scores, while the majority who pass do so with marginal or moderate grades. Regrettably, many of the nursing students who fail biomedical science courses drop out of their academic programs, while others face delays due to difficulties progressing smoothly. Even those who advance often encounter challenges with clinical courses, which rely heavily on the foundational knowledge provided by biomedical sciences [21].

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 [22]. 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.

Academic achievement in biomedical sciences among nursing degree students is a critical concern, yet the influence of student educational factors such as commitment to learning, prior academic performance, career choice, and learning methods on academic achievement remains insufficiently understood. This gap has hindered efforts to address the issue, leaving many students struggling without support. To address this gap, we conducted a study to examine the level of academic achievement in biomedical sciences and the influence of student educational factors on academic performance among undergraduate nursing students in Uganda. Based on this, we formulated two hypotheses: the null hypothesis, stating that no student educational factors influence academic achievement, and the alternative hypothesis, proposing that there are student educational factors that significantly impact academic achievement among these students.

2 Methods

2.1 Study design and site

Analytical cross-sectional study was conducted between April and June 2024 at four public universities in Uganda offering undergraduate nursing programs. This design was preferred because it allows for the simultaneous measurement of exposure and outcome within a single time period. However, it does not establish temporal directionality between them [23]. Private universities were excluded from study due to differences in funding sources, student sociodemographic characteristics, academic backgrounds, leadership and management structures, institutional missions and visions, policies, admission requirements, and tuition fees. Universities were purposively sampled to represent each region of Uganda, ensuring fair regional representation.

2.2 Study participants and sampling method

The target population of this study comprised all undergraduate nursing students in Uganda who had completed biomedical sciences and were enrolled in a 4-year degree nursing program at public universities. Due to the small study population, we employed a census sampling approach, including all nursing students who met the criteria of being in the target population and have all their examination results available on their online portals. Students who had transferred credits from other universities, declined to consent, or were absent on the day of data collection were excluded. Accordingly, 208 students participated in the study.

2.3 Data collection instrument

The structured questionnaire was developed by the principal investigator based on existing literature and validated by the two co-authors and two peer researchers, all experts in nursing education. It consisted of 51 short, structured items and included sections on participants' sociodemographic characteristics, academic achievement, and educational factors. Academic achievement was defined as the extent to which undergraduate nursing students met the learning

objectives and outcomes in biomedical sciences. Student educational factors encompassed the cognitive, behavioural, and psychological processes that influence how students receive, process, and apply knowledge in biomedical sciences. These factors included prior academic performance, the type of school previously attended, mode of admission to the nursing program, nursing career choice, locus of control (students' sense of responsibility for their academic achievement), intention to continue in the nursing profession, commonly used learning methods, and lecture attendance. The questionnaire was pretested with 30 nursing students from a non-participating university to ensure clarity and reliability. Its internal consistency was assessed, yielding a Cronbach's alpha of 0.9366, indicating excellent reliability.

2.4 Data collection procedure

After obtaining ethical approval and administrative clearance from the vice chancellors of the participating universities, the principal investigator scheduled visits to each university on separate days. Accompanied by a research assistant who held a postgraduate qualification in health research but was still trained by the principal investigator on data collection, the investigator engaged with students through their heads of departments and class representatives. Students were informed about the study, and those who consented provided their mobile numbers, which were used to share an online questionnaire. Participants completed and submitted the questionnaire immediately via Kobo Collect software. Upon submission, the research assistant asked each participant to access their online results portal. The submitted data, including grades in anatomy, physiology, and biochemistry, were then verified before the student's departure.

2.5 Data analysis

The dependent variable was the level of academic achievement, measured in the form of Grade Point Average (GPA), while the independent variables were student educational factors such as the previous school attended, type of admission, nursing career choice, study methods, prior academic performance, lecture attendance, and locus of control. The GPA score was calculated for each biomedical course and for the three courses combined.

Descriptive statistics were used to characterize the sample and academic achievement. Welch's Analysis of Variance (ANOVA) was used for bivariate analyses. Pearson correlation was applied to assess the relationship between academic achievement at the advanced level of secondary education and university-level academic achievement in biomedical sciences. A Linear Mixed-Effects model was employed for multivariate analyses, with the university as a random effect. All analyses were performed using R (version 4.4.1), with statistical significance defined as $p < 0.05$.

