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Slack, Google Meet and Zoom and Academic Performance of Chemistry Students in Tertiary Institutions in Calabar, Cross Rivers State

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Abstract:

This study investigates the effect of Slack, Zoom, and Google Meet on the academic performance of undergraduate Chemistry students in tertiary institutions in Calabar, Nigeria. Two research questions and two null hypotheses guided the study. A pretest-posttest quasi-experimental design was used in this study. The study population comprised 172-year 3 Chemistry Education students from both UNICAL and UNICROSS respectively. 134 students were drawn using stratified proportionate sampling techniques. The instrument used for data collection was Chemical Bonding Assessment Test (CBAT), with a reliability coefficient of 0.91 established via Spearman-Brown formula. Data collected were analyzed using mean, standard deviation for the research questions, while Analysis of Covariance (ANCOVA) tested the hypotheses at 0.05 level of significant. Study findings revealed a significant difference in academic performance among students exposed to Slack and Zoom, as well as Google Meet and Slack in favor of zoom and google meet. Based on the study findings, conclusion was drawn and recommendations made which is, science teachers should incorporate Slack and Zoom into teaching strategies to enable both asynchronous and synchronous learning. Slack can be used for ongoing discussions and resource sharing, while Zoom can facilitate real-time interaction, virtual labs, and demonstrations.

Keywords: Slack, Zoom and Google Meet, and Undergraduate Chemistry Education Students.

Introduction

Chemistry occupies a strategic place in the educational system of most countries of the world including Nigeria. Currently, Nigeria needs a functional science education to meet the needs of the local industries, citizens as well as satisfy the practical needs of the society. Chinda viewed Chemistry as one of the branches of pure science that deals with the study of matter, its structure, composition, properties and the changes it undergoes [1]. Science Teachers Association of Nigeria broaden the definition of chemistry as a branch of science that studies the properties of matter in terms of compositions, structures, transformations, interactions and energy implications of chemical changes. Chemistry can also be defined as the constitution, properties and uses of matter and the changes it undergoes as a consequence of alterations in the composition of their molecules. The Federal Ministry of Education of Nigeria through the Senior Secondary Education Curriculum, stipulated the objectives of chemistry education among others are: develop interest in the subject of chemistry; acquire basic theoretical/practical knowledge and skills in chemistry; apply skills to meet societal needs of creating employment and wealth; and adequately prepared for further studies in chemistry.

Achimugu further pointed out that Chemistry is concerned with identifying common materials around us and then turning them into more useful products, and hence, Chemistry plays an important role in influencing the rate of economic and technological development. Operationally, Chemistry is the science subject that primarily focuses on identifying matter in terms of its physical and chemical properties and its valuability for economic and technological advancement. Perhaps, from these assertions, it is inferable that Chemistry can exert a dominant and decisive influence on the life of individuals in the areas of industry, agriculture, infrastructure as well as in the developmental effort of a nation [2].

The progress of any nation depends on the achievement in the field of Chemistry. By nurturing a well-educated populace in Chemistry, a continuous pipeline of innovative minds capable of addressing global challenges, contributing to scientific discoveries, and propelling societal progress is ensured. Chemistry education thus becomes not only a gateway to understanding the intricacies of the natural world but also a key driver for fostering a scientifically literate and empowered society. Chemistry education has been identified to be one of the major bedrocks for the transformation of a nation's economy. Chemistry education is a necessary ingredient for becoming self-reliant, earning a living and contributing towards building sustainable national development. Chemistry education is a pivot through which many individuals could be transformed into entrepreneurship discoveries whose profound impacts could be noticed if carefully utilized for proper everyday learning, being one of the targets of national development. To the researcher, Chemistry education is the study of the teaching and learning of Chemistry in all academic institutions such as schools, colleges and universities. Chemistry Education is considered a key agent of development, either as a way of developing human capacity, increasing the skilled workforce for modernization, or as a matter of personal freedom, developing capability and empowerment.

