An Evaluation of Student Performances in Online vs. Physical Learning Environments

University of Sri Jayewardenepura
Faculty of Computing

B.comp (Hons.) in Computer Science – CCS2042
Statistical Distribution and Inferences

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Statistical Distribution and Inferences

Submitted by –

M.A.O.Rodrigo (Group leader) – FC221019

W.M.T.N.Waidyathilake – FC221011

M F Sarah - FC223034

E.K.A.R.L.Egalla - FC221048

B.A.B. Mewanya - FC223047

Requested by: **Ms. D.N.M. Hettiarachchi**

1. Introduction

Over the years, the field of tertiary education has witnessed increased attention on the effectiveness of online and in-class learning modes in stimulating student performances. While online learning offers benefits in terms of flexibility and wider access to materials, the in-class setting provides a structure, instantaneous interaction and instant feedback. Understanding the impact of the two learning modes upon student performance is particularly relevant for complex and technically challenging courses like Data Structures and Algorithms (DSA), for which conceptual understanding and practice remain as important determinants of academic achievement.

This research examines the impact of the two learning methods - online classrooms compared with traditional classrooms - on student performance within the DSA module at the Faculty of Computing, University of Sri Jayewardenepura. Data were gathered through two distinct structured surveys, targeted separately at current third year students who undertook the module in a physical environment and current second year students who participated in an online format. The survey questions addressed two primary areas: the impact of each educational mode on students' academic achievement (including engagement, understanding, and assessment results) and the difficulties encountered in each setting (such as concentration, communication, timing, and resource accessibility).

This study attempts to clarify how learning modes significantly affect academic performance and outlines the specific challenges faced by students in each learning mode. Furthermore, the findings of this study can benefit the faculty and curriculum developers in preparing better teaching strategies and potentially creating blended learning models that take the best of the online and physical learning experience and enhance the performance of students.

2. Literature review

To conduct our research, first we reviewed similar works done by others.

- *Influence of Online and Physical Classrooms on Students Academic Performance* - Ebenezer Omolafe Babalola*, Samuel Adenubi Onasanya
- *From Classroom to Online: Comparing the Effectiveness and Student Academic Performance of Classroom Learning and Online Learning* - Bernard Fentim Darkwa , Samuel Antwi
- *Online Versus Traditional Learning: Academic Performance and Learning Disabilities* - Camri p. Middleton

This research relies heavily on Babalola and Onasanya's (2024) extensive work on the effects of both traditional classroom delivery and virtual learning environments on student's achievement in the University of Ilorin, Nigeria. It developed a framework for a descriptive examination that compares conventional classroom delivery modes with virtual learning systems with deep insights into effects, problems, as well as results behind both learning paradigms.

Results from the research conducted by Babalola and Onasanya found that both types of learning have a positive impact on students' learning success, with online learning having slightly advanced effectiveness with respect to flexibility and encouraging individual participation. In their investigation. However, they also discovered critical barriers that were connected to both types of learning. It was found that learning environments with online learning were connected to internet accessibility problems, whereas traditional classroom-based learning environments were found to have a variety of stress-connected issues among students. Due to the high similarity between purposes and setting of their work and objectives of this current work, their framework was taken as the central template to be utilized for such analysis. [1]

Furthermore, research conducted by Darkwa and Antwi (2021) were found to produce relevant results from their learning effectiveness analysis between face-to-face traditional classroom instruction and online learning during the COVID-19 pandemic among University of Cape Coast students. Results indicated that though classroom instruction performed better than online delivery concerning quality instruction, interactivity, and systems for providing feedback, significant differences were found between final academic outcomes for face-to-face-based versus online-based learning contexts. Such results were found to inform practical issues institutions experience with regard to transitions to online learning spaces as well as contribute relevant contextual information to support knowledge available. [2]

Additionally, Research conducted by Middleton (2022) introduced a critical perspective with a particular analysis of the intersection between face-to-face and online learning modalities, focusing on academic achievement, retention rates, integrity concerns within academics and learning disabilities experience. Results indicated that online learning structures might offer unique benefits for high achievers and learning disabilities mostly because they allow for additional flexibility and access to assistive technologies. At the same time, Middleton noted difficulties such as additional susceptibility to distractions and integrity concerns with respect to academic work. These results deepened an understanding of overall learning results within various learning environments more significantly than anticipated beforehand. [3]

The insights derived from these studies not only broadened the scope of our understanding but also informed and guided the methodological and analytical approaches adopted in the present research.

