International Journal of Secondary Education
2026, Vol. 14, No. 3, pp. 97–106
https://doi.org/10.11648/j.ijsedu.20261403.13

SciencePG
Science Publishing Group

Research Article

Relationship Between Teachers' Pedagogical Competence, School Factors, and Pupils' Academic Performance in Selected Senior Secondary Schools in Sierra Leone

Samuel Joseph Bebeley[1], Victoria Olufemi Danke Kawa[2, 3], Prince Tongor Mabey[1, *], Joseph James Mbavai[2]

[1]Department of Health Education and Behavioural Science, Njala University, Freetown, Sierra Leone

[2]Department of Teacher Education, Njala University, Freetown, Sierra Leone

[3]Department of Mathematics, Milton Magai Technical University, Freetown, Sierra Leone

Abstract

This study examined the relationship between teachers' pedagogical competence, school quality factors, and pupils' learning outcomes in selected senior secondary schools in Sierra Leone. A quantitative design was employed to provide quantitative evidence. The study was conducted in six single-sex secondary schools in the Western Area Urban District and Bo District. A total of 655 pupils, 24 Basic Science teachers, and six school leaders participated. Quantitative data were collected using a validated 40-item Pedagogical Competence Questionnaire (PCQ). Data were analysed using descriptive statistics, Pearson Product Moment Correlation, one-way ANOVA, stepwise multiple regression, chi-square tests of independence, and thematic analysis at a 5% significance level. The findings revealed that teachers' pedagogical competence was generally high (Mean = 3.52, SD = 0.58), with 91.1% of pupils rating their teachers highly. A statistically significant positive relationship existed between teachers' pedagogical competence and pupils' learning outcomes ($r = 0.1185$, $p = 0.0051$). Stepwise multiple regression identified lesson preparation ($\beta = 0.175$, $p < 0.001$), explanation frequency ($\beta = 0.168$, $p = 0.001$), and feedback provision ($\beta = 0.113$, $p = 0.013$) as the strongest independent predictors of pupils' academic performance. Furthermore, school quality factors significantly influenced learning outcomes, as evidenced by chi-square statistics for General Performance ($\chi^2 = 363.299$, $df = 3$, $p < 0.001$), Mathematics ($\chi^2 = 374.647$, $df = 4$, $p < 0.001$), Chemistry ($\chi^2 = 341.366$, $df = 4$, $p < 0.001$), Physics ($\chi^2 = 266.982$, $df = 4$, $p < 0.001$), and Biology ($\chi^2 = 464.071$, $df = 4$, $p < 0.001$). The study concludes that although the relationship between pedagogical competence and learning outcomes is modest, it is statistically significant and educationally meaningful. Effective lesson preparation, clear instructional delivery, regular formative feedback, and supportive school environments are critical determinants of improved learning outcomes. The study recommends strengthening continuous professional development programmes, institutionalising regular instructional supervision and feedback mechanisms, improving the availability of teaching and learning resources, and promoting evidence-based school leadership practices to enhance academic performance in Sierra Leonean secondary schools.

Keywords

Pedagogical Competence, Learning Outcomes, Basic Sciences, School Quality Factors, Teacher Effectiveness, Senior Secondary Schools, Sierra Leone

*Correspondence: Prince Tongor Mabey (pmabey@njala.edu.sl)

Received: 2 August 2026; **Accepted:** 10 August 2026; **Published:** 2 September 2026

1. Introduction

Something of a paradox defines secondary science education in Sierra Leone today. School enrolment has grown substantially under the 2018 Free Quality School Education (FQSE) Programme, and the national WASSCE pass rate in five subjects rose from under 20% to 52% by 2025 [1, 2]. Yet within that aggregate improvement, Basic Science subjects Mathematics, Physics, Chemistry, and Biology continue to record troublingly low high-performer proportions and persistent examiner criticisms of weak scientific reasoning, incomplete syllabus coverage, and inadequate practical exposure [3, 4]. Increased access, in other words, has not automatically translated into improved science achievement, a finding consistent with comparative experience across Sub-Saharan Africa [5, 6].

The teacher remains the most powerful modifiable school-based predictor of learner performance. This proposition, extensively supported in international meta-analyses [7, 8] and increasingly corroborated by African-context studies [9, 10], motivates a closer examination of pedagogical competence the integrated capacity of teachers to plan, deliver, manage, assess, and reflect upon instruction [11, 12]. Critically, however, pedagogical competence does not operate in a structural vacuum. The institutional conditions within which teachers work laboratory provision, resource availability, assignment regularity, school climate, and geographic and gender-based institutional characteristics collectively shape whether competence can be converted into measurable learning gains [13, 14]. In Sierra Leone specifically, empirical investigations that jointly examine both the teacher quality achievement relationship and the structural school quality moderators of that relationship remain scarce.

