Comparative study between e-learning and Classroom Learning System among Polytechnic Students Learning Calculus course

Sufiyanu Muhammad Dakin-gari*[1], A. Ahmed[2], A. M. Tankouchiri[3], U. M. Layya[4], U. Sahabi[5]

Department of Mathematics, Kebbi State Polytechnic Dakingari. Nigeria[1, 2, 4 & 5]
Integral University Lucknow, India[3]

ABSTRACT
The current study attempts to compared the academics performance ofexperimental (e-learning) and control group (Classroom) of National Diploma I and II (ND I and II) students participated in learning Calculus course in Kebbi state polytechnic Dakingari, Umaru Ali Shinkafi polytechnic Sokoto, and Abdu Gusau polytechnic Talata- Mafara.The total population of the participants in this study was one hundred and forty nine (149) students from the three aforementioned tertiary institutions randomly selected. Eighty one (81) students participated as experimental group and Sixty eight (68) students as control group in all the three (3) selected tertiary institution. The data were collected using 20 items essay test questions with reliability coefficients of0.76 and was analysed with SPSS-V21 using independent sample t-test after sixteen (16) weeks of continuous treatment. The study were guided by one (1) research question and one (1) null research hypotheses (Ho) at significance alpha value 0.05. The groups were exposed to pre-test before the actual commencements of the treatments. The result of the post-test revealed that,the calculated p-values of the experimental and control group of the students participated in learning Calculus in Umaru Ali Shinkafi polytechnic Sokoto was higher than the alpha-value 0.05, p-val = 0.241 (0.241 > 0.05), the null hypotheses decision were accepted. However, the opposite results was obtained in Kebbi state polytechnic Dakingari and Abdu Gusau polytechnic Talata- Mafara in which the p-values are less than the alpha-value 0.05, P-val = 0.004 (0.004 < 0.05) and P-val = 0.012 (0.012 < 0.05) respectively, therefore, the null hypotheses was rejected. Finally, out of three (3) selected polytechnics in this study, the null hypotheses was failed to be accepted after the independent sample t-test in the two (2) polytechnics, we drawn a conclusion that there is significance difference on the polytechnic students that learn Calculus using e-learning and others using classroom approach.The study concluded that there is significant difference between the experimental and control group students that learned Calculus using e-learning and others using traditional (classroom) method in the polytechnics learning system.
Keywords, E-learning, Calculus, Classroom, Students, Polytechnic.

I. INTRODUCTION
In the classroom, instruction and learning take place in a complex, multidimensional social setting. Due to the large number of simultaneous events, teachers and students must quickly analyze and absorb these events.

The social experience of teaching and learning in the classroom is intricate and multidimensional. Teachers and students must quickly interpret and process the multitude of simultaneous events that are occurring. Teaching is a two-way exchange of ideas. since pupils have just as much control over the process as do teachers. While teachers are crucial in helping students find meaning in the classroom, students' learning and responses are ultimately determined by their own social and psychological activities. The most crucial element in determining each student's educational outcomes is how they see, interpret, process, and comprehend the activities that take place in the classroom—not what the teachers do.

With the integration of digital learning through the use of online learning platforms to assist instructional delivery, teaching and learning processes are quickly becoming more and more technology-driven. One of the best methods for raising student engagement in an online learning environment is to use the Google Classroom learning platform (Noah &Gbemisola, 2020).

Because of the ease of learning opportunities and advancements in technology, distance learning has become a well-known and generally recognized mode of instruction. Since remote learning allows students greater flexibility in their career and home interactions, many opt for it over traditional learning methods. Encouraging student engagement and achieving the same level of effectiveness in online learning as in-person instruction remained formidable obstacles. Additionally, the majority of distant learners choose to study and communicate with academics outside of regular business hours, which puts their work-life balance to the test. An efficient use of technology to increase student engagement and success rates while reducing the inconvenience of academic obligations after hours is provided by online support tools like Zoom, which enable students and instructors to connect through virtual tutorials from any convenient location (Sayem, Taylor, Mcclanachan, &Mumtahina,

Consequently, this study intends to close this gap by examining the academic performance of students taking Calculus courses at a few chosen polytechnics using e-learning as opposed to traditional classroom instruction.

