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RESEARCH ARTICLE

The role of depression and examination anxiety in predicting undergraduate students' achievement in organic chemistry: A gender-moderated regression analysis

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ABSTRACT

The study investigated the predictive power of depression and examination anxiety on undergraduate students' achievement in organic chemistry. It also explored how gender could moderate the prediction between these variables. A descriptive correlational research design was adopted for the study using a sample size of 250 (141 males & 109 females) undergraduate chemistry education students in a public university in Anambra State, Nigeria. Data were collected using the Chemistry Education Students Depression Scale (CESDS) and the Chemistry Students Examination Anxiety Scale (CSEAS). In addition, the Organic Chemistry Achievement Scores Proforma (OCASP) was used to obtain students' achievement scores in organic chemistry. The analyses were done using regression and moderation analysis with Hayes Process Macro. The findings of the study revealed that the predictive power of depression and examination anxiety on undergraduate students' achievement in organic chemistry is significantly inverse, with depression (45.9%) accounting for more variance in students' achievement than examination anxiety (21.6%). Moreover, the moderating influence of gender on the association between depression and examination anxiety on undergraduate students' achievement in organic chemistry is significantly positive. Based on the findings, the study recommended that effective intervention strategies like the use of therapy, student-centred instructional methods and helpful coping techniques should be encouraged in universities to reduce depression and anxiety and boost students' academic success.

Keywords: depression; examination anxiety; undergraduate students; organic chemistry; achievement; gender

1. Introduction

The scientific field of chemistry examines the make-up, structure, characteristics, and interactions of matter as well as the changes that occur between different types of matter. It is concerned with understanding the behaviour of atoms, molecules, and ions, and how they interact with each other through chemical reactions. The applications of chemistry can be found across various fields, such as materials science, energy, environmental science, and medicine [1]. Chemistry is essential to our comprehension of the physical world, ranging from the tiniest particles to the vast complexities of the universe. It provides the building blocks for

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advancements in medicine, technology, energy production, and environmental sustainability. Chemistry has several branches, including organic chemistry, which consists of long chains and complex molecules that play a vital role in every nation's medicine and agricultural sectors.

The study of carbon-based compounds, including their structure, characteristics, synthesis, and reactions, is the focus of the field of organic chemistry. Since carbon is the only element that can form long chains and intricate structures, organic chemistry is essential to comprehending the molecules that make up many manufactured products and living things. Organic chemists investigate various substances from tiny molecules like medications and hormones to large, complex molecules like DNA and proteins. Organic chemistry is essential in many areas of science, including medicine, materials science, agriculture, and environmental science. Despite all the benefits of organic chemistry, undergraduate students still find it challenging and perform poorly in their learning outcomes.

Success is achieved when a learner, instructor, or institution meets their learning goal. Examinations or ongoing evaluations are frequently used to quantify it. Empirical evidence from South Africa, Bantjes et al.[2] and Nigeria, Ezeudu et al. [3] showed that undergraduate students have poor performance in their overall academic activities due to their mental health challenges. For instance, chemistry education students in Nnamdi Azikiwe University, Awka, Nigeria, have continually achieved poorly in organic chemistry courses (CHM 101 = Basic organic chemistry; CHM 201 = General Organic Chemistry I; CHM 202 = General Organic Chemistry II) from the 2021/2022 to 2023/2024 academic sessions. Data collected from the Department of Science Education showed that in the 2021/2022 academic session, students recorded a credit pass rate of 56.73% and a failure rate of 43.27% in CHM 101, while in CHM 201, a credit pass rate of 63.04% and a failure rate of 36.96% were recorded. CHM 202 reported a credit pass rate of 73.81% and a failure rate of 26.19%. During the 2022/2023 academic session, CHM 101 recorded only a 9.02% credit pass rate and a 90.98% failure rate. CHM 201 had a credit pass rate of 57.78% and a failure rate of 42.22%, while CHM 202 showed a credit pass rate of 55.56% and a failure rate of 44.44%. In the 2023/2024 session, CHM 101 recorded a further decline, with only 4.40% of students achieving credit passes and 95.60% failing. CHM 201 had 47.83% of students passing and 52.17% failing, while CHM 202 recorded a credit pass rate of 43.48% and a failure rate of 56.52%.

Some factors that contribute to students' poor achievement in undergraduate organic chemistry include test anxiety, insufficient understanding of the subject matter, inadequate resources, poor chemistry background, use of the lecture method, lack of motivation, health issues and personal problems [4,5,6,7]. Consequently, there are conflicting findings regarding the effectiveness of individual factors in predicting academic achievement. This is because models explaining students' achievement must consider factors like test anxiety, emotions, stress, motivation, environment, learner psychological well-being, depression and other psychological constructs. Individual disparities in academic performance have been attributed to a combination of personality and IQ [8]. Academic success is typically attained by students who exhibit higher levels of mental capacity as measured by IQ tests and conscientiousness, which is associated with effort and achievement motivation. Exam anxiety, melancholy, self-control, motivation, extracurricular activities, and non-cognitive characteristics influence academic accomplishment[9,10]. For this study, depression and examination anxiety were discussed.