3. Methodology

This present study applied a quantitative survey design to explore the influence of physical and online modes of learning on the students’ performance in the Data Structures and Algorithm (DSA) module at the Faculty of Computing, University of Sri Jayewardenepura. The sampling population comprised undergraduate students who had been through the study in the DSA course and were separated into two distinct groups: the current-day second-year students studied through an online mode and the present-day third-year students through a physical classroom mode.

Data was collected by researcher-constructed structured questionnaires given to both groups. 43 responses were gathered from the online group, and 38 responses were gathered from the physical group. Four separate sections made up the questionnaire:

(i) The impact of online learning
(ii) The impact of physical learning
(iii) The challenges in online learning
(iv) The challenges in physical learning.

Strongly agree (SA), agree (A), disagree (D), and strongly disagree (SD) were the response categories on the four-point Likert rating scale used in the questionnaire. The points were from 1 to 4 from SD to SA.

Analysis entailed the computation of a weighted score of each response alternative. For every student, the sum of the weighted score on all questionnaire items was computed to provide a single data point. This process was repeated for every student to provide a dataset of individual values of performance. The overall mean and standard deviation of each group were calculated from the above data points. This approach ensured that the combined statistics of the group embedded the overall individual student contributions.

To determine whether online or physical learning was superior in terms of student performance, a pooled t-test was conducted. This inferential test was suitable since the comparison involved two independent samples. Descriptive statistics (frequencies, percentages, and grand means) were used to summarize survey responses, while the pooled t-test provided evidence for hypothesis testing.

Pooled T test

A pooled t-test is used to compare the means of two independent groups (e.g., students in online vs. physical classes) when we assume that both groups have approximately the same variance. The word *pooled* means that we combine (pool) the two sample variances into a single estimate of the common population variance.

This method is suitable here because we want to test whether there is a significant difference in the average performance between students in online and physical learning modes.

Pooled Standard deviation (S_p)

$$S_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

n_1, n_2 = sample sizes of each group

s_1, s_2 = standard deviation of each group

Pooled t-statistic (t)

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$\bar{x}_1, \bar{x}_2$ =Sample means of the 2 groups

Interpretation:

- If the absolute value of t is larger than the corresponding critical value, we reject the null hypothesis.
- This means there is a significant difference between the two group means (online vs. physical).

4. Discussion

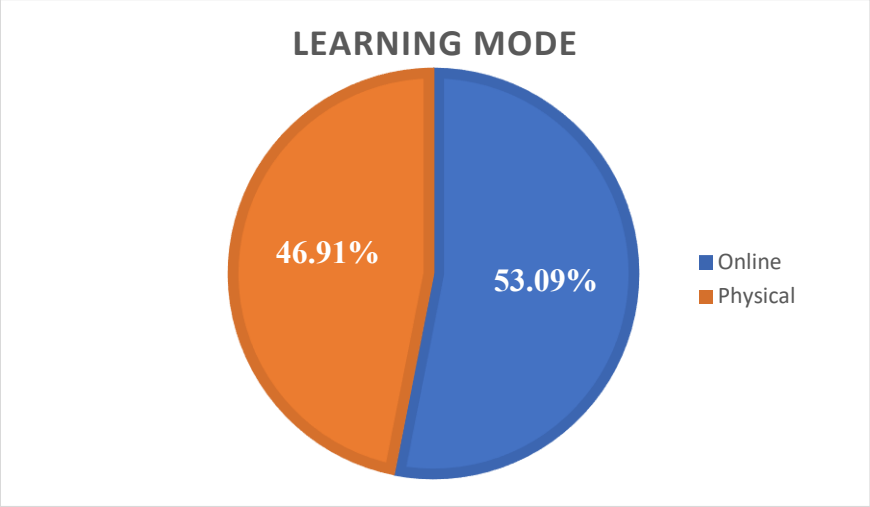
4.1 Data Analysis: Demographic Information of the Respondents

For this survey, 81 students participated. From these respondents, 43 students (53.09 %) had been through the DSA module in an online mode of education, and 38 students (46.91 %) went through the module in the traditional classroom mode. This reveals a relatively even split of the respondents into the two groups, with slightly higher dominance by the online classroom group.

Learning Mode	Population Group	Sample Size	Percentage (%)
Online	Second-year students	43	53.09
Physical	Third-year students	38	46.91
Total		81	100.0

Table 1. Distribution of respondents by learning mode

This breakdown is further depicted in the pie chart below, demonstrating the relative breakdowns of participants in online and physical groups.