Research Question
What is the impact of e-learning on students' academic achievement in Calculus courses compared to traditional classroom settings?

II. LITERATURE REVIEW

The traditional in-person learning method has been replaced with online learning. According to Tang and Lim (2013), because they are capable of learning on their own and are adept with technology, students prefer online training over in-person instruction. Different academics have brought forward various justifications for selecting online education. Serttaş and Kasabalı (2020) and Wright (2017), for instance, view time and location flexibility as a crucial component of online learning. However, depending on the situation, children may face distinct difficulties with each learning style.

Effective time management is crucial for both in-person and virtual learning. While some students think taking classes online saves time, others feel that managing time while taking school online is challenging. According to Serttaş and Kasabalı (2020), time management is difficult for students enrolled in online courses since they are easily sidetracked by online browsing and instant messaging. Numerous other researchers have also made the same observation. Yeboah and Smith (2016), for instance, found that study participants struggled with time management in online learning. Therefore, when examining the two modalities of learning, some factors that should be taken into account include the learners' preferences, their willingness to participate, and their prior experiences.

In teaching-learning processes, student choice is crucial because certain students may feel more at ease in a particular learning style than another. Shy students tend to participate more in online classes than in traditional classroom settings, on average. Thus, according to Alammary (2022), achieving a healthy balance between in-person and virtual learning could boost student engagement. Different justifications are offered by those who support this idea. For instance, according to Wright (2017), shy students may be afraid to ask questions in a face-to-face class due to their peers' presence; as a result, online classes allow them to develop into autonomous learners.

According to academics, giving students autonomy in an online learning environment can increase their motivation (Abuhassna et al., 2020; Alzahrani, 2022; Ryan &Deci, 2020). All students might not feel the same way about online learning, though. According to Yeboah and Smith (2016), students of today anticipate that their teachers will incorporate online learning management systems into in-person instruction. This could meet the needs of students who are more driven to learn online and who are more at ease in traditional classroom settings.

Even if online learning is thought to be simple and adaptable, there are a few reasons why some students might be hesitant to select it. Reluctance could stem from a bad online course experience that students or their peers had (Jaggars, 2014). It's possible that various students will have different bad experiences. For instance, students might not have a strong internet connection or they might not be adept at using technology. A poor connection could be the source of learners' disinterest. According to Cigdem and Ozturk (2016), a server failure can have a detrimental

impact on students' enthusiasm and participation in online courses, so internet service quality is crucial.

Online learning environments alter the dynamics of relationships between students and teachers (Arias, Swinton, & Anderson, 2018). The utilization of internet resources can enhance students' comprehension of the subject matter beyond what they learn in class. Online resources are helpful, according to Coates and Humphreys (2001), but students need to make the most of them by actively using them (as mentioned in Arias et al., 2018). Put another way, technology is viewed as a tool that students can use. Shahid and Shaikh (2019) come to the conclusion that WhatsApp is a useful tool for improving students' cognitive abilities and encouraging teacher-student relationships. If learners can effectively utilize technology, it could potentially function as a facilitator in the connections between students and teachers.

III. RESEARCH METHODOLOGY
Research Design

This study used a quasi-experimental approach to answer research question (RQ) by using experimental and control group. The experimental group were taught the Calculus courses using e-learning calculus tutoring system while control group taught the same using face-to-face (classroom) method. Before the actual commencements of the treatments a pre-test was conducted to both groups in order to assess their level of basic calculus. An e-learning calculus tutoring system were used for the online lectures delivery and a system (website) was developed and hosted online to view the uploaded instructional videos from the YouTube. Sixteen (16) weeks of continuous treatment was conducted, at the end the, two groups undergo a post-test. Collected data were analysed using mean, standard deviation and t-test statistics to find significance differences in academic performance between the groups.