The word "depression" originates from the Latin word "depressio", meaning "to sink". It is a mental illness that can manifest as anything from a mild, temporary depression in day-to-day activities to a severe, clinical syndrome with noticeably abnormal symptoms [11]. Depression is a mood disorder marked by a constant feeling of gloom along with apathy. Other names for it include clinical depression and severe

depressive disorder[12]. The following symptoms are common in depressed individuals: feelings of sadness, emptiness, lack of motivation, hopelessness, or pessimism; decreased interest and pleasure; low self-esteem and increased self-depreciation; loss of appetite; slowness of thought or action; diminished energy and vitality; and insomnia or disturbed sleep[13-15]. A hazardous mental disorder that inversely alters a person's feelings and mental health is depression, characterised by apathy, anger and lack of interest[16]. Work and school issues might also lead to depression[17].

Studies in South Africa showed that mild depression affects 24.2% of university students, while moderate and severe depression affect 12.4% of them [18,19]. In Nigeria, on the other hand, 1.6% of students experience severe depression, with 58.2% experiencing mild depression (Dabana & Gobir,[20]). Depression is also common (97.3%) among undergraduate students studying chemistry education (Ezeudu et al.,[3]) due to the abstract nature of the subject, with male students accounting for 51.1% and female students 48.9% experiencing moderate to severe depression[21]. Research on the correlation between depression and academic achievement in various nations has produced a range of findings. For instance, Khurshid et al.[22] found that several factors, including depression, affect academic performance and students' behaviour in female Government Colleges in Rawalpindi city, Pakistan. Similarly, Bantjes et al.[2] contended that undergraduate learners who were depressed were inclined to have academic difficulties. Animba and Obika [10] conducted additional research using secondary school learners on the effect of depression on achievement in Enugu State, Nigeria. They discovered that there is a minimal association between academic performance and depression across all students, regardless of gender. Mirhosseini et al.[23] found a substantial and inverse correlation between depression and students' academic satisfaction, topic, and interest in Iranian university students. Additionally, Suleiman[24] conducted a study with Northern Nigerian secondary school students and discovered no connection between depression and academic achievement. The disparity with the present study could be due to the differences in school environment, sample size and social and cultural factors that influence how students view and experience depression. Nevertheless, Suleiman[24] suggested that professional psychologists and counsellors use cognitive behavioural techniques to provide psychological interventions to secondary school students who might be experiencing anxiety or depression.

Extreme tension, worry, and uncertainty before or during exams are symptoms of examination anxiety, commonly known as test anxiety, a form of performance anxiety[25]. The anticipation of an exam often causes more worry and distress than the exam itself, with anxiety sometimes persisting even after the test has concluded[26]. Students who experience exam anxiety internalise this behaviour, which presents a significant emotional challenge that hinders their ability to learn. It is perceived as an adverse emotional reaction triggered by the expectations of an upcoming test; most learners view it as a threat to their emotional well-being. Examination anxiety may be triggered by cues related to an individual's previous experiences with tests or assessments[27]. This psychological syndrome causes people to feel highly stressed, anxious, and uncomfortable before, during, and after an exam. Performance and learning are severely hampered by this anxiety[28]. Exam anxiety can have broader effects, impairing a student's self-esteem and their social, emotional, and behavioural development[29].

In South Africa, it has been reported that undergraduate students have high levels of anxiety, depression and stress, which are associated with achievement, social life and financial status [30,31,32]. According to a World Health Organisation study[33], one in three South Africans suffers from mental health conditions like anxiety, depression, and substance misuse. The study also found that around 30 million Africans suffer from depression. Reduced academic success, psychological or physical anguish, panic, fear of defeat, difficulties concentrating, as well as emotional worry are all consequences of elevated anxiety, according to studies[9,34,35]. Mandler and Sarson[36] also clarified that responses to examination anxiety can be extrapolated

from prior experiences to exam scenarios. Anxiety reactions include feelings of inadequacy, powerlessness, and fear of punishment or a decline in status and self-worth. Those who are less worried can perform better on exams, while those who are more anxious can perform worse. Individuals with high anxiety scores frequently use negative, self-deprecating language to describe themselves. Examinees who are highly nervous also place a lot more responsibility on themselves for failing than those who are not. Rehman et al. [37] found that fear of exams and testing circumstances is common and seems to be increasing in Lahore, India, perhaps due to the importance and frequency of testing. According to Nnorom et al.[38], secondary school pupils' exam anxiety is caused by a combination of personal, school, and parental influences. Examination anxiety does not predict achievement in mathematics and English among Nigerian students, according to Ilo and Unachukwu[39]. Rosado[40] discovered that while students at East Texas Baptist University in Texas saw reduced test- and generalised anxiety, which improved their study habits and academic achievement, this difference was not statistically significant. According to studies by Alexander and Annapriya[41] and Khalid[42], students in secondary schools in India and Pakistan experienced high levels of exam anxiety, and there is a substantial inverse relationship between exam anxiety and academic achievement. However, male and female students may feel different levels of sadness and exam anxiety. Essentially, the prediction of depression and examination anxiety on students' achievement in organic chemistry may be influenced by gender.

