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ASSESSING THE IMPLEMENTATION AND IMPACT OF THE FREE QUALITY SCHOOL EDUCATION POLICY ON MATHEMATICS OUTCOMES IN SECONDARY SCHOOLS IN THE WESTERN AREA OF SIERRA LEONE

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ABSTRACT

The Free Quality School Education (FQSE) policy, introduced in Sierra Leone in September 2018, represents a state commitment to eliminating direct financial barriers to primary and secondary schooling. While national gross enrolments expanded by over half a million learners, questions persist regarding whether fee abolition has translated into improved cognitive learning gains in foundational subjects like Mathematics. This study evaluated the implementation status of the FQSE policy and its impact on secondary Mathematics achievement across four purposively selected schools in the Western Area of Sierra Leone: Ahmadiyya Secondary School and Albert Academy (Western Area Urban), and Peninsular Secondary School and Salam Secondary School (Western Area Rural). Grounded in the Education Production Function and human capital frameworks, data were gathered from 200 Senior Secondary School students ($n=50$ per school) using a validated 50-item Mathematics Achievement Test (MAT; Cronbach's $\alpha=.81$) and a 20-item structured Likert questionnaire ($\alpha=.84$). A one-way Analysis of Variance (ANOVA) revealed statistically significant disparities in Mathematics performance across the schools, $F(3,196)=12.87, p<.001, \eta^2=.16$, with an aggregate sample mean of 59.68 ($SD=10.45$). Urban schools significantly outperformed their rural counterparts ($p<.01$), while within-stratum pairwise differences were not statistically significant ($p>.05$), demonstrating an urban–rural achievement divide. Student perceptual evaluations ($M=3.13, SD=1.03$) indicated that while textbook supply ($M=3.84$) and learner motivation ($M=3.61$) were viewed favorably, classroom overcrowding ($M=2.43$) and depleted laboratory facilities ($M=2.78$) represent severe operational bottlenecks. The study concludes that expanding educational access must be matched with targeted classroom construction, specialized instructional kits, and continuous in-service teacher development to sustain Mathematics learning gains.

Keywords: Free Quality School Education; Mathematics Achievement; Secondary Education; Educational Policy; Urban–Rural Disparity; Sierra Leone.

1 INTRODUCTION

Access to equitable, high-quality education is universally acknowledged as a foundational human right and a principal engine for sustainable socio-economic development, productivity, and poverty eradication [1, 2]. Across sub-Saharan Africa, cost-sharing policies and household-borne tuition fees historically disenfranchised economically vulnerable demographics, institutionalizing generational disparities in formal educational completion [3]. Sierra Leone has faced pronounced developmental and educational bottlenecks resulting from the 1991–2002 civil conflict and public health crises including the 2014–2016 Ebola outbreak [4]. These structural shocks left basic and secondary tiers characterized by low retention, high dropout rates among adolescent learners, and severe shortages of school infrastructure.

To address these chronic access barriers, the Government of Sierra Leone initiated the Free Quality School Education (FQSE) program in September 2018 [5]. Under this social-sector initiative, tuition fees and official public examination fees (such as the Basic Education Certificate Examination and the West African Senior School Certificate Examination) were abolished for government and government-assisted primary and secondary schools. The reform package coupled cost removal with state procurement of syllabus-approved core textbooks, specialized stationery, and school-feeding schemes in targeted districts. The Ministry of Basic and Senior Secondary Education registered an influx exceeding 500,000 additional pupils during the initial rollout, marking an unprecedented expansion in school access [6].

However, empirical literature in international development economics indicates that rapid access democratization does not automatically guarantee instructional quality [7, 8]. When demand-side subsidies induce large enrollment surges without corresponding supply-side investments—such as teacher recruitment, classroom construction, and instructional laboratory provision—per-pupil resource dilution can impair learning environments [9, 10].

Mathematics is particularly sensitive to sudden increases in classroom density. Because Mathematics learning is cumulative and hierarchical, requiring consistent formative feedback, error diagnostics, and interactive scaffolding, overcrowded classrooms risk degrading instructional delivery into rote dictation. While aggregate access statistics are documented in government reports, empirical evaluations focusing on secondary Mathematics outcomes and geographic equity across urban and rural institutions remain sparse. This study investigates Mathematics achievement levels, institutional variations, and student perceptions of the operational conditions influencing Mathematics instruction in the Western Area of Sierra Leone.

1.1 Conceptual Framework

This study is framed using the classical Education Production Function (EPF) combined with human capital theory [8, 11]. Human capital theory posits that eliminating schooling costs lowers the opportunity threshold for household participation, expanding human capital formation. However, the EPF conceptualizes student cognitive learning outcomes (A) as the output of interacting input vectors:

$$A_{it}=f(S_{it},T_{it},I_{it},P_i)$$

where:

- A_{it} represents the Mathematics achievement of student i at time t ;
- S_{it} represents school physical resources (such as classroom density, desk space, and laboratory apparatus);
- T_{it} denotes teacher characteristics (including subject-matter competency, instructional load, and pedagogical practices);
- I_{it} encompasses institutional and curricular inputs (including textbook provision and administrative support);
- P_i captures student affective attributes (such as academic motivation).