Participants and Sampling

In this study, the participants are students from the departments of Computer Science, Science Laboratory Technology (SLT) and Electrical and electronics engineering in National Diploma II (ND II) Programmes in Kebbi state polytechnic Dakingari, Kebbi State, Umaru Ali Shinkafi polytechnic Sokoto, Sokoto State and Abdu Gusau polytechnic Talata- Mafara, Zamfara State. The total population of the participants in thisstudy was one hundredand forty nine (149) students from the three aforementioned tertiary

institutionsrandomly selected. Eighty one (81) students participated as experimental group and Sixty eight (68) students as control group in all the three (3) selected tertiary institution.

i. In Kebbi state polytechnic Dakingari, Kebbi State, the total participants are fifty six (56) students. Twenty students (20) from the department of computer science, twenty two (22) students are in Science Laboratory Technology (SLT) and fourteen (14) students from Electrical and electronics engineering. Out of fifty six (56) students, Thirty one (31) students selected as experimental group were taught Calculus through E-learning tutoring system using instructional videos were recorded during online lectures and open broadcaster software (OBS) were used to make the instructional videos which were uploaded on the YouTube channel and linked to the developed hosted system and twenty five (25) students as control group they were taught same using the conventional (classroom) approach.

ii. Umaru Ali Shinkafi polytechnic Sokoto, Sokoto State, the participants are forty five (45) students from the three selected departments. Seventeen (17) students were studying computer science, sixteen (16) students are in Science Laboratory Technology (SLT) and twelve (12) students from Electrical and electronics engineering. The participants were groups into two (2) namely, experimental group and control group. Out of forty five (45) students, twenty five (25) students selected as experimental group who learnt Calculus online and twenty (20) students as control group they were taught same using the conventional (classroom) approach.

iii. Abdu Gusau polytechnic Talata- Mafara, Zamfara State,the participants are forty eight (48) students from the three selected departments. Sixteen (16) students were from computer science, eighteen (18) students are in Science Laboratory Technology (SLT) and fourteen (14) students from Electrical and electronics engineering. The participants were groups into two (2) groups namely, experimental group and control group. Out of forty eight (48) students, twenty three (23) students selected as experimental group who learnt Calculus online and twenty five (25) students as control group they were taught same using the conventional (classroom) approach.

Data Collection Procedure
The study and data collection were in the academic year (2023/2024). Participants were National Diploma II (ND II) students taking the Calculus course as one of their units. Polytechnic classes last for 16 weeks. The two groups were taught differently. The participants in the experimental group were taught using an e-learning calculus tutoring system provided by the researchers. The online platform on which classes were held was e-learning calculus system. In the first session, the researchers introduced the materials that were supposed to be implemented during the term. Also, the researchers presented guidelines for students on how to connect during e-learning sessions. For the control group, students participated in regular classrooms at the polytechnics. They received traditional in-person teaching methods. The researchers lectured and presented the materials to the students. Students completed exercises and participated in group activities. At the end of the treatments, the test was conducted as an instrument to collect data for the study. A twenty (20) items essay test questions which has a reliability coefficients of 0.76, indicating that it was reliable to assess the academic performance of the students. Thestudents from both groups were expected to score a maximum of hundred (100) marks.

Data Analysis
The Data collected were analysed using independent sample t-test in Statistical Package for Social Sciences version 21 (SPSS-V21).

Research Hypotheses
Ho: Regarding the academic performance, there is no significant difference between the control group, which received instruction via a typical face-to-face classroom method, and the experimental group, which used an e-learning calculus tutoring system. The hypotheses were tested at 0.05 level of significance difference.

SYSTEM DEVELOPMENT
HTML, CSS, JAVASCRIPT and JQUERY scripting languages was used to developed the front-end of the calculus e-learning system while MySQL Database was used to developed the back-end and PHP programming language was used to communicate information between the front-end and the back-end and the vice vasa.