The gender gap in academic attainment has long been a source of concern for educational scholars and administrators, particularly in Africa, where gender roles are still prevalent due to the large number of ethnic groups. Gender is a socially constructed concept that is associated with behaviours and characteristics, according to Nwafor et al.[4]. Therefore, it is a role that society has created to influence others. Gender, as used in this study, denotes the socially and culturally constructed roles, behaviours, and attributes associated with being male or female. Gender has been a crucial factor in shaping the academic outcomes of students in science in multicultural African countries, including Nigeria. Various scholars have proposed different hypotheses to explain the gender disparities in chemistry academic performance that they have seen.

According to Ezeudu et al.[43], for example, gender had no discernible impact on students' performance in chemistry; nevertheless, Eze et al.[44] found that female students performed better. Onyi et al. [45] claim that male students outperformed female students by a large margin due to the perception that science is male-dominated. A study conducted in Cross River State, Nigeria, found that depression differs significantly between male and female students (Ekpang et al.[46]). Conversely, male and female undergraduate students at the University of Prishtina, Kosovo, did not significantly differ in their display of depressive symptoms, according to Maliqi et al.[47]. At Yarmouk University in Irbid, Jordan, Maysaa[48] discovered that no gender disparities between male and female students in the depression variable, and that there was a negative connection between the two variables. According to Animba and Obika's[10] research, there is a substantial correlation between academic achievement and depression in secondary school pupils in Enugu State, Nigeria, regardless of gender. Alemu and Feyssa[49] discovered that there is a strong gender moderating effect on the relationship between students' achievement and exam-related anxiety. Exam anxiety is significantly greater in female secondary school students than in males, according to studies by Siddiqui and Rehman[50], Manikandan et al.[51], and Altamimi and Altamimi[52]. While Adewuyi et al.'s[53] findings indicated a modest relationship between students' exam anxiety and gender, Adelana et al.'s[54] findings showed that examination anxiety has nothing to do with gender. Since anxiety was found to be common in both male and female students, Anwar and Batool[55] posited that there is no significant gender difference in the association between anxiety and achievement. Boys in grade 12 in Tamil Nadu, India, experienced higher levels of anxiety than girls, according to Mary et al.[56].

From the foregoing, there exist many studies on how psychological constructs determine students' academic achievement; most of the literature examined depression and examination anxiety as separate construct determining their influence on students' achievement without a special interest in a particular subject area. Organic chemistry, an essential but challenging area of undergraduate chemistry that interests the researchers of the present study, remains understudied and has received limited attention in scientific research. Hence, the study focused on the joint prediction of both depression and examination anxiety on undergraduate students' organic chemistry achievement. Furthermore, though studies have reported gender effects on students' academic achievement, there exist contradictions in findings, and most of them looked at how the depression and anxiety of male or female students differ using basic statistical tools like the mean instead of considering the dimension and strength of the relationships. This study, therefore, applied a regression moderation framework to explore how gender influences these predictions, offering a more refined understanding than previous studies that relied on basic statistical comparisons. Moreover, conducting such a study in a multicultural developing nation provides culturally and educationally relevant insights into the global literature on achievement and mental health. Therefore, these gaps form the interest the present study wished to address.