When free education policies focus primarily on demand-side fee elimination (P) and textbook distribution (I) without scaling school facilities (S) and teacher capacity (T), the production function encounters supply constraints. In secondary Mathematics education, where conceptual mastery requires structured classroom interaction and concrete manipulatives, this structural imbalance risks disconnecting enrollment gains from measurable academic competencies.

2 MATERIAL AND METHODS

2.1 Research Design and Context

The investigation employed a cross-sectional descriptive comparative survey design integrating standardized achievement testing with structured perceptual surveys [12]. This methodology enables the quantitative examination

of existing academic competencies and instructional environments across contrasting institutional settings without experimental manipulation. The study was conducted in the Western Area of Sierra Leone, which comprises two administrative divisions: Western Area Urban (the capital city of Freetown) and Western Area Rural.

2.2 Sampling Framework and Participants

The target population comprised Senior Secondary School (SSS) students enrolled in government and government-assisted secondary schools operating under the FQSE policy. Purposive sampling was utilized to select four secondary schools representing distinct geographic, historical, and infrastructure profiles:

- **School A (Ahmadiyya Secondary School):** A large public co-educational secondary school situated in the metropolitan center of Freetown (Western Area Urban).
- **School B (Albert Academy):** An established, historically endowed urban secondary school in central Freetown featuring comparatively stable academic infrastructure (Western Area Urban).
- **School C (Peninsular Secondary School):** A government-assisted secondary school serving peri-urban and semi-rural coastal communities along the Western Area Peninsula (Western Area Rural).
- **School D (Salam Secondary School):** A secondary school situated within the agricultural, rural interior of the Western Area Rural district.

A stratified random sampling technique was deployed within each institution to draw 50 students across Senior Secondary levels (SSS 1 through SSS 3) using official class registers, resulting in a total sample size of $N=200$ respondents (100 urban, 100 rural). Stratification ensured proportional representation across grade cohorts and genders.

2.3 Research Instrumentation

Two researcher-developed quantitative instruments were used:

- **Mathematics Achievement Test (MAT):** A 50-item objective examination designed in alignment with the approved national Senior Secondary Mathematics curriculum. The test sampled five core areas: Number and Numeration (10 items), Algebraic Processes (12 items), Plane and Coordinate Geometry (10 items), Statistics and Probability (10 items), and Introductory Calculus and Trigonometry (8 items). Each correct response was assigned 2 marks, yielding a maximum cumulative score of 100. Content and construct validity were verified by an expert panel of two secondary Mathematics educators and a university lecturer in Mathematics education. Pilot testing with 30 students in a non-sampled Western Area public school produced a Cronbach's alpha reliability coefficient of $\alpha=.81$.
- **Likert-Scale Questionnaire (LSQ):** A 20-item instrument measuring student appraisal of FQSE operational conditions across six dimensions: textbook availability, class size dynamics, instructional quality, subject motivation, laboratory equipment, and teacher institutional support. Items were rated on a 5-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). The scale demonstrated high internal consistency ($\alpha=.84$).

2.4 Data Collection and Ethical Considerations

Data collection was conducted over a three-week testing window following administrative approval from the Ministry of Basic and Senior Secondary Education (MBSSE) and institutional consent from school principals. Parental consent and student assent were obtained prior to test administration; participation was voluntary and anonymous. The MAT was administered during a proctored 90-minute morning session, followed immediately by completion of the perception survey. Participant confidentiality was maintained through numeric coding.

2.5 Statistical Analysis

Data were analyzed using IBM SPSS Statistics (Version 26). Descriptive metrics, including arithmetic means (M), standard deviations (SD), and ranges, were calculated for each school and the pooled cohort. A one-way Analysis of Variance (ANOVA) was conducted to test for differences in Mathematics scores across institutional environments. Pairwise post-hoc comparisons were conducted using Tukey's Honestly Significant Difference (HSD) test at $\alpha=.05$. Effect size was estimated using partial eta squared (η^2). Perceptual items were interpreted using established interval cutoffs: <2.50 = Disagree/Unfavorable, $2.50 - 3.49$ = Neutral/Ambivalent, and $3.50 - 5.00$ = Agree/Favorable.

3 RESULTS

3.1 Descriptive Performance on the Mathematics Achievement Test

The performance of Senior Secondary School students on the 100-point Mathematics Achievement Test across all four schools is presented in Table 1.

