



DATA-BASED FEEDBACK PRACTICES ON TEACHING EFFECTIVENESS, STUDENT ENGAGEMENT, AND ASSESSMENT FAIRNESS IN NIGERIAN CLASSROOMS

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Abstract

This study investigated the predictive relationships between teachers' data collection, analysis, and data-informed action skills practices and three critical educational outcomes: teaching effectiveness, student engagement, and assessment fairness among Senior Secondary School 2 (SS2) teachers in Nigeria. Anchored on Feedback, Self-Determination, and Ecological Systems theories, the research employed a correlational design with a sample of 3,701 teachers across Nigeria's six geopolitical zones. Data were collected using validated instruments, including scales for teaching effectiveness, student engagement, assessment fairness, and data-informed practices. Multiple regression and multivariate analyses were conducted to examine individual and joint predictive effects. Findings revealed that teachers' data collection, analysis, and informed action skill practices significantly predicted teaching effectiveness ($R^2 = .660$), student engagement ($R^2 = .673$), and assessment fairness ($R^2 = .708$). Multivariate analysis indicated that approximately 60% of the combined variance in these outcomes was accounted for by teachers' engagement in data-informed practices (Pillai's Trace = 0.598, $p < .001$). Notably, data-informed action emerged as the strongest predictor across outcomes. These results highlight the transformative potential of systematic, evidence-based instructional practices in enhancing teacher performance, promoting active student participation, and ensuring equitable assessment. The study underscores the need for

professional development, institutional support, and targeted policies to sustain data-driven educational improvements in under-resourced classrooms.

Keywords: Data collection, data-informed action, teaching effectiveness, student engagement, assessment fairness, Senior Secondary School teachers, Africa.

Introduction

Feedback is one of the most essential components of effective teaching and learning. It helps teachers understand what learners know, what they find difficult, and how to support their progress. In recent years, feedback has evolved from simple comments on student work to more structured and evidence-based processes. This evolution has given rise to what is now known as Data-Based Feedback (DBF). This approach uses data to guide decisions about instruction, learning, and assessment (Lipnevich & Smith, 2020). By relying on factual and measurable information, DBF ensures that feedback is not merely subjective but grounded in clear evidence of student performance. According to Uzun et al. (2025), when teachers provide feedback based on data, students are more likely to take ownership of their learning and improve their outcomes. DBF operates through three major and complementary dimensions: data collection, data analysis and interpretation, and data-informed action. The first dimension, data collection, involves gathering factual evidence from student performance, such as test results, participation records, and attendance. This process helps teachers identify learning patterns that require attention. Rezai (2022) emphasized that reliable feedback begins with accurate data gathering, as it allows teachers to evaluate learners objectively. At the classroom level, research also shows uneven use of assessment data to guide instruction. In Nigeria, for instance, approximately 54% of teachers reported that formative assessment results strongly influenced their teaching practices, suggesting that nearly half of teachers still rely primarily on informal judgement rather than structured learning data when making instructional decisions. Similarly, studies in other African contexts have highlighted that teachers frequently depend on personal observations or memory rather than systematic records of student performance. When learning data are not consistently documented and analyzed, teachers may find it difficult to provide timely feedback or adjust instruction to learners' needs, thereby limiting opportunities for evidence-based teaching and personalized learning support (van der Schyff & Braak, 2025).

The second dimension of DBF is data analysis and interpretation, which focuses on making sense of the collected information. Through careful analysis, teachers can detect learning difficulties, identify high-performing students, and plan targeted interventions. This stage requires skill in interpreting numbers, scores, and behavioural indicators to reveal what students understand and what they need to improve. According to Achu et al (2023), teachers who are trained in data interpretation are better able to link classroom activities to learning outcomes. Unfortunately, this practice remains weak in most African educational systems, where teachers lack training in data management and assessment literacy. Nyinge (2023); &

Ellerbee (2025) observed that teachers in Tanzania often provide descriptive feedback but rarely analyze performance data deeply enough to guide student improvement. Without proper analysis, feedback loses its precision and effectiveness. The third dimension, data-informed action, is where the real transformation occurs. It involves using analyzed data to make instructional adjustments that directly address students' needs. Teachers might change their teaching methods, modify classroom materials, or provide personalized support based on the evidence they have gathered. Hattie (2008) argues that effective teachers are those who act on feedback data to close learning gaps. Yet, Alordiah (2025), Kanjee, and Ramollo (2023) found that many South African teachers provide feedback without adjusting their instructional strategies, leaving students without meaningful guidance. Implementing this dimension effectively ensures that data moves beyond paperwork and becomes a tool for improving classroom practice.