The demographic analysis confirms here that the study successfully obtained an equal representation of students in both educational settings and thus facilitated comparability in the subsequent analysis.

4.2 Impact of Online Learning on Students' Performance

Table 2 presents the responses on the influence of online learning on students' performance. **The decision benchmark** for this study was set at **2.45** on a 4-point Likert scale. **The calculated grand mean** for this section was **2.73**, which indicates that online learning had a generally positive influence on students' academic performance.

Impact of Online learning						
Q.no	**SA**	**A**	**D**	**SD**	**Mean**	**No. of responses**
1	1	15	23	4	2.30	43
2	7	27	9	0	2.95	43
3	12	25	6	0	3.14	43
4	17	21	5	0	3.28	43
5	3	23	17	0	2.67	43
6	1	19	17	6	2.35	43
7	4	23	14	2	2.67	43
8	2	20	19	2	2.51	43
9	7	22	14	0	2.84	43
10	3	23	14	3	2.60	43
Grand Mean					**2.73**	**Positive**

Table 2 – Analysis of influence of online learning on students' performance

Among the ten items, the **highest mean score** was recorded for "*Learning in online classes helps me manage my study time*" with a **mean of 3.28**, suggesting that students felt empowered by the flexibility of online sessions to plan their study schedules. Conversely, the **lowest mean score** (found as **2.30**) was reported for *"I was able to focus without distraction during online classes.*" These findings highlights one of the common challenges of online learning which is maintaining concentration in a home or remote environment.

Overall, the results indicate that online learning contributes positively to students' performance, primarily because of its convenience and time-management benefits, though maintaining consistent engagement remains a key area to address.

4.3 Impact of Physical Learning on Students' Performance

Table 3 displays the results regarding the impact of physical classroom learning. **The decision benchmark remains 2.45**, and the **grand mean** for this section **was 3.06**, showing that physical learning also had a positive influence on student performance — slightly higher than that of online learning.

Impact of Physical learning						
Q.no	**SA**	**A**	**D**	**SD**	**Mean**	**No. of responses**
1	14	18	4	2	3.16	38
2	5	25	8	0	2.92	38
3	9	25	4	0	3.13	38
4	6	22	9	1	2.87	38
5	4	23	11	0	2.82	38
6	10	27	1	0	3.24	38
7	11	25	2	0	3.24	38
8	6	29	3	0	3.08	38
9	10	24	4	0	3.16	38
10	8	23	7	0	3.03	38
Grand Mean					**3.06**	**Positive**

Table 3 – Analysis of influence of physical learning on students' performance

The **highest mean** (**3.24**) was reported for two items: "*I am encouraged to participate actively during physical classes*" and "*The classroom environment motivates me to stay engaged.*" These responses reinforce the importance of direct interaction and immediate feedback from lecturers and peers, which tend to be stronger in face-to-face learning environments. The **lowest mean** (**2.82**) was observed for "*I find physical classes to be more flexible for self-study,*" which is understandable as physical classes usually follow a fixed timetable.

This suggests that students still appreciate the structured nature of physical classrooms, where personal interaction and peer motivation enhance academic engagement and performance.

4.4 Challenges of Online Learning

Table 4 summarizes students' responses to challenges faced during online learning. The **grand mean of 2.80** (above the **2.45 decision value**) indicates that these challenges were a significant concern for many students.

Challenges of Online learning						
Q.no	**SA**	**A**	**D**	**SD**	**Mean**	**No. of responses**
1	13	23	7	0	3.14	43
2	4	24	13	2	2.70	43
3	12	24	6	1	3.09	43
4	4	19	16	4	2.53	43
5	3	19	17	4	2.49	43
6	8	28	5	2	2.98	43
7	8	26	7	2	2.93	43
8	5	23	14	1	2.74	43
9	4	21	16	2	2.63	43
10	5	26	10	2	2.79	43

Grand Mean	**2.80**	**Positive**

Table 4 – Analysis of challenges in online learning affecting students' performance

The **highest mean** (**3.14**) was reported for "*Unstable internet connection disrupts my learning experience,*" reflecting a key technological barrier in online education. The **lowest mean** (**2.49**) was for "*Difficulty in getting timely responses from lecturers,*" suggesting that while communication delays existed, they were perceived as less severe compared to connectivity issues.