Intelligent tutoring systems consist of four basic components based on a general consensus amongst researchers those components are Domain model, Student Model, Tutoring (Pedagogical) Model and User Interface Model (Sivarasan & Rameshkumar, 2017).
The calculus e-learning system in this research was developed using the four (4) modules but not the fully Intelligent Tutoring System (ITS) rather the E-learning approach. Therefore, this system has Domain module, Learning module, Student/User Menus module and User interface module.

User Interface
The user interface is divided into two (2) parts:
i. Admin/Lecturer part
The admin/lecturer part provided the features for adding new lesson, videos and audios based on the topics and sub-topics as explained in the domain module, viewing registered users and managing the system in general. Fig. 3 shows where admin/lecturer can add new lesson with examples and exercises.

ii. Students/User part
This are the interfaces where user can create new profile before he/she can access the lessons, videos and audios provided by the admin/lecturer. Figs. 2, 4, 5, 6 and 7 shows the user interfaces for the students/user part.

Domain Module
The domain module contained the information that are to be taught to the students/users in the learning module. It is the stage that make the users to understand what he/she expected in the system during learning and how lessons were arranged or presented in the system.
The domain module in this calculus e-learning system covers the following:
➢ Limit
• Evaluating limit
• Just put the value in
• Factors
• Conjugates
• Formal Definition
• Delta and Epsilon
➢ Continuity and Discontinuity
• Continuity
• Discontinuity
• Jump Discontinuity
• Infinite Discontinuity
• Point Discontinuity
➢ Differentiations

- Derivatives
- Differentiation from the first principle
- Standard derivatives of some basic function
- Rules of differentiations
- Implicit function
➢ Integrations
- Constants of integration
- Standard integral
- Integrating a sum/difference of a function
- Integrating a simple trigonometric function
- Integration by substitution
- Integration involving powers of sine and cosine
- Integration by parts
- Integration by partial fraction
➢ Maximum and Minimum
- Maximum and minimum

Learning Module

Learning module conveyed the actual lesson of the calculus to the students/users inform of textual explanation, video instruction/demonstration and audio explanation for each topic and sub-topic as in domain module above. The videos physically show the step-by-step examples and exercises as explained textually, while audios provided the sound explanation which corresponded to the texts and videos explained. Therefore, students/users learn calculus by reading text or viewing instructional videos or audio explanation, users can also use both at the same time during learning process. The videos are uploaded on the YouTube while the audios are uploaded on the SoundCloud and all are embedded in the system.

User Menus

The user menus contained information about registered students/users, date and time the user login or logout of the system and access for materials and resources that help user during learning.
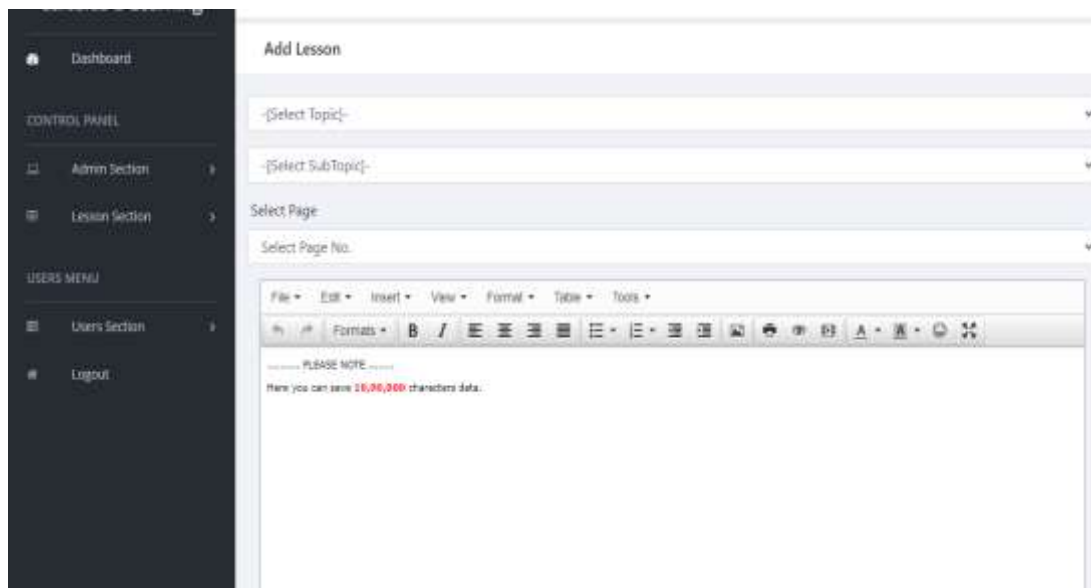