2.6 Ethical considerations

The study was approved by The AIDS Support Organization Research Ethics Committee (TASO-2023-261) and registered with the Uganda National Council for Science and Technology (HS3522ES). We obtained written informed consent from all participants.

3 Results

3.1 Characteristics of study participants and university enrollment distribution

A total of 208 nursing students participated in the study. The majority were male (58.7%, n = 122), aged 20–24 years (71.6%, n = 149), single by marital status (79.3%, n = 165) and on government sponsorship (54.3%, n = 113). In terms of university distribution, 25.5% (n = 53) were from University A, 13.9% (n = 29) from University B, 28.4% (n = 59) from University C, and 67% (n = 32.2) from University D. See Table 1.

3.2 Academic achievement in biomedical sciences

The overall mean GPA for biomedical courses was 2.80 (SD = 0.747), with slight variations in academic achievement across universities. Among individual courses, the mean GPAs were 2.89 (SD = 0.768) for Physiology, 2.87 (SD = 0.773) for Biochemistry, and 2.63 (SD = 0.824) for Anatomy. The majority of students earned grades of C (37%, n = 77) or D (33.7%, n = 70) in biomedical courses. University A had the highest failure rate at 16.51%, followed by University C at 11.72% and

Table 1 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

University B at 5.17%, while University D had the lowest failure rate at 0.75%. The overall failure rate across all universities was 8.53%.

3.3 Student educational factors associated with academic achievement in biomedical sciences

Bivariate analysis 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 ($F = 5.679$, $p = 0.003$). Further, students who selected nursing as their second, third, or fourth choice performed better than those who chose nursing as their first choice ($F = 3.581$, $p = 0.008$). Those who intended to remain in the nursing profession showed better academic achievement than those who planned to leave the profession ($F = 5.761$, $p = 0.003$). Moreover, students who actively participated in group discussions performed better than those who did not ($F = 2.534$, $p = 0.041$). See Table 2.

Further analysis using a linear mixed-effects model showed that nursing students who chose nursing as their second choice had GPAs higher by 0.31 ($\beta = 0.31$, 95% CI 0.04–0.58, $p = 0.03$), while those who chose nursing as their

Table 2 Bivariate analysis of the 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 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 in future					
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		
Paediatric 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		

Table 2 (continued)

Factor	N (%)	Mean GPA	Sd	F-statistic	P-value
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 h and less	8 (3.8)	2.86	0.36	0.097	0.962
2–3 h	82 (39.4)	2.80	0.94		
4–5 h	77 (37.0)	2.86	0.91		
6 h 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					
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					
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		

fourth choice had GPAs higher by 0.42 compared to those who chose it as their first choice (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 compared to those who participated very often ($\beta = -0.61$, CI −1.21 to −0.12, $p < 0.001$). Similarly, those who sometimes participated in group discussions had GPAs lower by 0.34 compared to those who participated very often ($\beta = -0.34$, CI −0.88 to −0.10, $p = 0.01$). See Table 3.

When Pearson's correlation between advanced secondary school performance and academic achievement in biomedical sciences was examined, a correlation coefficient (r) of 0.1163 was found, suggesting that higher academic performance at the advanced secondary school level (prior to admission) had negligible contribution to better GPA in biomedical sciences at university. See Fig. 1.

Based on the study findings, the null hypothesis stating that no student educational factors influence academic achievement in biomedical sciences among undergraduate nursing students was rejected in favor of the alternative hypothesis, which states that student educational factors significantly impact academic achievement in Uganda.