The National Policy on Education (NPE) in the National Curriculum for Senior Secondary Schools Science stated specific objectives to be achieved by each subject curriculum. For Chemistry, the specific objectives to be achieved in the curriculum include: facilitating a transition to the use of scientific concepts and techniques acquired in Integrated Science with Chemistry, providing the students with basic knowledge of chemical concepts and principles through efficient selection of content and sequencing, show Chemistry in its interrelationship with other subjects, show Chemistry and its link with industry, everyday life, benefits and hazards and provide a course which is complete for pupils not proceeding to higher education while it is at the same time a reasonably adequate foundation for a postsecondary Chemistry course [3]. Therefore, Chemistry education is of paramount importance to the development of any country, especially in the context of Nigeria as a developing nation. It serves as a catalyst for economic growth by contributing to various industries

such as pharmaceuticals, agriculture, and manufacturing industries. In spite of the numerous importance of Chemistry toward societal development, factors such as inadequate instructional materials, teaching methods, and student-teacher relationship which amount to improper implementation of its curriculum.

The Rise of Collaborative Online Learning Platforms (COLPs)

The emergence of COLPs offers a promising solution to some of the limitations of traditional classrooms. These platforms provide an interactive and accessible environment for students to connect, collaborate, and actively engage with the learning materials [4]. Key features of COLPs relevant to chemistry education include: Platforms like Zoom and Google Meet facilitate synchronous communication, allowing students to discuss concepts, ask questions, and collaborate on problem-solving in real-time, replicating aspects of a physical classroom setting. Slack, launched in 2004 is an acronym for Searchable Log of All Conversation and Knowledge which is a fairly new collaboration platform recently added to the suite of social networking platforms and part of a group of similar platforms known as "Enterprise Social Networks" (ESNs) [5]. These networks, are specifically designed to provide users with easy sharing of photos and other files, documents, sharing and collaborative editing of code, group and private discussions, place for sending messages, sharing files, communicate with other users and sharing knowledge that can be accessed through any web browser and can be integrated with mobile devices such as smartphone [5]. Slack is a digital workspace that integrates with third parties like Google Drive and Google Hangouts and allows users to collaborate on group projects. [6]. *Slack is a web platform aimed at improving team communication and offers some promising features for academic communities. It is* a team chat platform that emphasizes open channels and groups for the power of real-time text chat with searchable archives, app integrations and easy sharing of files and documents. It also allows all communication in one place.

Google Meet, formerly known as Google Hangouts Meet, is a video-communication service developed by Google. It was initially released in 2017 as part of the Google Workspace suite, offering high-definition video meetings and integration with other Google tools like Gmail, Google Calendar, and Google Drive [7]. Google Meet provides features such as real-time captions, screen sharing, and secure access controls, making it suitable for virtual classrooms, corporate meetings, and personal use. The platform's ease of use and deep integration with the Google ecosystem make it an attractive choice for educational institutions. According to Barnes, Google Meet offers a streamlined, user-friendly experience that allows teachers and students to connect effectively in real-time. Its support for large group meetings and breakout rooms enables collaborative learning, which supports constructivist approaches by fostering interactive environments where students can engage in discussions, problem-solving, and peer learning [8]. Zoom is another popular video communication platform that gained significant traction during the COVID-19 pandemic. Developed by Eric Yuan and launched in 2013, Zoom is known for its reliable, high-quality video conferencing capabilities. It offers features such as virtual backgrounds, screen sharing, meeting recording, and breakout rooms [9]. Zoom's simplicity and ease of use have made it a popular tool for remote work, education, and social interactions Zoom is particularly beneficial in educational settings because of its flexibility in hosting both large lectures and small group discussions. Its breakout rooms feature supports constructivist learning by enabling students to collaborate and work in smaller, more focused groups. This facilitates deeper engagement and critical thinking, which is essential for academic performance.