Fig. 2: Home Page

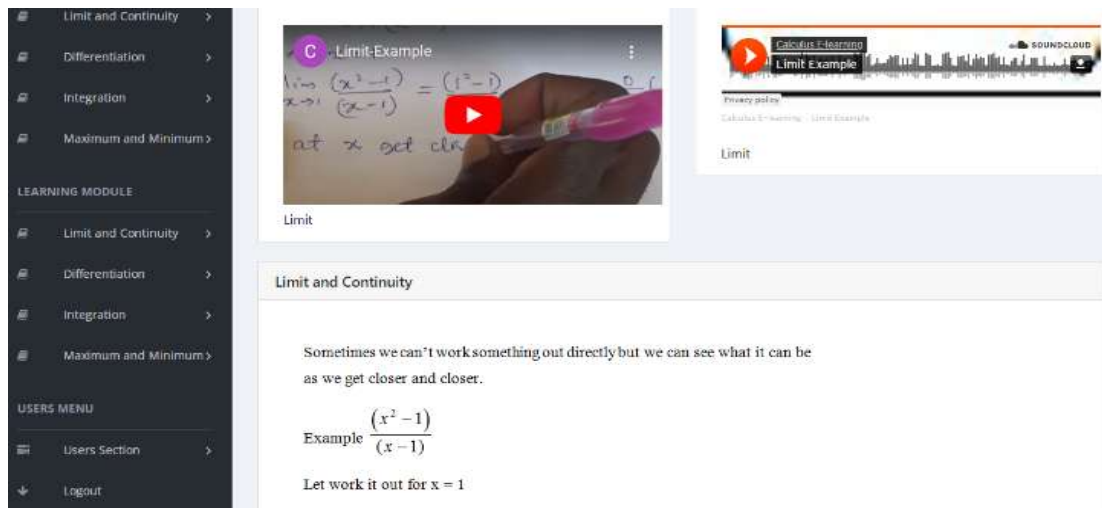**Fig. 3: Admin/Lecturer to add lesson, examples and exercises**

Fig. 4: Limit and Continuity

Fig. 5: Derivatives/Differentiation
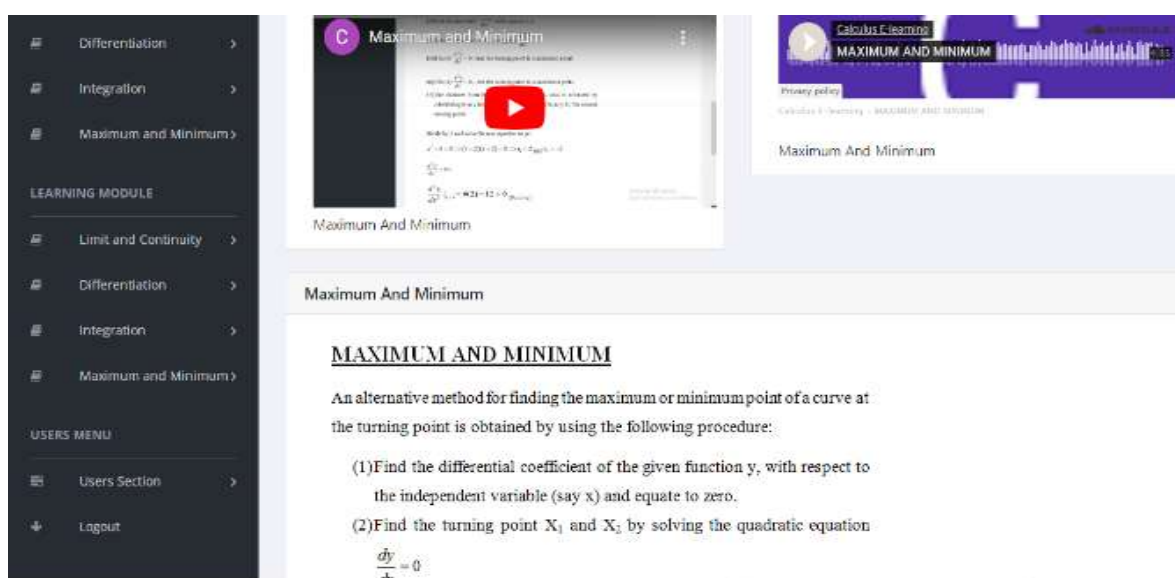
Fig. 6: Integration

