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ijbas@uniosun.edu.ng

Authors Affiliation:

Department of Statistics,
 School of Science, Yaba
 College of Technology, Yaba,
 Lagos, Nigeria

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Gender Bias in Mathematics Achievement: A Comparative Study of Senior Secondary School Students in Educational District IV, Lagos State, Nigeria

*Gbenga I. Bamidele¹, Yemisi O. Ajiboye², Gbenga B. Karokatose³, Yinusa A. Ganiyu⁴ and Janet O. Nowel⁵

Email: gbenga.bamidele@yabatech.edu.ng

ABSTRACT

Mathematics achievement remains a critical gateway to science, technology, engineering, and Mathematics (STEM) disciplines, yet persistent debates continue regarding whether observed gender disparities stem from true ability variations or psychometric bias within testing instruments. This study examined gender differences in Mathematics achievement, evaluated item-level Differential Item Functioning (DIF) across gender, and assessed performance variations across educational zones among senior secondary school students in Educational District IV of Lagos State, Nigeria. Adopting a comparative descriptive survey research design, a multistage cluster sample of 400 SS3 students (167 males, 233 females) was selected from 10 public secondary schools across Surulere and Mainland zones. Data were collected using a validated 60-item Mathematics Achievement Test (MAT) spanning Algebra, Trigonometry, Ratio and Proportion ($\alpha = 0.809$). Item psychometric fairness was evaluated via Mantel-Haenszel DIF analysis, while subgroup variations were tested using Welch's independent-samples t-tests and a 2 x 2 factorial ANOVA. Mantel-Haenszel DIF analysis classified 58 items (96.7%) under ETS Category A (negligible DIF) and two items (3.3%) under Category B, confirming high measurement invariance across genders. Inferential analysis indicated that male students achieved higher overall scores ($M = 29.56$, $SD = 6.54$) than female students ($M = 28.18$, $SD = 5.63$; $t(323.52) = 2.20$, $p = .029$, $d = 0.23$), though the practical effect size was small. Mainland students ($M = 30.00$, $SD = 6.00$) significantly outperformed Surulere students ($M = 27.50$, $SD = 5.95$; $p < .001$, $d = 0.42$). The two-way ANOVA revealed significant main effects for zone ($p < .001$) and gender ($p = .023$), but no significant Gender x times Zone interaction ($F(1, 396) = 0.082$, $p = .775$, $< .001$). The MAT demonstrates robust psychometric fairness across gender. Observed score variations are primarily driven by contextual and school-level factors rather than systematic assessment bias.

1. INTRODUCTION

Mathematics is the abstract study of relationships, logic, symbols and patterns used to solve problems, make predictions and model real-world phenomena; it underlies scientific reasoning, technological innovation and rational decision-making (Okpala et al., 2018). As a compulsory core subject in the Nigerian secondary

school curriculum, Mathematics is central to students' access to science, technology, engineering and Mathematics (STEM) pathways and, by extension, to national socio-economic transformation (Akinsola, 2017; Gottfried et al., 2017; Kolawole et al., 2013; Okeke, 2011).



A recurrent question in Mathematics education research concerns whether male and female students perform differently in Mathematics, and if so, whether such differences reflect genuine ability gaps or bias embedded in instructional practice, classroom interaction, or assessment instruments. Cross-national meta-analytic evidence highlights that gender similarities often characterize broad Mathematics performance (Else-Quest et al., 2010; Hyde et al., 2008). However, empirical findings across developing and sub-Saharan African contexts remain mixed: some studies report a male advantage (Bulala & Ntuma, 2025; Fussy et al., 2023; Ibrahim et al., 2024; Mayer, 2016; Shah et al., 2020), other identified female advantages or no significant gender disparities (Ajai & Imoko, 2020; Awoniyi et al., 2025; Bertoletti et al., 2023; Luo & Chen, 2024; Uche & Abara, 2021), and others show divergent trends across internal classroom tests versus external examinations (Musa & Ibrahim, 2022).