Table 3 Multivariate analysis of the 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	3.00 [1.93–4.05]	0.56	37.00	5.18	0.00***
Entry scheme					
Diploma	1				
From secondary school	0.20 [−0.17 to 0.57]	0.20	182.63	1.02	0.31
Type of secondary school attended					
Government, non-universal	1				
Government, universal	−0.08 [−0.35 to 0.20]	0.15	182.14	−0.52	0.60
Private, faith-based	−0.05 [−0.28 to 0.19]	0.13	182.12	−0.36	0.72
Private, non-faith-based s	−0.13 [−0.38 to 0.12]	0.13	182.21	−0.98	0.33
Never went to A' Level	−0.23 [−0.77 to 0.31]	0.29	182.08	−0.78	0.43
Location of advanced level secondary school attended					
Peri urban	1				
Rural	−0.05 [−0.38 to 0.28]	0.18	182.21	−0.28	0.78
Urban, city/municipality	0.13 [−0.08 to 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 to 0.18]	0.13	182.31	−0.47	0.64
Not sure	0.10 [−0.12 to 0.33]	0.12	182.17	0.87	0.39
Participation in group discussions					
Very often	1				
Often	−0.24 [−0.80 to 0.20]	0.13	182.44	−1.92	0.06
Rarely	−0.61 [−1.21 to −0.12]	0.17	182.38	−3.61	0.00 ***
Sometimes	−0.34 [−0.88 to 0.10]	0.12	182.43	−2.72	0.01 **
Never	0.06 [−0.56 to 0.44]	0.27	182.26	0.22	0.83
Extent of missing class/lectures					
Great extent	1				
Never	−0.18 [−0.96 to 0.60]	0.42	182.12	−0.43	0.67
Some extent	−0.36 [−1.14 to 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 to 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 to 0.62]	0.22	182.24	1.04	0.30

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 AIC = 485.169

4 Discussion

This study examined the level of academic achievement in biomedical sciences and student educational factors that influence it among undergraduate nursing students in Uganda. Findings indicated that achievement ranged from marginal to moderate, with an overall mean GPA of 2.80.

Academic achievement varied slightly across courses and universities, highlighting its context-dependent nature. Choosing nursing as a later rather than a first-choice option was associated with higher achievement. Conversely, infrequent participation in group discussions negatively impacted academic achievement. Academic achievement at the advanced level of secondary school had little to no influence on biomedical science performance at the university.

The mean GPA of 2.80 in biomedical sciences suggests marginal to moderate academic performance among Ugandan nursing students. This finding is consistent with previous studies reporting significant difficulties faced by nursing students in biomedical sciences [24]. However, the 8.41% failure rate found in this study is lower than that reported in some international studies, which ranges from 20 to 50% [14, 25]. This discrepancy in academic achievement

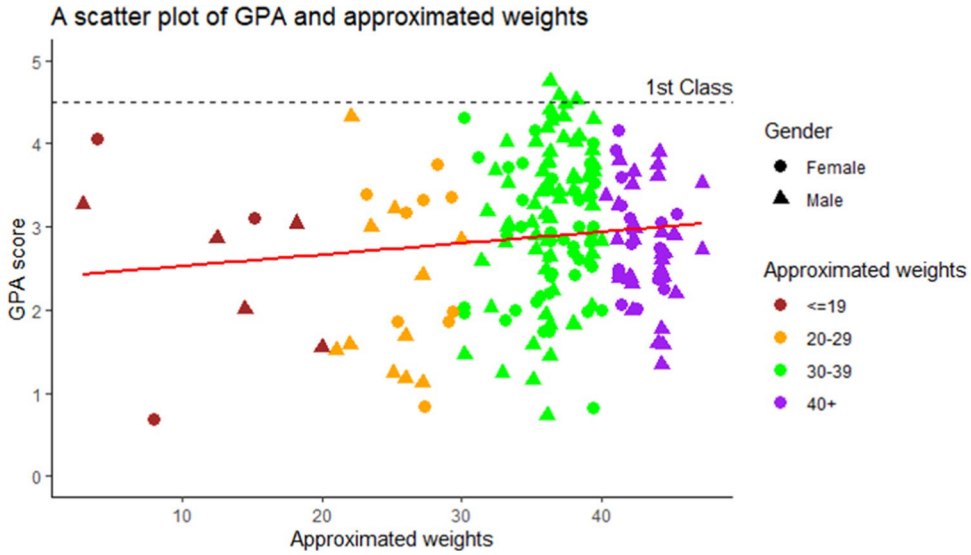


Fig. 1 Scatter plot showing the relationship between examination scores at secondary level education and GPA in biomedical sciences among degree nursing students

may reflect differences in educational systems, teaching approaches and methods, assessment criteria, biomedical sciences content in the curricula, quality of students admitted, or the support services offered to students. Better performance in physiology compared to anatomy and biochemistry is an interesting finding that warrants further investigation. It may reflect differences in the perceived relevance of these courses to nursing practice, the quality of teaching, or the nature of the content in the curriculum. Future studies could explore the underlying reasons for these performance differences and their implications for nursing curriculum.