Fig. 7: Maximum and Minimum

IV. RESULTS AND FINDINGS

A study was conducted to determine the significance of the differences between the experimental and control groups of Calculus students who were taught the course via online learning for the former and traditional classroom lectures for the latter. One (1) week following the sixteen (16) weeks of nonstop treatment, the post-test was administered to both groups. As a result, the study's alpha value of 0.05 was used to compare the computed p-values with the mean, standard deviation, and independent sample t-test. Table 1 displayed the outcomes for the two (2) student groups.

Table 1: Post-test result in Kebbi state polytechnic Dakingari

Test	Group	Class size	Mean	SD.	df	MD	t-test-val	p-value
CALCULUS_Post _Test	EG_E-LEARNING	31	38.480	8.651	53	16.082	5.861	0.004
	CG_CLASSROOM	25	54.562	11.996				

NOTE: EG = Experimental Group; CG = Control Group; SD = Standard Deviation; df = Degree of Freedom; MD = Mean Difference; t-test-val = T test value; P-val = Probability Value.

An independent sample t-test was conducted to compare the effectiveness and student academic performance for face-to-face (classroom) learning and online learning in Calculus course. The result in table 1 showed that p-val is 0.000 which is less than our chosen significance alpha value of 0.05 (0.000 < 0.05), this indicate that there is significant differences between the two groups t(88) = 5.861, p-val = 0.000, df = 88, mean difference = 13.235 and 95% Confidence Interval

(CI) = [8.74757, 17.72243]. The mean and standard deviation score for the Face-to-face (classroom) students (control group M = 66.560, Std = 11.996) Therefore, students that learned calculus course using Face-to-face (classroom) that is control group scored is significantly higher than students in the experimental group whose learned the course using e-learning with (M = 53.325, Std = 8.651). Equal variances was assumed from the levene's test for equality of variances. Therefore, since the p-val 0.000 is less than the alpha value of 0.05 (p-val = 0.000 < alpha value = 0.05). Hence, the null hypotheses (Ho) was rejected and we draw the conclusion that there is significant difference between the two groups of students whose learned calculus

course using e-learning and traditional method classroom inkebbi state polytechnic Dakingari.

Table 2: Post-test result in Umaru Ali Shinkafi polytechnic Sokoto

Test	Group	Class size	Mean	SDdf	MD	t-test-val	p-value
CALCULUS_Post _Test	EG_E-LEARNING	2557.325	8.651	378.1583.861		0.241	
	CG_CLASSROOM20		49.167	11.996			

NOTE: EG = Experimental Group; CG = Control Group; SD = Standard Deviation; df = Degree of Freedom; MD = Mean Difference; t-test-val = T test value; P-val = Probability Value.