The study was guided by Beck's cognitive behavioural theory (CBT)[57]. The theory postulates an interconnection between an individual's emotions, behaviours and thoughts. According to the theory, negative thoughts and patterns (cognitive distortions) and/or maladaptive behaviours contribute to psychological distress such as anxiety and depression. The theory aims to identify and provide therapies that balance an individual's thoughts and emotions to improve wellness and conduct. According to this study, students who question their abilities or fear failing are more likely to experience sadness and anxiety, impairing the cognitive processes necessary for strong academic performance in organic chemistry. Thus, the theory offers the appropriate framework to comprehend the link between examination anxiety and depression on students' organic chemistry achievement. Understanding cognitive processes and their impact on students' performance in various academic subjects, including organic chemistry, may help reduce levels of depression and anxiety. This approach enables undergraduate students, regardless of socio-economic status, to feel less depressed, manage their anxiety more effectively, and remain confident during examinations. This theoretical framework directly informed the study's hypotheses by suggesting that depression and examination anxiety would negatively predict academic achievement, and that gender could moderate these effects due to differences in emotional processing and coping strategies. Based on the aforementioned theory and study gaps, the researchers proposed the following research questions: (1) What is the association between depression and undergraduate students' achievement in organic chemistry? (2) What is the predictive power of examination anxiety on undergraduate students' achievement in organic chemistry? (3) What is the relative predictive power of depression and examination anxiety on undergraduate students' achievement in organic chemistry? (4) What is the moderating influence of gender on the predictive power of depression on undergraduate students' achievement in organic chemistry? (5) What is the moderating influence of gender on the predictive power of examination anxiety on undergraduate students' achievement in organic chemistry? Accordingly, the study hypothesised that: (1) The association between depression and undergraduate students' achievement in organic chemistry is not statistically significant. (2) The predictive power of examination anxiety on undergraduate students' achievement in organic chemistry is not statistically significant. (3) The relative predictive power of depression and examination anxiety on undergraduate students' achievement in organic chemistry is not statistically significant. (4) The moderating influence of gender on the predictive power of depression on undergraduate students' achievement in organic chemistry is not statistically significant. (5) The moderating influence of gender on the predictive power of

examination anxiety on undergraduate students' achievement in organic chemistry is not statistically significant.

2. Materials and methods

2.1. Research design

The study employed a quantitative approach using a correlation survey research design. The design helps to provide an in-depth understanding of determining the prediction of depression and examination anxiety on undergraduate students' achievement in organic chemistry. Moreover, a correlation study establishes the relationship, association or covariance between two or more variables. It also reveals the magnitude and/or direction of a relationship between two (or more) variables, which can be positive, negative or zero.

2.2. Participants

The study's participants were Nnamdi Azikiwe University's undergraduate chemistry education students in Awka, Anambra State, Nigeria. Students in their second, third, and fourth years from the Department of Science Education made up this group. Out of the 324 students that comprised the total population, 250 individuals (77.16%) were chosen for the sample size using proportionate stratified random sampling to guarantee fair representation according to their academic year. The researchers conducted the study in December 2024, during the first semester of the 2024/2025 academic session. **Table 1** below displays the study's demographic information.

Table 1. Demographic information of the respondents.

Characteristics	Number of Students	Percentage
Gender		
Male	141	56.4
Female	109	43.6
Total	250	100.0
Age		
17-19 years	97	38.8
20-22 years	129	51.6
23 years and above	24	9.6
Total	250	100.0
Level of Study		
Year Two	92	36.8
Year Three	75	30.0
Year Four	83	33.2
Total	250	100.0

Table 1 shows the demographic information of the respondents used in the study. The males are the dominant respondents (141, 56.4%) compared to their female counterparts (109, 43.6%). Students within the age brackets of 20-22 years are more (129, 51.6%) compared to those within 20-22 years (97, 38.8%) and 23 years and above (24, 9.6%). Moreover, the sample size comprised more Year two students (92, 36.8%) than those in Year four (83, 33.2%) and Year three (75, 30.0%).

2.3. Research instruments

Data for this study were collected using the Chemistry Education Students Depression Scale (CESDS) and Chemistry Students Examination Anxiety Scale (CSEAS). In addition, the Organic Chemistry Achievement Scores Proforma (OCASP) was used to retrieve students' organic chemistry achievement scores. The CESDS comprised 21 items and was adapted from Beck's Depression Inventory [58], while the CSEAS included 10 items adapted from the Westside Test Anxiety Scale Validation [59]. The CESDS was scored on a scale from 0 to 3 for each of the 21 items, following Beck's scoring pattern, while the CSEAS

employed a four-point Likert scale of Not at all (4), A little (3), Sometimes (2), and A lot (1). Within the scope of the research, the instruments were modified in terms of language alteration to ensure that they addressed the academic subject. The researchers used the OCASP to retrieve the respondents' CHM 101 results for the 2021/2022, 2022/2023, and 2023/2024 academic sessions from the Departmental Records Unit. These results were used as the study's achievement scores. Three experts validated these instruments, and the pilot test was conducted using 30 Chemistry Education students from the Department of Science Education, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State, Nigeria. Cronbach's alpha was used to assess the reliability of the CESDS and CSEAS, yielding values of 0.81 and 0.88, respectively.

2.4. Ethical considerations

The participants signed the consent forms before the commencement of data collection. They were also assured of the anonymity and confidentiality of the research and their choice to withdraw from the study at any time. The ethical clearance was obtained from the Research Ethics Committee of the Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria, with the clearance number REC/DSE/NAU/24/0125.

2.5. Data collection procedure

The researchers utilised on-the-spot administration of instruments to ensure a 100% return. First, the researchers explained the nature of the study to the students, assured them of the anonymity and confidentiality of the survey, provided them with the consent forms to fill out and invariably shared the instruments with them. Only the sample of those who agreed to participate in the study was used, and their achievement scores were obtained from the department, as previously stated.