A surprising finding was that students who did not choose nursing as their first option performed better in biomedical sciences. This result contrasts with previous studies suggesting that intrinsic motivation for nursing is associated with better academic performance [26]. The findings also differ from what was reported in one of the longitudinal cohort studies in Australia [27].This observed contrary finding could be due to the fact that students who ranked nursing lower in their choices may have a stronger academic background in sciences, having initially aspired to other health professions. They may also be more motivated to prove their suitability for the profession, resulting in greater academic effort. Similarly, their initial preference for another career may reflect a broader interest in health sciences, which could enhance their performance in biomedical disciplines. Another possible explanation is that students who chose nursing as their first choice may have been influenced by extrinsic factors such as high wages, parental expectations, peer influence, or the appeal of the nursing uniform [28, 29]. As a result, their interest in studying nursing may have diminished after gaining a deeper understanding of the profession. This finding has important implications for admission processes in nursing programs and challenges the assumption that choosing nursing as a first option is always the best predictor of academic success.

The finding of the positive influence of group discussions on academic achievement confirms the role that student-centred, contemporary learning methods or teaching approaches play in enhancing academic achievement in biomedical sciences among undergraduate nursing students. A GPA lower by a difference of 0.61 or 0.34 suggest a substantial academic disadvantage for students who do not engage in discussions regularly. The influence of group discussions on academic achievement aligns with social constructivist learning theory and broadly reflects the evolving approach to teaching biomedical sciences in contemporary times, particularly in the twenty-first century. Social constructivist theory postulates that students learn more effectively and achieve learning objectives and outcomes when they construct and share knowledge collaboratively in discussion groups [30]. Findings from this study are consistent with those of previous studies, which also demonstrated that promoting learning of biomedical sciences through group discussions or learning in teams improved academic achievement [31, 32]. In fact, one of the studies in United States of America concluded that team-based learning is an effective approach to augment cadaveric dissection laboratory experience for anatomy [32].

This is possibly because group discussions encourage active participation, which enhances critical thinking and deeper understanding. Explaining concepts to peers and engaging in discussions help students process information more effectively than passive learning methods like rote memorization which is commonly associated with lecture teaching method. Biomedical sciences involve complex concepts which are usually difficult to grasp through self-study alone. Participating in group discussions enables students to clarify doubts, clarify concepts and grasps various new concepts

and perspectives, thereby making learning more comprehensive and meaningful. In the process of discussing concepts for others, questioning some aspects that are not clear yet, strengthens knowledge retention which will be easily recalled during examinations. In addition, group discussions strengthen critical thinking skills of students which are essential for excelling in biomedical sciences.

The finding that academic achievement at the advanced level of secondary school had little to no influence on biomedical science performance at the university is controversial in many respects. However, it is not entirely surprising given the existing literature on the subject. It is considered controversial because secondary school academic performance serves as a key criterion for university admissions in Uganda and likely in many other countries. Students who excel at this level are typically admitted to their preferred university programs and awarded government sponsorships. Yet, this study suggests that previous academic achievement has little to no correlation with how the same students perform at the university, particularly in biomedical sciences among nursing students. However, this finding is not very surprising, as it aligns with results from previous studies. For instance, a study in Uganda involving medical students from two prominent universities also found no statistically significant relationship between academic performance at the secondary level and academic achievement in medicine and surgery at the university [33]. Similarly, a study in Kenya found that secondary school performance did not predict the academic achievement of medical students in preclinical and clinical courses [34]. On the contrary, our finding differs from a systematic review study which reported students with lower pre-entry grades performed poorly at the university and were at a higher risk of dropping out [35]. However, that study had a broad scope and did not account for course or program-specific factors, such as biomedical sciences among nursing students. Furthermore, another study in Uganda reported that academic achievement at the advanced level of secondary education predicted academic achievement at the university [36]. However, this finding was based on self-reported academic scores, raising the potential for social desirability bias.