The result in table 2 shows that there were no significant differences between the two groups t(28) = 3.861, p-val = .241, df = 37, mean difference = 8.158 and 95% Confidence Interval (CI) = [-3.284628, 31.151294]. The mean and standard deviation score for e-learning students(experimental group M = 57.325, SD = 8.651) was higher than that of classroom students (control group M = 49.167, SD = 11.996). Since

the p-val was .241which was higher than alpha value .05 (p-val = .241> alpha value = 0.05). Hence, the null hypotheses (Ho1) was supported and we draw the conclusion that there is no significant difference between the two groups of students who learned calculus using e-learning and others using traditional method (classroom)in Umaru Ali Shinkafi polytechnic Sokoto.

Table 3: Post-test result in Abdu Gusau polytechnic Talata- Mafara

Test	Group	Class size	Mean	SDdf	MD	t-test-val	p-value
CALCULUS_Post _Test	EG_E-LEARNING	23	53.325	26.651	4313.235	3.861	0.012
	CG_CLASSROOM	25	66.560	11.996			

NOTE: EG = Experimental Group; CG = Control Group; SD = Standard Deviation; df = Degree of Freedom; MD = Mean Difference; t-test-val = T test value; P-val = Probability Value.

The result in table 3 depict Post-test result inAbdu Gusau polytechnic Talata- Mafara, The result in table 1 showed that p-val is 0.012 which is less than our chosen significance alpha value of 0.05 (0.012< 0.05), this shows that there is significant differences between the two groups

t(28) = 3.861, p-val = .241, df = 37, mean difference = 8.158 and 95% Confidence Interval (CI) = [-3.284628, 31.151294]. The mean and standard deviation score for e-learning students (experimental group M = 53.325, SD = 26.651) was higher than that of classroom students (control

group M = 49.167, SD = 11.996). Since the p-val was .012 which was lower than alpha value .05 (p-val = .012 < alpha value = .05). Hence, the null hypotheses (Ho1) was rejected and we draw a conclusion that there is significant difference between the two groups of students who learned calculus using e-learning and others using traditional method (classroom)in the Abdu Gusau polytechnic Talata- Mafara.

Table 4: Summary for the Post-test results in the polytechnics

S/n	Tertiary institutions	Group	P-Value Comparison Against Alpha Value (.05)	Null Hypotheses Decision	Level of Significance
1	Kebbi state polytechnic Dakingari	EG_Java	P-val = 0.004	Rejected	There is Significance Difference
		CG_Java	0.004 < 0.05		
2	Umaru Ali Shinkafi polytechnic Sokoto	EG_Java	P-val = 0.241	Accepted	No Significance Difference
		CG_Java	0.241> 0.05		
3	Abdu Gusau polytechnic Talata-Mafara	EG_Java	P-val = 0.012	Rejected	There is Significance Difference
		CG_Java	0.012 <0.05		

The null hypotheses decision, level of significances and compared p-values against alpha-value of the three (3) independent sample t-test presented in Table 1, 2 and 3 was summarised in Table 4. The calculated p-values of the experimental and control group of the students participated in learning Calculus in Umaru Ali Shinkafi polytechnic Sokoto was higher than the alpha-value 0.05, p-val = 0.241 (0.241 > 0.05), the null hypotheses decision were accepted. However, the opposite results was obtained in Kebbi state polytechnic Dakingari and Abdu Gusau polytechnic Talata- Mafara in which the p-values are less than the alpha-value 0.05, P-val = 0.004 (0.004 < 0.05) and P-val = 0.012 (0.012 < 0.05) respectively, therefore, the null hypotheses was rejected. Finally, out of three (3) selected polytechnics in this study, the null hypotheses was failed to be accepted after the independent sample t-test in the two (2) polytechnics, we drawn a conclusion that there is significance difference on the polytechnic students that learn Calculus using e-learning and others using classroom approach.

V. CONCLUSION

An investigation was carried out to addressedthe research question if the two methods of e-learning and traditional classroom settings have animpacts on students' academic achievement in Calculus courseinkebbi state polytechnic Dakingari, Umaru Ali Shinkafi polytechnic Sokoto and Abdu Gusau polytechnic Talata- Mafara. The mean scores by the two (2) groups relatively varies for the three (3) selected polytechnics learning Calculus in which the null hypotheses failed to be accepted after the independent sample t-test on the two (2) Polytechnics in the study. Therefore, we concluded that there is significant differences between the experimental and control group students that learned Calculus using e-learning and others using traditional (classroom) method in the selected polytechnics. Finally, the two groups and students in the selected polytechnics asked researchers to continue these types of projects in other courses.