Taken together, the findings highlight that although online learning has a positive impact, challenges related to infrastructure and environment still limit its effectiveness. Addressing these issues, particularly internet reliability, would likely enhance students' overall online learning experience.

4.5 Challenges of Physical Learning

Finally, Table 5 presents the challenges experienced in physical learning. The **grand mean** for this section **was 2.66**, slightly higher than the **benchmark** which is **2.45**, meaning students recognized some challenges but not at a critical level.

Challenges of Physical learning						
Q.no	**SA**	**A**	**D**	**SD**	**Mean**	**No. of responses**
1	1	13	20	4	2.29	38
2	7	27	3	1	3.05	38
3	4	21	11	2	2.71	38
4	6	29	3	0	3.08	38
5	8	19	8	3	2.84	38
6	2	11	22	3	2.32	38
7	3	20	14	1	2.66	38
8	1	17	15	5	2.37	38
9	1	20	14	3	2.50	38
10	7	18	12	1	2.82	38
Grand Mean					**2.66**	**Positive**

Table 5 – Analysis of challenges in physical learning affecting students' performance

The item with the **highest mean** (**3.08**) was "*Travelling to campus consumes time and energy*," which is a consistent concern for students who commute long distances. The **lowest mean** (**2.29**) was for "*I feel demotivated during physical classes*," suggesting that physical environments generally foster motivation rather than hinder it.

These findings reveal that, while logistical issues such as commuting remain a drawback, physical learning continues to be viewed positively by students particularly for its interactive and engaging nature.

4.6 Hypothesis testing

To conduct the final hypothesis testing, we first need to calculate the mean and standard deviation of each sample. In here we will focus on the impact of the learning methods rather than the challenges as we are trying to figure out at the end of the day which learning method is better or which has the most impact on a student.

To calculate the mean of standard deviation for online and physical learning, we first calculated the summation of all the scores (score from 1 to 4) a student received for all the 10 questions. For each student this summation is calculated. Afterwards the final sum of all each student (taken as X_i)is added again and divided by the number of students to get the mean. Afterwards the Standard deviation is calculated accordingly with the normal formula. The following table contains the mean and standard deviation of each group.

#	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	X_i	$(X_i - mean)^2$
1	3	4	4	3	2	3	3	2	4	4	32	21.8089
2	1	2	2	2	3	1	1	1	2	1	16	128.3689
3	2	3	3	4	3	2	2	3	2	2	26	1.7689
4	3	2	3	3	2	2	2	3	3	3	26	1.7689
5	3	4	4	4	3	3	4	2	4	3	34	44.4889
6	2	3	3	2	2	2	2	2	2	2	22	28.4089
7	1	2	2	2	2	2	2	2	2	2	19	69.3889
8	3	3	4	3	3	3	2	3	2	3	29	2.7889
9	1	2	3	2	2	1	1	2	2	1	17	106.7089
10	2	3	3	3	3	3	3	3	3	3	29	2.7889
11	3	3	3	2	2	2	2	2	2	2	23	18.7489
12	2	3	2	4	3	2	2	3	2	2	25	5.4289
13	2	3	3	3	2	2	2	2	2	2	23	18.7489
14	3	4	4	3	2	2	3	3	3	3	30	7.1289
15	2	3	3	4	3	2	3	2	3	3	28	0.4489
16	3	4	4	3	4	3	3	1	2	3	30	7.1289
17	4	4	4	4	4	4	4	4	4	4	40	160.5289
18	2	3	3	3	3	2	2	2	3	3	26	1.7689
19	2	4	4	4	2	1	4	3	4	2	30	7.1289
20	1	3	4	3	2	1	2	2	3	1	22	28.4089
21	2	2	3	4	2	3	4	3	3	2	28	0.4489
22	2	2	2	3	3	2	3	2	2	2	23	18.7489
23	2	3	3	3	4	3	3	3	3	3	30	7.1289
24	2	2	3	3	2	2	3	2	3	2	24	11.0889
25	2	3	3	3	2	3	3	2	3	3	27	0.1089
26	2	3	3	4	3	3	3	2	3	3	29	2.7889
27	2	3	4	4	3	3	3	2	4	3	31	13.4689
28	3	3	3	4	3	3	3	4	4	3	33	32.1489
29	2	3	4	4	2	2	3	2	3	3	28	0.4489
30	3	3	3	3	3	2	2	3	3	3	28	0.4489
31	3	4	4	4	3	3	3	3	3	3	33	32.1489
32	2	3	3	3	2	1	2	2	3	2	23	18.7489
33	3	3	3	4	3	3	2	3	3	3	30	7.1289