In Nigeria, and in Lagos State in particular, gender-related issues in education have attracted growing concern (Adegboye & Otiogede, 2020; Adegboye & Ogunyemi, 2020; Etobe et al., 2019; Olonade et al., 2021). Social attitudes and prevailing cultural stereotypes frequently frame quantitative fields as male domains, which can negatively affect female learners' self-concept and participation (Nyarko & Asare, 2018; Tang & Zhao, 2023). Furthermore, affective barriers such as mathematics anxiety have been shown to mediate achievement gaps between male and female students (Aldrup et al., 2020; Foley, 2017; Namkung et al., 2019). Beyond affective traits,

home and pedagogical factors—such as parental support, teacher expectations, and instructional emphasis—exert considerable influence on secondary school performance (Adeyemo et al., 2013; Adigun & Salami, 2023; Aremu, 2016; Lee & Simpkins, 2021; Ofori-Attah, 2018; Rubach Bananati, 2020).

Despite these insights, few studies have systematically evaluated whether gender bias exists within the assessment instruments themselves via psychometric item analysis as opposed to simply comparing aggregate raw scores by sex. This distinction is crucial: a raw score difference may reflect instructional preparedness rather than systematic test bias. This study addresses this gap by comparatively examining gender invariance and Mathematics achievement in Educational District IV of Lagos State.

This study is grounded in two direct theoretical frameworks:

1. Expectancy-Value Theory (Eccles et al., 1983): Proposes that academic task performance is driven by learners' expectations of success and subjective task value. Gendered socialization can shape self-concept and domain-specific interest in quantitative subjects, resulting in small observable disparities in overall test performance (Bandura, 1977; Hyde & Mertz, 2009).
2. Stereotype Threat Theory (Steele, 1997): Posits that awareness of negative societal stereotypes regarding female mathematical capacity can include evaluation anxiety and intellectual

3. helplessness, depressing test scores among female students in high-stakes evaluative settings (Agnoli et al., 2019; Bedynska et al., 2018; Flore et al., 2019).
4. Differential Item Functioning Framework (Holland & Wainer, 1993): Outlines psychometric item fairness, defining an assessment item as unbiased if individuals of equal latent trait ability (θ) have an equal probability of answering the item correctly, regardless of subgroup membership (such as gender).

Despite policies aimed at promoting gender equity in education, disparities in students' mathematics performance persist in many Nigerian schools. Anecdotal and empirical evidence suggests that societal stereotypes and potentially biased assessment practices contribute to differences in Mathematics achievement between male and female students; if unaddressed, such biases could undermine students' self-esteem, academic motivation and future participation in STEM careers.

The primary aim was to examine gender differences in Mathematics achievement and evaluate the psychometric fairness of the Mathematics Achievement Test (MAT) in Educational District IV of Lagos State. The specific objectives were to:

1. Compare the Mathematics achievement of male and female senior secondary school students in Educational District IV.
2. Evaluate item-level Differential Item Functioning (DIF) across gender groups on the 60-item MAT.

3. Compare mathematics achievement across the Surulere and Mainland educational zones and determine whether a Gender $\times$ Zone interaction effect exists.

The following null hypotheses were tested at the 0.05 level of significance:

1. H_{01} : There is no significant difference in the Mathematics achievement scores of male and female students in Educational District IV.
2. H_{02} : Test items on the Mathematics Achievement Test do not exhibit statistically significant Differential Item Functioning (DIF) across gender.
3. H_{03} : There is no significant difference in Mathematics achievement between students in the Surulere and Mainland educational zones, and no significant Gender $\times$ Zone interaction effect.

Materials and Methods

A comparative descriptive survey research design was adopted. Educational District IV comprises three zones; two zones (Surulere and Mainland) were selected. Multistage cluster sampling was used: five public secondary schools were selected from each zone ($k = 10$ schools), and 40 Senior Secondary School III (SS3) students were sampled per school, yielding a total sample of $N = 400$ students.

To account for the hierarchical structure of students nested within schools, standard error adjustments (cluster-robust standard errors) and intraclass correlation evaluations were conducted to verify that

school-level clustering did not inflate Type I error rates.

The sample size was computed using the Taro Yamane formula:

$$n = \frac{N}{1 + N(e^2)}$$

For a target population of $N = 10,980$ SS3 students and margin of error $e = 0.05$, $n = 385.94$, which

was rounded up to 400 students which was rounded up to 400 to increase precision and reduce sampling error ($n = 200$ per zone).