2.6. Data analysis procedure

The data were analysed using both simple and multiple linear regression techniques. The correlation coefficient (r) and coefficient of determination (r^2) were applied to examine the relationships among the study variables. Regression ANOVA, Hayes Process Macro, and the t-test value connected to the regression were used to evaluate the hypotheses at the 0.05 significance level. The following five-way guidance served as the basis for the decision rule used to interpret the correlation coefficients: Very low is defined as 0.00 to 0.20, low as 0.21 to 0.40, moderate as 0.41 to 0.60, high as 0.61 to 0.80, and very high as 0.81 and above. The analysis of the study was conducted using the Statistical Package for the Social Sciences (SPSS, Version 23) and Hayes Process Macro (Version 4.1)

3. Results

The results below reveal the relationship of the study's variables on students' achievement in organic chemistry, with their corresponding hypotheses.

Research Question One: What is the association between depression and undergraduate students' achievement in organic chemistry?

Table 2. Linear regression model for depression predicting achievement in organic chemistry.

Model	N	R	R Square	Adjusted R Square	Decision
1	250	-.678	.459	.457	Strong inverse correlation

Table 2's findings indicate a -.678 correlation coefficient (r) between depression and undergraduate students' performance in organic chemistry. This suggests that there is a strong negative correlation between depression and undergraduate students' performance in organic chemistry. According to the coefficient of

determination (r^2) of .459, depression accounts for 45.9% of the variation in undergraduate students' organic chemistry achievement. The corresponding hypothesis was tested using the t-test linked to the linear regression.

Hypothesis One: The association between depression and undergraduate students' achievement in organic chemistry is not statistically significant.

Table 3. T-test associated with the linear regression model for depression predicting achievement in organic chemistry.

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95% CI for B	
		B	Std. Error	Beta			LB	UB
1	(Constant)	133.819	4.775		28.026	.000	124.415	143.224
	CESDS	-2.221	.153	-.678	-14.508	.000	-2.522	-1.919

Dependent Variable: OCAS (Organic Chemistry Achievement Scores)

Table 3 shows that ($t = -14.508$, $\beta = -.678$, $p < 0.05$ ($p = 0.000$), 95% CI [-2.522, -1.919]) was ascertained. Since the p-value is less than 0.05, the null hypothesis is rejected. Therefore, the inference drawn is that the association between depression and undergraduate students' achievement in organic chemistry is highly negative and statistically significant. This implies that as the depression of students increases, their achievement in organic chemistry decreases and vice versa.

Research Question Two: What is the predictive power of examination anxiety on undergraduate students' achievement in organic chemistry?

Table 4. Linear regression model for examination anxiety predicting achievement in organic chemistry.

Model	N	R	R Square	Adjusted R Square	Decision
1	250	-.465	.216	.213	Moderate inverse correlation

The correlation coefficient (r) between examination anxiety and undergraduate students' achievement in organic chemistry is -.465, as indicated in **Table 4**. This suggests that examination anxiety has a moderately negative impact on undergraduate students' achievement in organic chemistry. Examination anxiety accounts for 21.6% of the variance in undergraduate students' performance in organic chemistry, according to the coefficient of determination (r^2), which is .216. The t-test associated with the linear regression was utilised to test the corresponding hypothesis.

Hypothesis Two: The predictive power of examination anxiety on undergraduate students' achievement in organic chemistry is not statistically significant.

Table 5. T-test associated with the linear regression model for examination anxiety predicting achievement in organic chemistry.

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95% CI for B	
		B	Std. Error	Beta			LB	UB
1	(Constant)	111.588	5.674		19.667	.000	100.413	122.763
	CSEAS	-1.496	.181	-.465	-8.263	.000	-1.852	-1.139

Dependent Variable: OCAS

Table 5 shows that ($t = -8.263$, $\beta = -.465$, $p < 0.05$ ($p = 0.000$), 95% CI [-1.852, -1.139]) was established. Since the p-value is less than 0.05, the null hypothesis is rejected. Therefore, the inference drawn is that there is a significant inverse prediction ($P<0.05$) of examination anxiety on undergraduate students'

achievement in organic chemistry. This implies that as the examination anxiety of students increases, their achievement in organic chemistry decreases and vice versa.

Research Question Three: What is the relative relationship between depression and examination anxiety on undergraduate students' achievement in organic chemistry?

Table 6. Multiple regression model for depression and examination anxiety predicting achievement in organic chemistry.