Majorly, the studies of Chen, and Davis, revealed that teaching methods play vital roles in either promoting or demoting academic performance [10]. Williams and Green evaluated the effectiveness of Slack and Zoom on academic performance in introductory Chemistry in University of Florida, USA. The study included 90 undergraduate chemistry students, with 45 students in the Slack group and 45 in the Zoom group [11]. Pretest-posttest on chemistry concepts were administered, along

with a student engagement survey to assess participation and satisfaction. Independent samples t-tests were employed to compare the post-test scores between the two groups. The results showed that the Zoom group had an average post-test score of 85%, while the Slack group averaged 75%. The difference was statistically significant ($p < 0.05$), indicating that synchronous learning with Zoom enhanced academic performance more effectively than the asynchronous Slack platform.

Chen, and Davis, investigated the engagement and learning outcomes in Chemistry: A comparison of Slack and Zoom platforms in University of Toronto, Canada. The study involved 100 undergraduate chemistry students, split evenly into 50 students using Slack and 50 using Zoom. Data were gathered through performance assessments (pre- and post-tests) and a student satisfaction questionnaire designed to measure engagement and learning experience. ANOVA was used to analyze differences in academic performance and satisfaction levels between the two groups. The Zoom group achieved an average post-test score of 88%, while the Slack group scored 80%. Results indicated significant differences in both performance ($F(1, 98) = 8.24$, $p < 0.01$) and satisfaction, with 90% of Zoom users reporting a positive experience compared to 70% of Slack users [10].

Patel, and Lee, investigated collaboration and performance in Chemistry education: A Study of Slack vs. Zoom in National University of Singapore. The research included 120 undergraduate chemistry students, with 60 using Slack and 60 using Zoom. Academic performance was assessed using pre- and post-tests, complemented by a survey that evaluated collaborative learning experiences. Paired t-tests were used to analyze performance improvements, and descriptive statistics were applied to survey responses. The results indicated that the Zoom group had a mean post-test score of 86%, while the Slack group scored 78%. Survey results revealed that 85% of Zoom participants felt that real-time interaction improved their understanding of the material, compared to 65% of Slack users, highlighting the advantages of synchronous learning environments for academic success [12].

Thompson, investigated the impact of Google Meet versus Slack on Collaborative Learning in Online Education in ABC University, USA. A quasi-experimental design was utilized, assigning students to either Google Meet or Slack for group projects over a semester. Stratified random sampling was used based on academic major and year of study, 250 undergraduate students from various disciplines. The research employed Engagement surveys measuring interaction frequency and satisfaction, academic performance assessments based on group project outcomes, Observational checklists for monitoring interaction during sessions. Descriptive statistics summarized the data, and independent samples t-tests compared the engagement and performance metrics between the two platforms. Students using Google Meet reported significantly higher engagement levels ($M = 4.6$ on a 5-point scale) compared to those using Slack ($M = 3.8$). The t-test revealed significant differences in project scores, with Google Meet participants. The findings suggest that Google Meet is more effective in enhancing collaborative learning and students' performance compared to slack in online education settings [13].

Kim, explored comparative analysis of google meet and Slack in fostering Chemistry students' interaction in virtual learning in South Korea [14]. A mixed-methods approach was utilized, combining quantitative assessments with qualitative feedback from students. Random sampling based on course registration was used, 220 undergraduate students enrolled in online courses. The study used Interaction logs from both platforms to quantify engagement, Student surveys assessing satisfaction and perceived effectiveness focus group interviews for qualitative insights. Descriptive statistics and chi-square tests were used to analyze interaction levels, while thematic analysis was applied to qualitative data. Data indicated that Google Meet users had higher interaction rates ($M = 25$ interactions per session) compared to Slack users ($M = 15$ interactions per session). Chi-square analysis revealed significant differences in interaction frequency ($\chi^2 (1, N = 220) = 12.34$, $p < 0.01$). Focus group feedback highlighted the preference for Google Meet due to its video capabilities, which enhanced communication. The study concludes that Google Meet significantly improves

student interaction and engagement compared to Slack, emphasizing the importance of platform choice in online learning.