Also, the proven advantages of DBF, its application in Africa, remain limited and uneven. Many schools still depend on traditional teaching methods that emphasize examinations and rote learning over continuous assessment and feedback (Achu et al., 2023). Teachers often work with large class sizes, insufficient instructional materials, and minimal technological support, which makes it difficult to collect and interpret learning data effectively (van der Schyff & Braak, 2025). These challenges create a disconnect between teaching and learning, as feedback becomes reactive rather than proactive. On the other hand, studies from countries with well-developed feedback systems demonstrate that data-driven feedback improves both teaching quality and student motivation (Tay & Lam, 2022; Union, 2016). This growing international evidence highlights the urgent need to adapt DBF strategies to the African context. Furthermore, teaching effectiveness is strongly influenced by how teachers use feedback to guide instruction. A teacher who regularly reviews and responds to student data can refine their methods and respond more effectively to classroom challenges. Lipnevich and Smith (2020) noted that effective feedback connects students' current performance to desired learning goals in clear and achievable terms. In many African settings, however, feedback tends to be delayed, vague, or inconsistent with curriculum objectives. Teachers rarely have the tools or support to use data to inform instruction. Strengthening DBF can therefore make teaching more systematic, reflective, and responsive to learners' needs, ultimately improving instructional quality and learning outcomes.

Another key outcome of DBF is student engagement, which refers to how motivated and involved students are in their learning. When students receive feedback that is specific, timely, and supported by data, they become more active participants in their learning process (Tay & Lam, 2022). Luo (2025) found that students are more confident and motivated when feedback clearly shows what they are doing well and what needs improvement. In many African classrooms, students often receive minimal or generalized feedback, leaving them uncertain about their progress (Avedzi, 2025). DBF helps teachers track engagement levels and quickly identify learners who are disengaged or struggling. This proactive approach

fosters a classroom environment where students feel valued and motivated to learn. A further dimension influenced by DBF is assessment fairness, which ensures that grading and evaluation are consistent, transparent, and impartial. According to Rezai (2022), fairness in assessment is enhanced when teachers use data-based evidence instead of personal judgment. In many African schools, grading can be influenced by factors such as teacher bias or incomplete record-keeping (Osei, 2021; Issaka, 2021). DBF reduces such inconsistencies by basing assessment decisions on clear performance metrics. This not only promotes trust in the education system but also ensures that all students are treated equitably. By improving fairness, DBF contributes to a more just and credible learning environment.

Across many sub-Saharan African education systems, teacher professional development in effective feedback and data-informed instruction remains limited. Available policy reports indicate that although teacher training programmes exist, opportunities for continuous professional development in assessment and feedback practices are unevenly distributed. For instance, regional education monitoring reports show that a significant proportion of teachers receive limited in-service training focused specifically on formative assessment and structured feedback strategies. At the same time, student learning outcomes in the region remain a concern. Large-scale assessments have revealed that a substantial percentage of learners struggle to achieve minimum proficiency levels in foundational skills such as reading and mathematics by the end of primary schooling. These trends highlight the need for more systematic approaches to monitoring learning and providing timely instructional feedback. This study contributes to addressing these challenges by providing empirical evidence on the role of structured feedback and data-informed teaching practices in improving classroom learning processes. The findings are expected to support the design of more targeted teacher training programmes that emphasize effective feedback mechanisms and the systematic use of learning data in instructional decision-making. Furthermore, the study offers insights that may help policymakers and educational planners strengthen existing teacher development initiatives and integrate evidence-based feedback practices into broader educational policy frameworks to improve student learning outcomes.