VI. AKNOWLEDGEMENT

CONFLICT OF INTEREST

The authors have declared there is no conflict of interests exist.

REFERENCES

[1] Abuhassna, H., Al-Rahmi, W. M., Yahya, N., Zakaria, M. A. Z. M., Kosnin, A. B. M., &Darwish, M. (2020). Development of a new model on utilizing online learning platforms to improve students'academic achievements and satisfaction.International Journal of Educational Technologyin Higher Education, 17(1), 1-23. doi: 10.1186/s41239-020-00216-z

[2] Alammary, A. S. (2022). How to decide the proportion of online to face-to-face components of a blended course? A Delphi study.Sage Open, 12(4), 1-25. doi: 10.1177/21582440221138448

[3] Alzahrani, M. (2022). Traditional learning compared to online learning during the COVID-19 pandemic: Lessons learned from faculty's perspectives. Sage Open, 12(2), 1-11. doi: 10.1177/21582440221091720

[4]Arias, J., Swinton, J., & Anderson, K. (2018). Online vs. face-to-face: A comparison of student outcomes with random assignment. E-Journal of Business Education and Scholarship of Teaching, 12(2), 1-23.

[5] Cigdem, H., &Ozturk, M. (2016). Critical components of online learning readiness and their relationships with learner achievement.Turkish Online Journal of Distance Education, 17(2), 98-109.

[6] Coates, D., & Humphreys, B. R. (2001). Evaluation of computer-assisted instruction in principles of economics.Journal of Educational Technology & Society, 4(2), 133-144.

[7] Jaggars, S. S. (2014). Choosing between online and face-to-face courses: Community college student voices.American Journal of Distance Education, 28(1), 27-38. doi:

https://doi.org/10.1080/08923647.2014.867697

[9] Noah, O. O., &Gbemisola, O. K. (2020). Impact of google classroom as an online learning delivery during COVID-19 pandemic: The case of a secondary school in Nigeria. Journal of Education, Society and Behavioural Science, 33(9), 53–61. https://doi.org/10.9734/JESBS/2020/v33i930259

[10] Ryan, R. M., &Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. Contemporary educational psychology, 61, 101860.doi: 10.1016/j.cedpsych.2020.101860

[11] Sayem, M. S. A., Taylor, B., Mcclanachan, M., &Mumtahina, U. (2017).Effective use of Zoom technology and instructional videos to improve engagement and success of distance students in Engineering. Australasian Associations for Engineering Education, 1–6. CQUniversity Australia the School of Engineering and Technology. Retrieved from a.sayem@cqu.edu.au

[12] Serttaş, Z., &Kasabalı, A. (2020). Determining the English Preparatory School Students' Readiness for Online Learning.Near East University Online Journal of Education, 3(2), 66-78.

[13] Shahid, S., &Shaikh, M. A. (2019). Impact of" WhatsAppChaupal" on the Academic Performance of Graduate Students of Karachi–A Case Study.FWU Journal of Social Sciences, 13(2), 94-107.

[14] Tang, S. F., & Lim, C. L. (2013). Undergraduate students' readiness in e-learning: a study at the business school in a Malaysian private university. International Journal of Management & Information Technology, 4(2), 198-204.

[15] Wright, B. M. (2017). Blended learning: Student perception of face-to-face and online EFL lessons. Indonesian journal of applied linguistics, 7(1), 64-71.doi: dx.doi.org/10.17509/ijal.v7i1.6859

[16] Yeboah, A. K., & Smith, P. (2016). Relationships between Minority Students Online Learning Experiences and Academic Performance.Online Learning, 20(4), 245-271.