Patel, worked on Google Meet and Slack as tools for online Chemistry teaching: A comparative study in GHI University, India. A comparative study design was employed, assessing student experiences with both platforms over a semester. Simple random sampling from enrolled courses was used to select 300 undergraduate students from various departments. The research utilized Online surveys to measure student engagement and satisfaction, academic performance evaluations based on assignments and quizzes, Observational checklists for monitoring engagement during sessions. Descriptive statistics were used to summarize engagement data, and paired samples t-tests were conducted to compare academic performance metrics. The findings showed that Google Meet users had higher engagement scores ($M = 4.7$) compared to Slack users ($M = 3.9$). The paired samples t-test indicated significant differences in academic performance, with Google Meet participants scoring an average of 88.6 ($SD = 5.2$) compared to Slack users who scored 81.3 ($SD = 6.4$), $t(299) = 7.12$, $p < 0.001$. The study concludes that Google Meet is more effective than Slack in enhancing students' engagement and academic performance in online teaching environments. From the reviewed literatures, there exist some inconsistent results. The present study therefore sought to investigate the extent to which teaching methods of slack, zoom and google meet exert differences in performance among chemistry education undergraduates [12].

Chinda and Etokeren investigated digital teaching and learning in chemistry education: the use slack platform and flipped classroom teaching strategies on academic performance of science education undergraduates in Rivers State universities. The study was guided by three research question and three hypotheses. Quasi experimental design, specifically, the pretest-posttest control non randomized group design was adopted. 75 chemistry education undergraduates served as the sample. The instrument was a 25-item Performance Test validated by two Science Education Lecturers. The reliability coefficient of 0.91 for the instrument was determined by Alpha Cronbach formula. Research questions were answered using mean and standard deviation while hypotheses were tested using Analysis of Covariance at 0.05 level of significance. Findings of the study revealed no significant difference in performance of students subjected to slack platform and flipped classroom teachings. Students in both classroom environments performed better with very high scores in the performance test. However, there was a significant performance difference in undergraduate's performance on the use of slack platform and lecture teaching method. The same was applicable to the use of flipped classroom. Undergraduates in both Slack platform and flipped classroom environments obtained higher test scores that their counterparts in lecture classroom environment. It was recommended among others that; lecturers should embrace the use of slack platform and flipped classroom in delivering lectures to ensure students' understanding of concepts [1].

Statement of the Problem

Chemistry education in Nigerian tertiary institutions faces significant challenges, including declining students' enrollment and poor academic performance. Documented evidence has it that traditional teaching methods often fail to engage students effectively, as they promote passive learning and lack opportunities for active participation, collaboration, and visualization of abstract concepts. The onset of the COVID-19 pandemic exposed the inadequacies of Nigeria's education system, such as limited access to digital learning resources and insufficient training for both lecturers and students in the use of online platforms. Collaborative online learning platforms (COLPs) like Slack, Zoom, and Google Meet among others have been recommended to offer potential solutions to these issues, in our educational system. Student and teachers sometimes indicate interest to the use of these platforms, but may not have the capacity to accessing them as expected. Governmental and non-governmental agencies have made several attempts to address this issue, yet, their effort seems not to be substantive enough. The problem of this study put in question

form is; what are the effect of Slack, ZOOM and Google meet teaching strategies on undergraduate Chemistry education students' academic performance in Chemistry?

Aim and Objectives of the Study

This study examined the collaborative effectiveness of Slack, ZOOM and Google meet classroom (e-learning) teaching strategies on undergraduate Chemistry education students' academic achievement in Calabar. Specifically, the study tends to:

1. determine the difference in academic performance of undergraduate chemistry students exposed to slack and Zoom teaching strategies.

2. assess the difference in academic performance of undergraduate chemistry students exposed to Google Meet and Slack learning strategies.

Research Questions

1. What difference exist in the academic performance of undergraduate chemistry students exposed to slack and Zoom teaching strategies?

2. What difference exists in the academic performance of undergraduate chemistry students exposed to Google Meet and Slack learning strategies?

Statement of Hypotheses

Two null hypotheses guided the study.