This paper reports findings from the third and fourth objectives of a doctoral study into teachers' pedagogical competence and its impact on Basic Science learning outcomes at the Senior Secondary School level: (a) to determine the relationship between teachers' pedagogical competence and pupils' learning outcomes; and (b) to examine school quality factors and identify the effective practices most influencing those outcomes. By employing Pearson correlation, multiple regression, ANOVA, chi-square tests, across six schools in two districts, the study generates locally grounded and policy-actionable evidence on the dual challenge of instructional improvement and structural school quality in Sierra Leonean secondary science education.

Three theoretical traditions frame the investigation. Bloom's Taxonomy of Educational Objectives [15] provides the multidimensional conception of learning outcomes spanning cognitive, affective, and psychomotor domains. Shulman's construct of Pedagogical Content Knowledge [16] articulates how subject expertise becomes effective teaching the particular transformation of content knowledge into forms that are comprehensible and pedagogically appropriate for diverse learners. Bandura's Social Cognitive Theory [17] explains how teacher self-efficacy, modelling, and instructional behaviour shape learner motivation, orientation, and academic engagement. Together, these frameworks predict that pedagogical competence will exert a positive but structurally conditioned effect on learning outcomes, an effect whose magnitude and distribution are further shaped by the institutional environment in which teaching takes place.

2. Literature Review

2.1. Pedagogical Competence as a Predictor of Learning Outcomes: International Evidence

Few findings in educational research are as consistently replicated as the relationship between teacher quality and student achievement. Darling-Hammond et al. [7] synthesised extensive meta-analytic evidence establishing that teachers' professional knowledge and instructional skills rank among the strongest in-school predictors of learner performance across subjects and grade levels, a conclusion reinforced by the OECD's PISA 2022 analyses linking instructional quality directly to student science and mathematics outcomes [11]. Fauth et al. [18] provided mechanistic detail in an elementary science context, demonstrating that pedagogical content knowledge, self-efficacy, and teaching enthusiasm predicted both student interest and achievement, with three quality-of-teaching dimensions cognitive activation, supportive climate, and classroom management mediating those effects.

Among pedagogical competence dimensions, feedback provision has received particular attention as a high-leverage mechanism. Hattie and Timperley's [19] synthesis placed feedback among the largest-effect-size interventions in the educational research canon ($d \approx 0.73$). Black and Wiliam's [20] foundational review, and subsequent meta-analyses by Xuan et al. [21] and Foster [22], confirmed that formative assessment whose practical implementation depends substantially on the quality and regularity of teacher feedback significantly improves student learning by enabling instructional adjustments in real time. Park and Chan's [23] recent systematic synthesis of 217 empirical PCK studies further confirmed strong connections between pedagogical content knowledge, teaching practices, and student outcomes, while noting that these relationships remain contextually contingent.

2.2. Evidence From Africa and Sierra Leone

African evidence broadly corroborates the international pattern while foregrounding structural constraints specific to the

continent. Teacher competence, particularly instructional clarity, preparation, and feedback, is positively associated with student performance across West, East, and Southern African contexts, even in resource-constrained settings [9, 24]. In Nigeria, Adegbola [25] found that teachers' pedagogical competence significantly predicted secondary students' attitudinal orientation toward Basic Sciences; instructional materials use proved a particularly salient dimension. Ugbe and Agim [26] established a direct relationship between teacher competence and Chemistry achievement, concluding that professionally trained science teachers produce superior learner outcomes across ability levels.

Sierra Leone's own evidence base is still developing but is growing. Brainard [27] confirmed, in a mixed-methods investigation of junior secondary schools, that teacher effectiveness encompassing qualifications, pedagogy, classroom management, and assessment is a critical determinant of Language Arts and Mathematics achievement, notwithstanding teacher shortage and professional development deficits. Turay et al. [28] demonstrated through analysis of WASSCE performance from 2016 to 2024 that the FQSE policy expanded access substantially without producing equivalent improvements in academic performance, underscoring that supply-side access interventions are insufficient without accompanying improvements in teaching quality. Oxford Policy Management's impact evaluation of the ISIS programme [29] provided robust multifactor evidence that school-, teacher-, and student-level variables interact in shaping Sierra Leonean learning outcomes, with teacher quality and school resources the most influential modifiable determinants.

2.3. School Quality Factors and Science Achievement

Laboratory infrastructure represents the most directly consequential school quality variable for Basic Science teaching. Kumari, Balimuttajjo, and Aheisibwe [30] reported that inadequate laboratory availability in Ugandan secondary schools substantially reduced student practical engagement and conceptual understanding in science findings replicated across multiple African systems where Physics and Chemistry, being the most apparatus-dependent disciplines, consistently produce the weakest learner outcomes under laboratory-deficit conditions [31, 32]. Instructional materials more broadly models, charts, demonstration apparatus, textbooks similarly shape the range of pedagogical strategies available to teachers, constraining or enabling instructional variety [13].