Model	N	R	R Square	Adjusted R Square	Decision
1	250	-.678	.459	.455	High negative prediction

The relative relationship between depression and examination anxiety on undergraduate students' performance in organic chemistry is -.678, according to **Table 6**'s correlation coefficient (r). This suggests that there is a high negative correlation between depression and examination anxiety on undergraduate students' achievement in organic chemistry. The coefficient of determination (r^2) is .459, meaning that anxiety and depression account for 45.9% of the variation in organic chemistry achievement among undergraduate students. Multiple regression was used to evaluate the corresponding hypothesis.

Hypothesis Three: The relative relationship between depression and examination anxiety on undergraduate students' achievement in organic chemistry is not statistically significant.

Table 7. Regression ANOVA of the multiple regression model for depression and examination anxiety predicting achievement in organic chemistry.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17761.665	2	8880.833	104.893	.000[b]
	Residual	20912.435	247	84.666		
	Total	38674.100	249			

Dependent Variable: OCAS

Predictors: (Constant), CSEAS, CESDS

Table 7 shows that an F-value of (F (2, 249) = 104.893, $p < 0.05$ ($p = 0.000$)) was obtained for the relative relationship between depression and examination anxiety on undergraduate students' achievement in organic chemistry. The null hypothesis has been refuted because the significance level is less than 0.05. As a result, there is a considerable negative correlation between undergraduate students' levels of anxiety and depression before exams and their achievement in organic chemistry. This implies that if students' levels of anxiety and depression increase, their performance in organic chemistry will decrease, and vice versa.

Research Question Four: What is the moderating influence of gender on the predictive power of depression on undergraduate students' achievement in organic chemistry?

Table 8. Hayes' process macro analysis of the moderating influence of gender on the prediction of depression on undergraduate students' achievement in organic chemistry.

Model Summary						
R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**p**
.7172	.5144	76.3408	86.8660	3.0000	246.0000	.0000

Table 8 reveals that the correlation coefficient (r) between depression and undergraduate students' achievement in organic chemistry is .7172. This indicates that the moderating influence of gender on the association between depression and undergraduate students' achievement in organic chemistry is positive and high. The coefficient of determination (r^2) is .5144, which indicates that 51.44% variation in

undergraduate students' achievement in organic chemistry can be attributed to depression as moderated by gender. In comparison, 48.56% of the variance can be attributed to other factors not considered in this study.

Hypothesis Four: The moderating influence of gender on the predictive power of depression on undergraduate students' achievement in organic chemistry is not statistically significant.

Additionally, **Table 8** shows that the moderating effect of gender on the prediction between depression and undergraduate students' achievement in organic chemistry was found to have an F-value of ($F(3, 246) = 86.8660$, $p < 0.05$ ($p = 0.0000$)). Since the significance level is below 0.05, the null hypothesis is disproved. Therefore, gender has a statistically significant moderating effect on the prediction between depression and undergraduate students' performance in organic chemistry. This suggests that gender has a vital role in predicting depression and undergraduate students' achievement in organic chemistry.

Research Question Five: What is the moderating influence of gender on the predictive power of examination anxiety on undergraduate students' achievement in organic chemistry?

Table 9. Hayes' process macro analysis of the moderating influence of gender on the prediction of examination anxiety on undergraduate students' achievement in organic chemistry.

Model Summary						
R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**p**
.5542	.3072	108.9239	36.3521	3.0000	246.0000	.0000

Table 9 reveals that the correlation coefficient (r) between examination anxiety and undergraduate students' achievement in organic chemistry is .5542. This indicates that the moderating influence of gender on the relationship between examination anxiety and undergraduate students' achievement in organic chemistry is positive and moderate. The coefficient of determination (r^2) is .3072, which indicates that 30.72% of the variation in undergraduate students' achievement in organic chemistry can be attributed to examination anxiety as moderated by gender. In comparison, 69.28% of the variance can be attributed to other factors not considered in this study.

Hypothesis Five: The moderating influence of gender on the predictive power of examination anxiety on undergraduate students' achievement in organic chemistry is not statistically significant.

In addition, **Table 9** shows that the moderating effect of gender on the association between examination anxiety and undergraduate students' achievement in organic chemistry was found to have an F-value of ($F(3, 246) = 36.3521$, $p < 0.05$ ($p = 0.0000$)). Since the significance level is below 0.05, the null hypothesis is disproved. Therefore, gender has a statistically significant moderating effect on the association between examination anxiety and undergraduate students' performance in organic chemistry. This suggests that the prediction of examination anxiety on undergraduate students' achievement in organic chemistry is considerably influenced by gender.

4. Discussion

The study explored the prediction of depression and examination anxiety on undergraduate students' achievement in organic chemistry and determined the moderating influence of gender in the prediction. The study sample size shows that most respondents are male (56.4%) compared to their female counterparts (43.6%). The students within the age brackets of 20-22 years are more in number (51.6%), followed by those within 20-22 years (38.8%) and those from 23 years and above (9.6%). Also, the year two students (36.8%) are more numerous, in contrast to those in year four (33.2%) and year three (30.0%).