Data were collected using a researcher-developed 60-item multiple-choice Mathematics Achievement Test (MAT) aligned with the West African Examinations Council (WAEC) senior secondary syllabus. The instrument was structured across three mathematical subdomains:

Table2.1: Test Blueprint and Curriculum Content Coverage

Subdomain	Number of Items	Curriculum Content Areas
Algebra	24 Items	Linear/Quadratic equations, simultaneous equations, inequalities, polynomial expansions
Trigonometry	18 Items	Trigonometric ratios, sine/cosine rules, angles of elevation and depression, bearings
Ratio & Proportion	18 Items	Direct/inverse proportions, percentage change, financial arithmetic, rates
Total Test	60 Items	Four-option multiple choice (1 mark per correct answer, 0 to 60 scale)

Instrument Validation and Pilot Testing:

Content and face validity were confirmed through expert reviews by Lecturers in Mathematics Education and Psychometrics. Pilot testing on $n_0 = 30$ SS3 students from a non-participating school within the district yielded:

- Item Difficulty Index (p): Ranged between 0.32 and 0.76 (mean $p = 0.48$), confirming acceptable item difficulty.
- Item Discrimination Index (d): Ranged between 0.30 and 0.58, showing good discriminating power across ability groups.

- Internal Consistency: Cronbach's alpha across all 60 items was $\alpha = 0.809$, with subdomain reliabilities of $\alpha = 0.78$ (Algebra), $\alpha = 0.74$ (Trigonometry), and $\alpha = 0.72$ (Ratio).

Data analysis was structured to address measurement bias and group comparisons directly:

- Mantel Haenszel DIF Analysis: Evaluated item fairness by stratifying test-takers across matched total score ability intervals. The Mantel Haenszel common odds ratio (α_{MH}) and Educational Testing Service (ETS) classification metrics (A , B , C) were computed for all 60 items.
- Inferential Analyses: Group differences across gender and educational zone were evaluated using Welch's independent-samples t -tests and two-way factorial ANOVA (2×2 : Gender $\times$ Zone). Subdomain scores (Algebra, Trigonometry, Ratio) represent constitutive subparts of the MAT and were analysed as dependent components rather than treated as independent historical baseline covariates.
- Effect Sizes and Dispersion: Cohen's d , partial eta-squared (η_p^2), exact p -values, standard deviations, and 95% confidence intervals were reported.

Ethical Approval

Institutional ethical approval was granted by the Lagos State Ministry of Basic and Secondary Education and the Educational District IV Board. Administrative permission was obtained from the principals of all 10 participating secondary schools. Written informed parental consent and participant student assent were secured prior to testing. Participation was strictly voluntary, and confidentiality was maintained using unique alphanumeric identification codes.

Results

Demographics

Table 3.1: *Distribution of Respondents by Gender and Educational Zone*

Educational Zone	Male, n (%)	Female, n (%)	Total, n (%)
Surulere	92 (23.0%)	108 (27.0%)	200 (50.0%)
Mainland	75 (18.8%)	125 (31.3%)	200 (50.0%)
Total	167 (41.7%)	233 (58.3%)	400 (100.0%)

The sample consisted of 400 SS3 students: 167 males (41.7%) and 233 females (58.3%), distributed evenly across the Surulere and Mainland zones. Female students made up the majority of the sample, accounting for 233 participants (58.3%), while male students comprised 167 participants (41.7%). The total sample was split evenly across the two educational zones, with exactly 200 students (50.0%) from mainland. Surulere zone included 92 male students (23.0% of the total sample) and 108 female students (27.0%). Mainland zone include 5 male students (18.8% of the total sample) and 125 female students (31.3%).

Hypothesis One: There is no significant difference in the mathematics achievement scores of male and female students in Educational District IV.

Table 3.2: Descriptive and Inferential Statistics for Mathematics Achievement by Gender

Test Scale (Max Score)	Male (n=167) M (SD)	Female (n=233) M (SD)	Mean Diff.	95% CI of Difference	t-statistic (df)	p- value	Effect Size (Cohen'sd)
Algebra (24)	11.95 (3.12)	11.41 (2.85)	0.54	[0.05, 1.03]	t (331.2)=1.76	.079	0.18
Trigonometry (18)	8.84 (2.41)	8.35 (2.19)	0.49	[0.03, 0.95]	t (329.8)=2.08	.038*	0.21
Ratio (18)	8.77 (2.35)	8.42 (2.11)	0.35	[-0.09, 0.79]	t (334.4)=1.54	.125	0.16
Total MAT Score (60)	29.56 (6.54)	28.18 (5.63)	1.38	[0.14, 2.62]	t(323.52)=2.20	.029*	0.23

*Significant at $p < .05$ (Welch's t-test applied due to variance heterogeneity, Levene's $F = 4.22$, $p = .040$).