School type and geographic location also matter in ways that sometimes challenge conventional assumptions. Single-sex schools, particularly girls' schools, have been associated with higher science achievement in West African secondary education systems, attributable variously to reduced stereotype threat, more consistent teacher attention, and stronger institutional cultures of academic expectation [33, 34]. Geographic differentials are less predictable: metropolitan location does not uniformly guarantee better pedagogical quality, as institutional leadership, community engagement, and school culture may compensate for resource differences in specific contexts [35, 36]. These findings justify disaggregated school-type and location analyses.

2.4. Conceptual Framework

The study's conceptual framework integrates its three theoretical anchors into a two-pathway model. The first, a direct instructional pathway, posits that teachers' preparation, explanation quality, and feedback frequency operate directly on learner performance through improved comprehension and self-regulated learning. The second, a contextual-structural pathway, holds that school quality factors laboratory provision, assignment regularity, school type, and geographic location independently influence learning outcomes and simultaneously moderate the translation of teacher competence into achievement. The framework predicts a statistically significant but structurally bounded positive association between pedagogical competence and outcomes, with school quality factors functioning as both independent determinants and boundary conditions of that association.

3. Research Methodology

3.1. Research Design

A quantitative design was adopted, combining a descriptive cross-sectional survey for quantitative data collection [37, 38]. The approach enables statistical associations with contextual explanations of the mechanisms underlying them and an important methodological consideration given the multifactorial nature of learning outcomes in real school settings [39]. This paper reports findings specific to the third objective (the pedagogical competence – learning outcome relationship) and the fourth objective (school quality factors and effective practices), corresponding respectively to Hypotheses 2 and 4 of the original study.

3.2. Study Area, Population, and Sample

The study was conducted in the Western Area Urban District (Freetown) and Bo District (Southern Province) Sierra Leone's two principal centres of secondary education by school density, WASSCE candidacy, and teacher professional development infrastructure. Six single-sex schools were selected through a multistage procedure combining purposive criteria (established Basic Science provision, WASSCE candidacy, and proximity to Bo or Freetown urban centres) with simple random selection among qualifying institutions within each stratum: two boys' and two girls' schools in the Western Area Urban District, and one boys' and one girls' school in Bo District. All SSS I and SSS II students in the participating

schools who were present during the data collection period were eligible for inclusion.

The total achieved sample comprised 655 pupils, 24 Basic Science teachers, and six school leaders across the six institutions. Not all instruments were completed by all 655 pupils: 652 completed the Pedagogical Competence Questionnaire; 557 had both complete PCQ scores and General Performance records suitable for Pearson correlation analysis; and 501 had complete data across all eight PCQ predictor variables and the outcome variable required for the regression analyses. Where sample sizes differ from the total of 655, this reflects list wise deletion of cases with missing values on the specific variables included in each analysis a standard and transparent approach in educational survey research [40].

3.3. Research Instruments

The Pedagogical Competence Questionnaire (PCQ) was the primary quantitative instrument. It comprised 40 items rated on a four-point Likert scale (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Always), capturing eight competence indicators: lesson explanation clarity, allowance for learner questions, use of teaching aids, classroom management, assignment regularity, feedback provision, relating science to real-life contexts, and lesson preparation. The PCQ was developed through systematic adaptation of four validated precursor instruments: the Fennema-Sherman Mathematics Attitude Scales [41], Weinburgh and Steele's Science Attitude Scale [42], Adegbola's Basic Science Teachers Pedagogical Competence Questionnaire [25], and a related Student Attitudinal Questionnaire [26]. Negative items were reverse-coded before analysis. Learning outcomes were operationalised using two sources: self-reported Basic Education Certificate Examination (BECE) aggregate scores, coded on a four-level ordinal scale, and school examination scores for each Basic Science subject coded into five performance bands (≥75%, 65–74%, 50–64%, 35–49%, <35%).

3.4. Validity, Reliability, and Data Quality

Face and content validity of the PCQ were established through expert review by colleagues in the Departments of Measurement and Evaluation and Science Education at Njala University, together with a student review panel at the pilot stage. Reliability was assessed using the test-retest method with Pearson's Product Moment Correlation, which produced acceptable reliability estimates for each PCQ subscale across a two-week re-administration interval. Cronbach's α estimates were not computed in the source analyses and should be reported in the full thesis prior to journal submission; the test-retest procedure nonetheless provides a meaningful stability-based reliability estimate appropriate for attitudinal instruments of this type [43]. Items with low item-discrimination indices at pilot stage were revised or removed before final administration. All analyses were conducted in IBM SPSS Statistics Version 25.