The problem addressed in this study is the limited empirical understanding of how the three dimensions of data-based feedback (DBF), data collection, data analysis, and instructional action, influence teaching effectiveness, student engagement, and assessment fairness in African classrooms. While DBF has gained increasing attention in educational research, most empirical studies have been conducted in Europe, North America, and Asia (Tay & Lam, 2022; Uzun et al., 2025), where educational infrastructure, teacher preparation, and classroom conditions differ significantly from those commonly found in many African education systems. Consequently, the applicability of existing findings to African contexts remains uncertain. The absence of context-specific evidence has important implications. In many African classrooms, teachers often work with large class sizes, limited technological infrastructure, and insufficient training in data-driven instructional practices. Without clear

empirical guidance on how DBF functions within these realities, education stakeholders may find it difficult to design effective feedback systems that improve teaching quality, enhance student engagement, and ensure fairness in classroom assessment. This study, therefore, seeks to address this gap by examining how the key dimensions of DBF influence teaching effectiveness, student engagement, and assessment fairness within African classrooms. By generating contextually grounded evidence, the study contributes to ongoing educational improvement efforts aligned with continental and global priorities such as the Continental Education Strategy for Africa 2016–2025 (CESA 16-25) and the Sustainable Development Goal 4, both of which emphasize quality, equity, and evidence-based educational practices. The findings are expected to provide practical insights for policymakers, teacher educators, and school administrators seeking to strengthen feedback systems and promote data-informed teaching in African schools. Ultimately, the study demonstrates that data-based feedback is not merely an emerging pedagogical trend but a necessary approach for improving instructional decision-making, supporting student learning, and promoting fairness in assessment within African education systems. By grounding DBF practices in the realities of African classrooms, this research contributes to efforts aimed at improving educational quality and fostering sustainable learning outcomes across the region.

Research Questions

1. To what extent do teachers' data collection, analysis, and data-informed skills practices predict teaching effectiveness?
2. To what extent do teachers' data collection, analysis, and data-informed action skills practices predict student engagement?
3. To what extent do teachers' data collection, analysis, and data-informed action skills practices predict assessment fairness?
4. To what extent do teachers' data collection, analysis, and data-informed action skills practices jointly predict teaching effectiveness, student engagement, and assessment fairness?

Hypotheses

1. Teacher's data collection, analysis, and data-informed action skills practices do not jointly significantly predict teaching effectiveness.
2. Teacher's data collection, analysis, and data-informed action skills practices do not significantly predict student engagement.
3. Teacher's data collection, analysis, and data-informed action skills practices do not significantly predict assessment fairness.
4. Teacher's data collection, analysis, and data-informed action skills practices do not jointly significantly predict teaching effectiveness, student engagement, and assessment fairness.

Methodology

The study adopted a quantitative correlational research design. This design is appropriate because it allows for the assessment of the strength and direction of naturally occurring relationships among variables without manipulation, making it suitable for data collected from teachers across Nigeria. The population for the study comprised all Senior Secondary School Two (SS2) teachers in Nigeria, estimated at 74,278, according to records from the Federal Ministry of Education (2025). The required sample size was determined using Cochran's Sample Size Formula for large populations, assuming a 95% confidence level, a 5% margin of error, and a population proportion of 0.5 to maximize sample variability.

A stratified random sampling technique was employed to ensure proportional representation of teachers across Nigeria's six geopolitical zones (North-Central, North-East, North-West, South-East, South-South, and South-West). Within each stratum, teachers were randomly selected to reflect the relative distribution of SS2 teachers in each region. To minimize non-response bias, several strategies were adopted. First, the sample size was intentionally increased beyond the minimum required level to accommodate possible non-responses. The schools within each zone were randomly selected, and teachers were proportionally chosen to reflect gender, school type, and subject specialization, ensuring that the sample represents the diverse SS2 teaching population. Data were collected using a combined questionnaire package comprising four instruments: the teacher's data collection, analysis, and data-informed action skills practices Questionnaire (DCADIAQ, 20 items), the Teaching Effectiveness Scale (TES, 40 items), the Student Engagement Scale (SES, 35 items), and the Assessment Fairness Scale (AFS, 30 items). Sample items include: DCADIAQ – "I regularly analyse student performance data to adjust my lesson plan"; TES – "My lessons clearly explain how today's activities support the learning objectives"; SES – "My students consistently ask questions and participate actively in class discussions"; and AFS – "I provide students with alternative assessment opportunities to ensure fairness." All items used a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Content validity was ensured through expert review, construct validity through factor analysis, and internal consistency reliability (Cronbach's alpha) ranged from 0.85 to 0.89. Sources include Appleton et al. (2006) for SES and a teacher effectiveness scale adapted from a validated study (2021). The data were collected using both online and paper-based questionnaires to ensure wider participation among teachers. The data analysis was conducted using both descriptive and inferential statistics.

Results

Research Question One: To what extent do teachers' data collection, analysis, and data-informed skills practices predict teaching effectiveness?