HO1. There is no significant difference in the academic performance of undergraduate chemistry students exposed to slack and Zoom teaching strategies.

HO2. There is no significant difference in the academic achievement of undergraduate Chemistry students exposed to Google Meet and Slack learning strategies.

Methods

Research Design

The research design that was adopted for this study was quasi experimental design involving Pre-test and Post-test of experimental and control groups. It was used to carry out study on the Impact of Slack, Google Meet and Zoom on the academic performance of Chemistry students in tertiary institutions. Where Google meet and Zoom were experimental groups and Slack control group. The population for this study was gotten from the Chemistry Education unit of UNICROSS year 3 students (45) and 127 UNICAL Chemistry Education year 3 (B.Sc.Ed) students which gives a total of 172 students. Stratified proportionate and simple random sampling techniques were used in this study. The sample for the experimental group is 84 while 50 students form control group. The sample was reached after post treatment; hence, 134 here female students were 58 while the male are 76. The instrument, Chemical Bonding Assessment Test (CBAT) with 30 items of multiple-choice objectives test was developed and used for data collection. Face and content validity were ensured using experts in science education (Chemistry). A reliability index of .84 was reached via KR20. The instrument was administered on the respondents with the help of research assistants from the both institutions. Data collected were analyzed using mean, standard deviation and ANCOVA. However, hypotheses are restated and tested at .05 level of significant.

Results

Research Question One: What difference exit in the academic performance of undergraduate Chemistry students exposed to Slack and Zoom teaching strategies?

Hypothesis One: There's no significant difference in the academic performance of undergraduate Chemistry students exposed to Slack and Zoom teaching strategies. The dependent variable in this hypothesis is academic performance while teaching methods are the independent variables. To test the hypothesis, mean, standard deviation and ANCOVA were employed and result presented in Table 1.

Table 1: Summary of ANCOVA analysis of the difference in performance between Zoom group and SLACK group

GROUP	N	Mean	Std. Deviation
EXPERIMENTAL GROUP 1(ZOOM)	84	65.75	8.649
CONTROL GROUP (SLACK)	50	45.15	6.337
Total	134	55.45	12.802

Source of Variation	Type III Sum of Squares	Df	Mean Square	F	P	Decision
Corrected Model	14501.008[a]	2	7250.504	130.145	.000	HO1 Rejected Significant
Intercept	20172.730	1	20172.730	362.097	.000	
Covariate	289.068	1	289.068	5.189	.024	
Methods	13026.006	1	13026.006	233.814	.000	
Error	7298.127	131	55.711			
Total	433776.000	134				
Corrected Total	21799.134	133				

*Significant, p < .05 level of Significant

Results from Table 1, show the mean scores for zoom group to be 65.75 with a standard deviation of 8.649 while that of slack group was 45.15 and 6.337 respectively. This shows a higher mean difference in performance between the groups under study. The p-values (.000 & .024) associated with the computed f-values (130.145, 362.097, 5.189 & 233.814) for corrected model, intercept, covariate and methods are all lower at .05. this means that there is a significant difference in the academic performance of students taught Chemistry with slack and zoom methods in favor of zoom. With this result, the null hypothesis which stated no significant difference in performance is rejected[9], [15].

Research Question Two: What difference exist in the academic performance of undergraduate Chemistry students exposed to Google meet and Slack teaching strategies?

Hypothesis Two: There's no significant difference in the academic performance of undergraduate Chemistry students exposed to Google meet and Slack teaching strategies. Google meet and slack teaching methods are the independent variable while students' academic performance is the dependent variable. To the hypothesis, mean, standard deviation and ANCOVA were used for research questions and hypothesis respectively. See table 2 for results.