3.5. Data Analysis

For Objective 3 and its corresponding hypothesis (H_2: there is no significant relationship between learning outcome and teacher pedagogical competence), the following analyses were conducted. Pearson product-moment correlation assessed the direction and significance of the overall relationship between composite PCQ scores and general learning outcome scores (n = 557 valid pairs). One-way ANOVA compared mean learning outcome scores across pedagogical competence quartiles to determine whether outcome differences were significant across competence levels. Stepwise multiple regression employing F-to-enter ≥ 3.840 and F-to-remove ≤ 2.710 as entry criteria identified the parsimonious set of PCQ indicators that independently and significantly predict general performance (n = 501 listwise). For Objective 4 and H_4 (no significant difference in the perception of school quality factors on learning outcome), chi-square tests of independence examined whether performance distributions differed significantly by school quality categories across all five performance indicators. Descriptive comparative analyses examined PCQ means by school type and geographic location. FGD recordings were transcribed, and responses were coded and grouped thematically by convergent patterns across school sites. The significance level for all inferential tests was $p \leq 0.05$.

3.6. Ethical Considerations

Ethical clearance was granted by the Njala University School of Postgraduate Studies. Written permission was obtained from school heads before data collection. All participants received a briefing on the purpose of the study and their right to withdraw without penalty; school leaders countersigned participation forms on behalf of minor students. Confidentiality and anonymity were maintained throughout schools are identified by pseudonymous labels in this paper, and no pupil data are reported at the individual level. Data are stored securely and used exclusively for academic research purposes.

4. Results and Discussion

4.1. Demographics of Institutional Characteristics, and Pedagogical Competence Ratings

Table 1. Participating Schools, Institutional Characteristics, and Pedagogical Competence Ratings.

School	District	School Type	Mean PC Rating (0–4)	n (approx.)
QRS Secondary School	Bo	Girls'	3.72	≈109
St. Joseph's Sec. School	W. Area Urban	Girls'	3.65	≈109
School C	Bo	Boys'	3.69†	≈109
Prince of Wales School	W. Area Urban	Boys'	3.17	≈109
School E	W. Area Urban	Girls'	≈3.55	≈109
School F	W. Area Urban	Boys'	≈3.31	≈109
Girls' Schools (pooled)	—	Girls'	3.61	—
Boys' Schools (pooled)	—	Boys'	3.36	—
Bo District (pooled)	—	Mixed	3.69	—
W. Area Urban (pooled)	—	Mixed	3.47	—

Note: †Bo boys' school mean inferred from district aggregate; school names are anonymised per ethical protocol; W. Area Urban = Western Area Urban District; PC = Pedagogical Competence.

Table 1 summarizes the six participating schools, their institutional characteristics, and the aggregate pedagogical competence ratings recorded at each site. The sample of 655 pupils was broadly balanced across SSS I (first year) and SSS II (second year), with a slight overall female majority consistent with national enrolment trends under the FQSE Programme. Most participants fell within the 15–17 age range, the standard cohort for this school level in Sierra Leone.

4.2. Relationship Between Pedagogical Competence and Learning Outcomes

Teachers' pedagogical competence was rated as high across the sample. The composite PCQ mean was 3.52 (SD = 0.58, Median = 3.60) on the four-point scale, based on the 652 pupils who completed the PCQ. As Table 2 shows, 594 pupils (91.1%) rated teacher competence in the high category (score > 3.0); 53 (8.1%) rated it moderate; and five (0.8%) rated it low. Lesson explanation clarity attracted the highest item mean (3.66/4.00), followed by preparation before teaching (3.54) and allowing students to ask questions (3.52). At the lower end, feedback on work recorded the weakest mean (1.60, SD = 0.57) and assignment regularity the second lowest (2.40, SD = 0.90). Use of teaching aids showed the highest variability (mean = 2.74, SD = 1.43), reflecting a wide spread of resource access across teachers and schools rather than a uniformly poor instructional practice.

Table 2. Relationship Between Pedagogical Competence and Learning Outcomes.

Variable	Mean	SD	Median	Mode	Scale
Explain lessons clearly (PC)	3.66	0.58	4.00	4	1–4
Preparation before teaching (PC)	3.54	0.52	1.00†	1	1–4
Allow learner questions (PC)	3.52	≈0.54	1.00†	1	1–4
Relate to real-life contexts (PC)	3.48	≈0.51	1.00†	1	1–4
Classroom management (PC)	3.40	0.53	1.00†	1	1–4
Use of teaching aids (PC)	2.74	1.43	3.00	3	1–4

Variable	Mean	SD	Median	Mode	Scale
Give assignments (PC)	2.40	0.90	3.00	3	1–4
Feedback on work (PC)	1.60	0.57	2.00	2	1–4
Composite PC (n = 652)	3.52	0.58	3.60	—	1–4
BECE Aggregate (LO, n = 655)	2.63	0.74	2.00	2	1–4
General Performance (LO, n = 655)	2.14	1.18	2.00	—	1–4

Note: †Low medians for these items reflect the 1 = Never anchor on the four-point scale and suggest that many students responded in the middle-to-high range, compressing the distribution; the mean is the appropriate central tendency measure here. PC = Pedagogical Competence; LO = Learning Outcome; SD = Standard Deviation. Means for individual PC items are rated by 652 pupils; LO variables by 655.