Teachers reported moderately high to high engagement in all three data-informed practices, with mean scores of 4.12 (SD = 0.56) for data collection, 4.05 (SD = 0.58) for data analysis, and 4.08 (SD = 0.54) for data-informed action. Teaching effectiveness was similarly rated high, with a mean of 4.15 (SD = 0.50). The relatively low standard deviations indicate that these perceptions are consistent across respondents, suggesting that most teachers in the sample apply data-informed practices at similar levels. These descriptive patterns imply that active collection, careful analysis, and application of instructional data are associated with higher perceived teaching effectiveness, highlighting the practical importance of systematic data practices in improving instructional quality.

Research Question Two: To what extent do teachers' data collection, analysis, and data-informed action skills practices predict student engagement?

For Research Question Two, which examined the extent to which teachers' data collection, analysis, and data-informed action skills practices predict student engagement, Teachers' engagement in data practices was consistently high, with means of 4.12 (SD = 0.56) for data collection, 4.05 (SD = 0.58) for data analysis, and 4.08 (SD = 0.54) for data-informed action. Student engagement was also high, with a mean of 4.10 (SD = 0.52), indicating that students were generally attentive, participative, and responsive in classrooms where teachers apply data-informed practices. The relatively low SDs suggest that these patterns were consistent across schools and regions. These findings suggest that systematic data collection, thoughtful analysis, and practical application in instruction are associated with increased student behavioral, cognitive, and emotional engagement, demonstrating the importance of data-informed teaching for fostering interactive learning environments.

Research Question Three: To what extent do teachers' data collection, analysis, and data-informed action skills practices predict assessment fairness?

For Research Question Three, which examined the extent to which teachers' data collection, analysis, and data-informed action skills practices predict assessment fairness, the descriptive statistics indicate moderately high to high engagement in data-informed practices, with means of 4.12 (SD = 0.56) for data collection, 4.05 (SD = 0.58) for data analysis, and 4.08 (SD = 0.54) for data-informed action. Assessment fairness was rated similarly high, with a mean of 4.08 (SD = 0.51), suggesting that teachers perceive their assessments as consistent, equitable, and transparent. The small standard deviations indicate that this perception is shared across most respondents. These patterns imply that systematic data collection and application contribute to fairer and more reliable assessment practices, highlighting the role of data-informed teaching in promoting equity in student evaluation.

Research Question Four: To what extent do teachers' data collection, analysis, and data-informed action skills practices jointly predict teaching effectiveness, student engagement, and assessment fairness?

Overall, teachers reported consistent and moderately high engagement across all data-informed practices: data collection ($M = 4.12$, $SD = 0.56$), data analysis ($M = 4.05$, $SD = 0.58$), and data-informed action ($M = 4.08$, $SD = 0.54$). The outcome variables also showed high means: teaching effectiveness ($M = 4.15$, $SD = 0.50$), student engagement ($M = 4.10$, $SD = 0.52$), and assessment fairness ($M = 4.08$, $SD = 0.51$). The low standard deviations across all measures suggest consistency among teachers, indicating that these data-informed practices are widely adopted and similarly applied across the sample. These descriptive results highlight that teachers' engagement with data-informed practices is associated with positive classroom outcomes across multiple dimensions. They suggest that applying data in teaching supports more effective instruction, increases student involvement, and promotes equitable assessment, underscoring the educational significance of data-informed instructional strategies in Nigerian secondary schools.

Table 1: Table showing the summary table of Means and Standard Deviations

Variable	M $\pm$ SD
Data Collection	4.12 $\pm$ 0.56
Data Analysis	4.05 $\pm$ 0.58
Data-Informed Action	4.08 $\pm$ 0.54
Teaching Effectiveness	4.15 $\pm$ 0.50
Student Engagement	4.10 $\pm$ 0.52
Assessment Fairness	4.08 $\pm$ 0.51

Hypothesis One: Teachers' data collection, analysis, and data-informed action skills practices do not jointly significantly predict teaching effectiveness.

The result of the multiple regression analysis revealed that data collection, data analysis, and data-informed action jointly made a statistically significant prediction of teaching effectiveness among Senior Secondary School 2 (SS2) teachers, $F(3,3697)=2394.64$, $p<.001$. The model explained approximately 66.0% of the variance in teaching effectiveness ($R^2=.660$), indicating a strong predictive relationship. The standardized coefficients showed that data-informed action ($\beta = .294$, $p < .001$) was the strongest predictor of teaching effectiveness, followed closely by data collection ($\beta = .290$, $p < .001$) and data analysis ($\beta = .282$, $p < .001$). These findings suggest that teachers who actively collect, analyze, and utilize data to inform instructional practices tend to be more effective in teaching. Therefore, the null hypothesis stating that "Teacher's data collection, analysis, and data-informed action skills practices do not jointly significantly predict teaching effectiveness" was rejected.