Table 1: Descriptive statistics of Mathematics Achievement Test (MAT) scores by school and setting

School Name	Geographic Stratum	n	Mean (M)	Std. Dev. (SD)	Minimum	Maximum
School A (Ahmadiyya)	Urban	50	64.20	8.90	44	84
School B (Albert Academy)	Urban	50	66.40	8.15	46	86
School C (Peninsular)	Rural	50	55.80	10.45	32	76
School D (Salam)	Rural	50	52.30	11.20	28	74
Total Cohort	Combined	200	59.68	10.45	28	86

The aggregate mean score across the pooled cohort was $M=59.68$ ($SD=10.45$), indicating moderate overall curriculum mastery. Across institutional settings, School B recorded the highest performance ($M=66.40, SD=8.15$), followed by School A ($M=64.20, SD=8.90$).

Rural institutions exhibited lower mean achievement profiles: School C achieved a mean score of 55.80 ($SD=10.45$), while School D registered the lowest performance ($M=52.30, SD=11.20$). School D also exhibited the widest score dispersion (range: 28 to 74), pointing to substantial within-school heterogeneity in foundational student competencies.

3.2 Inferential Analysis: Differences Across School Environments

A one-way between-subjects ANOVA was executed to determine whether the observed variations in Mathematics scores across institutional environments were statistically significant. Summary results are presented in Table 2.

Table 2: One-way Analysis of Variance of Mathematics achievement scores across schools

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-ratio	p-value	Partial η^2
Between Groups	4,098.21	3	1,366.07	12.87	<.001	.16
Within Groups	20,781.96	196	106.03			
Total	24,880.17	199				

The one-way ANOVA indicated a statistically significant main effect of school environment on Mathematics attainment, $F(3,196)=12.87, p<.001, \eta^2=.16$. The calculated effect size indicates that 16% of the variance in Mathematics achievement is attributable to institutional setting.

Tukey's HSD post-hoc pairwise evaluations revealed that:

- School B scored significantly higher than School C ($MD=10.60, p<.001$) and School D ($MD=14.10, p<.001$);
- School A scored significantly higher than School C ($MD=8.40, p=.001$) and School D ($MD=11.90, p<.001$);
- The achievement difference between the two urban institutions (School B vs. School A) was not statistically significant ($MD=2.20, p=.412$);
- The performance difference between the two rural institutions (School C vs. School D) was not statistically significant ($MD=3.50, p=.284$).

These results identify a statistically significant performance divide between urban and rural secondary schools in the Western Area.

3.3 Student Appraisal of FQSE Operational Implementation

Student evaluations of operational learning conditions under the FQSE policy are detailed in Table 3.

Table 3: Student perceptions of FQSE operational dimensions on Mathematics learning (N=200)

Operational Dimension / Questionnaire Item	Mean (M)	Std. Dev. (SD)	Interpretation
Access to mathematics textbooks and printed materials has increased under FQSE	3.84	0.92	Agree / Favorable
The FQSE policy has enhanced my personal motivation to study mathematics	3.61	0.98	Agree / Favorable
The quality of secondary mathematics instruction has improved under FQSE	3.12	1.02	Neutral / Ambivalent
Mathematics teachers receive adequate institutional and pedagogical support	2.97	1.05	Neutral / Ambivalent
Mathematics infrastructure (laboratories, calculating tools, kits) is adequate	2.78	1.09	Disagree / Unfavorable
Class sizes have improved (decreased) following FQSE implementation	2.43	1.14	Disagree / Unfavorable
Composite Perceptual Index	3.13	1.03	Neutral / Ambivalent

Note: Evaluation scale: 1 = Strongly Disagree to 5 = Strongly Agree. Interpretation thresholds: < 2.50 = Disagree/Unfavorable; 2.50 - 3.49 = Neutral/Ambivalent; 3.50 - 5.00 = Agree/Favorable.

The composite perception index was $M=3.13$ ($SD=1.03$), reflecting an overall ambivalent appraisal. Students rated direct textbook availability favorably ($M=3.84, SD=0.92$), confirming that book distribution efforts under FQSE reached secondary classrooms. Similarly, fee elimination positively influenced personal learning motivation ($M=3.61, SD=0.98$).

Conversely, substantial dissatisfaction was recorded regarding physical learning environments. The item measuring class size improvement received the lowest rating ($M=2.43, SD=1.14$), with students noting increased classroom congestion following the 2018 policy. Perceptions regarding specialized Mathematics infrastructure (such as geometry sets, calculating tools, and laboratory spaces) were similarly unfavorable ($M=2.78, SD=1.09$), while perceived instructional quality ($M=3.12$) and teacher support ($M=2.97$) fell within the neutral range.