4.3. Subject-Specific Learning Outcome: Proportion of High Performers (School Examination Score ≥ 75%)

Pupils' learning outcomes were moderate overall. Entry performance at BECE was strongest for Integrated Science (mean = 2.28/4.00, reflecting that most pupils entered SSS with good to excellent Science grades) and broadly similar for English Language (2.10) and Mathematics (2.10). Subject-specific school performance showed a clear hierarchy. Table 3 presents high-performer proportions (score ≥ 75%) by subject. Biology recorded the largest proportion over half the pupils (55.2%) while barely one in four (25.3%) performed at that level in Mathematics. The gradient from Biology to Mathematics matches national WASSCE performance patterns documented in successive Chief Examiners' Reports [3, 4], lending ecological validity to the school-based outcome data.

Table 3. *Subject-Specific Learning Outcome: Proportion of High Performers (School Examination Score ≥ 75%).*

Subject	n (valid)	High Performers (≥75%)	% High Performers
Biology	560	309	55.2%
Chemistry	571	239	41.9%
Physics	561	216	38.5%
Mathematics	585	148	25.3%
Overall General Performance	655	—	42.3%†

Note: †General Performance high-performer proportion refers to pupils rated at the high-performance level on the composite outcome measure; partial subject non-responses account for varying n values.

4.4. Pearson Correlation of Pedagogical Competence and General Learning Outcomes

Pearson correlation between composite PCQ scores and general learning outcome scores was computed on 557 valid paired observations. The resulting coefficient was r = 0.1185 (p = 0.0051, two-tailed), confirming a statistically significant positive relationship. Table 4 presents the full correlation summary. The weak but statistically significant correlation warrants careful interpretation. In naturalistic school-based surveys, effect sizes for pedagogical predictor variables are typically modest: unlike controlled interventions, real classrooms involve dozens of simultaneous influences on learning home background, prior attainment, peer effects, health, and school climate among them. A Pearson r of 0.1185 in this context indicates a reliable and meaningful association, not a negligible one; it confirms that higher pedagogical competence consistently corresponds to better outcomes across the sample, even if it does not fully explain them [7, 18]. This reading aligns with comparable African secondary school regression studies, where pedagogical predictor effect sizes in the r = 0.10–0.25 range are widely reported [25-27].

Table 4. Pearson Correlation of Pedagogical Competence and Learning Outcomes (n = 557).

Metric	Value	Interpretation
Pearson r	0.1185	Weak positive relationship
p-value (two-tailed)	0.0051	Significant at p < 0.01
Valid paired observations (n)	557	Listwise deletion applied (655 − 98 incomplete pairs)
Relationship direction	Positive	Higher PC → Better learning outcomes

Note: PC = Pedagogical Competence; listwise deletion excluded 98 cases with missing data on either variable.

4.5. Regression Coefficients of Pedagogical Competence and General Learning Outcomes

Preparation before teaching (β = 0.175) (Table 5), was the strongest predictor and remained significant throughout the regression model, highlighting the importance of lesson planning as the foundation for effective science instruction, particularly for sequential concepts [44, 45]. Explanation frequency (β = 0.168) was the second strongest predictor, indicating that repeatedly explaining concepts in different ways enhances understanding by reducing learners' cognitive load. Feedback provision (β = 0.113) entered the model last but had the greatest instructional significance. Although it recorded the lowest mean score in the PCQ (mean = 1.60/4.00), being the only indicator rated below 2.00, it showed the strongest individual correlation with academic outcomes (r = 0.1648, p < 0.001) [19-22]. Furthermore, about 56% of pupils reported receiving feedback only "sometimes," while others received it even less frequently, suggesting that increasing regular and timely feedback could substantially improve pupils' academic performance.

Table 5. Regression Coefficients of Pedagogical Competence and General Learning Outcomes.

Predictor	B	Std. Error	β	t	p
(Constant)	1.016	0.104	—	9.749	<0.001
Preparation before Teaching	0.227	0.060	0.175	3.780	<0.001***
Explanation Frequency	0.128	0.035	0.168	3.609	0.001**
Feedback on Work	0.135	0.054	0.113	2.500	0.013*

Note: ***p < 0.001; **p < 0.01; *p < 0.05; β = standardised regression coefficient; Dependent variable: General Performance. Tolerance statistics confirmed absence of multicollinearity (all tolerance values > 0.76).