34	3	3	3	4	3	3	3	3	4	4	33	32.1489
35	2	3	4	3	3	2	2	3	2	2	26	1.7689
36	2	3	3	4	3	2	3	3	2	2	27	0.1089
37	3	3	3	3	3	3	3	3	3	3	30	7.1289
38	2	2	2	4	3	3	3	3	3	3	28	0.4489
39	2	3	3	3	2	2	3	2	2	2	24	11.0889
40	3	3	3	4	3	3	3	3	3	3	31	13.4689
41	2	3	3	3	3	3	3	3	3	3	29	2.7889
42	3	3	3	3	3	1	3	3	3	3	28	0.4489
43	2	2	2	3	2	3	3	2	3	3	25	5.4289
										Mean	**27.33**	**21.0344**
										Standard Deviation		**4.59**

Table 5 – Mean and Standard Deviation calculation for Impact on online learning

#	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	X_i	$(X_i - mean)^2$
1	2	4	3	3	3	3	3	3	2	3	29	2.6620
2	3	3	3	3	3	3	3	3	2	3	29	2.6620
3	4	4	4	4	4	3	3	3	3	4	36	28.8199
4	4	3	3	3	3	3	3	3	3	3	31	0.1357
5	3	2	3	4	2	3	3	2	3	2	27	13.1884
6	1	2	2	3	2	3	3	3	2	2	23	58.2410
7	3	3	3	3	3	3	3	3	3	3	30	0.3989
8	3	3	2	3	2	3	3	3	3	3	28	6.9252
9	4	3	4	4	4	3	3	3	3	3	34	11.3463
10	3	3	3	3	3	3	3	3	3	3	30	0.3989
11	3	3	2	3	2	4	3	4	4	3	31	0.1357
12	3	3	3	3	3	3	3	3	3	3	30	0.3989
13	2	3	3	2	3	3	3	3	3	2	27	13.1884
14	4	3	4	4	2	4	4	3	4	4	36	28.8199
15	4	3	4	3	3	3	3	3	4	4	34	11.3463
16	3	3	3	3	3	3	3	3	3	3	30	0.3989
17	3	3	3	3	3	3	3	3	3	2	29	2.6620
18	4	3	3	3	3	3	4	3	3	3	32	1.8726
19	3	2	3	4	3	3	3	3	3	3	30	0.3989
20	1	3	3	3	3	4	3	3	3	3	29	2.6620
21	2	2	3	1	4	4	4	4	4	4	32	1.8726
22	4	2	4	4	3	3	4	3	4	3	34	11.3463
23	4	4	4	2	2	4	4	4	4	4	36	28.8199
24	3	3	3	3	2	3	3	2	2	3	27	13.1884
25	4	4	3	3	3	3	3	3	3	3	32	1.8726
26	3	3	3	2	2	3	3	3	3	3	28	6.9252
27	2	2	2	3	2	3	2	2	3	2	23	58.2410
28	3	3	3	2	3	3	3	3	3	3	29	2.6620
29	4	3	4	2	4	4	4	4	4	4	37	40.5568
30	3	2	3	2	2	2	2	3	3	2	24	43.9778

31	3	3	3	3	3	3	3	3	3	3	30	0.3989
32	4	3	3	2	3	4	4	3	4	3	33	5.6094
33	3	3	3	3	3	3	3	3	3	3	30	0.3989
34	4	3	4	3	3	4	4	4	4	4	37	40.5568
35	4	4	4	3	3	4	4	4	4	4	38	54.2936
36	3	3	3	2	2	3	4	3	3	3	29	2.6620
37	4	3	3	3	3	4	4	3	3	3	33	5.6094
38	3	2	3	2	3	3	3	3	3	2	27	13.1884
Mean											**30.63**	**14.0228**
Standard Deviation												**3.74**

Table 6 – Mean and Standard Deviation calculation for Impact on physical learning

Variable	N	Percentage (%)	Mean	SD
Online	43	53.09	27.33	4.59
Physical	38	46.91	30.63	3.74

Table 7 – Summary of the 2 samples

Let's perform the hypothesis test.