Male students recorded a statistically higher mean total score ($M = 29.56, SD = 6.54$) than female students ($M = 28.18, SD = 5.63$), $t(323.52) = 2.20, p = .029, 95\% CI (0.14, 2.62)$. While H_{01} was rejected, the absolute difference was 1.38 points on a 60-point scale, and the effect size was small (Cohen's $d = 0.23$). Across subdomains, a significant difference emerged only in Trigonometry ($p = .125, d = 0.21$), with no statistically significant differences in Algebra ($p = .079$) or ratio and Proportion ($p = .125$).

Hypothesis Two: Test items on the Mathematics Achievement Test do not exhibit statistically significant Differential Item Functioning (DIF) across gender.

Table 3.3: Summary of Mantel–Haenszel Differential Item Functioning (DIF) by Content Domain

Domain	Total Items	CategoryA (Negligible DIF)	CategoryB (Moderate DIF)	CategoryC (Large DIF)
Algebra	24	23 (95.8%)	1 (4.2%) *	0 (0.0%)
Trigonometry	18	17 (94.4%)	1 (5.6%) **	0 (0.0%)
Ratio & Proportion	18	18 (100.0%)	0 (0.0%)	0 (0.0%)
Full MAT Instrument	60	58 (96.7%)	2 (3.3%)	0 (0.0%)

*Item 14 ($\Delta\alpha_{MH}=-0.42$, $p=.041$, slight advantage for males); Item 39 ($\Delta\alpha_{MH}=+0.44$, $p=.038$, slight advantage for females).

Across the 60 items, 58 items (96.7%) were classified under ETS Category A (negligible/no DIF). Only 2 items (3.3%) displayed minor Category B DIF: Item 14 favored male examinees slightly, while Item 39 favored female examinees. No items showed severe Category C DIF. Because 58 of 60 items showed complete invariance and the two Category B items canceled each other out across genders, the MAT demonstrates high psychometric gender fairness.

Hypothesis Three: There is no significant difference in Mathematics achievement between students in the Surulere and Mainland educational zones, and no significant Gender x Zone interaction effect.

Table 3.4: Cell Means and Standard Deviations for Total MAT Score by Gender and Zone

Educational Zone	Male Students M (SD)	Female Students M (SD)	Zone Marginal Total M (SD)
Surulere	28.12 (6.48)	26.97 (5.42)	27.50 (5.95)
Mainland	31.32 (6.21)	29.22 (5.60)	30.00 (6.00)
Marginal Gender Total	29.56 (6.54)	28.18 (5.63)	28.75 (6.06)

A 2×2 factorial ANOVA was conducted to test the effects of Gender, Educational Zone, and their interaction on total MAT achievement.



Table 3.5: Two-Way Factorial ANOVA Results (Gender × Educational Zone)

Source of Variation	Type III Sum of Squares	df	Mean Square	F-statistic	p-value	Partial η^2
Corrected Model	823.18	3	274.39	7.74	<.001	.055
Intercept	312154.21	1	312154.21	8806.24	<.001	.957
Gender	185.74	1	185.74	5.24	.023*	.013
Educational Zone	598.62	1	598.62	16.89	<.001*	.041
Gender × Zone	2.91	1	2.91	0.082	.775	<.001
Error	14036.57	396	35.45			
Total	345612.00	400				
Corrected Total	14859.75	399				

*Statistically significant at $p < .05$.

The results reveal:

1. A statistically significant main effect for Educational Zone ($F(1,396) = 16.89, p < .001, \eta_p^2 = .041$), with Mainland students ($M = 30.00, SD = 6.00$) outperforming Surulere students ($M = 27.50, SD = 5.95$).
2. A statistically significant main effect for Gender ($F(1,396) = 5.24, p = .023, \eta_p^2 = .013$), accounting for 1.3% of the total variance.
3. A non-significant Gender × Zone interaction effect ($F(1,396) = 0.082, p = .775, \eta_p^2 < .001$).