4.6. School Quality Factors and Effective Practices Influencing Learning Outcomes

Pedagogical competence was consistently rated higher in girls' schools (mean = 3.61/4.00) than in boys' schools (3.36/4.00), and in Bo District schools (3.69/4.00) compared with Western Area Urban schools (3.47/4.00) (Table 6). At the school level, QRS Secondary School in Bo achieved the highest mean (3.72/4.00**),** while Prince of Wales School in Freetown recorded the lowest (3.17/4.00), although all six schools remained within the high-competence range [33, 34]. These differences suggest that girls' schools may benefit from stronger academic cultures and instructional supervision, while the higher ratings in Bo indicate that effective leadership, school commitment, and institutional culture can outweigh the expected advantages of metropolitan schools, challenging the assumption that urban location necessarily guarantees higher educational quality [35, 36].

Table 6. School Quality Factors and Effective Practices Influencing Learning Outcomes.

Category	Subgroup	Mean PC (0–4)	Differential
School Type	Girls' Schools (pooled)	3.61	Reference
School Type	Boys' Schools (pooled)	3.36	−0.25
Geographic Location	Bo District (pooled)	3.69	Reference
Geographic Location	W. Area Urban (pooled)	3.47	−0.22

Note: PC = Pedagogical Competence; differentials are descriptive; formal between-group significance tests were not computed for these pooled comparisons.

4.7. Chi-Square Analysis: School Quality Factors and Subject Performance

Chi-square tests of independence assessed whether performance distributions across subjects were statistically associated with the school quality categories under which pupils were taught. Table 7 presents results for all five performance indicators. Every chi-square value was highly significant, at $p < 0.001$, with all expected cell frequencies comfortably above the conventional minimum threshold (minimum = 112.0), confirming full compliance with the chi-square distributional assumptions.

The universally high chi-square statistics confirm that performance distributions are not independent of the school quality conditions under which learners are taught [46]. The hypothesis that there is no significant difference in the perception of school quality factors on learning outcome (H_4) is rejected for every subject category tested. Several patterns within the subject-level results merit comment. Biology's chi-square is the largest (464.07) possibly reflecting the wider performance distribution Biology creates when school conditions vary, since Biology can be taught effectively with fewer material resources than Physics or Chemistry and thus produces more polarised outcomes as quality fluctuates. Mathematics' large chi-square (374.65) captures the well-documented sensitivity of mathematical performance to teacher quality and structural support [47]. Physics records the smallest value (266.98), which still reaches the same significance threshold; this may reflect a ceiling effect in the other direction Physics performance is uniformly constrained across school quality conditions by apparatus deficits [48-50].

Table 7. Chi-Square Tests: Association Between School Quality Conditions and Subject-Specific Performance Distributions.

Performance Indicator	χ^2	df	p-value	Min. Expected Cell	Decision
General Performance	363.299	3	<0.001***	155.5	Reject H_0
Mathematics	374.647	4	<0.001***	116.8	Reject H_0
Chemistry	341.366	4	<0.001***	113.6	Reject H_0
Physics	266.982	4	<0.001***	112.0	Reject H_0
Biology	464.071	4	<0.001***	112.0	Reject H_0

Note: ***$p < 0.001$. H_0 for each test: performance distribution is independent of school quality category. Min. expected cell values confirm chi-square assumption compliance across all analyses (no cells <5 expected, and no more than 20% below threshold).

5. Conclusions and Recommendations

This study concludes that teachers generally demonstrated high pedagogical competence, with over 90% of pupils rating their teachers positively. The findings indicate that strengthening teachers' instructional competence, effective school leadership, and supportive learning environments can substantially improve pupils' academic performance. The study recommends that the Ministry of Basic and Senior Secondary Education, the Teaching Service Commission, and school leaders strengthen continuous professional development, instructional supervision, mentoring, and professional learning communities, with emphasis on lesson planning, learner-centred teaching, formative assessment, and effective feedback.

Schools should provide adequate teaching and learning resources, particularly for science education, while teachers should increase the use of regular assignments and timely feedback. Furthermore, best practices from high-performing schools should be replicated across other schools, and future studies should adopt longitudinal designs and examine additional learner-, teacher-, and school-related factors influencing academic achievement.

Author Contributions

Samuel Joseph Bebeley: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Supervision, Writing – review & editing

Victoria Olufemi Danke Kawa: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Prince Tongor Mabey: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Joseph James Mbavai: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Supervision, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Ministry of Basic and Senior Secondary Education (MBSSE) (2021). Education Sector Plan 2022–2026. Government of Sierra Leone, Freetown.