STEP 1: State null and alternative hypothesis

$H_0 \Rightarrow \mu_p \leq \mu_o$ (p = physical, o = online)

$H_A \Rightarrow \mu_p > \mu_o$

STEP 2: Sample sizes and significance level

$n_o = 43$, $n_p = 38$, $\alpha = 0.05$ (95% level of confidence)

STEP 3: Identify correct test statistic

Pooled t-test is used

Pooled standard deviation = S_{pool}

$$S_{pool} = \sqrt{\frac{(n_P - 1)s_p^2 + (n_o - 1)s_o^2}{n_P + n_o - 2}}$$

Pooled t-statistic = t

$$t = \frac{\bar{x}_p - \bar{x}_0}{S_{pool} \times \sqrt{(\frac{1}{n_p} + \frac{1}{n_o})}}$$

STEP 4: Calculate critical value

$$\text{Degree of freedom} = df = n_o + n_p - 2 = 43 + 38 - 2 = 79$$

$$t_{\alpha,df} = t_{0.05,79} \approx 1.664$$

STEP 5: Compute test statistic

$$S_{pool} = \sqrt{\frac{(42 \times 4.59^2) + (37 \times 3.74^2)}{43 + 38 - 2}}$$

$$S_{pool} = 4.2133$$

$$t = \frac{30.63 - 27.33}{4.21 \times \sqrt{(\frac{1}{38} + \frac{1}{43})}}$$

$$t = 3.5213$$

STEP 6: Decision

$$t_{sample} > t_{critical}$$

$$3.5213 > 1.664$$

Therefore, reject H_o

STEP 7: Conclusion

At 5% level of significance, there is enough evidence to conclude that students in the physical classroom performed significantly better in Data Structures and Algorithm (DSA) module than the students in online classroom.

With this analysis, we can state that even though overall the online and physical classroom students did pretty well in the DSA module in their own relevant standards, if we compare the two groups together, it is much evident that the physical classroom students performed better than the online classroom students. This may be due to several factors such as,

- Challenges faced by students in physical students are somewhat less than the online students as physical students have a problem in attending the class on time due to travel issues, but online students have a major connectivity issue to the online class which is a much greater issue.
- Impact on the physical students is higher than online students due to them being more encouraged to participate actively in class and how the class environment motivates them

than the online students who are stuck behind a screen. In this area one of the main benefits for an online student is to manage time with the online class properly but it can also be done by a physical class student if they work and plan hard enough.

- Furthermore, the structured setting of physical classes enables students to keep track of their work properly and attend lectures and do any activities of the class without any issue. The non-rigid structure of online classrooms may benefit the student in handling stress and doing the class work at their own pace but in long term it may affect the studies of the student negatively.

The key takeaway of this study is that both students perform greatly in both modes, but the issue comes in the comparison of the 2 groups which proves physical classroom is better. However, that does not prove online classroom is bad as it is also advantageous in certain situations.

5. Conclusion

This research focused on investigating the impact of online and physical learning environments on undergraduate students' performance in the Data Structures and Algorithms module at the Faculty of Computing, University of Sri Jayewardenepura. By employing structured questionnaires and hypothesis testing with pooled t-test analysis, we compared two almost balanced groups of students and gained useful knowledge on how delivery methods influence learning outcomes.

Both modes of learning had good feedback, with mean scores above our decision criteria, showing that both are factors in academic success. Online learning provided flexibility and improved time management, enabling students to plan their time effectively but connectivity problems and difficulties in staying focused presented themselves as major drawbacks.

Physical learning provided greater engagement, active involvement, and motivation through face-to-face interactions with peers and lecturers, but students encountered practical barriers such as travel and inflexible timetabling.

Hypothesis testing detected a statistically significant difference, with students in physical classrooms performing better than online learners at the 5% level of significance. The implication is that structured settings and instantaneous feedback in physical classrooms offer more robust academic support.

That said, online learning provides useful accessibility and flexibility benefits. Far from being rival approaches, our results suggest that online learning is most effective as an alternative to conventional methods.

The evidence suggests that blended learning is the best approach. Merging the interactive advantages of face-to-face classes with online flexibility may be the most effective way to enhance student performance in technical classes, leveraging both method's strengths while avoiding their drawbacks.

6. References

[1] S. A. O. Ebenezer Omolafe Babalola, "Influence of Online and Physical Classrooms on Students," 2024.

[2] S. A. Bernard Fentim Darkwa, "From Classroom to Online: Comparing the Effectiveness and Student Academic Performance of Classroom Learning and Online Learning," 2021.

[3] C. P. Middleton, "Online Versus Traditional Learning: Academic Performance andLearning Disabilities," 2022.