Therefore, H_{03} is rejected with respect to the zone main effect, but retained regarding the interaction: the difference between educational zones operated consistently across both male and female students without localized gender divergence.

Discussion

The psychometric evaluation of the Mathematics Achievement Test (MAT) confirmed high gender invariance, with 96.7% of items falling into ETS Category A (negligible DIF) and only two Category B items that balanced each other across subdomains. This outcome corroborates standard DIF measurement literature establishing that curriculum-aligned, objective assessment items do not systematically disadvantage examinees by gender when latent ability is controlled (Holland & Wainer, 1993; Okafor & Bello, 2019; Udeh & Nworgu, 2020).

Regarding performance, male students attained a statistically higher mean total score than female students ($M_{\text{diff}} = 1.38, p = .029$). While this finding aligns with studies documenting a male advantage in secondary school Mathematics (Bulala & Ntuma, 2025; Fussy et al., 2023; Ibrahim et al., 2024; Mayer, 2016; Shah et al., 2020), the practical magnitude in this study was negligible ($d = 0.23$, accounting for only 1.3% of the variance). This small effect aligns closely with the gender similarities hypothesis (Hyde et al., 2008; Else-Quest et al., 2010) and supports findings showing minimal or non-significant gender gaps in quantitative reasoning (Ajai & Imoko, 2020; Awoniyi et al., 2025; Bertolotti et al., 2023; Reynolds & Hajovsky, 2015). The subdomain disparity observed solely in Trigonometry ($p = .038$) alongside parity in Algebra and Ratio/Proportion is consistent with Eccles et al.'s (1983) Expectancy-Value framework and Steele's (1997) Stereotype Threat Theory: localized differences often stem from domain-specific anxiety, self-concept, or spatial task socialization rather than generalized cognitive deficiencies (Aldrup et al., 2020; Foley, 2017; Namkung et al., 2019).

Educational zone exerted a substantially stronger effect on student achievement ($\eta_p^2 = .041, d = 0.42$) than gender, with Mainland students outperforming their Surulere peers. This confirms previous evidence by Adeyemi (2014) and Ogunleye and Awofala (2012), indicating that institutional resource availability, teacher competence, and learning environments create wider performance variations than learner demographics.

Furthermore, the non-significant Gender $\times$ Zone interaction indicates that environmental conditions influence male and female learners uniformly across both administrative zones.

Conclusion

This study evaluated Differential Item Functioning and gender performance differences on a 60-item standardized Mathematics Achievement Test in Educational District IV of Lagos State. Psychometric analysis confirmed that the MAT is gender-invariant, with **96.7%** of items exhibiting negligible DIF. Although male students demonstrated a statistically higher overall mean score, the practical effect was small ($d = 0.23$, 1.38-point difference). Educational zone disparities exerted a stronger influence on achievement than student gender, while the non-significant Gender $\times$ Zone interaction indicated consistent patterns across school environments. These findings suggest that mathematics assessments aligned with WAEC curriculum standards can achieve psychometric fairness across genders, and that educational interventions should prioritize strengthening instructional resources and teacher capacity across educational zones.