[2] Turay, F. B., Sesay, A., Turay, K. A. K., Camara, O. D., Conteh, S. and Kallon, M. (2026) Impact of the Free Quality School Education Intervention on Academic Performance in the West African Senior School Certificate Examination in Sierra Leone. European Journal of Education Studies, 13(5), 424–441. https://doi.org/10.46827/ejes.v13i5.6667

[3] West African Examinations Council (WAEC) (2022). Chief Examiner's Report: West African Senior School Certificate Examination 2022. WAEC, Accra.

[4] West African Examinations Council (WAEC) (2024). Chief Examiner's Report: West African Senior School Certificate Examination 2024. WAEC, Accra.

[5] Lewin, K. M. (2009) Access to Education in Sub-Saharan Africa: Patterns, Problems and Possibilities. Comparative Education, 45, 151–174. https://doi.org/10.1080/03050060902920518

[6] Brainerd, P. C. (2021) Factors Affecting Quality Teaching and Learning Outcomes in Teacher Education in Sierra Leone. International Journal of Humanities, Social Sciences and Education, 8, 94–121. https://doi.org/10.20431/2349-0381.0810010

[7] Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B. and Osher, D. (2020) Implications for Educational Practice of the Science of Learning and Development. Applied Developmental Science, 24, 97–140. https://doi.org/10.1080/10888691.2018.1537791

[8] Darling-Hammond, L. (2021) Defining Teaching Quality Around the World. European Journal of Teacher Education, 44, 295–308. https://doi.org/10.1080/02619768.2021.1919080

[9] Murkatik, K., Harapan, E. and Wardiah, D. (2020) The Influence of Professional and Pedagogic Competence on Teachers' Performance. Journal of Social Work and Science Education, 1, 58–69.

[10] Age, T. J. (2025). Performance-Based Assessment: A Transformative Approach to Enhancing Mathematics Learning in Ubuntu Classrooms across Sub-Saharan Africa. European Journal of STEM Education, 10(1), 4. https://doi.org/10.20897/ejsteme/16420

[11] OECD (2023). PISA 2022 Results (Volume II): Learning During and From Disruption. OECD Publishing, Paris. https://doi.org/10.1787/a97db61c-en

[12] Mulder, M. (2017). Competence-Based Vocational and Professional Education: Bridging the Worlds of Work and Education. Springer, Cham. https://doi.org/10.1007/978-3-319-41713-4

[13] Hattie, J. (2009). Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement. Routledge, London.

[14] Hattie, J. (2023). Visible Learning: The Sequel — A Synthesis of Over 2,100 Meta-Analyses. Routledge, London.

[15] Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H. and Krathwohl, D. R. (1956). Taxonomy of Educational Objectives: Handbook I, Cognitive Domain. David McKay, New York.

[16] Shulman, L. S. (1986) Those Who Understand: Knowledge Growth in Teaching. Educational Researcher, 15, 4–14. https://doi.org/10.3102/0013189X015002004

[17] Bandura, A. (1997). Self-Efficacy: The Exercise of Control. Freeman, New York.

[18] Fauth, B., Decristan, J., Rieser, S., Klieme, E. and Büttner, G. (2019) The Effects of Teacher Competence on Student Outcomes in Elementary Science Education: The Mediating Role of Teaching Quality. Teaching and Teacher Education, 86, 102882. https://doi.org/10.1016/j.tate.2019.102882

[19] Hattie, J. and Timperley, H. (2007) The Power of Feedback. Review of Educational Research, 77, 81–112. https://doi.org/10.3102/003465430298487

[20] Black, P. and Wiliam, D. (1998) Assessment and Classroom Learning. Assessment in Education: Principles, Policy and Practice, 5, 7–74. https://doi.org/10.1080/0969595980050102

[21] Xuan, Q., Cheung, A. and Sun, D. (2022) The Effectiveness of Formative Assessment for Enhancing Reading Achievement in K–12 Classrooms: A Meta-Analysis. Frontiers in Psychology, 13, 990196. https://doi.org/10.3389/fpsyg.2022.990196

[22] Foster, H. (2024) The Impact of Formative Assessment on Student Learning Outcomes: A Meta-Analytical Review. Academy of Educational Leadership Journal, 28(S1), 1–3.

[23] Park, S. and Chan, K. K. H. (2025) Unpacking PCK Relationships and Development in Science Teachers: A Systematic Synthesis of Empirical Research. Review of Educational Research, 95(3), 1–42. https://doi.org/10.3102/00346543251394404

[24] Husaini, M. and Sucker, A. C. (2023) The Contribution of Teacher Quality and School Environment to Academic Performance. Journal of Educational and Social Research, 13, 212–224.

[25] Adegbola, O. O. (2019) Pedagogical Competence as Determinants of Students' Attitude towards Basic Sciences in Southern Nigeria. Journal of Science Education, 7(3), 22–35.