4 DISCUSSION

The empirical findings of this investigation provide an evaluation of secondary Mathematics education under Sierra Leone's Free Quality School Education policy. The aggregate sample MAT mean of 59.68 reflects moderate conceptual mastery, indicating that while students can perform routine procedural computations, many struggle with non-routine problem solving, formal geometric proofs, and analytical calculations. This pattern corresponds with regional evidence from sub-Saharan Africa indicating that rapid educational fee abolition often outpaces gains in foundational numeracy competencies [1, 2].

The statistically significant inter-school variance, $F(3,196)=12.87, p<.001, \eta^2=.16$, exposes a spatial divide between urban and rural secondary schools. The performance differential exceeding 14 percentage points between the highest-performing urban school (Albert Academy, $M=66.40$) and the lowest-performing rural school (Salam Secondary School, $M=52.30$) illustrates that universal social policies can yield unequal outcomes when introduced across heterogeneous institutional environments.

Interpreted through the Education Production Function framework, established urban schools in central Freetown benefit from structural buffers: higher teacher retention, greater densities of certified subject specialists, active alumni support networks, and better access to supplementary learning materials. These factors help insulate metropolitan classrooms from the strains of enrollment surges, mirroring findings from secondary educational expansions in Ghana [13, 14].

In contrast, rural secondary institutions operate under compounding supply-side constraints. The broad score dispersion at Salam Secondary School ($SD=11.20$; range: 28–74) illustrates high within-school inequality, where a small cohort of high-performing students coexists with a majority lacking basic mathematical preparation. This reflects the

operational challenges identified by Kanu [15] and Tarawalie and Kamanda [16], who noted acute teacher shortages, high staff turnover, and geographic isolation across peri-urban and rural Sierra Leone.

Student perceptual appraisals clarify these trends. While FQSE succeeded on demand-side dimensions—stimulating pupil motivation ($M=3.61$) and delivering textbooks ($M=3.84$)—it generated operational strains on classroom environments. The unfavorable rating for class size ($M=2.43$) highlights that rapid enrollment growth without concurrent classroom construction has resulted in high classroom density. In secondary Mathematics, which requires individualized diagnostic feedback and active problem-solving discourse, overcrowded conditions often prompt instructors to rely on didactic, lecture-heavy teaching methods [8, 17].

Coupled with low satisfaction regarding specialized Mathematics learning kits ($M=2.78$) and teacher support ($M=2.97$), these findings show that while tuition abolition democratized school access, the material and physical conditions necessary for effective Mathematics instruction remain unevenly distributed.

5 CONCLUSION

The Free Quality School Education policy has removed direct financial barriers to secondary schooling in Sierra Leone, expanding enrollment access and distributing core textbooks to thousands of previously underserved learners. However, the empirical results of this study indicate that enrollment growth has not produced uniform Mathematics learning outcomes.

The persistent urban–rural achievement divide, combined with student concerns regarding classroom overcrowding and inadequate physical learning resources, demonstrates that access-oriented educational policies risk reinforcing geographic inequities if underlying instructional capacity is neglected. Aligning educational access with improvements in instructional infrastructure remains a central priority for national education development in Sierra Leone.

Recommendations

Based on these empirical findings, the following policy interventions are recommended:

- **Targeted In-Service Professional Development:** The Ministry of Basic and Senior Secondary Education (MBSSE), in collaboration with teacher training institutions, should institute structured, continuous professional development programs for secondary Mathematics teachers. Training should focus on active-learning methodologies, continuous diagnostic assessment, and instructional strategies for managing large, mixed-ability classrooms.
- **Prioritized Infrastructure Expansion in Rural Schools:** Capital budgets for school construction—specifically additional classrooms and dedicated Mathematics and Science facilities—should be prioritized for rural institutions to reduce student-to-classroom ratios.
- **Improved Logistics for Specialized Instructional Materials:** The MBSSE should improve its supply chain to ensure that geometric instruments, graphing aids, and scientific calculators reach peripheral and rural schools before the start of each academic year.
- **Institutionalization of National Diagnostic Assessments:** Standardized diagnostic Mathematics assessments should be conducted annually across Junior and Senior Secondary tiers to support data-informed policy tracking and early academic remediation across urban and rural districts.

Limitations and Future Research

This investigation was restricted to four purposively selected secondary schools ($N=200$) in the Western Area of Sierra Leone. Although these institutions offer clear urban and rural comparisons, the findings cannot be statistically generalized across all sixteen provincial districts. Furthermore, the cross-sectional survey design captured student performance at a single point in time, precluding direct causal conclusions regarding longitudinal learning trajectories. Subsequent research should utilize larger, nationally representative cohorts and incorporate structured classroom observations with direct assessments of teacher pedagogical content knowledge.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that they have no competing interests or financial disclosures associated with this research.

Statement of informed consent

Informed consent was obtained from all participating school administrations, parent-teacher associations, and participating students prior to the administration of research instruments.

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