The findings of the study showed that depression has a high and negative prediction on undergraduate students' achievement in organic chemistry. Further analysis revealed a significant negative prediction of depression on undergraduate students' achievement in organic chemistry. The results showed that depression accounted for 45.9% variation in achievement in organic chemistry. This implies that as depression increases among students, their achievement in organic chemistry will decrease and vice versa. This could be because of pressure and challenges associated with the institution's organic chemistry and other academic activities. Also, there exists an inadequate mental health facility in the institution, which could have helped with proper diagnosis and treatment. The researchers also observed that students show a lack of interest in accessing the few resources they have due to the stereotypes and stigma associated with mental health. The results are consistent with those of Maysaa [48], who found no statistically significant changes as a result of the gender variable's effect and a substantial negative association between academic achievement and depression. Additionally, Khadijatu et al. [60] claimed that depression and students' academic performance are significantly negatively correlated. The study also supports the findings of Mirhosseini et al. [23] and Maliqi et al. [47], who, in their different investigations, verified a strong and inverse relationship between the manifestation of depressive symptoms and poor academic performance. Suleiman's [24] findings, on the other hand, contradict the current study's findings since they did not discover any meaningful connection between academic achievement and depression.

The study's results showed that examination anxiety has a moderate and negative predictive influence on undergraduate students' achievement in organic chemistry. Further analysis revealed a significant negative prediction of examination anxiety on undergraduate students' achievement in organic chemistry. The results showed that examination anxiety accounted for 21.6% variation in achievement in organic chemistry. This suggests that students' achievement in organic chemistry would decline if their examination anxiety increases and vice versa. This could be due to students' high level of anxiety, which might have affected their cognitive ability to recall and retain. Also, the students show some negative self-doubt by believing that organic chemistry is an abstract branch of chemistry. This result is consistent with Alemu and Feyssa's [49] finding that a substantial inverse association exists between performance and examination anxiety. Additionally, Khalid[42] believed that there was a significant inverse relationship between secondary school academic achievement and exam anxiety, including physical, emotional, behavioural, and cognitive anxiety. The finding that there is a significant inverse association between achievement and examination anxiety is also corroborated by Nwafor et al. [4] and Alexander and Annapriya[41]. Similarly, Okeke et al.[61] found that academic stress and exam anxiety may account for a large percentage of the difference in students' physics achievement.

The research's findings demonstrated that depression and examination anxiety have a high and negative predictive influence on undergraduate students' performance in organic chemistry. Additionally, the results showed that depression and examination anxiety account for 45.9% of the difference in students' organic chemistry achievement. Furthermore, there is a significant negative prediction between both depression and examination anxiety on undergraduate students' achievement in organic chemistry. This indicates that students' achievement in organic chemistry is negatively impacted by both depression and examination anxiety. Poor time management and a lack of academic assistance from the university and instructors may cause this. This finding is consistent with Mirhosseini et al.[23], who identified academic anxiety and depression as significant predictors of students' academic achievement. This result also supports the findings of Afriliani and Holandyah[62], who found that students' educational goals (knowledge, attitude & skills) are affected by a diversity of physical, social, and psychological elements.

The study's findings revealed that the moderating influence of gender on the association between depression and undergraduate students' achievement in organic chemistry is positive and high. Gender accounted for 51.44% variation in the association between depression and undergraduate students' achievement in organic chemistry. Further analysis revealed that the moderating influence of gender on the association between depression and undergraduate students' achievement in organic chemistry is statistically significant. Hence, gender contributes significantly to the association between depression and undergraduate students' achievement in organic chemistry. This could be due to social expectations, as male students are expected to do well in science compared to their female counterparts, who are relegated to domestic and art/commercial fields. This may have affected their mental health and increased their depression. The findings align with those of Ekpang et al.[46], who discovered that male students have a significantly higher rate of depression than female students do and that there is a stronger link between depression and mass failure in male students than in female students. The findings also corroborate those of Elvira-Zorzo et al.[63], who asserted that female students have more mental health issues than their male counterparts during their academic careers. The results, however, go counter to those of Maysaa[48] and Animba & Obika[10], who found that while there is a strong negative link between academic achievement and depression, students' gender does not significantly influence this relationship.