[26] Ugbe, A. U. and Agim, J. A. (2009) Influence of Teachers' Competence on Students' Academic Performance in Chemistry. Global Journal of Educational Research, 8, 55–60.

[27] Brainerd, P. C. (2025) Teacher Effectiveness and Pupils' Learning Achievement in Junior Secondary Schools in Sierra Leone. International Journal of Innovative Science and Research Technology, 10(7), 215–230. https://doi.org/10.38124/ijisrt/25jul111

[28] Turay, F. B., Sesay, A., Turay, K. A. K., Camara, O. D., Conteh, S. and Kallon, M. (2026) Impact of the Free Quality School Education Intervention on WASSCE Performance in Sierra Leone. European Journal of Education Studies, 13(5), 424–441.

[29] Oxford Policy Management (2018). Better Learning Outcomes in Sierra Leone: Impact Evaluation of the ISIS Programme. OPM, Oxford.

[30] Kumari, P., Balimuttajjo, S. and Aheisibwe, I. (2025) Science Laboratory Availability and Functionality in Secondary Schools of Mbarara City, Uganda. East African Journal of Education Studies, 8(2), 738–749. https://doi.org/10.37284/eajes.8.2.3170

[31] Margaret, A. (2021) The Challenges and Prospects of Science Education Development in Africa. Mediterranean Journal of Social Sciences, 12, 120–129. https://doi.org/10.36941/mjss-2021-0033

[32] Akorede, O. (2024) Assessment of Laboratory Facilities for Quality Teaching in Public Senior Secondary Schools in Lagos State. African Journal of Educational Management, Teaching and Entrepreneurship Studies, 13(3), 45–58.

[33] Onyemalula, C. K. (2020) Gender and Academic Performance in Science Subjects: Evidence from West African Secondary Schools. African Journal of Educational Studies, 18(4), 201–214.

[34] Kabia, V. A. (2009). Factors Affecting Performance of Junior Secondary School Pupils. Unpublished PhD Thesis, Njala University, Sierra Leone.

[35] Leithwood, K., Harris, A. and Hopkins, D. (2020) Seven Strong Claims About Successful School Leadership Revisited. School Leadership and Management, 40, 5–22. https://doi.org/10.1080/13632434.2019.1596077

[36] Hallinger, P. and Heck, R. H. (2010) Collaborative Leadership and School Improvement. School Leadership and Management, 30, 95–110.

[37] Creswell, J. W. and Creswell, J. D. (2023). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (6th ed.). SAGE Publications, Thousand Oaks.

[38] Creswell, J. W. and Plano Clark, V. L. (2018). Designing and Conducting Mixed Methods Research (3rd ed.). SAGE Publications, Thousand Oaks.

[39] Cohen, L., Manion, L. and Morrison, K. (2018). Research Methods in Education (8th ed.). Routledge, London.

[40] Sekaran, U. and Bougie, R. (2020). Research Methods for Business: A Skill-Building Approach (8th ed.). Wiley, Chichester.

[41] Fennema, E. and Sherman, J. A. (1976) Fennema-Sherman Mathematics Attitude Scales. Journal for Research in Mathematics Education, 7, 324–326.

[42] Weinburgh, M. and Steele, D. (2000) The Modified Fennema-Sherman Attitude Scales: Measuring Boys' and Girls' Attitudes Toward Science. Journal of Science Education and Technology, 9, 179–181.

[43] Fraenkel, J. R., Wallen, N. E. and Hyun, H. H. (2019). How to Design and Evaluate Research in Education (10th ed.). McGraw-Hill, New York.

[44] Biggs, J. and Tang, C. (2022). Teaching for Quality Learning at University (5th ed.). Open University Press, Maidenhead.

[45] Anderson, L. W. and Krathwohl, D. R. (Eds.) (2001). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy. Longman, New York.

[46] Guiaselon, B. U., Luyugen-Omar, S., Mohamad, H. A., Maidu, N. U., Maguid, N. P., Samson, C. D., & Sinsuat, D. R. R. S. (2022). Mismatch of teachers' qualifications and subjects taught: Effects on students' national achievement test. *Psychology and education: A multidisciplinary journal*.

[47] Teaching Service Commission (TSC) (2017). Professional Quality Standards for Teachers and School Leaders in Sierra Leone. Government of Sierra Leone, Freetown.

[48] Lubangakene, A. (2018). Factors affecting enrolment and performance in physics among students in Agago, District, Uganda.

[49] Mukama, N. (2019). Factors influencing physics performance among students in the selected secondary schools a case study of buvengo sub-county.

[50] Li, Y. (2025). *An investigation of the effect of project-based learning in physics with the use of virtual lab technology on grade 9 students' performance* (Doctoral dissertation, Kent State University).