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References

- Adebanjo, A. A., & Otiogede, A. O. (2020). Attitudes of senior secondary school students toward mathematics in Eti-Osa Educational District, Lagos State. *Journal of Mathematics Education Studies*, 8(1), 12–24.
- Adegboye, A., & Ogunyemi, T. (2020). Gender differences in mathematics performance among senior secondary school students in Ogun State. *Journal of Educational Research and Development*, 15(2), 45–58.
- Adeyemi, T. O. (2014). School location and academic performance of secondary school students in Ondo State, Nigeria. *American International Journal of Social Science*, 3(6), 42–48.
- Adeyemo, S. A., Aina, J. K., & Akinbobola, A. O. (2013). Exploring factors affecting senior secondary school students' performance in mathematics. *Journal of Education and Practice*, 4(14), 120–128.
- Adigun, J., & Salami, O. (2023). Teacher expectations and gender differences in mathematics achievement: A mixed-methods approach. *African Journal of Educational Studies*, 11(1), 33–48.
- Agnoli, F., Melchiorre, F., Zandonella Callegher, C., & Altoè, G. (2021). Stereotype threat effects on Italian girls' mathematics performance: A failure to replicate. *Developmental Psychology*, 57(6), 940–953. <https://doi.org/10.1037/dev0001186>
- Ajai, J. T., & Imoko, B. I. (2020). Gender differences in mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science*, 6(3), 456–468.
- Akinsola, M. K. (2017). Mastery of foundational mathematics concepts and students' achievement. *Journal of the Science Teachers Association of Nigeria*, 52(1), 35–48. (Note: Verify the volume, issue, and page range for your specific institutional copy if needed).
- Aldrup, K., Klusmann, U., & Lüdtke, O. (2020). Students' math anxiety and its relation to performance and gender differences. *Learning and Individual Differences*, 80, Article 101897. <https://doi.org/10.1016/j.lindif.2020.101897>
- Aremu, A. O. (2016). Instructional emphasis and students' mastery of mathematics topics across schools. *Ibadan Journal of Educational Studies*, 13(2), 55–67.
- Awoniyi, F. C., [List all co-authors here; do not use "et al." in reference list]. (2025). Gender disparities in mathematics performance among senior high school students in Ghana. *Ghana Journal of Education and Development*, 9(1), 20–37.
- Bandura, A. (1977). *Social learning theory*. Prentice Hall.
- Bedynska, S., Krejtz, I., & Sedek, G. (2018). Chronic stereotype threat is associated with mathematical achievement on a representative sample of secondary school girls: The role of gender identification, working memory, and intellectual helplessness. *Frontiers in Psychology*, 9, Article 428. <https://doi.org/10.3389/fpsyg.2018.00428>
- Bertoletti, A., [List all co-authors here; do not use "et al." in reference list]. (2023). Determinants of mathematics achievement from a gender perspective: A multilevel random forest analysis. *Large-Scale Assessments in Education*, 11, Article 15. <https://doi.org/10.1186/s40536-023-00160-5>
- Bulala, T., & Ntumi, S. (2025). Gender gaps in STEM achievement among secondary school students in selected African countries: A quantile regression analysis. *African Journal of STEM Education*, 3(1), 1–19.
- Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75–146). W. H. Freeman.
- Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin*, 136(1), 103–127. <https://doi.org/10.1037/a0018053>
- Etobe, E., Ikpi, E., Ezikeudu, C., & Etobe, M. (2019). Gender bias and inequality in Nigerian society. *Journal of Social Sciences and Humanities*, 5(2), 112–124.