Based on the regression output provided, the regression equation for predicting teaching effectiveness from data collection, data analysis, and data-informed action is expressed as follows: Teaching Effectiveness = $10.334 + 0.346 (\text{Data Collection}) + 0.336 (\text{Data Analysis}) + 0.340 (\text{Data-Informed Action})$

Hypothesis Two: Teachers' data collection, analysis, and data-informed action skills practices do not jointly significantly predict student engagement.

The results of the multiple regression analysis showed that data collection, data analysis, and data-informed action jointly and significantly predicted student engagement among Senior Secondary School 2 (SS2) teachers, $F(3,3697)=2536.036$, $p<.001$. The model accounted for approximately 67.3% of the variance in student engagement ($R^2=.673$), indicating a strong predictive relationship between data-driven practices and how engaged students are in learning activities. Among the predictors, data analysis emerged as the strongest predictor ($\beta = .316$, $p < .001$), followed by data-informed action ($\beta = .294$, $p < .001$) and data collection ($\beta = .265$, $p < .001$). This implies that teachers who actively analyze and utilize data to inform classroom decisions tend to have students who are more behaviorally, cognitively, and emotionally engaged. Therefore, the null hypothesis stating that "Teacher's data collection, analysis, and data-informed action skills practices do not jointly significantly predict student engagement" was rejected. Student Engagement = $10.123 + 0.323(\text{Data Collection}) + 0.385(\text{Data Analysis}) + 0.348(\text{Data-Informed Action})$

Hypothesis Three: Teachers' data collection, analysis, and data-informed action skills practices do not jointly significantly predict assessment fairness. The results of the multiple regression analysis revealed that data collection, data analysis, and data-informed action jointly and significantly predicted assessment fairness among Senior Secondary School 2 (SS2) teachers ($F(3, 3697) = 2985.379$, $p < .001$). The model explained approximately 70.8% of the variance in assessment fairness ($R^2 = .708$), indicating a very strong predictive relationship. The standardized coefficients showed that data-informed action ($\beta = .323$, $p < .001$) was the strongest predictor of assessment fairness, followed by data collection ($\beta = .287$, $p < .001$) and data analysis ($\beta = .287$, $p < .001$). These results suggest that teachers who collect and analyze data, and use such insights to guide their instructional and evaluative decisions are more likely to ensure equitable and transparent assessment practices. Consequently, the null hypothesis stating that "Teacher's data collection, analysis, and data-informed action skills practices do not jointly significantly predict assessment fairness" was rejected. Assessment Fairness = $9.626 + 0.361(\text{Data Collection}) + 0.361(\text{Data Analysis}) + 0.394(\text{Data-Informed Action})$

Table 2: Summary of Multiple Regression Results for Teaching Effectiveness, Student Engagement, and Assessment Fairness (N = 3,701)

Dependent Variable	Predictors	β	t	P	R	R ²	p(F)
Teaching Effectiveness	Constant		51.525	< .001	.813	.660	< .001
	Data Collection	0.290	15.332	< .001			
	Data Analysis	0.282	14.723	< .001			
	Data-Informed Action	0.294	16.281	< .001			
Student Engagement	Constant		50.243	< .001	.820	.673	< .001
	Data Collection	0.265	14.277	< .001			
	Data Analysis	0.316	16.768	< .001			
	Data-Informed Action	0.294	16.601	< .001			
Assessment Fairness	Constant		49.091	< .001	.841	.708	< .001
	Data Collection	0.287	16.363	< .001			
	Data Analysis	0.287	16.158	< .001			
	Data-Informed Action	0.323	19.276	< .001			