Table 2: Summary of ANCOVA analysis of the difference in performance between Google meet group and SLACK group

GROUP	N	Mean	Std. Deviation
EXPERIMENTAL GROUP 1(GOOGLE MEET)	67	61.31	7.853

CONTROL GROUP (SLACK)		67			6.337	
Total		134		53.23	10.786	
Source of Variation	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**P**	**Decision**
Corrected Model	8773.168[a]	2	4386.584	85.759	.000	HO2 Rejected Significant
Intercept	25079.566	1	25079.566	490.313	.000	
Covariate	20.265	1	20.265	.396	.530	
Methods	8564.792	1	8564.792	167.444	.000	
Error	6700.661	131	51.150			
Total	395173.000	134				
Corrected Total	15473.828	133				

Significant, p < .05 level of Significant

From Table 2, the results show the mean scores for google meet to be 61.31 with a corresponding standard deviation of 7.853 while that of slack group was 45.15 and 6.337 respectively. This shows that there exists a difference in performance between those taught through google meet and slack in favor of Google meet group. The p-value (.000) associated with the computed f-values (85.759, 490.313 & 167.444) for corrected model, intercept and methods are less than the chosen .05 while the p-value (.530) associated with the computed f-value (.396) is higher than the chosen .05 level. The result therefore show that students taught with google meet perform better than those taught with slack teaching methods. With these results, the null hypothesis that stated no significant difference is rejected.

Summary of Findings

The summary of the findings includes;

1. There is a significant difference between the academic performance of chemistry students exposed to slack and zoom teaching strategies.

2. There is a significant difference between the academic performance of chemistry students exposed to google meet and slack teaching strategies.

Discussion of Findings

Difference between Zoom and Slack on Academic Performance of Students

The result here shows that there's a significant difference between the academic performance of chemistry students exposed to Zoom and Slack teaching strategies in favor of Zoom group. The reason for this is because Zoom is a synchronous platform, therefore it involves active participation of students but Slack is asynchronous meaning that students can assess information at their convenience and this can affect the academic performance of students, since it doesn't foster an active. The findings agree to Williams, and Green, that stated there's significant difference between the academic performance of students exposed to zoom and slack platforms. statistically significant ($p < 0.05$), indicating that synchronous learning with Zoom enhanced academic performance more effectively than the asynchronous Slack platform [11]. The findings of this work also agree to Chen, and Davis, (2023) Stated, that there's significant difference between the academic performance of chemistry students exposed to Zoom and Slack teaching strategies in favour of Zoom. The findings of this study disagree with Chinda and Etokeren revealed there is significant difference in performance of students subjected to slack platform in classroom teachings [1].

Difference between Google meet and Slack on Academic Performance of Students

From the findings of this study, result shows that there's significant difference between the academic performance of chemistry students exposed to Google meet and Slack teaching strategies in favour of Google meet group. The reason for this is because Google meet is engaging, it involves

effective interaction with both the teacher and students while Slack, doesn't not actually involve active participation of both students and teachers, reason being that in Slack students can assess information taught by the teacher at their convenient without participating effectively during the class. This way the student can't get to interact with the teacher effectively, to ask questions and get immediate feedback and this can affect their performance rate. The findings align with Thompson, Suggested that there's significant difference between the academic performance of students exposed to Google meet and Slack in favour of Google meet. The findings suggest that Google Meet is more effective in enhancing collaborative learning and student engagement compared to Slack in online education settings. The findings of this study also agree to that of Kim, Discovered a significant difference between the academic performance of students exposed to Google meet and Slack teaching strategies in favour of Google meet.

Conclusion

Based on the findings, the need for science educators to adopt innovative teaching strategies, such as the Slack, Zoom, and Google Meet which serve as a promising solution to the persistent issues in chemistry education becomes imperative. It may help in contributing to enhanced student outcomes and a more dynamic and effective learning experience in Nigeria's tertiary institutions.

Recommendations

Base on the findings of the study, the following recommendations are made;

1. Science teachers should endeavor to incorporate Slack and Zoom into teaching strategies to enable both asynchronous and synchronous learning. Slack can be used for ongoing discussions and resource sharing, while Zoom can facilitate real-time interaction, virtual labs, and demonstrations.

2. Leverage Google Meet for live lectures and collaborative sessions and Slack for follow-up discussions, assignments, and resource sharing. This combination offers both real-time engagement and flexibility for self-paced learning.

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