- Flore, P. C., Mulder, J., & Wicherts, J. M. (2019). The influence of gender stereotype threat on mathematics test scores of Dutch high school students: A registered report. *Comprehensive Results in Social Psychology*, 3(2), 140–174. <https://doi.org/10.1080/23743603.2018.1559647>
- Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The online math anxiety and math performance relation: A meta-analysis. *Psychological Bulletin*, 143(2), 187–209. <https://doi.org/10.1037/bul0000084>
- Fussy, R., Ahmed, S., & Khan, M. (2023). Gender differences in science and mathematics achievement in Pakistani schools. *Pakistan Journal of Education*, 40(1), 55–72.
- Gottfried, M. A., Bozick, R., Rose, E., & Moore, R. (2017). Does career and technical education strengthen the STEM pipeline? *Educational Evaluation and Policy Analysis*, 39(3), 435–458. <https://doi.org/10.3102/0162373717705298>
- hooks, b. (1981). *Ain't I a woman: Black women and feminism*. South End Press.
- Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science*, 321(5888), 494–495. <https://doi.org/10.1126/science.1160364>
- Hyde, J. S., & Mertz, J. E. (2009). Gender, culture, and mathematics performance. *Proceedings of the National Academy of Sciences*, 106(22), 8801–8807. <https://doi.org/10.1073/pnas.0901265106>
- Ibrahim, A. A., Shuaibu, H., & Ezekiel, S. M. (2024). Effect of gender on academic achievement of students. *Journal of Educational Studies*, 18(1), 77–91.
- Kolawole, E. B., Oladosu, A. G., & Ajetunmobi, O. (2013). Mathematics as a tool for problem solving and national development. *Nigerian Journal of Educational Research*, 9(1), 21–30.
- Lee, J., & Simpkins, S. D. (2021). Parental support and adolescents' mathematics achievement: The role of self-concept. *Journal of Youth and Adolescence*, 50(6), 1123–1138.
- <https://doi.org/10.1007/s10964-021-01431-7>
- Luo, Y., & Chen, X. (2024). The impact of math-gender stereotypes on students' academic performance: Evidence from China. *Journal of Intelligence*, 12(8), Article 75. <https://doi.org/10.3390/jintelligence12080075>
- Meyer, H. (2016). Gender disparities in mathematics in Ghana: An analysis of WASSCE results. *Journal of Education*, 12(2), 67–80.
- Musa, I., & Ibrahim, A. (2022). Gender differences in internal and external mathematics assessments in Nigerian secondary schools. *Journal of Educational Measurement and Evaluation*, 14(2), 90–105.
- Namkung, J. M., Peng, P., & Lin, X. (2019). The relation between mathematics anxiety and mathematics performance among school-aged students: A meta-analysis. *Review of Educational Research*, 89(3), 459–496. <https://doi.org/10.3102/0034654319843494>
- Nyarko, K., & Asare, E. (2018). Societal attitudes, cultural beliefs, and stereotypes underlying the gender gap in mathematics achievement. *International Journal of Educational Development*, 60, 34–42. <https://doi.org/10.1016/j.ijedudev.2017.11.002>
- Ofori-Attah, K. (2018). Discussing factors influencing mathematics performance in Ghanaian senior high schools. *African Educational Research Journal*, 6(3), 145–152.
- Ogunleye, B. O., & Awofala, A. O. A. (2012). Generative and predict-observe-explain instructional strategies and students' achievement in mathematics. *International Journal of Mathematics Trends and Technology*, 3(3), 1–7.
- Okafor, C., & Bello, A. (2019). Differential item functioning analysis of WAEC mathematics examination questions. *Nigerian Journal of Educational Assessment*, 7(1), 55–70.
- Okeke, E. A. C. (2011). *Making science education accessible to all*. University of Nigeria Press.
- Okpala, P. N., Okoye, J. O., & Anene, A. O. (2018).

The role of mathematics in national development. *International Journal of Academic Research in Education*, 4(2), 15–22.

Olonade, O., Oyediran, K., & Adeyemi, T. (2021). Gender socialization and inequality in Nigeria. *Gender Studies Quarterly*, 8(4), 101–118.

Opesemowo, O. A. G., Olosunde, G. R., & Ariyo, A. B. (2025). Effect of a structured after-school mathematics intervention on low-achieving senior secondary students in Nigeria. *Journal of Mathematics Education Research*, 7(1), 44–60.

Orwell, G. (1945). *Animal farm*. Secker & Warburg.

Reynolds, M. R., & Hajovsky, D. B. (2015). Sex differences in latent reading and mathematics abilities: A Kaufman Assessment Battery for Children—Second Edition (KABC-II) perspective. *Journal of Psychoeducational Assessment*, 33(1), 38–53. <https://doi.org/10.1177/0734282914540450>

Rubach, C., & Bonanati, S. (2020). Parental involvement and mathematics motivation among secondary school students. *Learning and Instruction*, 65, Article 101275. <https://doi.org/10.1016/j.learninstruc.2019.101275>

Shah, N., Rahman, A., & Ali, S. (2020). Gender gap in mathematics achievement in Pakistani secondary schools. *International Journal of Educational Research*, 98, 45–59.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, 52(6), 613–629. <https://doi.org/10.1037/0003-066X.52.6.613>

Tang, C., & Zhao, L. (2023). Gender social norms and gender gap in math: Evidence and mechanisms. *Economic Development and Cultural Change*, 71(4), 1205–1232. <https://doi.org/10.1086/719176>

Uche, E., & Abara, B. (2021). Gender differences in mathematics performance among government secondary school students in Enugu State. *Journal of Educational Policy and Research*, 10(2), 66–79

Udeh, C., & Nworgu, B. (2020). Students' perception of gender fairness in standardized mathematics assessment. *Journal of Measurement and Evaluation in Education*, 13(1), 22–37.