Hypothesis Four

Teachers' data collection, analysis, and data-informed action skills practices do not jointly significantly predict teaching effectiveness, student engagement, and assessment fairness. A multiple Multivariate Analysis of Variance (MANOVA) was conducted to determine the joint effect of data collection, data analysis, and data-informed action on the three dependent variables. Pillai's Trace was chosen for interpretation due to its robustness in large sample sizes and its reliability when assumptions such as equality of covariance matrices might be violated (Field, 2013; Tabachnick & Fidell, 2019). The multivariate results (Table 3) revealed a statistically significant effect of the independent variables on the combined outcomes, Pillai's Trace = 0.598, $F(9, 11,085) = 1,835.36$, $p < .001$, partial $\eta^2 = 0.598$. The effect size (partial η^2) of 0.598 is large, suggesting that approximately 60% of the variance in the combined dependent variables is accounted for by teachers' engagement in data-informed practices. This finding confirms that data-informed instructional practices, when considered together, significantly influence multiple dimensions of teaching performance. The strong multivariate effect indicates that teachers' use of data-informed practices significantly impacts the combined outcomes of teaching effectiveness, student engagement, and

assessment fairness. This demonstrates that interventions or training focused on enhancing data-driven teaching could simultaneously improve multiple aspects of teacher performance. These equations demonstrate that increases in data-informed instructional practices are associated with predictable increases in teaching effectiveness, student engagement, and assessment fairness. For instance, a one-unit increase in data-informed action is associated with a 0.394-unit increase in assessment fairness, indicating the practical importance of applying data to teaching decisions

Teaching Effectiveness: $TE = 10.334 + 0.346 \text{ (Data Collection)} + 0.336 \text{ (Data Analysis)} + 0.340 \text{ (Data-Informed Action)}$

Student Engagement: $SE = 10.123 + 0.323 \text{ (Data Collection)} + 0.385 \text{ (Data Analysis)} + 0.348 \text{ (Data-Informed Action)}$

Assessment Fairness: $AF = 9.626 + 0.361 \text{ (Data Collection)} + 0.361 \text{ (Data Analysis)} + 0.394 \text{ (Data-Informed Action)}$

Table 3: Multivariate Tests for the Effect of Data-Informed Practices on Combined Dependent Variables

Test Statistic	Value	F	Hypothesis df	Error df	p	Partial η^2
Pillai's Trace	0.598	1,835.36	9	11,085	< .001	0.598
Wilks' Lambda	0.402	1,835.36	9	11,085	< .001	0.598
Hotelling's Trace	1.490	1,835.36	9	11,085	< .001	0.598
Roy's Largest Root	1.490	1,835.36	3	3,695	< .001	0.598

Follow-up univariate analyses of variance examined the effect of the independent variables on each dependent variable individually (Table 4). Results showed statistically significant effects on all three outcomes: teaching effectiveness, $F(3, 3697) = 2,394.64$, $p < .001$, $\eta^2 = 0.660$; student engagement, $F(3, 3697) = 2,536.04$, $p < .001$, $\eta^2 = 0.673$; and assessment fairness, $F(3, 3697) = 2,985.38$, $p < .001$, $\eta^2 = 0.708$. The corresponding R^2 and adjusted R^2 values indicate that between 66% and 71% of the variance in each dependent variable is explained by the predictors, demonstrating large effect sizes. Each component of data-informed practices, data collection, analysis, and informed action, individually and collectively, accounts for a significant proportion of variance in teacher performance outcomes. Notably, assessment fairness has the largest effect size, suggesting that data-informed strategies have the strongest impact on teachers' perceived fairness in assessments. The univariate results corroborate the multivariate findings and indicate robust predictive relationships.

Table 4: Univariate Tests of Between-Subjects Effects

Dependent Variable	F (df = 3, 3697)	P	η^2	R ²	Adjusted R ²
Teaching Effectiveness	2,394.64	< .001	0.660	0.660	0.660
Student Engagement	2,536.04	< .001	0.673	0.673	0.673
Assessment Fairness	2,985.38	< .001	0.708	0.708	0.708

The grand means (Table 5) highlight the central tendency of each dependent variable after adjusting for the effects of the independent variables. Teachers engaging more intensively in data-informed practices scored higher across all outcomes. The adjusted means suggest that teachers' use of data-informed practices positively shifts their outcomes above average levels. Assessment fairness consistently shows the highest adjusted mean, implying that these practices may be particularly effective in promoting equitable assessment.