The lack of a significant correlation between secondary school academic performance and university achievement in biomedical sciences may be attributed to several factors. Secondary school learning is often exam-oriented, emphasizing rote memorization, whereas biomedical sciences at the university require critical thinking, problem-solving, and the application of concepts. As a result, students who excel in memorization may struggle with the analytical demands of biomedical courses. The transition from secondary school to university also involves a shift in teaching methodologies, student independence, and academic expectations. Some students may take longer to adapt, which can impact their performance regardless of their past success. Additionally, secondary school curricula may not provide adequate preparation for biomedical sciences, as students may have excelled in subjects that do not directly contribute to their understanding of university-level biomedical content. University studies require strong time management skills, discipline, and self-regulated learning which some students who previously excelled at secondary school may lack while at the university. Students who previously relied on structured learning environments at the secondary school may find it challenging to adapt to independent study expected at the university. Moreover, academic achievement at the university level is influenced by personal motivation and interest in the field of study. While some students may have achieved high secondary school grades, a lack of passion for biomedical sciences can also affect their engagement and performance. Beyond academic factors, university students often face additional challenges such as financial constraints, mental health issues, and personal responsibilities such as cooking which they did not do while at secondary level. These factors can impact academic achievement, regardless of previous academic success.

5 Conclusions and recommendations

The findings suggest that academic achievement in biomedical sciences among nursing students remains unsatisfactory and is partly influenced by educational factors, such as the ranking of the career choice students make when aspiring to be admitted into the program, as well as their level of participation in interactive learning sessions like group discussions. Surprisingly, this study reveals that academic performance at the advanced secondary school level has little to no relationship with academic achievement in biomedical sciences at the university.

To address the challenges in biomedical sciences education among undergraduate nursing students in Uganda and beyond, universities may need to provide additional support, such as academic counselling and remedial lessons, to students who select nursing as their first choice. At the same time, they should continue to admit students who choose nursing as a second, third or fourth option. Nursing education programs could formally integrate structured group discussions into the curriculum as a core component of teaching biomedical sciences. This could be achieved by emphasizing

study groups, peer-led discussions, or case-based learning activities. Educators may also need to allocate sufficient time in the teaching schedule specifically for student-to-student interactive sessions.

Digital collaborative platforms and structured discussion forums could be established or promoted to further support interactive learning. Some students may hesitate to participate in discussions due to confidence issues or differing learning styles. To address this, universities could offer mentorship programs, peer tutoring, or workshops to help students develop collaborative learning skills. Additionally, since some educators in universities may not have been trained in pedagogical skills, it may be necessary to provide training on how to facilitate and encourage collaborative learning approaches. This would ensure that group discussions are effectively used to enhance student engagement and comprehension.

Similarly, universities may need to review admission policies that rely solely on secondary school academic performance when selecting students for university education. They could consider alternative measures, such as pre-entry examinations or aptitude tests, which may better predict academic success. To strengthen the foundational knowledge required for biomedical sciences, universities and educators may need to revise undergraduate nursing curricula to incorporate advance organizers or concrete anchors that facilitate a smoother transition from secondary education. Additionally, the government may need to adjust secondary school curricula to better prepare students for university-level biomedical sciences, with a greater emphasis on critical thinking and application-based learning.

Finally, future research is needed to understand why academic performance at the secondary education level does not significantly influence similar academic achievement at the university level, in order to generate evidence-based interventions.

6 Study limitations

This study has the following limitations that should be considered:

1. This was a cross-sectional study and, therefore, does not allow for causal inferences about the observed relationships. It only indicates whether a relationship exists between the ranking of nursing as a career choice, participation in group discussions, previous academic performance, and academic achievement in biomedical sciences among undergraduate nursing students.
2. Although the study included four public universities, these purposively sampled institutions may not be fully representative of all nursing students in Ugandan universities.
3. 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.
4. The study did not examine other important aspects of nursing education, such as clinical skills or critical thinking, which are crucial to understand.

Therefore, future research could address these limitations through longitudinal studies, broader and more diverse samples, and the inclusion of more objective measures of learning characteristics and knowledge application.

Author contributions C.M: Conceptualized the idea, developed manuscript, collected and analyzed data, developed manuscript A.N and S.M supervised proposal development, data collection and analysis, and reviewed manuscript.

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Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate Ethical approval was obtained from The AIDS Support Organization (TASO) Research and Ethics Committee (TASO-2023-261). The study was registered with the Uganda National Council for Science and Technology (HS3522ES), and informed consent was obtained from all participants.

Competing interests The authors declare no competing interests.

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