The study's findings revealed that the moderating influence of gender on the relationship between examination anxiety and undergraduate students' achievement in organic chemistry is positive and moderate. Gender accounted for 30.72% variation in the prediction of examination anxiety on undergraduate students' achievement in organic chemistry. Further analysis revealed that the moderating influence of gender on the relationship between examination anxiety and undergraduate students' achievement in organic chemistry is statistically significant. This suggests that gender contributes significantly to the prediction of examination anxiety on undergraduate students' achievement in organic chemistry. This could be as a result of negative cultural stigma, which prevents students, irrespective of their gender, from disclosing their mental health issues or seeking help when they observe any anxiety symptoms. The findings of the study correspond with those of Alemu and Feyssa[49], who found that the association between achievement and anxiety is significantly moderated by gender. The results also corroborate the findings of Manikandan et al.[51] and Altamimi and Altamimi[52], who reported that female secondary school students exhibit significantly higher levels of exam anxiety than their male counterparts, negatively impacting their academic performance. The result, however, runs counter to Anwar and Batool's[55] findings, which showed no appreciable gender differences in the relationship between anxiety and students' academic achievement.

5. Conclusion

The researchers concluded that depression and exam anxiety have a significant negative contribution to undergraduate students' performance in organic chemistry based on the study's findings. This is because students will do worse in organic chemistry as their levels of depression and examination anxiety rise. The finding validates the cognitive behavioural theory (CBT) of Beck[57], which postulates that negative thoughts and patterns (cognitive distortions) and/or maladaptive behaviours contribute to psychological distress such as anxiety and depression, which could affect students' achievement. Also, gender has a significant contribution to the prediction of depression and examination anxiety on students' achievement in organic chemistry. This suggests that both predictor variables are vital to improving students' organic chemistry achievement. However, it is essential to note that the study was conducted within a single institution, which may limit the generalizability of the findings to other contexts. Furthermore, while gender-moderated depression and examination anxiety accounted for 51.44% and 30.72% of the variance, respectively, the

remaining 48.56% and 69.28% may be influenced by other unexplored factors such as socio-economic status, prior academic achievement, personality traits, and access to mental health support. Future studies should consider these variables to provide a more comprehensive understanding. The study's findings have many educational implications for the teachers (lecturers), students, parents, guidance and counsellors, researchers and education policymakers. For instance, chemistry students with high depression and examination anxiety should be encouraged to prepare for their examination on time and provided with interventions by the teachers (lecturers) and institutions to improve academically. Institutions of higher learning need to integrate mental health into university curricula in Nigeria, as this will promote students' well-being and academic success. Moreover, the actions of the teachers, parents, guidance and counsellors, researchers and education policymakers should be towards encouraging the students by nurturing/working towards having students with low depression and examination anxiety. This will invariably lead to improved students' mental health and academic achievement in organic chemistry courses and other disciplines within the university. Therefore, universities should set up a working guidance and counselling unit, which is required to take a bold step towards fostering interventions that would expose undergraduate chemistry students to situations that result in low depression and examination anxiety.

6. Limitations of the study and directions for future research

One of the limitations of the study is the use of self-reported measures (questionnaire method) to explore the depression and examination anxiety of undergraduate students, which could be prone to bias. Additionally, the study adopted a correlation design, which limits causation and was carried out at a single university within the country. These may have reduced the findings' generalisability compared to other designs and students from other universities, departments, and/or faculties. Based on these constraints, future researchers could look into carrying out the same study using students of different departments in as many universities in the country and in Africa as possible. Interventions should be implemented to help university students who are depressed and anxious before exams. Longitudinal research could be conducted to ascertain how these factors affect achievement over time. Also, other moderating variables such as age, cultural background, personality traits, prior academic achievement, learning styles and social-economic status can be considered. Moreover, machine learning and other statistical tools can be used to develop predictive models which can detect at-risk students who are prone to poor achievement due to depression and examination anxiety. A qualitative study can also be conducted to learn more about the predicted factors and how they impact students' performance.

7. Recommendations

The study's conclusions informed the following recommendations:

1. To lessen examination anxiety, undergraduate chemistry students should be urged to improve themselves and study for their tests in advance.
2. To improve student achievement, curriculum planners, parents, instructors (lecturers), and other education stakeholders should devise behavioural, affective, and cognitive techniques to reduce anxiety and depression during exams.
3. The government and educational stakeholders should arrange seminars and workshops to teach chemistry instructors, as well as other lecturers, on how to reduce and manage students' levels of anxiety and depression.

4. Parents must motivate their children to attain exceptional academic success despite academic obstacles.
5. Lecturers are encouraged to effectively plan their lessons using student-centred instructional strategies to reduce students' depression and examination anxiety in the classroom or laboratory.
6. Guidance and counselling units should be established in every faculty within the institution to effectively reduce/treat students' depression and examination anxiety and provide them with practical strategies to cope with depression and examination anxiety, including relaxation techniques, time management skills, and mindfulness practices.
7. An undergraduate chemistry curriculum that covers coping techniques for depression and examination anxiety should be produced, and the objectives for each content should be clearly stated to provide students with the necessary learning direction. This can take the form of a lesson guide and an examination guide.
8. Education policymakers should develop more robust intervention strategies aimed at mitigating depression and anxiety while enhancing academic achievement.

Conflict of interest

The authors declare no conflict of interest.

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