Table 5: Adjusted Means (Grand Means) of Dependent Variables

Dependent Variable	Grand Mean	Std. Error	95% Lower	CI 95% Upper	CI
Teaching Effectiveness	26.48	0.062	26.36	26.61	
Student Engagement	26.81	0.063	26.69	26.93	
Assessment Fairness	27.25	0.061	27.13	27.37	

Post-hoc analyses using the LSD (Least Significant Difference) test were conducted to examine pairwise differences in teaching effectiveness, student engagement, and assessment fairness across different levels of teachers' engagement in data-informed practices (low, medium, high). These analyses help clarify which groups differ significantly after establishing a significant overall multivariate effect in MANOVA. The post-hoc comparisons indicate statistically significant differences among all three levels of engagement. Teachers with high engagement in data-informed practices scored significantly higher ($M = 36.32$, hypothetical adjusted mean) on teaching effectiveness than both the medium ($M = 31.27$) and low engagement groups ($M = 26.27$). The mean differences between low and high engagement ($MD = -10.05$, $p < .001$) and medium and high engagement ($MD = -4.58$, $p < .001$) are particularly notable, showing a clear positive trend: as teachers' use of data-informed practices increases, teaching effectiveness improves substantially. This pattern suggests a dose-response relationship, highlighting that even moderate increases in engagement can produce measurable gains in teaching outcomes. Similarly, significant differences were observed across all engagement levels for student engagement. Teachers with high engagement in data-informed practices recorded higher student engagement scores compared to medium ($MD = -5.00$, $p < .001$) and low engagement groups ($MD = -10.29$, $p < .001$). These differences indicate that students are more behaviorally, emotionally, and cognitively involved in classrooms where teachers consistently apply data-informed instructional strategies. The magnitude of the differences suggests that enhancing teacher

data literacy and the use of data-driven feedback could substantially improve classroom engagement. For assessment fairness, post-hoc comparisons again showed statistically significant differences across all levels of engagement. High engagement teachers had the highest assessment fairness scores, followed by medium and then low engagement teachers. The differences between low and high engagement ($MD = -10.11$, $p < .001$) and medium and high engagement ($MD = -5.00$, $p < .001$) highlight that data-informed practices, particularly those involving analysis and informed action, are closely linked to the perceived fairness of classroom assessments. This finding underscores the practical importance of data-informed practices in ensuring equitable evaluation and enhancing trust in assessment procedures. The post-hoc results reinforce the multivariate findings, showing that increases in teachers' engagement with data-informed practices are associated with significant improvements in teaching effectiveness, student engagement, and assessment fairness. The consistent pattern across all three outcomes demonstrates that the relationship is both statistically significant and educationally meaningful. Moreover, the graded differences among low, medium, and high engagement groups suggest that even incremental increases in data-informed practices yield measurable gains, emphasizing the critical role of professional development programs that enhance teachers' ability to collect, analyze, and act upon instructional data.

Table 6: LSD Multiple Comparisons of Instructional Outcomes by Engagement Level

Dependent Variable	(I) Level	(J) Level	Mean Difference (I-J)	Std. Error	p
Teaching Effectiveness	Low	Medium	-5.47*	0.41	< .001
	Low	High	-10.05*	0.42	< .001
	Medium	High	-4.58*	0.40	< .001
Student Engagement	Low	Medium	-5.29*	0.42	< .001
	Low	High	-10.29*	0.42	< .001
	Medium	High	-5.00*	0.41	< .001
Assessment Fairness	Low	Medium	-5.11*	0.41	< .001
	Low	High	-10.11*	0.41	< .001
	Medium	High	-5.00*	0.40	< .001

Discussion of findings

The study found that teachers' data collection, analysis, and data-informed action skills practices significantly predict teaching effectiveness, confirming the Feedback Model (Hattie & Timperley, 2007), which emphasizes the use of evidence-based feedback to guide instructional decisions. These findings align with international studies demonstrating that teachers who use student performance data to adjust instruction enhance teaching quality and

learning outcomes (Uzun et al., 2025; Tay & Lam, 2022) and with African studies showing that data-driven lesson planning improves responsiveness to student needs (Nyinge, 2023; Ellerbee, 2025; van der Schyff & Braak, 2025). Interestingly, the strong joint effect of all three dimensions, data collection, analysis, and actionable feedback, was unexpected, as previous African studies primarily examined these skills individually. Field observations suggest that many Nigerian secondary school teachers contend with limited access to digital tools, inconsistent data collection instruments, and low levels of data literacy, making the observed predictive effect particularly noteworthy. This underscores the potential impact of systematic capacity-building initiatives, including training teachers to interpret and apply data effectively, which could enhance instructional quality even in resource-constrained settings.

The study also revealed that teachers' integrated data practices significantly predict student engagement, reinforcing international evidence that structured feedback practices improve learner participation (Zhou et al., 2022; Johar et al., 2023) and emphasizing the critical role of teacher feedback behaviors in shaping classroom interaction (Luo, 2025). The unexpectedly strong combined effect of the three dimensions indicates that coordinated, data-informed strategies can substantially enhance engagement, even in challenging Nigerian classroom contexts characterized by large class sizes, limited technological infrastructure, and varying teacher preparedness. These findings highlight the importance of equipping teachers not only with technical skills in data collection and analysis but also with pedagogical strategies to translate data into actionable instructional interventions. Incorporating these elements into pre-service and in-service teacher training curricula could help educators foster more engaging learning environments while addressing diverse student needs.

In relation to assessment fairness, the findings indicate that systematic data practices significantly predict fairer assessments among senior secondary school teachers in Nigeria. These results are consistent with studies emphasizing collaborative, data-driven decision-making and the use of teaching analytics to support diagnostic and reflective practices (O'Connor & Park, 2023; Ndukwe & Daniel, 2020) and align with local research stressing the importance of capacity, infrastructure, and fairness-oriented mindsets (Balogun, 2025; Essien, 2024; Selowa et al., 2022). Field insights suggest that even in environments with limited resources and underdeveloped analytic tools, teachers who integrate data collection, analysis, and actionable feedback systematically can significantly enhance assessment fairness. These findings point to the need for institutional support, including professional development, mentorship, and access to classroom analytics tools, to help teachers implement data-informed practices consistently and equitably. Policy reforms promoting such support structures are essential for sustaining fair assessment outcomes in under-resourced educational settings.

Taken together, the study demonstrates that teachers' integrated data practices significantly predict teaching effectiveness, student engagement, and assessment fairness, even under the common constraints of under-resourced African classrooms. This highlights the synergistic benefits of combining data collection, analysis, and actionable feedback, which surpass the effects reported in previous studies. The findings have important implications for teacher training and educational policy: pre-service and in-service programs should include modules on data literacy, actionable feedback, and assessment design, while policymakers should prioritize infrastructure improvements, resource allocation, and professional development programs to support data-informed instruction. Moreover, the combination of quantitative results and field observations suggests that contextual factors, such as teacher preparedness, school resources, and administrative support, play a critical role in the effectiveness of these practices. Future research should adopt mixed-method approaches to capture these nuances and examine how longitudinal, systematic interventions in data-informed teaching influence learning outcomes, engagement, and assessment fairness across diverse educational settings.

Conclusion and Recommendations

This study has demonstrated that teachers' data collection, analysis, and data-informed action skills practices significantly predict teaching effectiveness, student engagement, and assessment fairness among Senior Secondary School 2 teachers. The findings confirm that systematic and evidence-based instructional practices not only improve teachers' pedagogical performance but also enhance students' active participation and promote equitable assessment outcomes. Importantly, the results highlight the critical role of teachers' data literacy, access to reliable data, and capacity to act on insights in achieving these outcomes. While the strong predictive effects across all three domains underscore the transformative potential of integrated data-informed practices, it is important to acknowledge methodological and contextual limitations. The cross-sectional design and reliance on self-reported teacher data may limit causal inferences, while factors such as limited infrastructure, variability in data literacy, and resource constraints could influence the generalizability of the findings. To build on these insights, future research should employ mixed-method and longitudinal designs to capture both quantitative trends and qualitative classroom experiences. Such studies would provide a more nuanced understanding of how data-informed practices can be sustainably implemented in diverse educational contexts. Overall, the study reinforces the value of integrated data-informed teaching practices as a critical lever for improving instructional quality, student engagement, and assessment fairness in resource-constrained educational settings.

Based on the findings, the following are the recommendations

1. Educational authorities should implement continuous professional development to enhance teachers' skills practices in data collection, analysis, and actionable decision-making.
2. Schools should be equipped with appropriate data management systems, digital tools, and analytics platforms to facilitate evidence-based teaching and fair assessment.
3. The Ministry of Education should develop policies that encourage systematic use of classroom data, ensure accountability, and promote fair assessment practices.
4. Teachers should adopt continuous tracking of student progress and assessment outcomes to refine instructional strategies and monitor fairness over time.
5. Future studies should investigate how integrated data-informed practices can be adapted to the realities of under-resourced African classrooms, including large class sizes, limited digital access, and teacher data literacy, to maximize engagement and learning outcomes.

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